Development and validation of smartphone nutrition application for supporting dietetic professional practice

Mr. Thanasak Tantichaiyakul

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Food and Nutrition
Department of Nutrition and Dietetics
FACULTY OF ALLIED HEALTH SCIENCES
Chulalongkorn University
Academic Year 2022

การพัฒนาและทดสอบการใช้งานแอพพลิเคชั่นทางโภชนาการสำหรับการส่งเสริมการปฏิบัติการกำหนดอาหารวิชาชีพ

นายธนะศักดิ์ ตันติชัยยกุล

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาอาหารและโภชนาการ ภาควิชาโภชนาการและการกำหนดอาหาร
คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2565
ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

Thesis Title	Development and validation of smartphone nutrition application for supporting dietetic professional practice
By	Mr. Thanasak Tantichaiyakul
Field of Study	Food and Nutrition
Thesis Advisor	Assistant Professor TIPAYANATE ARIYAPITIPUN, Ph.D.
Thesis Co Advisor	Assistant Professor Pakpum Somboon, Ph.D.

Accepted by the FACULTY OF ALLIED HEALTH SCIENCES, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Science

.... Dean of the FACULTY OF ALLIED HEALTH SCIENCES

(Associate Professor PALANEE AMMARANOND, Ph.D.)

THESIS COMMITTEE

.... Chairman

(Associate Professor SUWIMOL SAPWAROBOL, DrPH.)

.... Thesis Advisor

(Assistant Professor TIPAYANATE ARIYAPITIPUN, Ph.D.)

.... Thesis Co-Advisor

(Assistant Professor Pakpum Somboon, Ph.D.)

.... External Examiner

(Associate Professor Prapaisri Sirichakwal, Ph.D.)

ธนะศักดิ์ ตันติชัยยกุล : การพัฒนาและทดสอบการใช้งานแอพพลิเคชั่นทางโภชนาการ สำหรับการส่งเสริมการปฏิบัติการกำหนดอาหารวิชาชีพ. (Development and validation of smartphone nutrition application for supporting dietetic professional practice) อ.ที่ปรึกษาหลัก : ผศ. ดร.ทิพยเนตร อริยปิติพันธ์, อ.ที่ปรึกษา ร่วม : ผศ. ดร.ภาคภูมิ สมบูรณ์

     ความก้าวหน้าทางเทคโนโลยีในปัจจุบันเปิดโอกาสให้เกิดการพัฒนาแอปพลิเคชันเพื่อ สนับสนุนกระบวนการให้โภชนบำบัด การศึกษานี้มีวัตถุประสงค์เพื่อพัฒนาและทดสอบการใช้งาน ของแอปพลิเคชันทางโภชนาการบนอุปกรณ์เคลื่อนที่และประเมินความพึงพอใจของนักกำหนด อาหารต่อการใช้งานแอปพลิเคชันที่พัฒนาขึ้น ทำการศึกษาในอาสาสมัครซึ่งเป็นนักกำหนดอาหาร วิชาชีพ จำนวน 70 คน ผู้เข้าร่วมการวิจัยประเมินรูปถ่ายอาหาร 2 ชุด ชุดแรกจัดเตรียมอาหาร อ้างอิงตามรายการอาหารแลกเปลี่ยนไทยและชุดที่สองอ้างอิงอาหารแลกเปลี่ยนตามข้อปฏิบัติการ กินอาหารเพื่อสุขภาพที่ดีของคนไทย 3 วันต่อเนื่องกัน จากนั้นประมวลผลด้วยเครื่องคิดเลขและ ตามด้วยแอปพลิเคชันที่พัฒนาขึ้น ผลการศึกษา พบว่า อาสาสมัครพึงพอใจแอปพลิเคชันมาก คะแนนรวมเฉลี่ย 4.43 ± 0.67 และมีความรู้สึกในทิศทางบวก แอปพลิเคชันที่พัฒนาขึ้นช่วยลด เวลาในการประมวลผลลงอย่างมีนัยสำคัญทางสถิติ ($p < 0.01$) นอกจากนี้ สามารถวิเคราะห์ ผลลัพธ์ได้อย่างถูกต้องตามประเภทฐานข้อมูล มีประสิทธิภาพทั้งในแง่ของความถูกต้องและความ เสถียร ผลลัพธ์จากการคำนวณค่าพลังงานและแมคโครนิวเตรียนส์จากฐานข้อมูลของแอปพลิเคชัน ที่อ้างอิงรายการอาหารแลกเปลี่ยนไทยเปรียบเทียบกับค่าที่ใช้ในปัจจุบันมีความแตกต่างอย่างมี นัยสำคัญทางสถิติ ($p < 0.05$) โดยค่าไขมันแตกต่าง < 5% พลังงานและคาร์โบไฮเดรต อยู่ในช่วง 7 - 8% สำหรับฐานข้อมูลของแอปพลิเคชันที่อ้างอิงข้อปฏิบัติการกินอาหารเพื่อสุขภาพที่ดีของคน ไทยยังต้องปรับปรุงฐานข้อมูลอาหารในบางหมวดให้คำนวณผลลัพธ์ใกล้เคียงกับค่าที่ควรจะเป็น มากขึ้น

สาขาวิชา	อาหารและโภชนาการ	ลายมือชื่อนิสิต	....
ปีการศึกษา	2565	ลายมือชื่อ อ.ที่ปรึกษาหลัก	....
		ลายมือชื่อ อ.ที่ปรึกษาร่วม	....

6076851037 : MAJOR FOOD AND NUTRITION

KEYWORD: Mobile Application, Nutrition and Dietetics, Nutrition Care Process, Thai Food Exchange List, Nutrition Flag

Thanasak Tantichaiyakul : Development and validation of smartphone nutrition application for supporting dietetic professional practice. Advisor: Asst. Prof. TIPAYANATE ARIYAPITIPUN, Ph.D. Co-advisor: Asst. Prof. Pakpum Somboon, Ph.D.

Advancements in technology have allowed for the development of applications for supporting the nutrition care process. The objectives of this study were to develop and validate a nutrition application incorporating the food and nutrtion databases, and to assess the satisfaction of dietitians toward the developed application. Seventy registered dietitians were recruited to evaluate two sets of the food photographs prepared based on Thai food exchange list (Thai FEL) and Thai food based dietary guideline (Thai FBDG) for three consecutive days. The participants estimated and calculated manually using calculators, following by using the application. The participants' satisfaction indicated acceptance (overall score = 4.43 ± 0.67) and positive impressions toward the application. Both food exchange lists based NDPro applcations resulted in a significant reduction in time usage ($p < 0.01$). Furthermore, the application could analyze the data accurately indicating its performance as acceptable in terms of reliability and stability. Additionally, the results of energy and macronutrient contents from the Thai FEL based application also significantly differed from those calculated manually ($p < 0.05$) with 5% difference in fat and 7 - 8% difference in carbohydrate and energy. However, for the Thai FBDG based application, it was required to modify the representative values of some food groups for improving reliability.

Field of Study:	Food and Nutrition	Student's Signature ....
Academic Year:	2022	Advisor's Signature ....
		Co-advisor's Signature ....

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

1.1. Background and rationale

Nutrition counseling is the key role of professional dietitians. Dietary assessment is a valuable part of nutrition assessment which is the first step in formulating a nutrition care plan in the nutrition care process model [1]. If there is a tool able to support the dietetic professional practice by shortening or improving the dietary assessment process as well as providing more rapid, accurate, and informative dietary and nutrition data, both dietitians and patients will have more time spending on dietary plans and discussion during nutrition counseling.

Dietary recalls, food diaries, and food frequency questionnaires are the common methods used to collect the dietary information from patients and their caregivers. The 24-hour diet recall is a technique widely used among Thai dietitians to estimate amounts of all foods, beverages, and dietary supplements consumed during the last 24 hours [2]. The previous studies indicated that the errors of estimation from the memory-based dietary assessment is inevitable [3, 4]. Accordingly, the serving size and portion-size measurement aids (PSMAs) have been introduced and generally used to reduce the estimated error [5, 6]. PSMAs used during dietary recall to help respondents to recall their intake include two-dimensional (2D) PSMAs and three-dimensional (3D) PSMAs. The 2D-PSMAs such as food photographs seem to be better than the 3D-PSMAs such as food model. They have been proved to produce similar effectiveness but cheaper and easier storage than those 3-D PSMAs [7, 8]. In practice, however, error of estimation is the major limitation, especially among elderly [9].

In Thailand, Thai food exchange list, serving sizes, and portion sizes have been set up and normally used among Thai dietitians and nutritionist as tools for estimating the amounts of food intake and roughly calculating energy intake [10, 11]. The food exchange list refers to the food allocation based on their calories and macronutrient profiles per serving size [12]. Besides the measuring units, such as a

cup, a tablespoon, and a teaspoon used as serving sizes in Thai food exchange list [10], commonly used household utensils are also used in Thai Nutrition Flag [11]. Hence, it does not only help respondents to recall their food intake but dietitians can also estimate energy and nutrient intake roughly from the number of serving size reported. Even though using the food exchange list is easy, convenient, and rapid, it remains being complex in serving sizes of individual food items in the same list, as well as amounts of macronutrients and energy of each sub-food exchange list. In some cases, the errors of estimations and selected foods items may occur as a result of overlooking each food items in detail. At present, right after dietary assessment, prompt calculation for macronutrients and energy from food intake or nutrient and energy requirements for individuals could not achieve in the daily routine work.

In this era, later technological advances allowed not only application software but also dietary and nutrition databases to be installed through smartphone devices [13]. Many Thai and international dietary applications on mobile phones have been developed, mostly for the public [14]. Only a few of applications are responsible for the professional dietitians' need. Based on the international survey from dietitians from United Kingdom, Australia, and New Zealand in 2017, it indicated that dietetic professionals required smartphone health applications in the future to be credible apps, easy to use, dietitian-oriented support, patient-oriented support, and dietitians sharing support [15]. The mobile health (mHealth) app for dietitians launched in 2019 was agreed by majority of dietitians in this study that the application could helped them to improve the amount of time they spent on dietary assessment. Overall, both dietitians and their patients in this study indicated that they would continue using the application and recommend it to others [16]. However, numbers available applications supporting Thai language and Thai food databases remain being limited and only a few has been validated [15]. Additionally, some Thai dietary or nutrition applications could neither provide the information of all food items nor represent actual composition of foods as they use one-meal nutrient value from databases [17, 18] Likewise, no Thai application has been developed using data from the Thai food exchange list routinely used among dietitians and nutritionists. Generally speaking, foods consumed by the individuals in

Thailand combine both fresh cooked foods without nutrition label and commercial food products providing nutrition information. Integrating all food items available in both the Thai food exchange list [10] and the Thai nutrition flag based - food exchange [11], some selected food products, commonly consumed one-meal Thai dishes, and PSMAs to create Thai food exchange databases for the smartphone application may be able to answer these questions.

1.2. Objectives of the study

Primary objective

To develop the mobile nutrition application lunching in android platform and used though both smartphone and tablet for supporting dietetic professional practice to estimate nutrition requirement and perform dietary assessment providing dietary information and adjustable serving sizes from Thai food exchange list and Thai food based dietary guideline. The developed application can provide results accurately in terms of reliability and stability.

Secondary objective

To evaluate satisfaction of dietitians on the developed smartphone nutrition application.

1.3. Research questions

Primary question

Does the developed smartphone nutrition application function properly and analyze the results of energy and macronutrient intakes accurately in term of reliability and stability when compared with the reference value calculated based on the databases from Thai food exchange list, Thai food based dietary guideline and INMUCAL program?

Secondary question

Do dietitians satisfy the developed smartphone nutrition application?
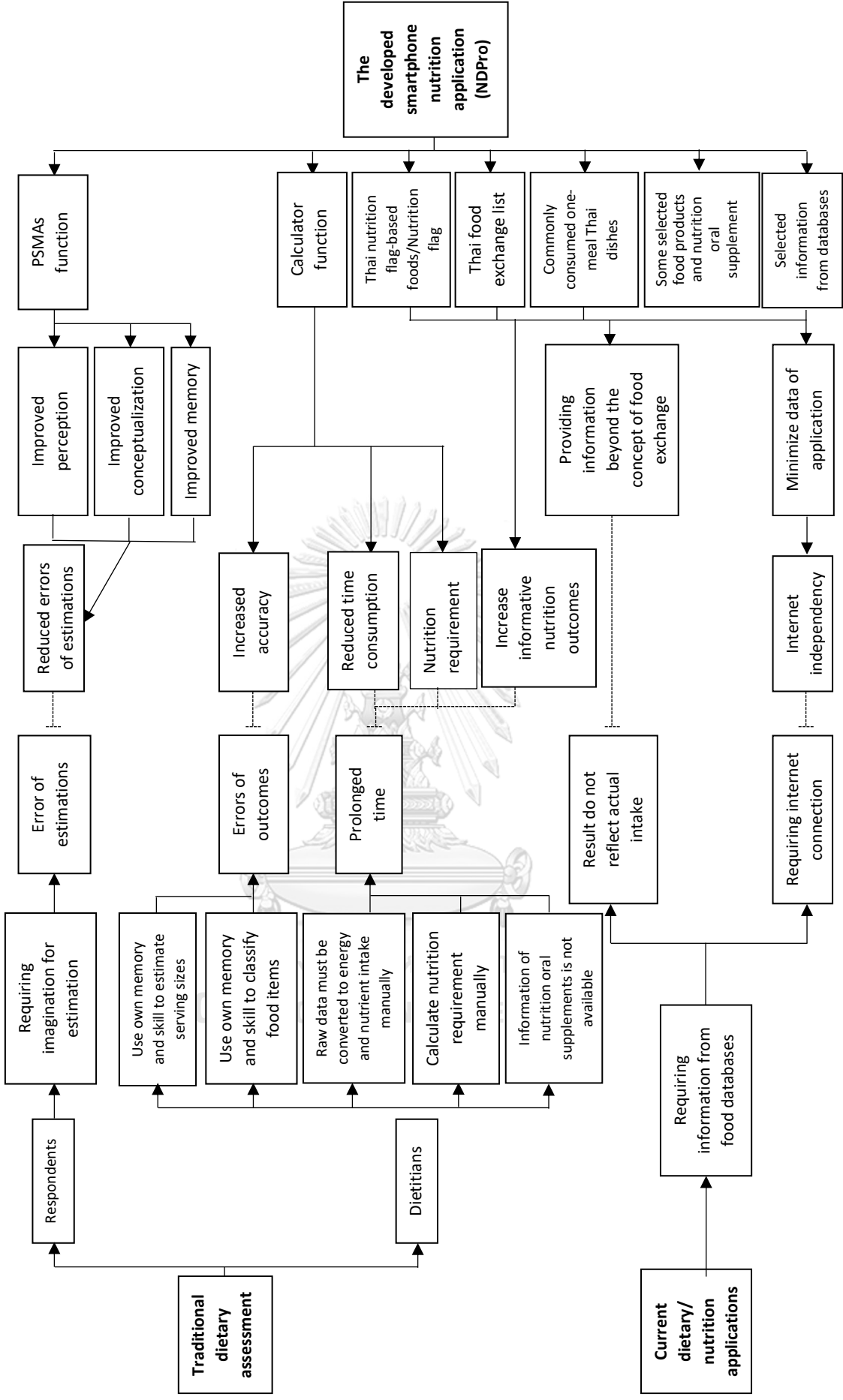
Figure 1 A conceptual framework of the research

1.4. Hypothesis

Primary hypothesis

The developed smartphone nutrition application may function properly and analyze the results of energy and macronutrient intakes accurately in term of reliability and stability when compared with the reference values calculated based on the databases from Thai food exchange list, Thai food based dietary guideline and INMUCAL program.

Secondary hypothesis

Dietitians satisfy the developed smartphone nutrition application.

จุฬาลงกรณ์มหาวิทยาลัย

CHULALONGKORN UNIVERSITY

Chapter 2

LITERATURE REVIEW

2.1 Nutrition care process

In order to achieve a successful intervention of registered dietitians-nutritionists (RDN), the nutrition care process is the systematic problem-solving method designed by Academy of Nutrition and Dietetics to obtain data required for dietary evaluation of nutritional status [1]. It composes of four steps including nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation. These steps have been suggested as the continuous approaches, but the process might not be linear [19].

Nutrition assessment is the first stage of collecting necessary information inquired to determine the nutritional problems. Then, dietary assessment would be interpreted in the next step of nutrition diagnosis. Typically, there are three problematic terms for nutrition diagnosis including intake, clinical, and behavioral-environmental aspect. Whichever aspects, nutrition-related problems result from imbalance between nutrition intake and requirement either from energy or nutrients. Therefore, identifying the etiology will lead to the proper nutrition intervention to resolve the root causes of problems. Nutrition diagnostic statement becomes important. It has been recommended to be concise, clear, and specify to problems and etiology based on signs and symptoms of patients. Accordingly, the PES statement which refers to the problem, etiology, signs and symptoms have been recommended as the standard format of nutrition diagnosis. Documentation of patient's status or problems should be followed by the word of "related to" to represent etiology and "as evidenced by" supported with signs, symptoms, and evidence-based dietary intake dietary intake as well, respectively [1]. Therefore, the informative data from dietary assessment come to play an important role for precise

nutrition diagnosis leading to the effective nutrition Intervention, and nutrition monitoring and evaluation as well.

Next, nutrition Intervention is the action phase after identifying problems. Interventional goals are planned and then carried out during this phase. Lastly, the step of nutrition monitoring and evaluation measure the improvement of the intervention. If the patient has no improvement or unexpected results occur, interventions should be revised and monitored [1].

2.2 Dietary assessment

Dietary assessment is a part of nutrition assessment which is the first step in nutrition care process. This step uses a combination of parameters to interpret the overall nutrition status. Several aspects of information are including anthropometrics, biochemical tests, clinical observations, as well as the information about dietary intake would be collected during this phase. In order to describe habitual dietary pattern, many methods including food record, food frequency questionnaire, and 24-hour recall are commonly used. Each method has its pros and cons, so it is important to choose suitable method with the type of information [5].

2.2.1   Food frequency questionnaire

Food-frequency questionnaire is the method designed for self-completion. It provides a list of foods with options for respondents to report how often they consumed each food. The number of the food list is not constant, but it varies based on the propose of the questionnaire. This method can potentially collect long-term dietary intake data from large numbers of respondents, but it is not appropriate to assess specific diet individually in clinic practice [5].

2.2.2   Food record and 24-hour dietary recall

Conversely, food record and 24-hour recall are more suitable than food-frequency questionnaire. The patients are generally asked by a trained

interviewer though interview to report all foods and beverages consumed during the past 24 hours. Besides, food record refers to the method that estimates food intake from recording either by respondents themselves or observer. Moreover, cooking methods, recipe ingredients, and description about locations, times, and feelings are also recorded as possible. Although food record by weighing food intake is the most accurate description of actual food intake, weighing all food is time-consuming and it seems to be burdensome to respondents. Therefore, performing food record or 24-hour recall generally ask respondents to estimate their food intake. However, they cannot provide accurate results as they rely on the memory and awareness of respondents.

In the study investigating the prevalence of misreporting from 37 studies using 24-hour recall and/or estimated or weighed food records reported the result of underreporting ranged from 21.5% to 67% (mean 31%) and overreporting ranged from 1% to 6% from studies using 24-hour recall in both sexes. Meanwhile, the percentage of underreporting in studies using estimated food record ranged from 11.9% to 44% (median 30%) in both sexes [4]. In some population such as elderly, underreporting in the following day could be reported only within 25% to 50% when compared with the reporting food intake on the day they consume [9]. Several aids such as multiple-pass dietary interviews and portion-size estimation aids (PSMAs) such as food models could be used to assist the estimation of portion sizes of foods consumed [2, 4].

2.2.3   Portion-size estimation aids (PSMAs)

Both serving size and portion size also important for estimating amounts of foods consumed. Serving size refers to the standard amount of food suggested to consume all in one time and displayed in the nutrition fact. Portion size refers to the amount of whole food consumed in daily life.

It means that some meals may have one portion size that enough to be consumed by two or more people but such portion size may contain multiple serving size [20]. Portion size is generally required in order to allow respondents and dietitians to describe and understand amounts of food intake [2]. Portion size is developed from a unit of measurement which consumers could easily multiply or divide to represent their actual eaten amount. In Thailand, house hold utensils such as spoon, tea spoon, and rice spoon are more familiar among Thai than international units such as cup- and once- equivalents [12]. Therefore, the specific portion size and values for Thais were developed and recommended. Two widely used portion size and values in Thai have been developed and recommended by Thai food exchange list (Table 6) and Thai food based dietary guideline (Table 7) [11, 12, 21].

In order to facilitate precise recording, quantitative amounts consumed can be described by some aids. Portion-size estimation aids or PSMAs refer to any aids which help respondents to describe and translate their dietary intake. In theory, respondents require ability of perception, conceptualization, and memory for estimation. Perception is the ability to relate the actual foods to PSMAs. While conceptualization is the ability to develop a mental picture of a food portion size without presence of PSMAs. Finally, memory is the ability to accurately recall the amount of food across the days. Overall, PSMAs could minimize estimated error by improving perception, conceptualization, and memory. Subsequently, there were recommendations to include PSMAs in dietary assessment for precise recording [22, 23].

Portion-size estimation aids could be classified into two types including two-dimensional PSMAs (2D PSMAs) and three-dimensional PSMAs (3D PSMAs). At present, both 2D PSMAs, such as food photography, and 3D PSMAs, such as food model and house-hold utensils, are widely used.

However, previous studies comparing these two types of aids reported no significant difference between effectiveness of 2D PSMAs and 3D PSMAs [7, 8, 23].

Later, some picture books have been developed such as EPIC-Soft picture book and food portion photograph books (FPPB) for adults and children. They have been proved to be useful to facilitate food estimation [24, 25]. Recently, developing food photographs as PSAMs stepped into the digital food photographs. For example, the Hellenic health foundation (HHF) is a web-based, automated, interviewer-administered application recently provide digital pictures to estimate portion size. The errors reported from using digital photographs were generally small, which indicated that digital food photographs were suitable [26]. As mentioned, digital food photographs provide high effectiveness similar to traditional food photographs. Moreover, the food photographs could be stored as much as possible through portable devices. Hence, technological innovation now rises the possibility to further improve the quality of PSMAs.

2.3 Food compositions

2.3.1 Carbohydrate

Carbohydrate is the organic compound made of the bonds between carbon, hydrogen, and oxygen. Specific carbohydrate results from a specified pattern of these bonds, as well as the numbers of these chemicals in their structures. Monomer is the smallest unit of carbohydrate. All of monomers have the same chemical formula ($C_6H_{12}O_6$), but their arrangements differ. In more complex structures, disaccharides consist of two single monosaccharides bound together. Finally, polysaccharides are the chains of monosaccharides including starches, glycogen, and dietary fibers [27].

Common monosaccharides found in the foods include glucose, fructose, and galactose. Glucose is often referred as blood sugar, or the

available form of sugar. It can yield energy to provide normal physiology. Fructose is the sugar found naturally in fruits and honey. They can be absorbed independently without the effect of insulin and converted into glucose in the liver. Galactose is not commonly found in the foods, but it can be found as lactose in milk. Similar to fructose, galactose is converted to glucose in the liver [28].

There are three types of disaccharides commonly found in foods including sucrose, fructose, and maltose. Firstly, sucrose is the disaccharide composed of glucose and fructose. It is often known as table sugar. Maltose, the disaccharide made of two units of glucose, is commonly found in plant starches. It is also found in beer and other malt beverages. Lastly, lactose is another disaccharide composed of glucose and galactose. The primary sources of lactose include milk and dairy products [28].

Starches and glycogen are digestible polysaccharides. They are needed to be digested before absorbed and metabolized. This digestion occurs along the gastric passage, except at the stomach, by enzyme alpha-amylase secreted by the salivary glands, following by pancreatic amylase in the intestine. At intestine, they are completely digested into monosaccharides and absorbed through brush-border membranes of the enterocytes. Besides digestible carbohydrates, dietary fibers are the undigestible carbohydrates commonly found in whole grain, legumes, fruits, and vegetables. They can not be completely or partially digested or absorbed in the gastrointestinal tract. Furthermore, they are also presented as commercial fiber supplements [28].

These polysaccharides do not only differ in term of digestibility and availability, they also act different physiological roles within the body. Digestible starches can be absorbed into the bloodstream to supply energy need and maintain other metabolic functions [27]. On the other hand, dietary

fibers are less likely to be digested and absorbed. However, they have been reported useful effects on gastrointestinal tract. Dietary fibers are able to thicken bulk in the intestine, which facilitate the movement of gastrointestinal tract. Dietary fibers are classified into two categories based on their solubility in fluids including soluble fibers and insoluble fibers. Soluble fibers, such as pectin, mucilage, psyllium seed husk, guar gum, have water holding capacity. Therefore, they can absorb water to thicken and soften feces in the intestine. Soluble fibers have been reported their preventive effects on cancer, cardiovascular disease, and type 2 diabetes. Unlike soluble fibers, insoluble fibers for example celluloses and some hemicelluloses do not dissolve in fluids. They can stimulate intestinal movement and water secretion which further soften feces [29].

At present, alternative sweeteners are more frequently used to control calorie and sugar intake. They are not considered as carbohydrate or sugar; however, they can provide the sweetness and be used to replace the usage of sugar. Products containing these sweeteners may be labelled as 'sugar free" but this label does not mean "calorie free". Some alternative sweeteners are nutritive sweeteners because they can yield 2 to 3 kcal per gram. In fact, when sugar is removed, fats are always added to improve the tasted and texture of the products. Therefore, it is important for dietitians to aware and account these products into 24-hr recall in order to assess entire calorie intake. Sorbitol, mannitol, and xylitol are the most commonly used for this purpose. Alternatively, some of sugar alcohols are non-nutritive as they do not yield energy or nutrients [30].

Carbohydrate is considered as primary source of energy. Therefore, it has been recommended approximately half of daily energy requirements. Approximately, one gram of carbohydrate yields four kcal of energy. In the other hand, dietary fibers yield less energy estimated approximately 1.5 to 2.5

kilocalorie per gram (kcal/g). However, regular fiber intake has been recommended because of their protective effects against many diseases. The 2015 US dietary guidelines recommended carbohydrate intake based on 2,000 kilocalorie intake. They recommended approximately six ounce-equivalents per day from grains, along with 2.5 cup-equivalents per day from vegetables. Meanwhile, added sugars has been recommended to limit within 5 to 10% of calories per day [31]. Thai food based dietary guidelines recommended cereal ten rice serving spoons per day, vegetable five rice serving spoons per day, and added sugars has been recommended six tea spoons based on 2,000 kilocalorie intake to cover DRI for Thais [11, 12, 21, 32].

2.3.2   Protein

Protein is a compound containing carbon, hydrogen, and oxygen. Unlike other nutrients, protein has been considered as nitrogen source from foods. Protein is made up of twenty different amino acids presented in nature. The sequences in different amino acids result in different types of proteins. Thousand types of proteins present throughout human body exert many physiological roles, such as enzymes, hormones, and cytokines. Plasma protein has the role involved stabilizing appropriate blood viscosity and osmolality. Another role of plasma protein includes transporting a variety of compounds throughout the bloodstream. Furthermore, protein is also used as energy source by converting amino acids into glucose by the process called gluconeogenesis during fasting. However, this process is uncommon to conserve protein for the numerous physiological functions. Long period of fasting result in muscle lost, and subsequently reductions in muscle strength [27].

Protein must be consumed daily to supply amino acids for physiological function. Some amino acids could be synthesized by human

body. These amino acids are called nonessential amino acids. Conversely, amino acids that the human body cannot synthesize or cannot synthesize enough to meet its need are called essential amino acids. There are two types of dietary proteins; complete proteins and incomplete proteins. Complete proteins refer to proteins containing all essential amino acids. Animal-derived foods, including meat, poultry fish, eggs, and most dairy products are an example of complete proteins. On the other hand, incomplete proteins lack one or more of essential amino acids. In other words, this type of proteins cannot supply all amino acid requirement. Most of plant foods, except for soybean, are the sources of incomplete proteins in diet. Besides soybeans, other plant proteins should be consumed along with a variety of other sources of incomplete proteins to cover essential amino acid requirement. Nevertheless, consuming plant proteins may provide another advantage since they contain less fat which seems to be useful for preventing chronic diseases [19].

Approximately one gram of protein yields 4 kcal of energy. Recommended Dietary Allowances of protein intake for Thai population was 1.0 gram per kg body weight per day (g/kg BW/day) based on nitrogen balance data [33]. The 2015 US dietary guidelines recommended approximately five and a half ounce-equivalents per day from protein foods and three cup-equivalents per day from dairy products based on 2,000 kilocalorie intake [31]. Thai food based dietary guidelines recommended protein intake nine table spoons per day from meat and one glass of milk per day 2,000 kilocalorie intake to cover DRI for Thai [11, 12, 21, 32] (Table 1).

Table 1 Dietary Reference Intake (DRI) for Thais: Energy and protein [32]

Life stage groups	Weight (kg)	Height (cm)	Energy (kcal/d)	Protein (g/d)
Children (male)				
1-3 years	13.1	90.8	1,050	16
4-5 years	18.3	109.5	1,290	19
6-8 years	23.0	122.3	1,440	24
Children (female)				
1-3 years	12.5	89.6	980	15
4-5 years	18.1	108.9	1,200	19
6-8 years	22.5	121.0	1,320	24
Adolescences (male)				
9-12 years	35.6	142.2	1,800	39
13-15 years	51.5	164.3	2,200	55
16-18 years	58.3	171.2	2,370	61
Adolescences (female)				
9-12 years	36.5	143.9	1,650	40
13-15 years	47.7	157.1	1,860	51
16-18 years	48.9	158.8	1,890	51
Adults (male)				
19-30 years	61.3	170.8	2,260	61
31-50 years	60.1	169.2	2,190	60
51-60 years	59.5	167.8	2,180	60
61-70 years	58.7	165.1	1,790	59
≥71 years	56.2	163.6	1,740	56
Adults (female)				
19-30 years	53.0	158.9	1,780	53
31-50 years	52.2	157.6	1,780	52
51-60 years	51.9	156.5	1,770	52
61-70 years	49.9	153.5	1,560	50
≥71 years	48.5	152.0	1,540	49

Life stage groups	Weight (kg)	Height (cm)	Energy (kcal/d)	Protein (g/d)
Pregnant women				
First trimester			+ 50-100	+ 1
Second trimester			+ 250-300	+ 10
Third trimester			+ 450-500	+ 31
Lactating women				
0-5 months			+ 500	+ 19
6-11 months			+ 300	+ 13

Daily protein requirement has to consider other factors including age, gender, physiologic state, and sources of protein [2]. In women with pregnancy, additional twenty-five gram per day protein from RDA has been estimated during last two trimesters. In the same way, similarly additional protein requirement (approximately twenty-five gram per day) were recommended among women during lactation based on the protein content of human milk [28]. Besides, athletes are prescribed for higher protein requirement as 1.2 to 1.7 g/kg BW/day to support protein balance after exercise [34]. Some physiological conditions have specific protein requirement. For instance, adults with chronic kidney disease have been prescribed for low protein diet (0.6 to 0.8 g/kg BW/day) to slow the progress of kidney disease [28, 35]. Conversely, high protein diet has been prescribed for patients with maintenance dialysis therapy approximately 1.2 to 1.5 g/kg BW/day [28, 36] as well as for patients with critical care in the range of 1.2 to 1.5 g/kg BW/day [37].

2.3.3   Fat

Like carbohydrates, fat is the organic compound containing carbon, hydrogen, and oxygen. However, it can yield more energy because it contains more proportion of carbon and hydrogen. Approximately, one gram of dietary fat yields nine kilocalorie of energy. Although dietary fat has the roles which

involve maintaining the physiological functions, such as organs protection, temperature regulation, and insulation. Additionally, fat is also used as energy source. Although human body has limitation of storing carbohydrates within the body, it can store fat unlimitedly. Naturally, body fat is conserved as energy source during fasting.

Lipids can be divided into three classifications including triglycerides, phospholipids and cholesterol. Triglycerides are the richest lipids found in the foods. They present either in the form of fats (solid) or oils (liquids). Triglyceride results from one molecule of glycerol bounded with three fatty acids. There are many types of fatty acids based on the presence of double bond including saturated fatty acids, monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids (PUFAs), and trans-fatty acids.

Firstly, saturated fatty acids refer to those containing no double bond in their chains. Conversely, Monounsaturated fatty acids contain the double bond at one site of their chain while PUFAs refer to those containing two or more double bonds in their chains. The major sources of saturated fatty acids come from animal fats and meats while vegetable fat and oil contains large proportions of MUFAs and PUFAs [19]. Each type of fatty acids appears to exert different physiological effects. Saturated fatty acids appear to associate directly with increasing in the level of LDL cholesterol [38]. However, replacing saturated fatty acids with MUFAs and PUFAs appears to reduce the risk of cardiovascular diseases [39]. Some of polyunsaturated fatty acids, linoleic acid and alpha-linolenic, are considered as the essential fatty acids. They cannot be synthesized in the body and must be consumed from diet. polyunsaturated fatty acids are required for growth and maintaining body metabolism and organ functions. Lastly, trans-fatty acids are another type of fatty acids containing trans-configuration within their structures. Although trans-fatty acids can be found only few in nature because most

fatty acids naturally contain double bond in form of cis- configuration. However, amounts of trans-fatty acids recently increase in the processed foods since it has advantages of prolonging shelf life and improving the texture of foods. Increasing of trans-fatty acids in food products has been reported to associate with cardiovascular diseases by increasing plasma total and LDL concentration in similar to those saturated fatty acids and lowering plasma HDL concentration [40, 41].

In addition to triglycerides, dietary fats also include phospholipid and cholesterol. Phospholipid contains a phosphate group at the third site of glycerol. In the body, phospholipids are parts of cell membranes and can be found naturally from eggs, liver, soybeans, wheat germ, and peanuts. Lecithin is phospholipid found in soybean and egg yolk [27]. Cholesterol is the lipid containing multiple-ring structures of sterols within its structure. Cholesterol can be found in animal fats but not in plant sources. Most of cholesterol is derived from animal foods, such as eggs, meat, poultry, fish, and dairy products. In the body, cholesterol is the precursors of steroid compounds including vitamin D, adrenocorticoid, and sex hormone [28].

Although dietary fats are useful in maintaining physiological functions, average daily fat consumption usually ranges from 20 to 35 percent of total calories intake [33]. Exceed dietary fat intake relates to several chronic diseases, such as cardiovascular diseases, obesity, and hypertension [38]. The 2015 US dietary guidelines recommended fat intake based on 2,000 kilocalorie intake should come from twenty-seven gram or five teaspoons of oils per day. Meanwhile, saturated fats should be limited to less than 10 percent of calories per day, and trans fats, such as margarine and partially hydrogenated fat should be limited as low as possible. Oils should replace solid fats rather than being added to the diet [31]. It is consistent with the recommendation of Dietary reference intake (DRI) for Thai 2003 to limit

saturated fats, cholesterol, and trans fats as low as possible to reduce the risk of cardiovascular diseases [33]. Thai food based dietary guidelines recommended oils approximately seven teaspoons per day, vegetable five rice serving spoons per day, and added sugars has been recommended six tea spoons based on 2,000 kilocalorie intake [11, 12, 21].

2.3.4 Alcohol

Alcohol is not classified as macronutrient, but it can provide energy. Approximately, one gram of alcohol could yield seven kilocalorie. Apart from calories, however, alcohol consumption does not provide any nutrients, except ethanol, and associate with many nutrient deficiencies. As a result, exceed alcohol consumption along with exceed dietary intake can result in overweight, obesity, and liver damage leading to cirrhosis in the long run. Therefore, alcohol consumption should be considered within calorie calculation [31]. Table 2 show nutrient of alcoholic beverages as mentioned by Franz MJ, 1990 [42] as cited by Mahan, L.K. and J.L. Raymond, 2016 [37].

2.3.5 Micronutrients

Micronutrients are defined to organic molecules required in very small amounts for cellular metabolism. Micronutrients are presented in almost all foods but no single food group has been considered as a good source of all micronutrients.

Table 2 Nutrition facts on alcoholic beverages [42]

(as cited by Krause's Food & the Nutrition Care Process ed.14 [37])

Beverage	Serving (oz)	Alcohol (g)	Carbohydrate (g)	Calories[1]	Exchange for calorie or diabetes control
Beer					
Regular	12	13	13	150	1 starch, 2 fat
Light	12	11	5	100	2 fat
Near beer	12	15	12	60	1 starch
Distilled spirits					
BD-Proof (gin, rum, vodka, whiskey, scotch)	1.5	14	Trace	100	2 fat
Dry brandy, cognac	1	11	Trace	75	1.5 fat
Table wines					
Dry white	4	11	Trace	80	2 fat
Red or rose	4	12	2	85	2 fat
Sweet wine	4	12	5	105	1/3 starch, 2 fat
Light wine	4	6	1	50	1 fat
Wine cooler	12	13	30	215	2 fruit, 2 fat
Dealcoholized wines	4	Trace	6-7	25-35	0.5 fruit
Sparkling wines					
Champagne	4	12	4	100	2 fat
Sweet kosher wine	4	12	12	132	1 starch, 2 fat
Appetizer and dessert wines					
Sherry	2	9	2	74	1.5 fat
Sweet sherry, port, muscatel	2	9	7	90	0.5 starch, 1.5 fat
Cordials, liqueurs	1	13	18	160	1 starch, 2 fat
Vermouth					
Dry	3	13	4	105	2 fat
Sweet	3	13	14	140	1 starch, 2 fat
Cocktails					
Bloody mary	5	14	5	116	1 vegetable, 2 fat
Daiquiri	2	14	2	111	2 fat
Manhattan	2	17	2	178	2.5 fat
Martini	2.5	22	Trace	156	3.5 fat
Old-fashioned	4	26	Trace	180	4 fat
Tom collins	7.5	16	3	120	2.5 fat
Mixes					
Mineral water	Any	0	0	0	Free
Sugar-free tonic	Any	0	0	0	Free
Club soda	Any	0	0	0	Free
Diet soda	Any	0	0	0	Free
Tomato juice	4	0	5	25	1 vegetable
Bloody mary mix	4	0	5	25	1 vegetable
Orange juice	4	0	15	60	1 fruit

Beverage	Serving (oz)	Alcohol (g)	Carbohydrate (g)	Calories[1]	Exchange for calorie or diabetes control
Grapefruit juice	4	0	15	60	1 fruit
Grapefruit juice	4	0	15	60	1 fruit

Original published by Franz MJ, 1990 [42] and cited by Mahan, L.K. and J.L. Raymond, 2016 [37].

[1]The caloric contribution from alcohol of an alcoholic beverage can be estimated by multiplying the number of ounces by the proof and then again by the factor 0.8. For beers and wines, kcal from alcohol can be estimated by multiplying ounces by percentage of alcohol (by volume) and then by the factor 1.6.

Vitamins, except for vitamin D, must be obtained through dietary intake. Vitamins are divided into two categories based on their solubility in solutions including water-soluble vitamins and fat-soluble vitamins. Water-soluble vitamins include vitamin B complex and vitamin C while vitamin A, vitamin D, vitamin E, and vitamin K belong to fat-soluble vitamins. Solubility characteristics involve the ways to absorb and store these vitamins. Water-soluble vitamins are absorbed in the small intestine and then pass into the bloodstream for circulation throughout the body. However, fat-soluble vitamins, like dietary fats, have more complicated mechanisms since they cannot be dissolved freely within the intestine as well as bloodstream. Their absorption occurs through the mechanisms of fat absorption. In term of storage, fat-soluble vitamins can be stored in fatty tissues. Therefore, they tend to be stored within the body more than those water-soluble vitamins. As the result, fat-soluble vitamins tend to be more toxic than water soluble vitamins.

Minerals serve a variety of functions in the bodies such as producing strength teeth and skeleton, produce muscle contraction, maintain nerve and muscle functions, and some minerals are the cofactors for enzymes within the body. They can be divided into two categories including major elements and trace elements. First, major elements refer to any minerals which are required approximately 100 mg or higher from daily dietary intake. In contrast, trace elements are required less than 100 mg daily. Because micronutrients may not be obtained from natural sources high enough, many fortified foods are available today in order to meet the requirement. In

Thailand, the recommendation for daily intake of micronutrients were established as the Thai Dietary Reference Intake (DRI) recommendations, providing guidelines for the optimal consumption of essential nutrients. The recommendations were considered based on various factors such as age, sex, and physiological conditions to ensure individuals receiving adequate amounts of micronutrients for optimal health (Table 3 to Table 4) [32]. For commercial products under provision of Thai FDA, nutrition facts display on the package based on the Thai recommended daily intakes (Thai RDI) established from the recommendation of dietary reference intake (DRI) for Thai 2003 (Table 5) [33, 43].

2.4 Conversion of dietary intake to nutrients

Once information regarding dietary intake is collected, it can be analyzed either by computerized methods or manual calculation. Dietitians determine total calories intake and nutrient contents. Traditionally, in Thailand dietitians initiate analysis manually by converting dietary intake into numbers of portion sizes before they further determine total calories and macronutrient profiles based on food exchange lists. It is important for dietitians to identify nutrition problems and educate their patients to achieve calories intake and nutrient balance individually. Therefore, dietitians need to be familiar and understand the concept of food exchange lists and portion sizes of foods to assess dietary intake from patients [10].

In addition to traditional methods, dietary intake analysis can also be analyzed by computerized methods. Recently, nutrient calculation software program include nutrient databases are developed for institutional use [37]. Although they could provide accurate nutrition analysis, many developed programs price individual for using. Therefore, dietary assessment remains relied on the traditional methods. However, complexity and time cost of traditional methods are major challenge in clinical setting. Reliable, robust, and accurate nutrient calculation software programs are still required.

Table 3 Dietary Reference Intake for Thais: Vitamins [32]

Life stage groups	Vitamin A µg/dᵃ	Vitamin D IU/dᵇ	Vitamin E mg/dᶜ	Vitamin K µg/d	Thiamin mg/d	Riboflavin mg/d	Niacin mg/dᵈ	Pantothenic acid mg/d	Vitamin B6 mg/d	Folate µg/dᵉ	Vitamin B12 µg/d	Biotin µg/d	Choline mg/d	Vitamin C mg/d
Children
1-3 years	300	600	6	30*	0.5	0.5	6	2*	0.5	120	0.9	8*	200*	25
4-5 years	350	600	9	55*	0.6	0.6	8	3*	0.6	140	1.2	12*	250*	30
6-8 years	350	600	9	55*	0.6	0.6	8	3*	0.6	180	1.2	12*	250*	40
Adolescent (male)
9-12 years	550	600	13	60*	0.9	0.9	12	4*	1.0	240	1.8	20*	375*	60
13-15 years	750	600	13	75*	1.2	1.3	16	5*	1.3	300	2.4	25*	550*	85
16-18 years	750	600	13	75*	1.2	1.3	16	5*	1.3	300	2.4	25*	550*	100
Adolescent (female)
9-12 years	550	600	11	60*	0.9	0.9	12	4*	1.0	240	1.8	20*	375*	60
13-15 years	700	600	11	75*	1.0	1.0	14	5*	1.2	300	2.4	25*	400*	80
16-18 years	600	600	11	75*	1.0	1.0	14	5*	1.2	300	2.4	25*	400*	80
Adults (male)
19-30 years	700	600	13	120*	1.2	1.3	16	5*	1.3	300	2.4	30*	550*	100
31-50 years	700	600	13	120*	1.2	1.3	16	5*	1.3	300	2.4	30*	550*	100
51-60 years	700	600	13	120*	1.2	1.3	16	5*	1.7	300	2.4	30*	550*	100
61-70 years	700	600	13	120*	1.2	1.3	16	5*	1.7	300	2.4	30*	550*	100
≥71 years	700	800	13	120*	1.2	1.3	16	5*	1.7	300	2.4	30*	550*	100
Adults (female)
19-30 years	600	600	11	90*	1.1	1.1	14	5*	1.3	300	2.4	30*	425*	85
31-50 years	600	600	11	90*	1.1	1.1	14	5*	1.3	300	2.4	30*	425*	85
51-60 years	600	600	11	90*	1.1	1.1	14	5*	1.5	300	2.4	30*	425*	85
61-70 years	600	600	11	90*	1.1	1.1	14	5*	1.5	300	2.4	30*	425*	85
≥71 years	600	800	11	90*	1.1	1.1	14	5*	1.5	300	2.4	30*	425*	85
Pregnant women
First trimester	+ 100	+ 0	+ 0	+ 0	+ 0.3	+ 0.3	+ 4	+ 1*	+ 0.6	+ 250	+ 0.2	+ 0	+ 25*	+ 10
Second trimester	+ 100	+ 0	+ 0	+ 0	+ 0.3	+ 0.3	+ 4	+ 1*	+ 0.6	+ 250	+ 0.2	+ 0	+ 25*	+ 10
Third trimester	+ 100	+ 0	+ 0	+ 0	+ 0.3	+ 0.3	+ 4	+ 1*	+ 0.6	+ 250	+ 0.2	+ 0	+ 25*	+ 10
Lactating women
0-5 months	+ 700	+ 0	+ 0	+ 0	+ 0.3	+ 0.5	+ 3	+ 2*	+ 0.7	+ 150	+ 0.4	+ 5*	+ 125*	+ 60
6-11 months	+ 700	+ 0	+ 0	+ 0	+ 0.3	+ 0.5	+ 3	+ 2*	+ 0.7	+ 150	+ 0.4	+ 5*	+ 125*	+ 60

Note: The values presented in this table for the Recommended Dietary Allowance (RDA) are represented as bold numbers, while the Adequate Intake (AI) values are represented as plain numbers accompanied by an asterisk (*). Both RDA and AI values are recommended nutrient intakes for individuals. The difference of both values is that RDA values cover the needs of nearly all individuals in a specific group (97 - 98%), while AI values are based on observed or experimentally determined approximations of nutrient intake based on age and gender. It is believed that determined AI values will be sufficient for the nutrient needs of individuals within a group, but data may be lacking or uncertain when used to determine consumption level.

ᵃRetinol activity equivalent (RAE), 1 RAE = 1 µg retinol, 12 mg β-carotene, 24 mg α-carotene, or 24 mg β-cryptoxanthin; ᵇCholecalciferol, 1 µg cholecalciferol = 40 IU (international units) vitamin D; ᶜα-tocopherol equivalent (α-TE), 1 α-TE = 1 mg RRR-α-tocopherol; ᵈNiacin equivalent (NE), 1 mg niacin = 60 mg tryptophan; ᵉDietary folate equivalent (DFE), 1 DFE = 1 µg dietary folate = 0.6 µg fortified food.

Table 4 Dietary Reference Intake for Thais: Minerals [32]

Life stage groups	Minerals											Electrolytes		
	Calcium mg/d	Phosphorus mg/d	Magnesium mg/d	Iron mg/d	Iodine µg/d	Zinc mg/d	Selenium µg/d	Copper mg/d	Manganese mg/d	Molybdenum µg/d	Chromium µg/d	Sodium mg/d	Potassium mg/d	Chloride mg/d
Children														
1-3 years	500*	460	60	5.0	90*	4.4	20	0.7*	0.6*	15*	11*	225-675*	1,175-1,950*	350-700*
4-5 years	800*	500	80	6.0	90*	5.3	30	1.0*	0.8*	20*	15*	300-900*	1,525-2,550*	450-900*
6-8 years	800*	500	120	6.6	90*	6.3	30	1.0*	1.1*	25*	15*	325-950*	1,625-2,725*	500-975*
Adolescent (male)														
9-12 years	1,000*	1,000	170	11.5	120*	9.5	40	(9 - 10 years =1.0) (11 - 12 years =1.3)*	1.6*	35*	25*	400-1,175*	1,975-3,325	600-1,200*
13-15 years	1,000*	1,000	240	15.0	130*	12.5	55	1.3*	2.2*	50*	35*	500-1,500*	2,450-4,100	750-1,500*
16-18 years	1,000*	1,000	290	11.0	130*	12.9	55	1.3*	2.5*	55*	35*	525-1,600*	2,700-4,500	825-1,650*
Adolescent (female)														
9-12 years	1,000*	1,000	170	(12.5*)(15.6^b)	120*	9.0	40	(9 - 10 years =1.0)(11 - 12 years =1.1)*	1.6*	35*	21*	350-1,100*	1,875-3,125*	550-1,125*
13-15 years	1,000*	1,000	220	16.0	130*	9.8	55	1.1*	2.2*	50*	24*	400-1,250*	2,100-3,500*	625-1,250*
16-18 years	1,000*	1,000	250	16.0	130*	9.8	55	1.1*	2.5*	55*	24*	425-1,275*	2,150-3,600*	650-1,300*
Adults (male)														
19-30 years	800*	700	310	11.5	150*	11.6	55	1.6*	2.5*	55*	35*	500-1,475*	2,525-4,200*	750-1,500*
31-50 years	800*	700	320	11.5	150*	10.9	55	1.6*	2.5*	55*	35*	475-1,450*	2,450-4,100*	725-1,475*
51-60 years	1,000*	700	300	11.5	150*	10.9	55	1.6*	2.5*	55*	30*	475-1,450*	2,450-4,100*	725-1,475*
61-70 years	1,000*	700	300	11.0	150*	10.9	55	1.6*	2.5*	55*	30*	475-1,450*	2,450-4,100*	725-1,475*
≥71 years	1,000*	700	280	11.0	150*	10.3	55	1.6*	2.5*	55*	30*	400-1,200*	2,050-3,400*	600-1,225*
Adults (female)														
19-30 years	800*	700	250	20.0	150*	9.7	55	1.3*	2.5*	55*	25*	400-1,200*	2,050-3,400*	600-1,225*
31-50 years	800*	700	260	20.0	150*	9.2	55	1.3*	2.5*	55*	25*	400-1,200*	2,050-3,400*	600-1,225*
51-60 years	1,000*	700	260	10.0	150*	9.2	55	1.3*	2.5*	55*	20*	400-1,200*	2,050-3,400*	600-1,225*
61-70 years	1,000*	700	260	10.0	150*	8.6	55	1.3*	2.5*	55*	20*	400-1,200*	2,050-3,400*	600-1,225*
≥71 years	1,000*	700	240	10.0	150*	8.6	55	1.3*	2.5*	55*	20*	350-1,050*	1,825-3,025*	600-1,075*
Pregnant women														
First trimester	+ 0	+ 0	+ 30	-^c	+ 50*	+ 1.6	+ 5	+ 0.2*	+ 0	+ 0	+ 5*	+ 50-200*	+ 0	+ 0
Second trimester	+ 0	+ 0	+ 30	-^c	+ 50*	+ 1.6	+ 5	+ 0.2*	+ 0	+ 0	+ 5*	+ 50-200*	+ 350-575*	+ 100-200*
Third trimester	+ 0	+ 0	+ 30	-^c	+ 50*	+ 1.6	+ 5	+ 0.2*	+ 0	+ 0	+ 5*	+ 50-200*	+ 350-575*	+ 100-200*
Lactating women														
0-5 months	+ 0	+ 0	+ 0	13.0^d	+ 50*	+ 2.9	+ 15	+ 0.2*	+ 0	+ 0	+ 20*	+ 125-350*	+ 575-975*	+ 175-350*
6-11 months	+ 0	+ 0	+ 0	20.0^d	+ 50*	+ 2.9	+ 15	+ 0.2*	+ 0	+ 0	+ 20*	+ 125-350*	+ 575-975*	+ 175-350*

Note: The values presented in this table for the Recommended Dietary Allowance (RDA) are represented as bold numbers, while the Adequate Intake (AI) values are represented as plain numbers accompanied by an asterisk (*). Both RDA and AI values are recommended nutrient intakes for individuals. The difference of both values is that RDA values cover the needs of nearly all individuals in a specific group (97 - 98%), while AI values are based on observed or experimentally determined approximations of nutrient intake based on age and gender. It is believed that determined AI values will be sufficient for the nutrient needs of individuals within a group, but data may be lacking or uncertain when used to determine consumption level. For fluoride, there is no established reference intake value; For women who have not yet experienced their menstrual cycle, it is recommended to receive dietary iron 12.5 mg per day; For menstruating women, it is recommended that they receive 15.6 milligrams of iron per day from their diet; Pregnant women are advised to take a daily iron supplement of 60 mg; Breastfeeding women should aim to consume dietary iron of 13 mg per day during 0 - 5 months, and 20 mg of iron per day during 6 - 11 months.

Table 5 Recommended daily intakes (RDI) for Thais [43]

Nutrients	Thai RDI[1]	Units	Nutrients	Thai RDI[1]	Units
Macronutrients (6)					
Protein	50[2]	grams	Total fat	65[2]	grams
Total carbohydrate	300[2,3]	grams	Saturated fat	20[2]	grams
Dietary fiber	25	grams	Cholesterol	300	milligrams
Vitamins (13)			**Minerals (15)**		
Vitamin A	800	µg RE[4]	Calcium	800	milligrams
Thiamin	1.5	milligrams	Phosphorus	800	milligrams
Riboflavin	1.7	milligrams	Iron	15	milligrams
Niacin	20	mg NE[5]	Iodine	150	micrograms
Vitamin B_6	2	milligrams	Magnesium	350	milligrams
Folate	200	micrograms	Zinc	15	milligrams
Biotin	150	micrograms	Copper	2	milligrams
Pantothenic acid	6	milligrams	Potassium	3,500	milligrams
Vitamin B_{12}	2	micrograms	Sodium	2,000[8]	milligrams
Vitamin C	60	milligrams	Manganese	3.5	milligrams
Vitamin D	5	micrograms[6]	Selenium	70	micrograms
Vitamin E	10	mg α-TE[7]	Fluoride	2	milligrams
Vitamin K	80	micrograms	Molybdenum	160	micrograms
			Chromium	130	micrograms
			Chloride	3,400	milligrams

[1]Annex 3 in the notification of the Ministry of Public Health (No. 182) B.E. 2541 (1998) Re : Nutrition Labelling [44]; [2]Total fat, saturated fat, protein, and total carbohydrate calculated from 30%, 10%, 10%, and 60% of energy intake (2,000 kcal/d), respectively.; [3]Daily sugar intake should not exceed than 10% of total energy intake; [4]RE = retinol equivalent, 1 RE = 1 µg retinol = 6 µg β-carotene = 3.33 IU; [5]NE = niacin equivalent, 1 NE = 1 mg niacin = 60 mg tryptophan; [6]Micrograms vitamin D, 1 µg = 40 IU; [7]α-TE = α-Tocopherol equivalent, 1 α-TE = 1 mg D-α-tocopherol = 1.5 IU; [8]defined in the notification of the Ministry of Public Health (No. 392) B.E. 2561 (2018) Re : Nutrition Labelling (No.3) [45].

2.4.1   Food exchange list

The exchange system is a systematic allocation of foods into food groups based on their calories and nutrient profile per serving size. Foods can exchange with other foods in same group as these foods share same

level of calories and nutrient contents. Consequently, it reduces the burdensome of dietitians to remember all nutrient content from all food items. Although it was originally developed as a meal-planning guide for people with diabetes, but it also be useful even for general diet planning to achieve calorie and fat balance. However, grouping foods bases on their calories and macronutrient contents rather than by their source, appearance, or micronutrient contents. Some foods may not appear on the exchange list as expected. For example, corn and potato containing significant amount of carbohydrate are categorized in a starch group rather than in the vegetables group. Besides, alcoholic beverages are not included within any group as they contain only carbohydrate and calories. Hence, they have been grouped as their own list [27]. No food exchange list for alcohol beverage has been developed and recommended in Thailand. However, dietary information of alcohol beverage was published previously by Franz MJ (1990) (Table 2) [42].

In Thailand, two widely used food exchange lists were developed and recommended by Thai food exchange list (Table 6) and Thai food based dietary guideline/Nutrition flag (Table 7) [11, 12, 21].

2.4.2   Thai Food exchange list

Thai food exchange list was developed from the original food exchange designed by the committee of the American Dietetic Association to be the basic of a meal planning system [46]. Although it was designed primarily for applying to people with diabetes, food exchange list now become the basic of nutrition that is able to apply into everybody [37]. However, original food exchange list seems not be suitable to be used among Thai people because it was firstly developed based on western diet culture. One of the limitations is that food items as well as its portion size were not familiar among Thai people. Additionally, some food groups such as starch contains different nutrient profiles when compared with starch products sold in Thailand. Accordingly, Thai food exchange was developed based on Thai diet culture by changing the numbers of food groups to be six groups.

Additionally, food items and nutrient profiles of each food group were also modified based on Thai diet culture (Table 6) [10].

2.4.3. Thai food based dietary guidelines

Thai food based dietary guidelines was developed by the group of researchers from Institute of Nutrition, Mahidol University and applied jointly in public with Nutrition Division, Ministry of Public Health to support the development of Thai food based dietary guidelines (Thai FBDG) (Figure *2*) [11, 12, 21]. The objective of Thai FBDG is to support for nutrition education, nutrition labelling, and food policy. Because of the believe that there is no single model can cover all aspect of the food guide massages. Therefore, one instrument of Thai FBDG is the nutrition flag which suggested patterns of food intake by a range of daily servings from each of the major food groups to achieve three energy levels including 1,600, 2,000, and 2,400 kcal per day [11]. Like Thai food exchange list, developed food exchange list was developed based on Thai diet culture. Food items have been categorized into six groups to support the original Thai food group concept. Serving sizes used in Thai food based dietary guidelines or nutrition flag are obtained from the commonly used household utensils rather than the standard measurement units. At present, food exchange list of nutrition flag remains being used as the part of Thai FBDG with the promotion to apply with the electronic instruments in order to achieve the effective education and communication [21].

2.5 Energy expenditure and requirement

2.5.1. Energy balance

Energy refers to the abilities to perform work or produce change. The unit of calorie refers to amount of heat required to rise the temperature of a gram of water by 1°C. However, the term of kilocalories (kcal), 1,000 times of calorie, is commonly used in practice. Foods contain nutrients that human can convert into energy including carbohydrate, proteins, and fats. Alcohol also provides energy even though it is not considered as nutrient. After foods

were consumed, these chemical forms are converted to heat and mechanical energy to maintain normal physiology. However, exceed or inadequate calorie intake associates with problematic conditions. Excess energy intake results in the deposition of body fat and eventually obesity, while inadequate energy intake results in wasting. Energy balance can be achieved when total energy expenditure (TEE) is covered by adequate, but not exceed, energy intake. It is important for dietitians to estimate energy requirement from their patients to determine whether they can achieve their energy balance.

Figure 2 Nutrition flag: Healthy eating for Thais [11]

Table 6 Food portion sizes and nutrient values defined in six food groups of
Thai food exchange list[1] [10]

Food groups	Amounts per portion size	Energy (kcal)	CHO[2] (g)	Protein (g)	Fat (g)
Cereals	Variety[3]	80	18	2	-
Vegetables					
Vegetables type 1[4]					
Raw	70-100 g	-	-	-	-
Cooked	50-70 g	-	-	-	-
Vegetables type 2[5]					
Raw	70-100 g	25	5	2	
Cooked	50-70 g	25	5	2	
Fruits					
Fruits	Variety[6]	60	15	-	-
Milk					
Whole milk	240 mL	150	12	8	8
Low fat milk	240 mL	120	12	8	5
Skim milk	240 mL	90	12	8	0-3
Powder whole milk[7]	30 g[8]	150	12	8	8
Powder skim milk[7]	30 g[8]	90	12	8	0-3
Evaporated milk[7]	120 mL	150	12	8	8
Meat and products[9]					
Lean meat	30 g[10]	35	-	7	0-1
Low fat meat	30 g[10]	55	-	7	3
Moderate fat meat	30 g[10]	75	-	7	5
High fat meat	30 g[10]	100	-	7	8
Fat					
Oil	1 tsp[11]	45	-	-	5
Margarine	1 tsp[11]	45	-	-	5
Coconut milk	1 tbsp[12]	45	-	-	5
Butter	1 tsp[11]	45	-	-	5

[1]No data provided for saturated fat, cholesterol, dietary, vitamins and minerals; [2]CHO = carbohydrate; [3]Amounts of cereal based foods per serving size are based on types of cereal based foods defined by weight, cup, table spoon, or pieces of certain types of the cereal based foods;

[4]Vegetables type 1: napa cabbage, lettuce salad, water spinach, water cover, lettuce, lotus stem, spinach, pumpkin sapling, sweet basil leave, cabbage, cauliflower, celery, tomato, small eggplant, white turmeric, cucumber, long cucumber, young watermelon, winter melon, calabash, marrow, zucchini, green chili, green peppers, green taro, Tung-Ho, young banana trunk

[5]Vegetables type 2: pumpkin, onion, bitter bean, carrot, Cassia flower/leaf, phak-wan, soy bean sprout, sugar pea, string bean, bean sprout, bush bean, winged bean, beetroot, leek, climbing wattle, katuri flower, horse tatarind, neem leaf, cowslip creeper, sesbania flower, bog choy, sweet peeper, phak-teaw, water mimosa, Chinese kale, bai-thong-lang, bai-yor, baby corn, lotus root, ta-giang-kalarm, broccoli, phak-tarm-leung, ma-keua-sha-woie, ma-keua-krob, raw papaya, bamboo shoot, lung oyster, abalone mushrooms, Chinese bitter gourd, young coconut shoot

[6]Amounts per serving size are based on types of fruits defined by weight, size, or numbers of pieces of certain types of fruits; [7] 240 mL per serving size after filling water; [8] 30 g.= 4 tablespoons; [9] cooked meat = 30 g, raw meat = 40 g; [10] 30 g = 2 tablespoons; [11] tsp = teaspoon; [12] tbsp = tablespoon

Table 7 Weight and nutrient values per portion size defined in six food groups of
Thai food based dietary guidelines [21]

Food groups	Weight (g)	Energy (kcal)	CHO[1] (g)	Protein (g)	Fat (g)	Chol[2] (mg)	DF[3] (g)	Vitamins			Minerals		
								A (RE)	B$_1$ (mg)	B$_2$ (mg)	C (mg)	Fe (mg)	Ca (mg)
Cereals													
Cooked rice noodles	60	83	17.9	1.4	0.65	0	0.46	0	0.02	0.01	0	0.85	3.9
Cooked sticky rice	35	80	18.2	1.6	0.11	0	0.28	0	0.01	0.04	0	0.42	6.3
Bread	30	98	18.8	3.7	0.9	0	0.16	0	0.06	0.05	0	0.59	6.7
Meat and products													
Meat, fish, poultry	15	26	0	2.7	1.7	9	-	12.6[4]	0.06	0.03	-	0.15	2.4
Soybean curd, nuts	30	25	1.1	2.4	1.5	-	0.42	1.5	0.03	0.05	-	0.50	12.0
Egg	25	41	0.2	3.2	2.9	107	-	32.5[5]	0.03	0.09	-	0.86	15.3
Vegetables													
Vegetables	40	11	1.9	0.9	0	0	0.90	36[6]	0.08	0.04	2.8[7]	0.4	22.0
Fruits													
Fruits	120	67	15.4	0.98	0.12	-	2.26	73.5	0.06	0.07	57.6	0.65	18.5
Milk													
Milk	200	134	9.8	4.0	7.4	20	-	76	0.08	0.32	2.0	0.10	236
Low fat milk	200	96	11.0	7.4	2.6	12	-	24	0.10	0.34	1.0	0.12	253
Fat													
Oil	5	45	-	-	5	-	-	-	-	-	-	-	-

[1]CHO = carbohydrate; [2]Chol = cholesterol; [3]DF = dietary fiber; [4]Vitamin A decreased 9.25% after cooking; [5]Vitamin A decreased 27% after cooking; [6]Calculated both decrement and increment of beta-carotene after cooking; [7]Calculated only from raw vegetables.

2.5 Energy expenditure and requirement

2.5.1. Energy balance

Energy refers to the abilities to perform work or produce change. The unit of calorie refers to amount of heat required to rise the temperature of a gram of water by 1°C. However, the term of kilocalories (kcal), 1,000 times of calorie, is commonly used in practice. Foods contain nutrients that human can convert into energy including carbohydrate, proteins, and fats. Alcohol also provides energy even though it is not considered as nutrient. After foods were consumed, these chemical forms are converted to heat and mechanical energy to maintain normal physiology. However, exceed or inadequate calorie intake associates with problematic conditions. Excess energy intake

results in the deposition of body fat and eventually obesity, while inadequate energy intake results in wasting. Energy balance can be achieved when total energy expenditure (TEE) is covered by adequate, but not exceed, energy intake. It is important for dietitians to estimate energy requirement from their patients to determine whether they can achieve their energy balance.

2.5.2. Energy requirement

Energy requirement is complex since it is affected by many factors. Total energy expenditure results from three compartments including basal metabolism, thermogenesis, and physical activity. First, the basal metabolism refers to the basic energy needed to sustain the metabolic activities of cells and tissues. The indicator includes basal metabolic rate (BMR) measured from subjects under the condition of supine, awake, and motionless in a thermo-neutral environment after 12-hour overnight fasting. However, these conditions make it less likely to be conducted. Resting metabolic rate (RMR) can also represent for basal metabolism. It is measured under the same conditions of BMR except only three to four hour fasting period is required. Generally, RMR is higher approximately 10 to 20 percent than BMR. There are many factors which affect BMR values including age, gender, body composition, and health status. Of them, fat free Mass (FFM) has been suggested as the most important predictor for RMR in adults [47, 48]. The important organs include brain, heart, kidney, and liver accounting for approximately 60 to 70 percent of the RMR in adults. The following 20 to 30 percent of the RMR results from skeletal muscles. For this reason, the difference of basal metabolism varies between individuals due to the difference in body compositions [28]. Second, thermogenesis is defined as the energy required in response to food ingestion and cold/heat exposure. Thermogenesis is accounted for approximately 10 to 15 percent of TEE [49] Food ingestion-induced thermogenesis, also called thermic effect of food (TEF), is the energy cost for food digestion and absorption. Thermic effect of food depends on the contents of food intake, especially after consume protein-rich meals [50]. Last, physical activity is also the compartment of

energy expenditure. Besides BMR is defined as the basic requirement under the non-movement condition, physical activity is the additional energy cost to provide physical movement. Physical activity includes both nonexercised activity thermogenesis and energy expended during exercise. Therefore, the amounts of physical activities vary greatly depended upon individual lifestyles [49].

2.5.3. Equations for estimating energy requirement

To determine TEE, double labeled water (DLW) method is considered as the gold standard. However, this method still has the limitation. It is expensive and expertise skill required for analysis. These disadvantages make this method to be impractical by dietitians [37]. Equations for estimating basal energy expenditure have therefore been developed as shown in Table 8. First, Harris-Benedict equation is the oldest equation that still be widely used in clinical practice. It was developed from normal-weight white men (N = 136) aged 16 to 63 years old (mean = 27 ± 9 years old) and women (N = 103) aged 15 to 74 years old (mean = 31 ± 14 years old) [51]. Second, Owen equation was developed separately between men and women. The equation for men was developed from 60 subjects aged 18 to 82 years old (mean = 38 ± 15.6 years old) including twenty-four nonobese, eleven obese, and five extremely obese men [52]. The equation for women was developed from forty-four healthy, lean and obese women aged from 18 to 65 years old (mean = 35 ± 12 years old) [53]. Third, Mifflin-St Jeor equation was developed from using indirect calorimetry in 251 males and 247 females aged from 19 to 78 years old (mean = 44.5 ± 14.1 years old). Approximately, 47 percent of obese with BMI between 30 to 42 kg/m^2 participated this study [47]. In the study comparing the result of RMR predicting from Harris-Benedict, Owen and Mifflin-St Jeor equation in 130 obese and nonobese people, they found that Mifflin-St Jeor equation is the most accurate equation for predicting RMR [54]. Fourth, Schofield and colleagues used the data from 7,549 persons to

develop another equation. Equations mentioned above include the equations to predict RMR from weight or weight and height separated by gender. All these equations predict RMR. However, considering TEE must also include energy cost from thermogenesis, physical activity, and stress conditions, and illness (Table 8, Table 9 and Table 11). Overall, the minimal, moderate, and active activities can increase RMR by 10 to 20, 25 to 40, and 45 to 60 percent, respectively [37]. In the case of hospitalized patients, additional 10% to 15% of RMR should be included to calculate TEE [55]. In addition to these equations, estimating the body surface area (BSA) is necessary for certain energy equations used in critical ill patients, such as the Swinamer equation (Table 9). Several methods exist to estimate BSA, including the DuBois-DuBois equation, the Mosteller equation, and the Boyd equation (Table 10). These equations provide a means to calculate BSA, which is then used as a parameter in the energy calculations for critically ill patients.

More recently, newer equation for directly predicting TEE has been reported by the Institute of Medicine (IOM) and Food and Nutrition Board based on the information from DLW database (Table 12 and Table 13) Predicted TEE aims to maintain energy balance in healthy, normal weight individuals, as well as TEE among pregnant and lactating women. The equations for overweight or obese patients (BMI > 25 kg/m^2) were also developed with aim of maintaining current body weight. They are not intended to promote weight loss [56]. However, interpretation of BMI definitions in Asians should be modified as they commonly have higher proportion of adiposity than European even at same BMI level. Generally, BMI definition for Asians is lower than European approximately 1 or 2 kg/m^2 (Table 14) [57, 58].

Table 8 Equations for predicting the resting metabolic rates in adults

Equation names	Equations
Harris-Benedict equation [51]	Male RMR = 66.4730 + (13.7516 x W) + (5.0033 x H) – (6.7550 x A)
	Female RMR = 665.0955 + (9.5634 x W) + (1.8496 x H) – (4.6756 x A)
Mifflin-St Jeor equation [47]	Male RMR = (10 x W) + (6.25 x H) – (5 x A) + 5
	Female RMR = (10 x W) + (6.25 x H) – (5 x A) - 161
Owen equation [52, 53]	Male RMR = 879 + (10.2 x W)
	Female RMR = 795 + (7.18 x W)
Schofield equation [59]	Equations predicted RMR from weight Male RMR 　　　　Age 18 – 30 y　　RMR = (15 x W) + 692.1 　　　　Age 30 – 60 y　　RMR = (11.5 x W) + 873 　　　　Age > 60 y　　RMR = (11.7 x W) + 587.7
	Female RMR 　　　　Age 18 – 30 y　　RMR = (14.8 x W) + 486.6 　　　　Age 30 – 60 y　　RMR = (8.1 x W) + 845.6 　　　　Age > 60 y　　RMR = (9.1 x W) + 658.4
	Equations predicted RMR from weight and height Male RMR 　　　　Age 18 – 30 y　　RMR = (15 x W) + (10 x (H/100)) + 706 　　　　Age 30 – 60 y　　RMR = (11.5 x W) + (2.6 x (H/100)) + 877 　　　　Age > 60 y　　RMR = (9.1 x W) + (972 x (H/100)) - 834
	Female RMR 　　　　Age 18 – 30 y　　RMR = (13.6 x W) + (283 x (H/100)) + 98 　　　　Age 30 – 60 y　　RMR = (8.1 x W) + (1.4 x (H/100)) + 844 　　　　Age > 60 y　　RMR = (7.9 x W) + (458 x (H/100)) + 17.7

W = Weight in kg; H = Height in cm; A = Age in year

Table 9 Energy equations for adults with critical illness

Equation names	Equations
Ireton-Jones equation (ventilator-dependent) [60]	Male EE = 1784 − 11A + 5W + 239T + 804B + 244 Female EE = 1784 - 11A + 5W + 239T +804B
Ireton-Jones equation (spontaneously breathing) [60]	EE = 629 − 11A + 25W − 609Ob
Swinamer equation [61]	EE = 945BSA − 6.4A + 108Temp + 24.2RR + 817TV - 4349
Penn State equation (2003a) [62]	EE = 0.85 (Harris-Benedict) + 33V_E + 175T_m - 6433
Penn State equation (2003b) [62]	EE = 0.96 (Mifflin-St Jeor) + 31V_E + 167T_m - 6212

W = Weight in kg; H = Height in cm; A = Age in year; T = Trauma condition (present = 1, absent = 0); B = Burn (present = 1, absent = 0); Ob = Obesity (BMI > 27 kg/m^2) (present = 1, absent = 0); BSA = Body surface area in m^2; Temp = Temperature in ℃ scale; RR = Respiratory rate in breaths per minute; TV = Tidal volume in liter; V_E = Minute ventilation in liter/minute; T_m = Maximum temperature in liter/minute

Table 10 Body surface area equations for adults

Equation names	Equations
DuBois-DuBois equation [63]	BSA = 0.007184 * $W^{0.425}$ * $H^{0.725}$
Mosteller equation [64]	BSA = $\sqrt{(W * H) / 3600}$
Boyd equation [65]	BSA = 0.0003207 * $(W * 1000)^{0.7285 - 0.0188 * \log10(W * 1000)}$ * $H^{0.3}$

BSA = Body surface area in m^2; W = Weight in kg; H = Height in cm

Table 11 Disease-specific stress factors for hospitalized patients

Diagnosis	Male	Female
Solid tumor	1.15 ± 0.18	1.25 ± 0.27
Leukemia/lymphoma	1.27 ± 0.10	1.37 ± 0.30
Inflammatory bowel disease	1.11 ± 0.15[2]	1.12 ± 0.17[2]
Liver disease	1.07 ± 0.16[3]	1.11 ± 0.24[3]
Burns	1.64 ± 0.09[2]	1.52 ± 0.28[2]
Pancreatic disease	1.13 ± 0.12[3]	1.21 ± 0.20
Fistula	-	1.15 ± 0.16
Surgery (general)	1.20 ± 0.19	1.39 ± 0.31[2]
Surgery (transplantation)	1.19 ± 0.12	1.27 ± 0.29
Infection (average)	1.20 ± 0.16	1.35 ± 0.33
Infection (with sepsis)	1.33 ± 0.19[3]	1.27 ± 0.40
Infection (with abscess)	1.12 ± 0.11	1.39 ± 0.31[2]
Infection (others)	1.16 ± 0.12	1.39 ± 0.21

Results are shown as mean ± SD; [1]The stress factor was calculated from the ratio of measured energy expenditure (by indirect calorimetry tests) to the predicted energy expenditure by the Harris-Benedict equation; [2]$p < 0.05$ compared with the entire group; [3]$0.05 < p < 0.75$.

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

Table 12 Equations for calculating total energy expenditure (TEE) in adults[1]

Populations	Levels of physical activity
Normal weight adult male (≥19 years; BMI 18.5 to 25 kg/m^2) TEE = 661.8 – (9.53 x A) x (PA x ((15.91 x W) + (539.6 x H)))	Sedentary : PA = 1 Low active : PA = 1.11 Active : PA = 1.25 Very active : PA = 1.48
Normal weight adult female (≥19 years; BMI 18.5 to 25 kg/m^2) TEE = 354 – (6.91 x A) x (PA x ((9.36 x W) + (726 x H)))	Sedentary : PA = 1 Low active : PA = 1.12 Active : PA = 1.27 Very active : PA = 1.45
Overweight and obese adult male (≥19 years; BMI ≥25 kg/m^2) TEE = 1086 – (10.1 x A) x (PA x ((13.7 x W) + (416 x H)))	Sedentary : PA = 1 Low active : PA = 1.12 Active : PA = 1.29 Very active : PA = 1.59
Overweight and obese adult female (≥19 years; BMI ≥25 kg/m^2) TEE = 448 – (7.95 x A) x (PA x ((11.4 x W) + (619 x H)))	Sedentary : PA = 1 Low active : PA = 1.16 Active : PA = 1.27 Very active : PA = 1.44
Normal and overweight or obese adult male (≥19 years; BMI ≥18.5 kg/m^2) TEE = 864 – (9.72 x A) x (PA x ((14.2 x W) + (503 x H)))	Sedentary : PA = 1 Low active : PA = 1.12 Active : PA = 1.27 Very active : PA = 1.54
Normal and overweight or obese adult female (≥19 years; BMI ≥18.5 kg/m^2) TEE = 387 – (7.31 x A) x (PA x ((10.9 x W) + (660.7 x H)))	Sedentary : PA = 1 Low active : PA = 1.14 Active : PA = 1.27 Very active : PA = 1.45

[1]Recommended by Institute of Medicine and Food and Nutrition Board (2005) [56].

W = Weight in kg; H = Height in m; A = Age in year; PA refers to coefficient for Physical Activity Levels (PAL)

Table 13 Equations for calculating total energy expenditure in

pregnant and lactating women[1]

Pregnant women (age 19 to 50 years)
1st trimester : TEE = Adult TEE + 0 kcal 2nd to 3rd trimester : TEE = Adult TEE + 180 kcal + additional energy each   week (8 kcal/week)
Lactating women (age 19 to 50 years)   First 6 months: TEE = Adult TEE + 500 − 170   Second 6 months: TEE = Adult TEE + 400
[1]Recommended by Institute of Medicine and Food and Nutrition Board (2005) [56].   W = Weight in kg; H = Height in m; A = Age in year

Table 14 Classifications of weight by BMIs in adult European and Asian [57]

Classifications	BMIs for European (kg/m^2)	BMIs for Asian (kg/m^2)	Risk of co-morbidities
Underweight	< 18.5	< 18.5	Low (but increased risk of other clinical problems)
Normal weight	18.5 − 24.9	18.5 − 22.9	Average

2.6. Technological innovation in dietary assessment

As mentioned above, the informative data from dietary assessment can enhance dietitians' performance on precise nutrition diagnosis and effectiveness of nutrition Intervention, and nutrition monitoring and evaluation. During dietary assessment, dietitians have the burdensome to analyze dietary intake and then calculate into calorie, along as well as carbohydrate, protein, and fat content based on food exchange system before they finally convert into total calorie and nutrient intake. Moreover, dietary assessment sometimes be problematic when dietitians are introduced with foods beyond the list of food exchange system which forces them to estimate calorie and nutrient content by their own decision. Therefore, low

reliability and time cost are major challenge in traditional dietary assessment. In order to minimize these limitations, it rises the importance of using technological innovation to improve the quality of dietary assessment [13].

Over the past few years, later technological advances allowed dietary intake to be computerized to improve the quality of assessment such as web-based, automated software program and smartphone applications. With the rapid growth of the number of smartphone users in Thailand which already reached to 45.5 million in 2017 (approximately 72.3% of the population), smartphone applications become one of the interesting aids to provide technological innovation to publication [66].

There are many smartphone applications for performing dietary assessment being developed. For example, mobile app called "Nutrabem" was developed in Brazil for assessing dietary recall. Previous study suggested that it was useful among university students [67]. Commercial mobile app such as "MyFitnessPal", barcode scanners app developed to monitoring food intake, has been suggested the comparable results to the traditional assessment method in a sample of military personnel [68]. In term of validation, previous study investigated the reliability from seven barcode containing applications with more than 1 million downloads from Google play. They compared the calories and nutrient content from selected application with the product's labels from one hundred products sold in Netherland. This study suggested that "MyFitnessPal" was the most accurate barcode containing application. Although the results calories and fat value seem to be accurate and consistent, other nutrients varied greatly. These applications seem to be less suitable for assessment on the nutrient outcomes. The authors suggested that these results might be due to different nutrient contents from using different database between these applications. Some applications developed in USA tended to provide lower accuracy than those developed in Netherland. Therefore, it is important to use country-specific database for developing technological innovation in specific country. Although the result of nutrients is inaccurate, the consistency and accuracy

of calories and fat indicated that dietary application might be useful in the purpose of weight loss [69]. These studies therefore showed the possibility to apply these innovations in clinical setting. More applications which support Thai specific database should be developed and validated.

However, mobile applications specific for the professional dietitians has been limited. Based on the international survey from dietitians from United Kingdom, Australia, and New Zealand in 2017, it indicated that dietetic professionals required smartphone health applications in the future to be credible apps, easy to use, dietitian-oriented support, patient-oriented support, and dietitians sharing support [15]. The mobile health (mHealth) app for dietitians launched in 2019 was agreed by majority of dietitians in this study that the application could helped them to improve the amount of time they spent on dietary assessment. Overall, both dietitians and their patients in this study indicated that they would continue using the application and recommend it to others [16].

In Thailand, "Dietary assessment scanning calculator" or "DiSC" was the dietary assessment application recently developed by Thai dietetic and association of Thailand. This application provides barcode scanner innovation to assess and monitor dietary intake. During dietary recall, foods and beverages would be asked from subjects. Then, the application would provide amounts of total energy and nutrients according to the reference values from the food database. Although DiSC has remained only in development-phase, it was already validated in clinical setting. In two studies which applied DiSC application in dietary assessment and education to reduce protein and phosphorus intake in patients with chronic kidney disease. It showed the improvement of protein and phosphorus intake which indicated that DiSC supported dietitians practice and improve dietary intake among such kind of patients [17, 18].

Although DiSC has been validated to be useful, it has some limitations. First, application does not support all foods commonly consumed in Thailand. It mostly

supports the foods in central region. Second, application cannot assess the quantity of energy and nutrient based on actual portion sizes consumed by respondents since it relies on the reference data from food database. Last, it might not be suitable to use in some situations since it requires an internet connection for accessing the database. The DiSC still having many limitations even though its effectiveness has already been validated. These limitations also be founded in many applications which require reference value from database. Therefore, more alternative applications supporting Thai database without these limitations are still required.

Chapter 3

MATERIALS AND METHODS

This study aimed to develop and validate the smartphone nutrition application for Thai dietitians to use in routine nutrition practice. There were five phases of the mobile nutrition application development as shown in Figure 3 and described below. Dietary and nutrition information were prepared and used for creating databases for calculating nutrition intake, nutrition requirement, and related results. Methods and processes of the application development were based on the process of software validation including data preparation, requirements specification, implementation, precautions, validation and acceptance test [70].

3.1. Phase 1 Database preparation

3.1.1. **Objective**: To determine source and extent of information to be used in the developed application.

3.1.2. **Method:** The application developed in this study was evidence-based development. Both equations for estimating nutritional requirement and dietary information were obtained from previous studies and Thai nutrition databases and guidelines.

　　3.1.2.1. Five types of body weight were included in this application.

　　　　3.1.2.1.1. Adjust body weight

　　　　　　ABW (kg) = (IBW (kg) + 0.25 [ABW (kg) − IBW (kg)])

　　　　　　When: ABW = Adjust body weight

　　　　　　　IBW = Ideal body weight

　　　　3.1.2.1.2. Actual body weight

　　　　3.1.2.1.3. Ideal body weight I

　　　　　　Ideal body weight (kg) = Height (cm) − 100 (male) or 110 (female)

3.1.2.1.4. Ideal body weight II: body weight where making body mass index (BMI) become 21 kg/m^2

Ideal body weight (kg) = 21 x Height^2 (m^2)

3.1.2.1.5. Ideal body weight III: calculating by Hamwi equation (1964) [64] [37])

Men: 106 pounds for first 5 feet of height and 6 pounds per inch over 5 feet; or 6 pounds subtracted for each inch under 5 feet

Female: 100 pounds for first 5 feet of height and 5 pounds per inch over 5 feet; or 5 pounds subtracted for each inch under 5 feet (inputted weight could be modified further by amputation conditions based on the recommendation of Charney P. (2009) [71] [37].

3.1.2.2. Eleven equations and three recommendations to predict energy requirement were included into the application.

3.1.2.2.1. Five predicted equations (Table 8) for resting metabolic rate for adults.

3.1.2.2.2. Five predicted equations (Table 9) for resting metabolic rate or energy expenditure in adult with critical illness.

3.1.2.2.3. Three nutrition recommendation by Dietary reference intake (DRI) for Thais 2020 [32] (Table 1 and Table 3 - Table 4), Thai recommend daily intake (RDI) [43] (Table 5), and Institute of Medicine (IOM) of the National Academies 2005 [56] (Table 12 and Table 13).

3.1.2.2.4. Simple equation to support some dietary guidelines such as K/DOQI clinical practice guidelines [35].

TEE = Bodyweight (kg) x number of kcal/kg

3.1.2.3. Stress factors for hospitalized patients recommended by the American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) (2002) were included for calculation of total energy requirement in hospitalized patients. Average value of 1.25 was added into the application as a default value for any conditions which were not investigated in previous studies (Table 11) [55].

3.1.2.4. The recommendation of macronutrient distribution ranges by Thai DRI 2020 [32], Thai RDI [43], and IOM 2005 [56].

3.1.2.5. Energy yield by macronutrients including carbohydrate = 4 kilocalorie/gram, protein = 4 kilocalorie/gram, fat = 9 kilocalorie/gram [56].

3.1.2.6. Food photographs were developed as portion size measurement aids based on Thai exchange list and Thai food based dietary guidelines.

3.1.2.7. For food databases, there were ten sources of food data collected and prepared for developing the application as follow.

    3.1.2.7.1. Thai Food exchange list (Thai FEL) including names of food groups, food items, serving sizes, energy, amounts of carbohydrate, protein, and fat from six food groups (16 subgroups) and each food items [10] (Table 6) (APPENDIX K).

    3.1.2.7.2. Thai food based dietary guidelines (Thai FBDG) including names of food groups, food items, serving sizes, energy, amounts of carbohydrate, protein, and fat, cholesterol, dietary fiber, four vitamins (vitamin A, thiamin, riboflavin, vitamin C), and two minerals (calcium, iron) from six food groups (11 subgroups) and each food item [11, 12, 21] (Table 7) (APPENDIX L).
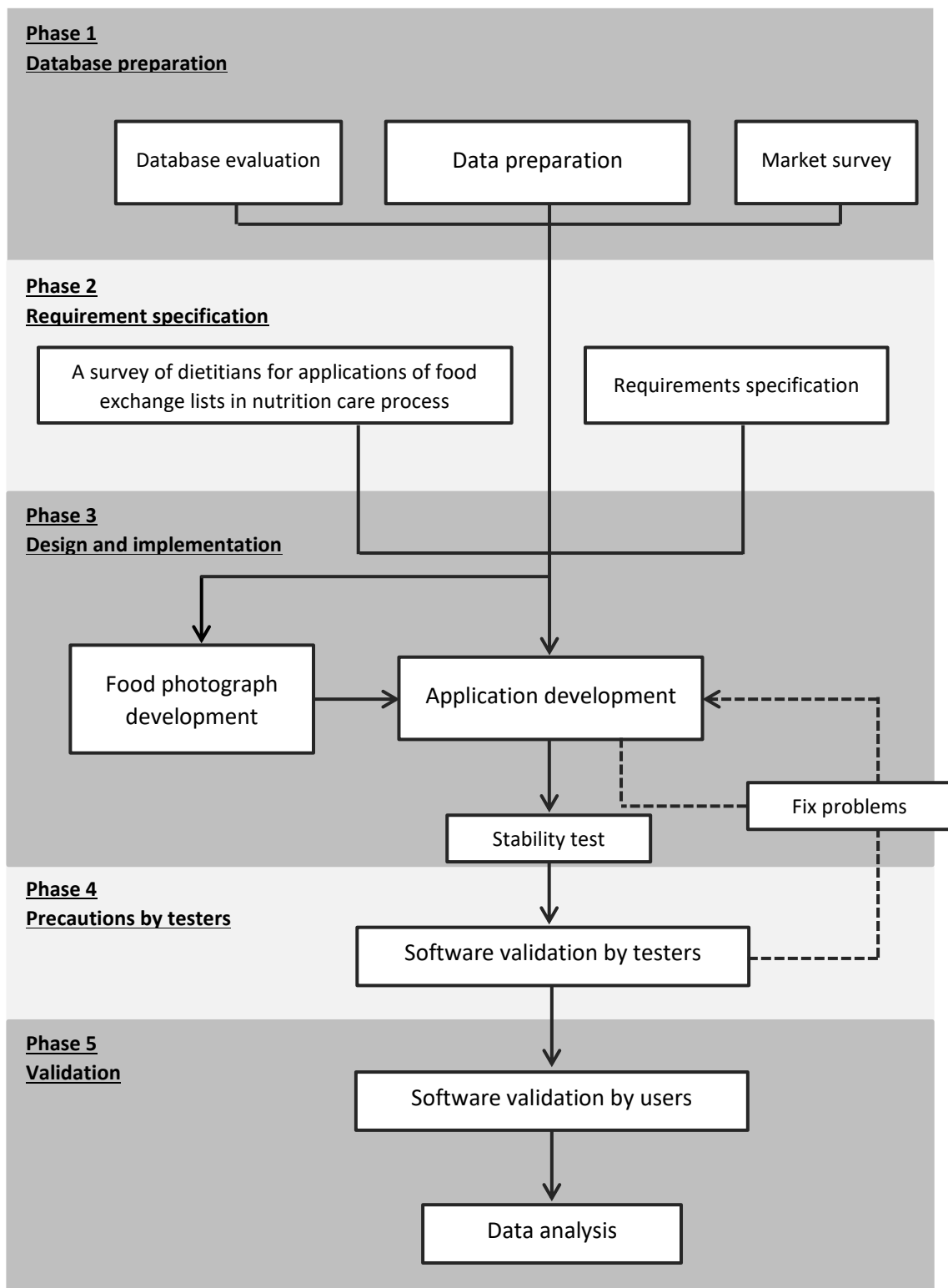
Figure 3 A study design for the mobile nutrition application development

3.1.2.7.3. In order to support the functions in the developed application for providing nutrition information beyond macronutrients defined in TFEL and TFBGD, the surrogate values of energy and 19 nutrients in each food group calculated from the food items described in each food group based on Thai FEL and Thai FBDG (3.1.2.7.1 and 3.1.2.7.2) were developed as a model in this study using the nutrients profiles from the INMUCAL food databases version 4.0 as following steps (Figure 4).

3.1.2.7.3.1. Lists of food items in each food group of Thai FEL and Thai FBDG were prepared as mentioned in 3.1.2.7.1 and 3.1.2.7.2 Raw weight and cooked weight at one portion size reported from either Thai FEL or Thai FBDG were used to determine energy nutrient contents depending upon the source indicated.

3.1.2.7.3.2. Energy and 19 nutrients including carbohydrate, protein, total fat, saturated fat, cholesterol, dietary fiber, sugar, five vitamins (vitamin A, thiamin, riboflavin, niacin, vitamin C), and seven minerals (calcium, phosphorus, potassium, sodium, cupper, iron, zinc) in each food item per portion size were investigated from the food databases available in the INMUCAL program.

3.1.2.7.3.3. The calculations of energy and nutrient value were performed separately between Thai FEL-

based application and Thai FBDG-based application.

3.1.2.7.3.4. Then, the median values of energy and nutrients from these food items in each food group were used as the surrogate values for calculating energy and nutrients when users choose a function with the Thai FEL-INMUCAL database or the Thai FBDG-INMUCAL database in the NDPro application.

3.1.2.7.3.5. For Thai FEL-based application, it included 16 subgroups, including starches, meat (very low fat), meat (low fat), meat (medium fat), meat (high fat), vegetables type 1, vegetables type 2, fruits, whole milk (regular), milk (low fat), milk (skim milk), milk (evaporated), milk powder (regular), milk powder (none fat), fat (MUFA / PUFA), and fat (SFA). For Thai FBDG-based application, it included 11 subgroups, including cereals (cooked rice/noodle), cereals (rice glutinous), cereals (bread), meat (meat), meat (soybeans), meat (egg), vegetables, fruits, whole milk (regular), milk (low fat), and fat (oil, butter).

3.1.2.7.4. Energy and nutrient profiles of one meal dishes commonly consumed by Thai people which were published in Thai food composition tables 2015 [72].

3.1.2.7.5. Energy and nutrient profiles of chili pastes commonly consumed by Thai people were collected from a book of

The 84 menu of chili paste and Vegetable for health by Ministry of Public Health [73].

3.1.2.7.6. Energy and nutrients of food products and products related to nutrition sold in the markets were obtained by the market survey as follows.

    3.1.2.7.6.1. Food products were collected from a total of six food markets including three minimarts and three supermarkets around Chulalongkorn university.

    3.1.2.7.6.2. Dietary and nutrition information regarding energy, nutrients, brand names, and serving sizes displayed on food labels and nutrition facts were recorded and verified before installation in the developed application.

    3.1.2.7.6.3. Food products were categorized into 13 groups. If some nutrients were not reported from manufacture's labels, such nutrients were set as zero.

        1. Bakery products

        2. Cereal products

        3. Snack products

        4. Ice cream products

        5. Ready-to-eat chilled and frozen products

        6. Semi-finished and ready-to-eat products

        7. Milk and dairy products

        8. Grain, legume, nut-based beverage products

         9. Beverage products (ready-to-eat)

         10. Beverage products (dried powder)

         11. Beverage additive products

         12. Condiment products

         13. Food supplement products

3.1.2.7.6.4. Nutrient profiles and alcohol contents of alcoholic beverages displayed on the labels of packaging were collected and added into the databases, and their predicted carbohydrate content are according to Franz MJ (1990) [42] (Table 2).

3.1.2.7.6.5. The information on food labels, energy, and nutrients on nutrition facts of nutrition oral supplement (NOS) products, enteral nutrition products, and parenteral nutrition products were included directly into the databases of the developed application. If some nutrients were not reported from manufacture's label, such nutrients were set as zero.

3.1.2.7.7. Nutrients and information related to applications of peritoneal dialysis solution products available in Thailand were included into the developed application using manufacture's information leaflet. If some nutrients were not reported from manufacture's label, such nutrients were be set as zero.

3.1.2.7.8. Fatty acid compositions and cholesterol contents in foods and oil were obtained from a book of "Fatty acids and

cholesterol in Thai foods 2002" [74]. and "Cholesterol and fatty acids in Thai foods 2004" by Ministry of Public health [75].

3.1.2.7.9. Folic acid in foods were obtained from a book of "Food composition table of Thai foods" [72].

3.1.2.7.10. Food items in the subgroup "protein free rice-starchy food" under the cereal food group were developed for providing databases for some circumstance, for example, planning low protein diet. Based on the Notification of the Ministry of Public Health (No. 182) B.E. 2541 (1998) Re: Nutrition Labelling Annex 1, the criteria of displaying the quantity of protein as zero was less than 0.5 gram per serving size [44]. Therefore, this study considered any starchy food items containing protein less than 1% (1 gram per 100 grams of food) as "protein free rice-starchy foods".

```
┌─────────────────────────────────────────────────────────────────────┐
│          Setting up the surrogate values of energy and nutrients      │
└─────────────────────────────────────────────────────────────────────┘
```

Thai FEL-based NDPro application	Thai FBDG-based NDPro application

Food items and their portion sizes reported in 6 food groups (16 subgroups) of Thai FEL list were collected.	Food items and their portion sizes reported in 6 food groups (11 subgroups) of Thai FBDG were collected.

Investigated nutrients:

(Carbohydrate, protein, fat, saturated fat, cholesterol, dietary fiber, sugar, vitamin A, thiamin, riboflavin, niacin, vitamin C, calcium, phosphorus, potassium, sodium, cupper, iron, and zinc)

Dietary values of collected food items at one portion size were calculated using the food databases available in the INMUCAL program.

Median values of 16 food subgroups were used as the surrogate values in the database for calculating energy and nutrients when users choose a function with the Thai FEL-INMUCAL database in the application	Median values of 11 food subgroups were used as the surrogate values in the database for calculating energy and nutrients when users choose a function with the Thai FBDG-INMUCAL database in the application

Figure 4 Calculating nutrient values of food exchange list using INMUCAL database.

3.2. Phase 2 Software requirements specification

3.2.1. **Objective:** To determine sources and extent of information to be used in the developed application.

3.2.2. **Method:** Details including goal, users, user interface, functions, platform, and data sources were determined. This application would be developed in android platform development using Android studio version 3.3.2 for Windows.

    3.2.2.1. Application program interface (API) level 15 was set at the beginning of development. It means that all devices using android system can use this the developed application. This application aimed to facilitate users to perform dietary recall by integrating the food exchange list and digital PSMAs. Therefore, this application can help users to calculate dietary requirement and consumption from respondents. The features of the developed application include following:

        3.2.2.1.1. Allowing users to fill out the assessment date and personal information, for example name, age, gender, body weight, height, health conditions, stress factors, physical activity.

        3.2.2.1.2. Allowing users to select adjusted body weight, actual body weight, and ideal body weight.

        3.2.2.1.3. Allowing users to select or adjust predicted energy requirement equations and nutrient requirement distributions.

        3.2.2.1.4. Allowing users to select types of food and portion sizes properly, as well as sub-portion sizes of each food item based on Thai food exchange list.

        3.2.2.1.5. Allowing users to select types of food and portion sizes properly, as well as sub-portion sizes of each food item based on Thai food based dietary guidelines (Nutrition flag).

3.2.2.1.6. Allowing users to select sources of nutrition references including Thai DRI 2020, Thai RDI 1998, and IOM 2005 [32, 44, 56].

3.2.2.1.7. Providing the information of one-meal dishes which could not be estimated portion sizes easily by the traditional food exchange list.

3.2.2.1.8. Providing the information of varieties of food products available in food markets as mentioned in 3.1.2.7.6.1 to 3.1.2.7.6.4 to perform dietary intake.

3.2.2.1.9. Providing the information of nutrition oral supplements, enteral nutrition products, and parenteral nutrition products to perform dietary intake.

3.2.2.1.10. Providing the information of peritoneal dialysis solution products to perform energy and nutrient intake.

3.2.2.1.11. Providing food photographs as the PSMAs to perform dietary assessment.

3.2.2.1.12. Allowing users to search for food items or products to quickly obtain information.

3.2.2.1.13. Allowing users to create accounts for recording weight, along with the results of dietary recall to help users for monitoring the results.

3.2.2.1.14. Calculating and reporting BMI, ideal body weight, energy and nutrient requirements from the input data by selected equations.

3.2.2.1.15. Calculating and reporting energy and nutrient intakes from food databases.

3.2.2.1.16. Calculating and reporting amounts of macronutrients based on selected macronutrient distribution.

3.2.2.1.17. Displaying first three menus that contain highest values of each nutrient to help users to consider which foods should be avoided when excess of some nutrient intakes such as energy, fat, sodium, or sugar.

3.2.2.1.18. Providing functions could record nutrition diagnosis, nutrition intervention, nutrition prescription, goals, action plans, follow up, and nutrition monitoring and evaluation for supporting dietitians as a part of the nutrition care process.

3.2.2.2. Apart from specifications determined initially by a developer, further functions and attributes were obtained from the survey of Thai registered dietitians related to behaviors, attitudes, and opinions on food items, dietary assessment method, and functions preferred to be included in the developed application for the nutrition counselling as follows.

3.2.2.2.1. A developed questionnaire consisted of three parts (APPENDIX I).

Part I : General information: gender, age, religions, education, occupation, working place, areas of specialist, years of work experience.

Part II : Dietitians' behaviors on dietary assessment: numbers of clients serviced per day, commonly used dietary assessment methods and tools, time usage for estimating and calculating nutrient intakes, information

management system, limitations of calculating, recording, and accessing the individual nutrition history (15 items).

Part III : Dietitians' attitudes toward numbers of clients serviced per day, time usage for estimating and calculating nutrient intakes, errors in dietary assessment, outcomes of dietary and nutrition intake for supporting nutrition counselling, technology in aiding dietary assessment and evaluation (10 items).

3.2.2.2.2. Questionnaires were validated by three experts in the fields related to nutrition and dietetics. The content of validity indexes including item-level (I-CVI) and scale-level (S-CVI) were calculated for each item. The relevance of each item was evaluated based on a 4-point scale (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant). The I-CVI and S-CVI values of 0.5 and above, and 0.8 and above were acceptable, respectively. Comments related to any limitations of using the Thai food exchange list and performing dietary recall were included for consideration.

3.2.2.2.3. An online form of the validated questionnaire was created and validated again by the same three experts by following the procedure in 3.2.2.2.2 before using in Phase 5.

3.3. Phase 3 Development phase: Design and implementation

3.3.1. **Objective:** To develop the mobile application named "NDPro" according to the requirement specification in Figure 2.

3.3.2. **Concept:** The concept of development was shown in Figure 5, the developed application relied on the food exchange lists rather than information values from databases. However, information values from databases remained being used. Instead of adding entire databases into the application, only some food items commonly consumed by Thai people were selected and added into the application. The expectation was that this concept might be able to solve the problems found in database-dependent applications and corresponded to dietitian practice based on Thai food exchange list mainly. It meant that the developed application could assess nearly all food items and provide a representation of their actual composition, which was previously impossible with the database-dependent applications.
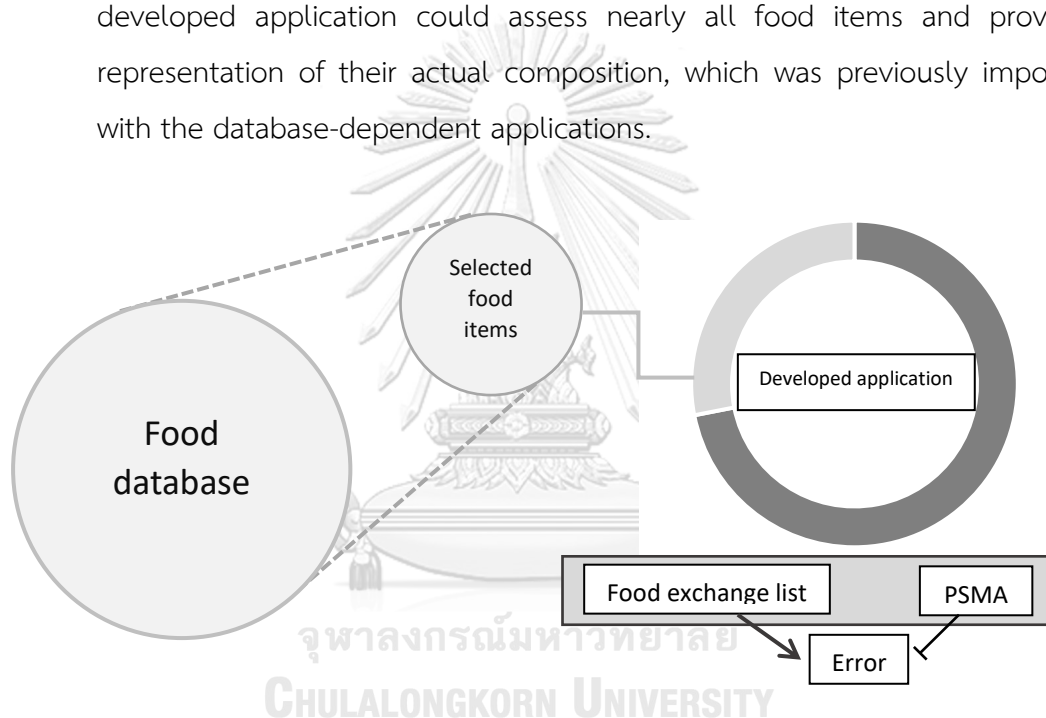
Figure 5 A concept of the developed application

3.3.3. **Methods:** The applications were developed collaboratively with the experts. Any problems found during this phase were fixed.

3.3.3.1. The user interface and functions of the application were developed as shown in Figure 6 to Figure 13.

3.3.3.2. Food photographs were developed as portion size measurement aids (PSMAs). PSMAs from each of food group consisted of 8 sub-group and 43 food items, bases on their different expressions as follow.

3.3.3.2.1. PSMAs consisted of five photographs of ingredients or foods after cooking revealing four levels of portion sizes (1, 2, 3 and 4 portion size), and one photograph revealing a half level of portion size based on the portion sizes obtained from Thai FEL and Thai FBDG.

3.3.3.2.2. Foods were displayed on different types of containers including dishes, glasses, spoons, and teaspoons.

3.3.3.2.3. Containers were placed on a white background with a scale bar to help users to estimate portion sizes.

3.3.3.2.4. Photographs were taken at the view of angle of 45°C by camera from iPhone 7 smartphone. The images were color digital with the size of 2048 px width and 1536 px height.

3.3.3.3. All scientific information in Phase 1 used in the NDPro application were validated. A questionnaire along with the NDPro application installing on the tablet were submitted to three experts in the fields related nutrition and dietetics for evaluation. The content of validity indexes including I-CVI and S-CVI were calculated for each item. The relevance of each item was evaluated based on a 4-point scale as described in 3.2.2.2.2. The I-CVI and S-CVI values of 0.5 and above, and 0.8 and above were acceptable, respectively.

3.3.3.4. A questionnaire for investigating the satisfaction of participants toward the NDPro application was developed. It consisted of two parts. The first part investigated users' experience using a short version of the User Experience Questionnaire (UEQ-S) which scores ranged from -3 to +3 transferred to score range from 1 to 7 for calculation. The second part asked respondents to rate the usefulness of each component of the NDPro application using a scale ranging from not very useful (1) to very useful (5) (APPENDIX J). The validation of the questionnaire was performed by sending it to three experts in the field of nutrition and dietetics for evaluation. The I-CVI and S-CVI were calculated for each

item with the relevance of a 4-point scale and the acceptable cut-off scores as mentioned above.

An online form of the validated questionnaire was created and validated again by the same three experts by following the procedure as mentioned above before using in Phase 4 and Phase 5.

3.3.3.5. To determine the stability of the developed application, its ability to provide the same results from triplicate data of twelve meals from the food photographs prepared by a researcher in either Thai FEL based NDPro application (Control 1_{FEL} & NDP 1_{FEL}) or Thai FBDG based NDPro application (Control 1_{FBDG} & NDP 1_{FBDG}) were investigated.
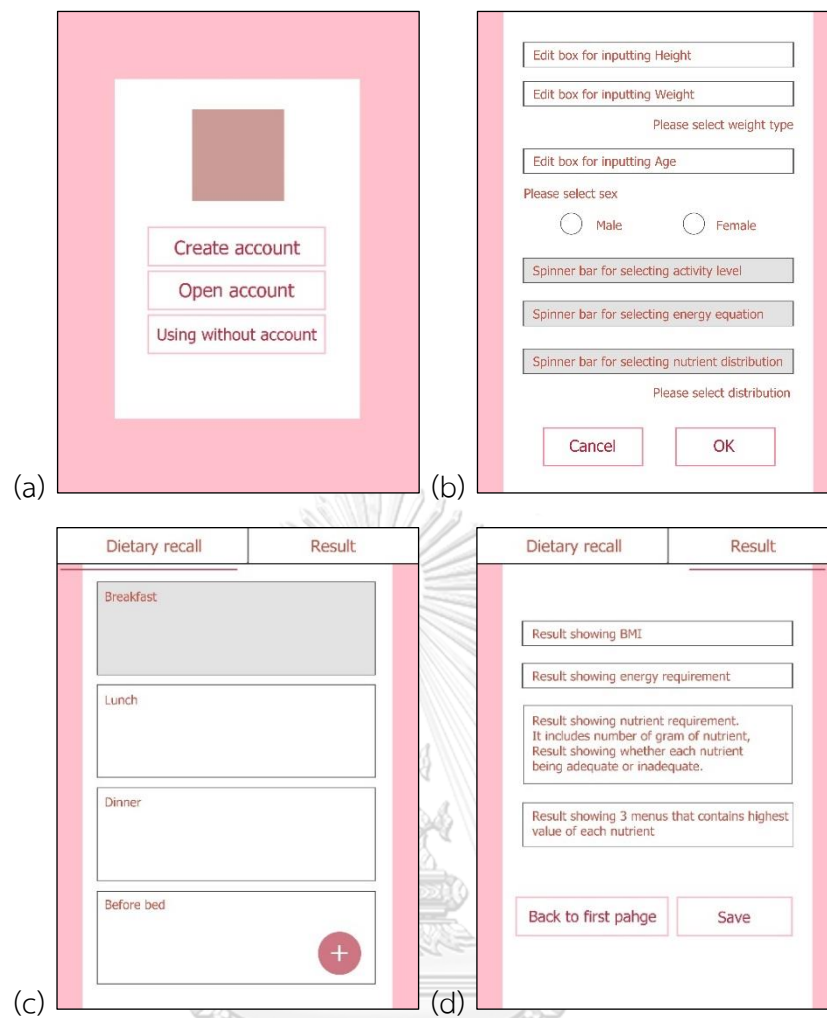
(a) The developed application consisted of four main pages, first page contains three buttons including buttons for creating new account, opening saved accounts, and using application without using saved accounts.

(b) Second page had feature to input information including height, weight, age, sex, energy requirement, and nutrient distribution.

(c) Third page was a page for performing dietary recall.

(d) Last page was a page showing the results.

Figure 6 A design of the NDPro application for creating main pages.
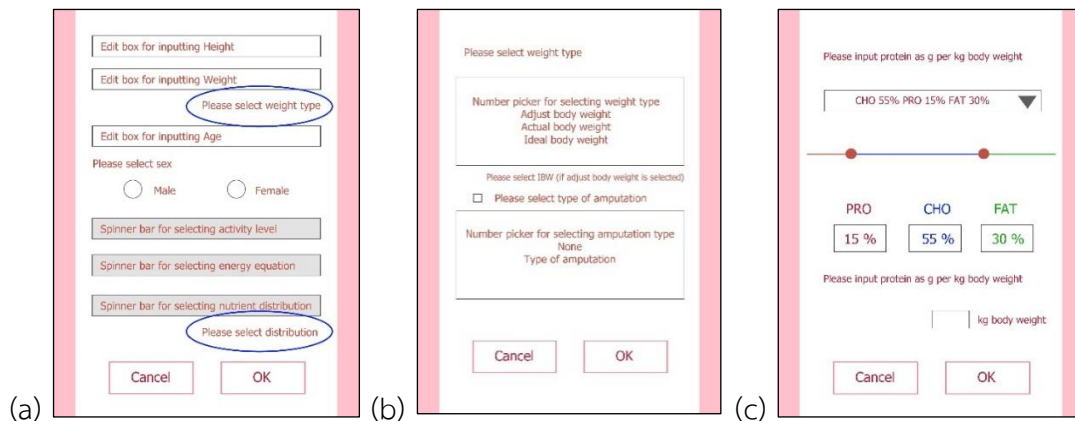
(a) At the main second page, there were options to change weight types and nutrient distributions.

(b) Clicking at TextView "Please select weight type" to open the page that contained two NumberPickers. First one contained weight types including adjusted body weight, actual body weight and ideal body weight (IBW). There were three types of ideal body weight. Firstly, IBW calculated from height – 100 (male) or 110 (female). Secondly, IBW calculated from BMI equals 21. Lastly, IBW based on the Hamwi equation (1964) (Men: 106 pounds for first 5 feet of height and 6 pounds per inch over 5 feet; or 6 pounds subtracted for each inch under 5 feet; Female: 100 pounds for first 5 feet of height and 5 pounds per inch over 5 feet; or 5 pounds subtracted for each inch under 5 feet) [76] [37]. The application asked further about IBW when users select adjust body weight through TextView "Please select IBW". Second NumberPicker contained types of amputation to determine weight loss from amputation based on the recommendation [71] [37].

(c) Clicking at TextView "Please select nutrient distribution" to open the page that users could change nutrient distribution. At the top of the page, there was a spinner that users could quickly assess the saved options. Below the spinner, there were tools for adding new nutrient distribution including SeekBar, EditBox for inputting distribution as the percentage and EditBox for inputting protein as gram per kilogram body weight. Changing values in one tool would affect values displayed on other tools.

Figure 7 A design of the NDPro application for entering personal information, body weight, and macronutrient distribution data
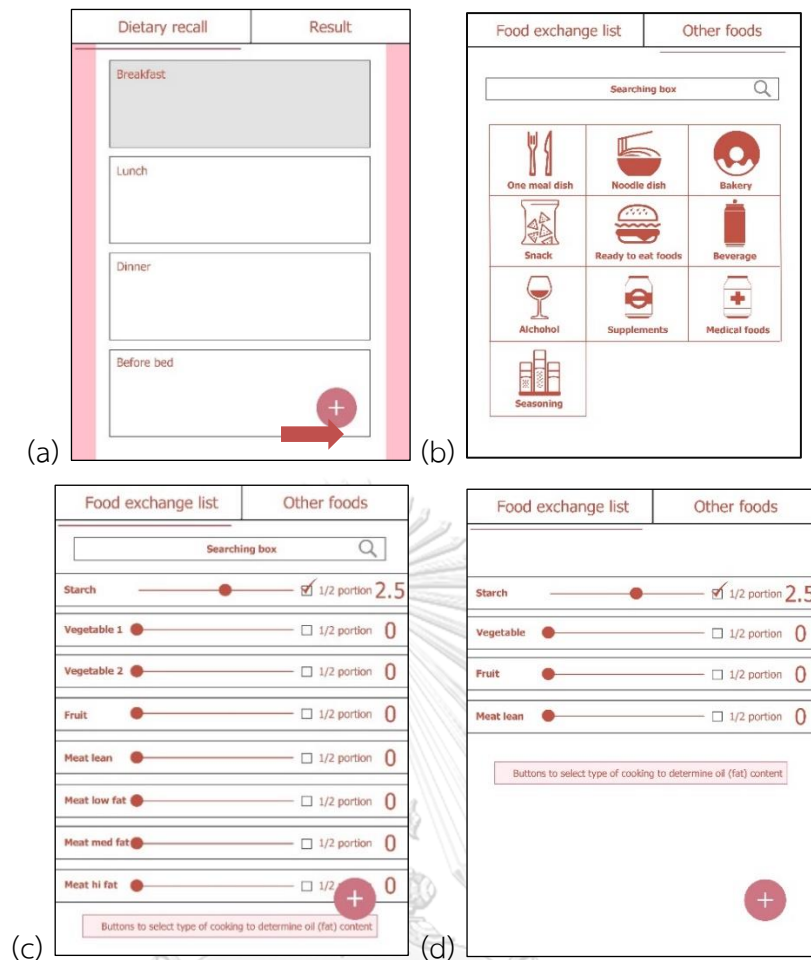
(a) At the top of page of the dietary recall, there was a tab which users could switch between "Food exchange list" and "Other foods". Clicking a floating action button at the right bottom (red arrow) would open the page for inputting menu.

(b) Tab "Other foods" contained food items from databases.

(c) After clicking the floating action button, the page for inputting menu would open. This page contained a list of seek bars for inputting amounts of portion sizes from each food group and checked boxes to input a half of portion size. Below these tabs, there was a search box. At the bottom of the page, there was a list of buttons to select types of cooking methods to determine oil content that such cooking methods should have.

Figure 8 A design of the Thai FEL-based NDPro application for selecting types of foods and portion sizes of each food item based on Thai food exchange list
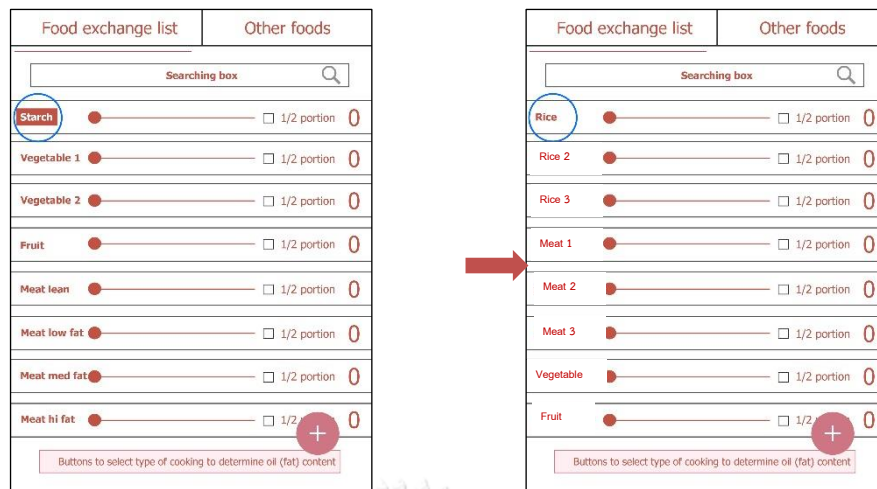
There were two user interfaces based on the sources of food exchange lists.

(a) User interfaces when Thai food exchange lists was selected [10].

(b) User interfaces when Thai food based dietary guideline was selected [11, 12, 21].

Figure 9 A design of the Thai FEL-based NDPro application and Thai FBDG-based NDPro application for selecting types of foods and portion sizes of each food subgroup.
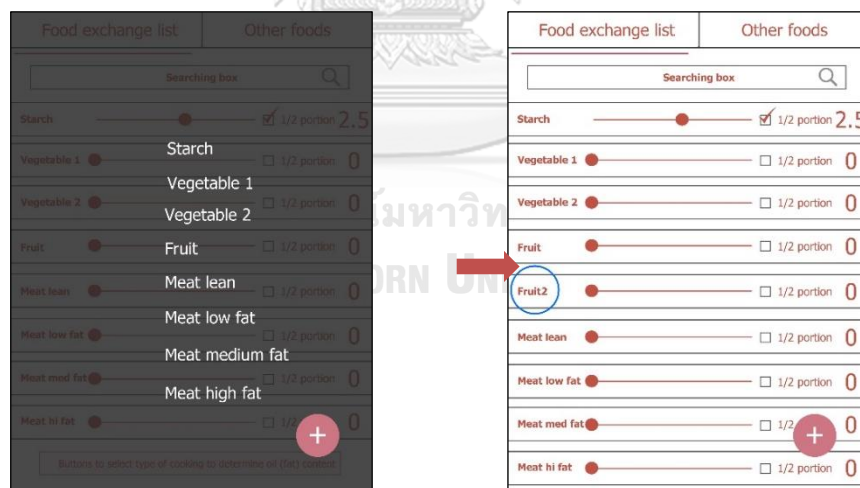
In the case that there were two or more subgroup foods were consumed at the same time. For example, banana and apple were consumed at breakfast. Clicking a floating action button on tab "Food exchange list" could allow users to add more food items. The names of added lists were set as shown in the figure. Users could change the default food names to the specific names later.

Figure 10 A design of the Thai FEL-based NDPro application for selecting types of foods and portion sizes in the same food subgroup

(a) When Thai food exchange list was selected, user interface showed a searching box that users could search for the types of meat and vegetables.

(b) Clicking food items showing in a search box allowed users to add more food items. The names of added lists would be set as the names of selected foods, but it could be changed by users later. Users could change the default food names to the specific names later.

Figure 11 A design of the Thai FEL-based NDPro application for selecting types of foods and portion sizes of each food subgroup
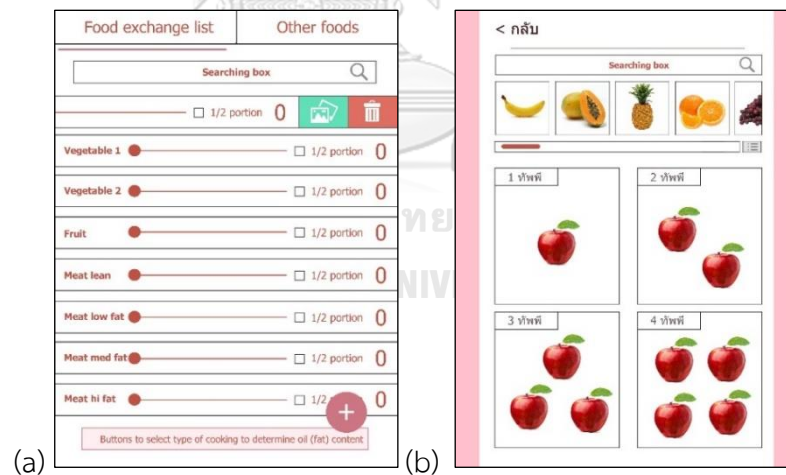
(a) In tab "Food exchange list", each food item could be swiped to use more features. They included opening PSMAs and deleting such food items.

(b) Opening PSMAs, application would show users with food photographs of such food subgroups that users could show them to their respondents. Food photographs would present with five portions (one to four portion size and one sub-portion). At the top of the page, there were a search box and lists of other subgroups food items that allowed users to easily assess other subgroups food items. The lists could be presented as either picture lists or text lists.

Figure 12 A design of the Thai FEL-based NDPro application for working on PSMAs

(a) After adding food items, the menus recording information would be added into the page of dietary recall. "Menu with the number" was the default name of the added menu but users could change it later. Also, among of dishes would present as "x number" which users could change them later.

(b) In the case that respondents reported that they consumed same menu across two meals, users could select, drag, and copy such menus into other meals.

Figure 13 A design of the NDPro application for recording dietary recall

3.4. Phase 4 Precautions phase by testers

3.4.1. **Objective:** To ensure that the developed application did not have any error when it was used.

    The experiment of this phase imitated the process of validation phase (phase 5) with a small sample size. Any issues found during this phase were considered to develop the dietary assessment application. After the problems was not found, the study stepped into the validation phase.

3.4.2. **Subjects:** The developed application was evaluated in practice by five registered dietitians who had experience in hospitals more than one year and willed to participate the validation. Inclusion and exclusion criteria were showed in Table 15.

Table 15 Inclusion and exclusion criteria for enrolling subjects

Inclusion criteria	Exclusion criteria
1. Registered dietitians under Bureau of Sanatorium and Art of Healing, Ministry of health, Thailand or dietitians certified by Thai Dietetic Association 2. Individuals having experience of counseling and nutrition care process for more than 1 year	1. Individuals lacking the nutrition counseling experience 2. Individuals unable to use a smartphone or a tablet either due to physical disabilities or lack of skills 3. Individuals having visual problems except myopia (nearsightedness), hyperopia (farsightedness) and astigmatism which were corrected by eyeglasses, contact lenses or surgery 4. Individuals having brain and neurological disorders which affected memory, decision making and calculation 5. Individuals who did not participate the validation at least once

3.4.3. **Methods:**

3.4.3.1. All eligible participants were invited into an experimental room at Chulalongkorn university. They received an information sheet and consent form. The consent form was submitted after signing. A tablet (HUAWEI MatePad T 10s) installing the NDPro application was used for validation.

3.4.3.2. Participants were invited to complete an online questionnaire for investigating behavior and attitude of dietitians toward dietary assessment, a part of the nutrition care process. The online questionnaire was comprised of three parts including "General information part" (10 questions), "Behavior toward nutrition care

process part" (15 questions), and "Attitude toward nutrition care process part" (10 questions). A link of the online questionnaire was sent to all participants through the Line application. The questionnaire did not require participants to fill out their names. It took approximately 15 – 20 minutes to complete the online form. While completing the online questionnaire, a researcher was available to provide the information if participants had any questions.

3.4.3.3. The validation of reliability and stability of the NDPro application was performed by the process in Figure 14 including estimations of food portions displayed in food photographs using Thai FEL or Thai FBDG and calculation of energy and macronutrients by dietitians manually or the NDPro application. The validation process lasted for four consecutive days.

    3.4.3.3.1. The first day (Day 0), participants were trained with a researcher to use the NDPro application and to perform the validation process. Training lasted for approximately 2 hours. All participants were allowed to keep the tablet for 2 days for self-training.

    3.4.3.3.2. Each day of validation (Day 1 to Day 3), each participant received an information sheet (ND-01/64), five evaluation forms (ND-02/64 to ND-06/64), a set of food photographs based on Thai FEL and a set of food photographs based on Thai FBDG.

        1) ND-01/64 An Information sheet explaining the process of dietary assessment using the NDPro application either Thai FEL based application or Thai FBDG based application and performing by dietitians manually.

        2) ND-02/64 An evaluation form for recording dietary intake assessment based on Thai FEL and Thai FBDG.

3) ND-03/64 An evaluation form for recording energy and amounts of macronutrients per serving size based on Thai FEL and Thai FBDG defined by dietitians.

4) ND-04/64 An evaluation form for recording dietary intake and results from calculating total energy and amounts of macronutrients based on Thai FEL by dietitians.

5) ND-05/64 An evaluation form for recording dietary intake and results from calculating total energy and amounts of macronutrients based on Thai FBDG by dietitians.

6) ND-06/64 An evaluation form for recording results from calculating total energy and amounts of macronutrients by using the NDPro application.

7) Two same menu sets of food photographs were prepared based on 2,000 kcal per day by one set using portion sizes of food items from the Thai FEL and another using portion sizes of food items from Thai FBDG. The distributions of carbohydrate, protein, and fat were 55%, 15%, and 30%, respectively. Each set of food photographs consisted of three day menu sets with four meals per day including breakfast, lunch, break, and dinner. Each meal was presented to participants by three photographs with three different points of view. Therefore, each set of food photographs contained twelve meals with thirty-six images. Totally twenty-four images were used (for validation; twelve meals for Thai FEL validation and twelve meals for Thai FBDG validation). Food items of food photographs were

different across three consecutive days. All participants received the same sets of food photographs. A pattern of food photographs were shown to participants as Figure 15 and APPENDIX H.

3.4.3.3.3. The validation process in each day was run in five steps as follows. A researcher used a clock application from smartphone (iPhone 13 Pro) to record time spending in all experiment. A starting time was defined by a researcher, but an ending time depended upon the performances of participants. Five minutes of resting periods were given between consecutive steps. Validation was expected to last for approximately one hour discrepancy individually. Participants who are not able to participate in the validation at least once were excluded from this study.

3.4.3.3.3.1. **Step I**: Participants estimated amounts of foods displaying on the food photographs based on the portion size of Thai FEL or Thai FBDG and recorded the results in the evaluation form ND-02/64. Total time spending for estimating dietary intake from each set of food photographs were recorded in the evaluation form ND-02/64.

3.4.3.3.3.2. **Step II**: Participants were required to recall the reference values of energy and macronutrients defined in Thai FEL and Thai FBDG based on their own memory and filled up the evaluation form ND-03/64. The recalled reference values were used for calculating total calories and

amounts of macronutrients per day in the Step III and Step IV individually.

3.4.3.3.3.3. <u>**Step III**</u>: Participants were asked to copy the portion sizes based on Thai FEL of all meal recorded in the evaluation form ND-02/64 into the evaluation form ND-04/64. Total calories and amounts of macronutrients per day were calculated with the recalled reference values by participants themselves or using a calculator as desire. However, participants were not allowed to look at the reference except for the evaluation form ND-03/64. The results and total time spent for calculating were recorded in the evaluation form ND-04/64.

3.4.3.3.3.4. <u>**Step IV**</u>: Participants were asked to copy the portion sizes based on Thai FBDG of all meal recorded in the evaluation form ND-02/64 into the evaluation form ND-05/64. Total calories and amounts of macronutrients per day were calculated in the same way as mentioned in Step III. The results and total time spent for calculation were recorded in the evaluation form ND-05/64.

3.4.3.3.3.5. <u>**Step V**</u>: At the final step of validation, participants activated the NDPro application installed in the tablet and evaluated two sets of food photographs from portion sizes recorded in the evaluation form ND-02/64. After all participants selected the functions designed for

calculating energy and nutrients based on the databases collected from Thai FEL or Thai FBDG a researcher started counting time. Based on the food photographs provided and functions of the NDPro application, participants were required to set up four meals for filling food items and filled in only numbers of portion sizes in each food group displaying on the applications. Total calories and amounts of macronutrients per day were calculated automatically. The results and total time spent for calculation were recorded in the evaluation form ND-06/64.

3.4.3.3.3.6. At the end of Day 3, participants were invited to complete a satisfaction questionnaire to obtain their acceptability and commentaries related to functionalities, usability, information, and data managements of the NDPro application. It comprises of three parts including "General information part" (10 questions), Short version of the User Experience Questionnaire (UEQ-S) [77] (26 questions), and "Satisfaction and commentary toward the developed application part" (6 questions). If participants had any questions while filling in the questionnaire, they could ask a researcher for suggestion. The questionnaire did not require participants to fill out their names. It took approximately 10 – 20 minutes to complete the form.

3.4.3.3.4. To determine the stability of the developed application by participants, its ability to provide the same results from triplicate data of twelve meals from the food photographs prepared by a researcher and estimated and inserted by five participants in either Thai FEL based NDPro application (Control 2_{FEL} & NDP 2_{FEL}) or Thai FBDG based NDPro application (Control 2_{FBDG} & NDP 2_{FBDG}) were investigated.

3.4.3.3.5. Any errors and problems from using the NDPro application reported during this phase were fixed and the activities in the precaution phase were repeated. The study would step into the validation phase (Phase 5) when errors and problems are not further reported during this phase.

3.4.4. Ethical consideration:

All participants were provided with information sheets and agreed to participate in this study by giving written informed consent. This protocol was submitted to the Research Ethics Review Committee for Research Involving Human Research Participants, Group 1, Chulalongkorn University for approval (Protocol number 152.1/2564 and Date of approval 27 June 2022).

| N = 5 | → | Day 0 | → | Thai FEL validation Day 1 | → | Thai FEL validation Day 2 | → | Thai FEL validation Day 3 |

Training

| Four meals of food photograph (Thai FEL) Day 1 | Four meals of food photograph (Thai FEL) Day 2 | Four meals of food photograph (Thai FEL) Day 3 |

| Estimation food photographs from own experience based on Thai FEL (4 meals with 12 food images) (MN$_{FEL}$) | Estimation food photographs from own experience based on Thai FEL (4 meals with 12 food images) (MN$_{FEL}$) | Estimation food photographs from own experience based on Thai FEL (4 meals with 12 food images) (MN$_{FEL}$) |

| Estimation using Thai FEL based NDPro application (NDP$_{FEL}$) | Estimation using Thai FEL based NDPro application (NDP$_{FEL}$) | Estimation using Thai FEL based NDPro application (NDP$_{FEL}$) |

| Thai FBDG validation Day 1 | Thai FBDG validation Day 2 | Thai FBDG validation Day 3 |

| Four meals of food photograph (Thai FBDG) Day 1 | Four meals of food photograph (Thai FBDG) Day 2 | Four meals of food photograph (Thai FBDG) Day 3 |

| Estimation food photographs from own experience based on Thai FBDG (4 meals with 12 food images) (MN$_{FBDG}$) | Estimation food photographs from own experience based on Thai FBDG (4 meals with 12 food images) (MN$_{FBDG}$) | Estimation food photographs from own experience based on Thai FBDG (4 meals with 12 food images) (MN$_{FBDG}$) |

| Estimation using Thai FBDG based NDPro application (NDP$_{FBDG}$) | Estimation using Thai FBDG based NDPro application (NDP$_{FBDG}$) | Estimation using Thai FBDG based NDPro application (NDP$_{FBDG}$) |

Figure 14 Validation procedure in Phase 4

Br			
L			
Sn			
D			

Br = Breakfast L = Lunch Sn = Snack D = Dinner

Figure 15 Examples of one day meal food images presented to participants (APPENDIX H).

3.5. Phase 5 Validation phase

3.5.1. Objectives:

a) To evaluate whether the NDPro application either Thai FEL based application or Thai FBDG based application functioned properly and analyzed the results of energy and macronutrient intakes accurately when compared with the reference values and the results calculated manually by dietitians.

b) To evaluate whether dietary assessment conducted by using the NDPro application requires significant less time consuming compared with that performed by dietitians manually.

c) To evaluate the satisfaction of dietitians with the NDPro application.

Software validation focused on the accuracy in the term of reliability referring to the degree of relationship between application's outcomes and reference value. The results of energy and nutrient intake calculated by the Microsoft excel from serving sizes of cooking ingredients estimated by a researcher and databases per serving size in each food groups installed in the NDPro application were considered as the reference value (see 3.6.).

3.5.2. Subjects:

The sample size was calculated according to the formula of Cochran (1977) by using the results from previous study of Ainaa Fatehah, A., et al. (2018) who reported the accuracy of the ability of nutritional professionals to identify food item and estimate portion size from food photographs [78]. In this study, they reported that thirty-eight nutritionists, dietitians, and nutrition researchers could estimate portion size from food photographs presented on plates and bowls equally 47.6 ± 21.2 % and 44.3 ± 16.6 % of actual weight, respectively. The comparison did not show significant difference between the results from food photographs presented on plates and bowls. Therefore, standard deviations of from food photographs presented on plate were used to estimate the sample size at power 95% as shown in following formula.

$$n = \frac{\sigma^2 Z^2}{e^2}$$

When;   n = number of dietitians

σ = 21.2

Z = the abscissa of the normal curve that cuts off an area α

at the tails which equal to 1.96 (at α = 0.05)

e = the desired level of precision which equal to 5

$$n = \frac{(21.2)^2\,(1.96)^2}{5^2}$$

n = 69

An additional 10% sample size was preserved for drop out, therefore sample size in this study was equal 76. Total seventy-six individuals who pass inclusion criteria as showed in Table 15 were included into the validation phase.

3.5.3. Methods:

3.5.3.1. To recruit participants, a copy of an information sheet, a copy of poster, and five copies of screening form were sent to the nutrition department of forty hospitals in Bangkok and surrounding areas by email or posters. In case of sending by posters, participants also received the stamped document envelopes with written addresses that participants could send the screening forms back to the researcher. Alternatively, interested participants could also register online by scanning the QR code on poster.

3.5.3.2. When participants passed inclusion criteria, the researcher informed participants by email and submitted the letters to directors of their organizations for permission and support.

3.5.3.3. After enrolling the eligible participants and notifying them by email, the researcher visited all participants individually to provide an information sheet (ND-01/64), submitting a consent form, and collected the signed consent forms before starting the further process.
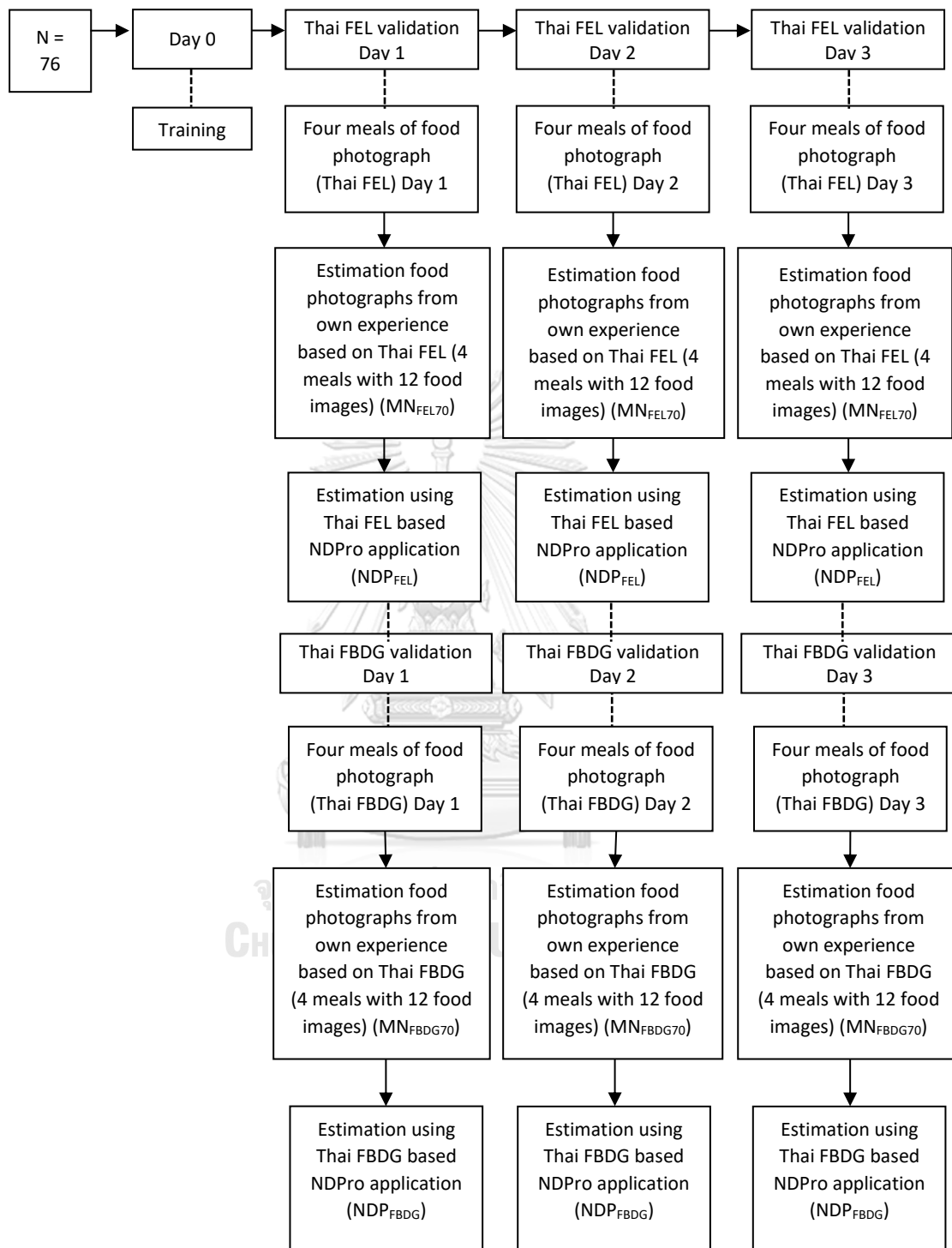
Figure 16 Validation procedure in Phase 5

3.5.3.4. Participants were invited to complete an online questionnaire for investigating behavior and attitude of dietitians toward dietary assessment, a part of the nutrition care process. A link of the online questionnaire was sent to all participants through email or the Line application as appropriate. The online questionnaire comprised of three parts including "General information part" (10 questions), "Behavior toward nutrition care process part" (15 questions), and "Attitude toward nutrition care process part" (10 questions). The questionnaire did not require participants to fill out their names. It took approximately 15 – 20 minutes to complete the online form. While completing the online questionnaire, the researcher was available to provide the information.

3.5.3.5. The validation of reliability of the NDPro application was performed by following the process of dietary assessment including estimations of food portions displayed in food photographs using Thai FEL or Thai FBDG and calculation of energy and macronutrients by dietitians manually or the NDPro application. The validation of reliability of the NDPro application lasted for four consecutive days.

3.5.3.6. On the first day (Day 0), each participant received a tablet (HUAWEI MatePad T 10s) installing a NDPro application and were trained with the researcher to use the NDPro application and to perform the validation process. Training lasted for approximately two hours. All participants were allowed to keep the tablet for 2 days for self-training. Then, participants had chance for self-training for 1 – 2 days before returning a tablets to the researcher on the day of validation.

3.5.3.7. On the day of validation (Day 1 to Day 3), each participant received a tablet installing a NDPro application (HUAWEI MatePad T 10s), five documents (ND-02/64 to ND-06/64) as mentioned in 3.4.3.3.2, and a set of food photographs based on Thai FEL and a set of food

photographs based on Thai FBDG. Each set of food photographs consisted of the food items for four meals including breakfast, lunch, break, and dinner. Food items were prepared based on 2,000 kilocalories with portion sizes defined by Thai FEL or Thai FBDG. The distributions of carbohydrate, protein, and fat as 55%, 15%, and 30%, respectively. Each meal was presented by photographs with three different points of view. Therefore, each set of food photographs contained twelve food photographs. Totally, twenty-four photographs were used for evaluation each time. Food items in food photographs were different across three consecutive days.

3.5.3.8. During validation, the participants estimated energy and macronutrients of food photographs. The validation process was run in five steps like performed in 3.4.3.3.3.1 to 3.4.3.3.3.6. A starting time was defined by the researcher, but an ending time depended upon the performances of participants. Five minutes of resting periods were given between consecutive steps. Validation was expected to last for approximately one hour discrepancy individually. Participants who were not able to participate the validation at least once were excluded from this study.

3.5.3.9. At the end of Day 3, each participant was invited to complete a satisfaction questionnaire as mentioned in 3.4.3.3.3.6 to obtain their acceptability and commentary related to functionalities, usability, information, and data managements of the NDPro application. If participants had any questions while filling in the questionnaire, they could ask a researcher for information. The questionnaire did not require participants to fill out their names. It took approximately 10 - 20 minutes to complete the form.

3.6. Data analysis

3.6.1. All statistical analysis was performed by using the Statistical Package for the Social Science for Windows (SPSS), version 29.0. The characteristics of participants were described as means, standard deviations (SD), and percentages. The accuracy of estimations and satisfactions were described as mean percentages, mean percentage difference and SD.

3.6.2. To determine accuracy of results calculated by participants' manually (MN_{FEL70} or MN_{FBDG70}, MN_{FBDG30}), total energy and amounts of three macronutrients recorded in Step III, based on Thai FEL or Thai FBDG were compared with the reference values calculated using Microsoft excel calculation program from either actual serving sizes prepared by the researcher (Control 1_{FEL} or Control 1_{FBDG}) or estimated serving sizes assessed by participants (Control 2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}) in Step I. Energy and amounts of three types of macronutrients per serving size used for calculating the reference values exactly followed values defined in the Thai FEL or Thai FBDG.

The percentage differences of total energy or amount of each macronutrient were calculated by the equation A to D as follows. The percentage difference within ±10% from the reference values calculated from the actual serving sizes prepared by a researcher (Control 1_{FEL} or Control 1_{FBDG}) or ±5% from the reference values calculated from the estimated serving sizes assessed by participants (Control 2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}) was acceptable.

Equation A

$$\% \text{ Difference of energy} = (\frac{Ep - Er}{Er}) \text{x } 100$$

E_p = Energy calculated by participants manually (MN_{FEL70} or MN_{FBDG70}, MN_{FBDG30})

E_r = A Reference value of energy calculated from actual serving sizes by a
researcher (Control 1_{FEL} or Control 1_{FBDG}) or estimated serving sizes by

participants (Control 2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}) using Thai FEL or Thai FBDG and calculated by Microsoft excel program

Equation B

$$\% \text{ Difference of carbohydrate} = (\frac{Cp - Cr}{Cr})x\ 100$$

C_p = Amount of carbohydrate calculated by participants manually (MN_{FEL70} or MN_{FBDG70}, MN_{FBDG30})

C_r = A Reference value of carbohydrate calculated from actual serving sizes by a researcher (Control 1_{FEL} or Control 1_{FBDG}) or estimated serving sizes by participants (Control 2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}) using Thai FEL or Thai FBDG and calculated by Microsoft excel program

Equation C

$$\% \text{ Difference of protein} = (\frac{Pp - Pr}{Pr})x\ 100$$

P_p = Amount of protein calculated by participants manually (MN_{FEL70} or MN_{FBDG70}, MN_{FBDG30})

P_r = A Reference value of protein calculated from actual serving sizes by a researcher (Control 1_{FEL} or Control 1_{FBDG}) or estimated serving sizes by participants (Control 2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}) using Thai FEL or Thai FBDG and calculated by Microsoft excel program

Equation D

$$\% \text{ Difference of fat} = (\frac{Fp - Fr}{Fr})x\ 100$$

F_p = Amount of fat calculated by participants manually (MN_{FEL70} or MN_{FBDG70}, MN_{FBDG30})

F_r = A Reference value of fat by calculated from actual serving sizes by a researcher (Control 1_{FEL} or Control 1_{FBDG}) or estimated serving sizes by

participants (Control 2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}) using Thai FEL or Thai FBDG and calculated by Microsoft excel program

3.6.3. To investigate the accuracy of results calculated by the NDPro application, total energy and amounts of three types of macronutrients calculated by the TFEL based NDPro application (NDP_{FEL70}) or the TFBDG based NDPro application (NDP_{FBDG70} or NDP_{FBDG30}) from estimated serving sizes assessed by participants in Step V were compared with the reference values calculated from estimated serving sizes assessed by participants and calculated using databases installed in NDPro application with the aid of Microsoft excel calculation program (Control 2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}).

The percentage difference of total energy or amounts of each macronutrient was calculated by the equation E to H as follows. Total energy or amount of each macronutrient calculated by the NDPro application (NDP_{FEL70} or NDP_{FBDG70}, NDP_{FBDG30}), and the Microsoft excel calculation program (Control2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30}) should not be difference.

Equation E

$$\% \text{ Difference of energy (NDPro)} = (\frac{E(np) - E(rm)}{E(rm)}) x\ 100$$

E_{np} = Energy calculated by the NDPro application (NDP_{FEL70} or NDP_{FBDG70}, NDP_{FBDG30})

E_{rm} = A Reference value of energy calculated from estimated serving sizes by participants using Microsoft Excel calculator program (Control2_{FEL70} or Control 2_{FBDG70}, Control 2_{FBDG30})

Equation F

$$\% \text{ Difference of carbohydrate (NDPro)} = (\frac{C(np) - C(rm)}{C(rm)}) x\ 100$$

C_{np} = Amount of carbohydrate calculated by the NDPro application (NDP_{FEL70} or NDP_{FBDG70}, NDP_{FBDG30})

C_{rm} = A Reference value of carbohydrate calculated from estimated serving sizes by participants using Microsoft Excel calculator program ($Control2_{FEL70}$ or $Control 2_{FBDG70}$, $Control 2_{FBDG30}$)

Equation G

$$\% \text{ Difference of protein (NDPro)} = (\frac{P(np) - P(rm)}{P(rm)}) \text{x } 100$$

P_{np} = Amount of protein calculated by the NDPro application (NDP_{FEL70} or NDP_{FBDG70}, NDP_{FBDG30})

P_{rm} = A Reference value of protein calculated from estimated serving sizes by participants using Microsoft Excel calculator program ($Control2_{FEL70}$ or $Control 2_{FBDG70}$, $Control 2_{FBDG30}$)

Equation H

$$\% \text{ Difference of fat (NDPro)} = (\frac{F(np) - F(rm)}{F(rm)}) \text{x } 100$$

F_{np} = Amount of fat calculated by the NDPro application (NDP_{FEL70} or NDP_{FBDG70}, NDP_{FBDG30})

F_{rm} = A Reference value of fat by calculated from estimated serving sizes by participants using Microsoft Excel calculator program ($Control2_{FEL70}$ or $Control 2_{FBDG70}$, $Control 2_{FBDG30}$).

3.6.4. In order to investigate whether the participants could remember the original values of energy and three types of macronutrients in each food group and manual calculation without errors, the results calculated by participants manually (MN_{FEL70}, MN_{FEL30} or MN_{FBDG70}, MN_{FBDG30}) were compared with the results calculated from estimated serving sizes assessed by participants and

original values of energy and nutrients from Thai FEL (Control 3_{FEL70} or Control 3_{FEL30}) or Thai FBDG (Control 3_{FBDG70} or Control 3_{FBDG30}).

3.6.5. The significant difference between the results from the food exchange list-based application (either Thai FEL or Thai FBDG) and non-food exchange list base application (control) were calculated using paired sample t-test when there was a normal distribution, with significance at $p < 0.05$. For variables with non-normal distribution, the differences are analyzed using Wilcoxon signed rank test.

3.6.6. To investigate the accuracy of estimating food portions and the accuracy of inserting portion sizes into the application, the estimated serving sizes recorded by participants in ND-02/64 were compared with the actual serving sizes prepared by a researcher. Accurate estimations should fall within ±10% difference from the actual serving sizes [78]. For example, if a set of food photographs provided a total of 9 serving sizes for the starch subgroup, any participants who estimated serving sizes within 8.1 – 9.9 were considered accurate. The percentage of accurate estimations was calculated based on the numbers of subgroups which participants could estimate within ±10% difference from the actual serving sizes by the equation I as follows.

Equation I

$$\% \text{ Accurate estimation} = \frac{\text{N(d10\%) x 100}}{\text{Total numbers of subgroups}}$$

N(d10%) = Numbers of subgroups which participants could estimate within ±10% difference from the actual serving sizes

The total numbers of subgroups would equal to 16 subgroup for TFEL-based NDPro application while equal to 11 subgroups for TFBDG-based application

Furthermore, the percentage of accurate insertion was calculated from the numbers of participants who inserted the serving size exactly equal to the recorded serving sizes in ND-02/64 by the equation J as follows.

Equation J

$$\% \text{ Accurate insertion} = \frac{N(eq) \times 100}{\text{Total numbers of participants}}$$

N(eq) = Numbers of participants who inserted the serving size exactly equal to the recorded serving sizes in ND-02/64

Chapter 4

RESULTS

The results in this study covered five phases of the experiment. The results of the first two phases involving in data preparation were shown in 4.1 and 4.3. The last three phases being the development and validation of the developed mobile application were shown in 4.4 to 4.6. The appearance and functions of the developed mobile nutrition application named "NDPro application" and validation of the developed application by researcher were presented in 4.5. The validation of the developed application by participants and the satisfactions of participants on the "NDPro application" were described in 4.6.

4.1. Food and nutrition databases in the NDPro application

All scientific information in Phase 1 installed in the NDPro application were prepared and evaluated by three experts in the fields related nutrition and dietetics. The results indicated that all databases and information used in this study were valid with the item level (I-ICV) and scale -level (S-CVI) scores as 0.66 – 1.00 and 0.97, respectively. The details of food and nutrition databases prepared and developed in this study as follows.

4.1.1. Selected nutrients and units

After assessing nutrient contents in all food lists in Thai FEL and Thai FBDG as described in 3.1.2.7.3.2, some food items installed in the INMUCAL database (version 4.0) [79] lacked of information of some micronutrients. To prepare the reliable surrogate values of nutrients for installing in the application, only nutrients providing information more than 50 percentages of all food items in same food group of each food databases were selected and used in the developed application. Therefore, twenty nutrients have been available in the NDPro application. All selected nutrients included energy, carbohydrate, protein, fat, saturated fatty acids, cholesterol, dietary

fiber, sugar, vitamin A, thiamine, riboflavin, niacin, vitamin C, calcium, phosphorus, potassium, sodium, copper, iron, and zinc.

Due to using four sources of data including three recommendations and one food database program [32, 43, 56, 79]. In order to apply them into the application, the nutrient units of the developed application were standardized and defined. Selection was decided based on congruence of the nutrient units being used in four databases. All units of energy, dietary fiber, cholesterol, and selected vitamin and minerals from each database were similar. However, the units of macronutrients, sodium, potassium, and cupper from some sources of food databases were different and required to convert from %TEE, gram, or microgram to gram. After determining nutrient units used in the application and converting the mismatch units, the selected nutrients and their units were installed in this application as shown in Table 16.

Table 16 Nutrients and units used in the NDPro application

1. Primary nutrients

Nutrients	Thai DRI (2020) [32]	Thai RDI (1998) [43]	IOM (2005) [56]	INMUCAL V.4.0 [79]	NDPro
Energy	kcal	kcal	kcal	kcal	kcal
Carbohydrate	%TEE and g[1]	g	%TEE and g[2]	g	g
Protein	g	g	g/kg and %TEE[3]	g	g
Fat	%TEE[4]	g	%TEE[5]	g	g
Saturated fat	%TEE[6]	g	ND[7]	g	g
Dietary fiber	g	g	g	g	g
Sugar	%TEE and g[8]	ND[7]	%TEE[9]	g	g
Cholesterol	ND[7]	mg	ND[7]	mg	mg
Vitamin A	µg RE	µg RE	µg RE	µg RE	µg RE
Vitamin B_1	mg	mg	mg	mg	mg
Vitamin B_2	mg	mg	mg	mg	mg

Nutrients	Thai DRI (2020) [32]	Thai RDI (1998) [43]	IOM (2005) [56]	INMUCAL V.4.0 [79]	NDPro
Niacin	mg	mg	mg	mg	mg
Vitamin C	mg	mg	mg	mg	mg
Sodium	mg	mg	g	mg	mg
Potassium	mg	mg	g	mg	mg
Phosphorus	mg	mg	mg	mg	mg
Calcium	mg	mg	mg	mg	mg
Iron	mg	mg	mg	mg	mg
Copper	mg	mg	μg	mg	mg
Zinc	mg	mg	mg	mg	mg

[1,2] %TEE was converted into grams using the formula TEE * (%TEE/100))/4, where TEE was calculated based on application; [3] %TEE was converted into grams using the formula TEE * (%TEE/100))/4, where TEE was calculated based on application and g/kg was converted into grams using the formula g/kg * weight, where weight was obtained from the user-inserted weight; [4,5] %TEE was converted into grams using the formula TEE * (%TEE/100))/9, where TEE was calculated based on application; [6] %TEE was converted into grams using the formula TEE * (%TEE/100))/9, where TEE was calculated based on application; [7] ND = No data (no information of those food items appeared in the databases); [8,9] %TEE was converted into grams using the formula TEE * (%TEE/100))/4, where TEE was calculated based on application;

2. Fatty acids

Nutrients	Thai DRI (2020) [32]	Fatty acids composition and cholesterol in Thai foods 2002 [74]	Cholesterol and fatty acid compositions in Thai foods 2004 [75]	INMUCAL V.4.0 [79]	NDPro
Saturated fatty acids	%TFA[1]	mg	mg	g	g
Monounsaturated fatty acids	%TFA[1]	mg	mg	ND[2]	g
Polyunsaturated fatty acids	%TFA[1]	mg	mg	ND[2]	g
Alpha-linolenic acid	%TFA[1]	mg	mg	ND[2]	g
Eicosapentaenoic acid (EPA)	%TFA[1]	mg	mg	ND[2]	g
Docosahexaenoic acid (DHA)	%TFA[1]	mg	mg	ND[2]	g

[1] % total fatty acid; [2] ND = No data (no information of those food items appeared in the databases)

3. Folic acid

Nutrients	Thai DRI (2020) [32]	Food composition table of Thai foods (2018) [80]	NDPro
Folic acid	µg	µg	µg

4.1.2. Representative values of energy and selected nutrients of Thai FEL and Thai FBDG for the NDPro application

The median values per serving size of energy and nutrients used in the NDPro application were set up from the recommended food items of either Thai FEL [10] or Thai FBDG [11, 12, 21]. For each food group, all food items from both food databases were sought for their energy, nineteen selected nutrients (as mentioned in 4.1.1), and contents per serving size from the INMUCAL database [79]. Energy was calculated from carbohydrate, protein, and fat by multiplying with 4, 4, and 9 kcal/g, respectively. Then, the median values of energy and nutrients in each food group were calculated and used as the representative nutrient values for the Thai-FEL or Thai-FBDG based application. The representative nutrient values as shown in Table 17, Table 18, Table 19, and Table 21 (APPENDIX K and APPENDIX L).

When comparing the medians of energy and macronutrients per serving size in each food groups developed for the NDPro application those defined in the Thai FEL or Thai FBDG, there were three subgroups whose values were quite different from each other. The representative values of energy and fat content in the low fat meat subgroup were almost twice those defined in Thai FEL. Whereas energy and all macronutrient contents in the low fat milk subgroup defined in Thai FEL were two times higher than the representative values. In addition, the representative values of energy and fat content in the whole milk subgroup were almost two and four time higher than those defined in Thai FBEG. (Table 17 to Table 21) (also see APPENDIX K to APPENDIX N).

For Thai food exchange list, food items in meat group were reallocated because their fat contents derived from INMUCAL database mismatched their belonging food group. (APPENDIX K) Totally, there are five food exchange lists available in the NDPro application as following.

1. Thai food exchange list (calculated by INMUCAL program without the meat group reallocation) (Table 17 and Table 18)
2. Thai food exchange list (calculated by INMUCAL program with the meat group reallocation) (Table 17 and Table 19)
3. Thai food exchange list (original) (Table 20)
4. Food based dietary guideline (calculated by INMUCAL program) (Table 21)
5. Food based dietary guideline (original) (Table 22)

4.1.3. Nutrient and units of condiments in the NDPro application

Energy and nutrient of twenty-three condiments commonly used in Thailand were included into the developed application. They were sought for their energy and nutrient contents from the IMNUCAL database (version 4.0) [79]. Nutrients in this category included carbohydrate, protein, fat, saturated fatty acid, cholesterol, dietary fiber, sugar, vitamin A, thiamine, riboflavin, niacin, vitamin C, calcium, potassium, phosphorus, sodium, copper, iron, and zinc. Energy was calculated from carbohydrate, protein, and fat by multiplying with 4, 4, and 9 kcal/g, respectively, as showed in Table 24.

Table 17 Representative values of energy, nutrients, and types of serving sizes of food groups used in the Thai FEL-based NDPro application[1]

Subgroups	Types of serving size	Energy (kcal)[2]	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Phosphorus (mg)	Potassium (mg)	Sodium (mg)	Copper (mg)	Iron (mg)	Zinc (mg)
1.Starches	1 ladle	87.08	18.62	2.15	0.45	0.13	0.44	0.19	0.00	0.00	0.04	0.02	0.46	0.00	10.13	38.29	36.50	9.73	0.58	0.07	0.29
2.Vegetables type 1	1 portion	24.06	4.34	1.28	0.18	0.02	1.71	0.00	0.00	4.44	0.04	0.05	0.42	15.97	10.50	189.86	29.23	21.03	0.45	0.05	0.16
3.Vegetables type 2	1 portion	34.38	5.83	2.08	0.31	0.06	2.67	0.00	0.00	12.51	0.09	0.08	0.69	23.52	10.82	204.78	48.04	33.52	0.58	0.08	0.35
4.Fruits	1 fruit portion	58.99	13.92	0.61	0.10	0.02	1.17	10.75	0.00	7.92	0.04	0.04	0.38	13.00	9.85	173.49	15.51	9.42	0.28	0.07	0.08
5.Whole milk (regular)	1 glass (240 mL)	152.85	11.34	7.69	8.53	3.38	0.00	22.20	17.58	74.12	0.07	0.51	0.22	0.00	137.73	273.60	212.16	258.40	0.21	0.02	0.82
6.Milk (low fat)	1 glass (240 mL)	104.66	12.33	7.13	2.98	1.78	0.00	19.08	0.00	31.20	0.05	0.50	0.00	0.00	146.40	0.00	0.00	428.80	0.17	0.00	0.00
7.Milk (skim milk)	1 glass (240 mL)	80.88	11.52	8.16	0.24	0.00	0.00	11.52	4.70	143.84	0.10	0.38	0.24	2.40	122.09	367.86	220.80	264.00	0.24	0.03	0.99
8.Milk (evaporated)	1 glass (240 mL)	165.12	11.40	8.28	9.60	6.46	0.00	11.40	34.85	81.60	0.05	0.38	0.24	1.20	127.39	364.16	242.40	306.00	0.24	0.02	0.93
9.Milk powder (regular)	4 tbsp.[3]	140.05	17.35	4.50	5.85	2.06	0.75	12.75	5.49	133.33	0.12	0.26	1.50	16.36	52.50	194.55	114.29	165.38	1.87	0.09	1.13
10.Milk powder (none fat)	4 tbsp.[3]	91.52	13.10	9.48	0.14	0.09	0.00	10.11	5.48	297.45	0.12	0.51	1.02	7.50	116.10	387.60	298.20	337.05	1.29	0.01	1.46
11.Fat (MUFA / PUFA)	1 tsp.[3]	49.03	0.87	0.25	4.95	0.70	0.00	0.29	0.00	0.00	0.00	0.00	0.09	0.00	3.93	0.03	15.95	2.13	0.09	0.00	0.00
12.Fat (SFA)	1 tsp.[3]	43.71	0.00	0.03	4.84	2.69	0.00	0.00	8.59	2.24	0.00	0.00	0.03	0.00	9.51	0.00	0.30	0.83	0.01	0.00	0.01

[1] Representative values were presented in medians, Five food groups contained 12 subgroups and were not included the meat group. Details were shown in APPENDIX K; [2] Energy was calculated from the sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively. Energy was not referred from the IINMUCAL database; [3] tsp refers to teaspoon.

Table 18 Representative values of energy and nutrients per one tablespoon of the meat group without reallocation used in the Thai FEL-based NDPro application[1]

Subgroups	Energy (kcal)[2]	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Phosphorus (mg)	Potassium (mg)	Sodium (mg)	Copper (mg)	Iron (mg)	Zinc (mg)
1.Meat (very low fat)	16.46	0.07	3.44	0.27	0.15	0.00	0.00	13.65	3.58	0.01	0.02	0.43	0.00	25.55	36.11	27.60	7.12	0.13	0.02	0.11
2.Meat (low fat)	42.15	0.14	3.41	3.11	0.88	0.00	0.00	16.20	0.68	0.02	0.03	0.48	0.00	20.18	34.93	22.35	2.93	0.25	0.02	0.25
3.Meat (medium fat)	35.44	0.20	3.87	2.13	0.74	0.00	0.00	10.13	0.11	0.06	0.05	0.05	0.00	20.91	42.07	41.74	2.70	0.32	0.02	0.24
4.Meat (high fat)	40.45	0.23	3.92	2.65	0.77	0.00	0.00	9.75	1.66	0.04	0.03	0.80	0.00	18.97	50.55	25.50	3.00	0.30	0.01	0.23

[1] Meat groups contained 4 subgroups. Items of meat in each subgroup were as defined in the Thai FEL and details were shown in APPENDIX K; [2] Energy was not referred from the IINMUCAL database. It was calculated from the sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

Table 19 Representative values of energy and nutrients per one tablespoon of the meat group after reallocation and used in the Thai FEL-based NDPro application[1]

Subgroups	Energy (kcal)[2]	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Phosphorus (mg)	Potassium (mg)	Sodium (mg)	Copper (mg)	Iron (mg)	Zinc (mg)
1.Meat (very low fat)	16.41	0.11	3.47	0.23	0.11	0.00	0.00	10.50	3.58	0.01	0.01	0.27	0.00	25.65	35.45	27.60	7.10	0.16	0.05	0.23
2.Meat (low fat)	23.88	0.04	4.17	0.78	0.33	0.00	0.00	13.20	0.60	0.01	0.03	0.58	0.00	13.58	34.50	34.40	1.75	0.15	0.02	0.11
3.Meat (medium fat)	33.25	0.14	3.44	2.11	0.67	0.00	0.00	15.38	1.03	0.01	0.03	0.58	0.00	18.90	48.16	24.00	3.30	0.12	0.01	0.20
4.Meat (high fat)	44.11	0.26	3.48	3.24	1.19	0.00	0.00	11.33	1.80	0.04	0.04	0.76	0.00	37.29	43.64	27.31	3.30	0.36	0.02	0.29

[1] Meat groups contained 4 subgroups. Items of meat in each subgroup defined in the Thai FEL were reallocated based on fat contents classified in the Thai FEL. Details were shown in APPENDIX K; [2] Energy was not referred from the IINMUCAL database. It was calculated from the sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

Table 20 Comparisons of the representative values of energy and nutrients developed for the Thai FEL-based NDPro application NDPro application and those per serving size in each food group[1] defined in the Thai FEL [10]

Subgroups	Thai food exchange list				Thai FEL-based NDPro application without reallocation of the meat group				Thai FEL-based NDPro application with reallocation of the meat group			
	Energy (kcal)[2]	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (kcal)[2]	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (kcal)[2]	Carbohydrate (g)	Protein (g)	Fat (g)
1.Starches	80.0	18.0	2.0	0.0	87.08	18.62	2.15	0.45	87.08	18.62	2.15	0.45
2.Meat (very low fat)	18.5	0.0	3.5	0.5	16.46	0.07	3.44	0.27	16.41	0.11	3.47	0.23
3.Meat (low fat)	27.5	0.0	3.5	1.5	42.15	0.14	3.41	3.11	23.88	0.04	4.17	0.78
4.Meat (medium fat)	36.5	0.0	3.5	2.5	35.44	0.20	3.87	2.13	33.25	0.14	3.44	2.11
5.Meat (high fat)	50.0	0.0	3.5	4.0	40.45	0.23	3.92	2.65	44.11	0.26	3.48	3.24
6.Vegetables type 1	0.0	0.0	0.0	0.0	24.06	4.34	1.28	0.18	24.06	4.34	1.28	0.18
7.Vegetables type 2	28.0	5.0	2.0	0.0	34.38	5.83	2.08	0.31	34.38	5.83	2.08	0.31
8.Fruits	60.0	15.0	0.0	0.0	58.99	13.92	0.61	0.10	58.99	13.92	0.61	0.10
9.Whole milk (regular)	152.0	12.0	8.0	8.0	152.85	11.34	7.69	8.53	152.85	11.34	7.69	8.53
10.Milk (low fat)	125.0	12.0	8.0	5.0	104.66	12.33	7.13	2.98	104.66	12.33	7.13	2.98
11.Milk (skim milk)	80.0	12.0	8.0	0.0	80.88	11.52	8.16	0.24	80.88	11.52	8.16	0.24
12.Milk (evaporated)	152.0	12.0	8.0	8.0	165.12	11.40	8.28	9.60	165.12	11.40	8.28	9.60
13. Milk powder (regular)	152.0	12.0	8.0	8.0	140.05	17.35	4.50	5.85	140.05	17.35	4.50	5.85
14. Milk powder (none fat)	80.0	12.0	8.0	0.0	91.52	13.10	9.48	0.14	91.52	13.10	9.48	0.14
15.Fat (MUFA / PUFA)	45.0	0.0	0.0	5.0	49.03	0.87	0.25	4.95	49.03	0.87	0.25	4.95
16.Fat (SFA)	45.0	0.0	0.0	5.0	43.71	0.00	0.03	4.84	43.71	0.00	0.03	4.84

[1] Except the meat group, their energy and nutrient contents were presented per one tablespoon which was equal to a half recommended serving size of Thai FEL; [2] Energy was not referred from the IINMUCAL database. It was calculated from the sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

Table 21 Representative values of energy, nutrients, and types of serving sizes of food groups used in the Thai FBDG-based NDPro application[1]

Subgroups	Types of serving size	Energy (kcal)[2]	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Phosphorus (mg)	Potassium (mg)	Sodium (mg)	Copper (mg)	Iron (mg)	Zinc (mg)
1.Cereals (cooked rice/noodle)	1 ladle	103.20	22.50	2.13	0.52	0.14	1.06	0.22	0.00	0.94	0.03	0.02	0.35	0.00	12.15	48.75	34.80	8.00	0.91	0.06	0.25
2.Cereals (rice glutinous)	1 Ladle	81.48	18.62	1.59	0.07	0.03	0.10	0.04	0.00	0.00	0.02	0.04	0.82	0.00	4.43	4.51	4.20	1.13	0.37	0.03	0.38
3.Cereals (bread)	1 slice of bread	87.23	16.66	2.24	1.29	0.40	0.67	1.61	0.83	2.13	0.08	0.00	0.46	0.00	107.03	26.85	24.87	3.74	0.24	0.03	0.18
4.Meat (meat)	1 tbsp.[3]	22.45	0.00	3.89	0.77	0.38	0.00	0.00	36.00	5.31	0.03	0.06	0.71	0.00	10.05	34.05	29.10	1.90	0.45	0.03	0.21
5.Meat (soybeans)	1 tbsp.[3]	28.87	1.78	2.42	1.34	0.33	1.10	0.27	0.00	0.18	0.05	0.01	0.23	0.20	17.09	51.79	36.06	8.75	0.45	0.08	0.25
6.Meat (egg)	a half egg	33.25	0.24	3.25	2.15	0.00	0.00	0.24	94.99	40.27	0.02	0.08	0.03	0.00	32.48	31.34	41.05	13.42	0.33	0.01	0.24
7.Vegetables	1 ladle	16.64	2.95	1.00	0.09	0.02	1.22	0.38	0.00	4.34	0.04	0.06	0.35	11.77	8.93	116.44	19.42	19.24	0.35	0.05	0.15
8.Fruits	1 fruit portion	57.86	13.70	0.54	0.10	0.03	1.81	8.90	0.00	5.35	0.04	0.04	0.37	16.94	10.23	129.20	12.23	9.18	0.31	0.05	0.08
9. Whole milk (regular)	1 glass (200 mL)	217.82	34.00	6.41	6.24	3.68	0.00	25.47	14.65	59.86	0.06	0.42	0.19	1.32	114.77	317.14	179.86	216.20	0.36	0.04	1.54
10.Milk (low fat)	1 glass (200 mL)	87.22	10.27	5.94	2.48	1.48	0.00	15.90	0.00	26.00	0.04	0.42	0.00	0.00	122.00	0.00	0.00	357.33	0.14	0.00	0.00
11.Fat (oil, butter)	1 tsp.[3]	37.76	0.00	0.03	4.18	2.69	0.00	0.00	4.75	14.40	0.00	0.00	0.03	0.00	11.35	0.00	0.30	0.90	0.01	0.00	0.01

[1] Representative values were presented in medians, Details were shown APPENDIX L; [2] Energy was not referred from the IINMUCAL database. It was calculated from the sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively; [3] tbsp. refers to tablespoon and [4] tsp refers to teaspoon.

Table 22 Original energy, nutrients, and types of serving sizes of each food group defined in the Thai FBDG [21]

Subgroups	Types of serving size	Energy (kcal)[1]	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)[2]	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Phosphorus (mg)	Potassium (mg)	Sodium (mg)	Copper (mg)	Iron (mg)	Zinc (mg)
1.Cereals (cooked rice/noodle)	1 ladle	83.05	17.9	1.4	0.65	0.0	0.46	0.0	0.0	0.0	0.02	0.01	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.85	0.0
2.Cereals (rice glutinous)	1 Ladle	80.19	18.2	1.6	0.11	0.0	0.28	0.0	0.0	0.0	0.01	0.04	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.42	0.0
3.Cereals (bread)	1 slice of bread	98.1	18.8	3.7	0.9	0.0	0.16	0.0	0.0	0.0	0.06	0.05	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.59	0.0
4.Meat (meat)	1 tbsp.[3]	26.1	0.0	2.7	1.7	0.0	0.0	0.0	9.0	12.6[2]	0.06	0.03	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.15	0.0
5.Meat (soybeans)	1 tbsp.[3]	27.5	1.1	2.4	1.5	0.0	0.42	0.0	0.0	1.5	0.03	0.05	0.0	0.0	12.0	0.0	0.0	0.0	0.0	0.5	0.0
6.Meat (egg)	a half egg	39.7	0.2	3.2	2.9	0.0	0.0	0.0	107.0	32.5[3]	0.03	0.09	0.0	0.0	15.3	0.0	0.0	0.0	0.0	0.86	0.0
7.Vegetables	1 ladle	11.2	1.9	0.9		0.0	0.9	0.0	0.0	36.0[4]	0.08	0.04	0.0	2.8[5]	22.0	0.0	0.0	0.0	0.0	0.4	0.0
8.Fruits	1 fruit portion	66.6	15.4	0.98	0.12	0.0	2.26	0.0	0.0	73.5	0.06	0.07	0.0	57.6	18.5	0.0	0.0	0.0	0.0	0.65	0.0
9. Whole milk (regular)	1 glass (200 mL)	121.8	9.8	4.0	7.4	0.0	0.0	0.0	20.0	76.0	0.08	0.32	0.0	2.0	236.0	0.0	0.0	0.0	0.0	0.1	0.0
10.Milk (low fat)	1 glass (200 mL)	97.0	11.0	7.4	2.6	0.0	0.0	0.0	12.0	24.0	0.1	0.34	0.0	1.0	253.0	0.0	0.0	0.0	0.0	0.12	0.0
11.Fat (oil, butter)	1 tsp.[3]	45.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[1] Energy was not referred from the IINMUCAL database. It was calculated from the sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively..

[2] Vitamin A decreased 27% after cooking; 5Calculated both decrement and increment of beta-carotene after cooking; 6Calculated only raw vegetables.

[3] tbsp. refers to tablespoon and [4] tsp refers to teaspoon.

Table 23 Comparisons of energy and macronutrients per serving size in each food group defined in the Thai FBDG [11, 12, 21] and the representative values of energy and nutrients developed for the Thai FBDG-based NDPro application

Subgroups	Thai food based dietary guideline				Thai FBDG-based NDPro application			
	Energy (kcal)[1]	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (kcal)	Carbohydrate (g)	Protein (g)	Fat (g)
1.Cereals (cooked rice/noodle)	83.05	17.9	1.4	0.65	103.20	22.50	2.13	0.52
2.Cereals (rice glutinous)	80.19	18.2	1.6	0.11	81.48	18.62	1.59	0.07
3.Cereals (bread)	98.1	18.8	3.7	0.9	87.23	16.66	2.24	1.29
4.Meat (meat)	26.1	0.0	2.7	1.7	22.45	0.00	3.89	0.77
5.Meat (soybeans)	27.5	1.1	2.4	1.5	28.87	1.78	2.42	1.34
6.Meat (egg)	39.7	0.2	3.2	2.9	33.25	0.24	3.25	2.15
7.Vegetable	11.2	1.9	0.9	0.0	16.64	2.95	1.00	0.09
8.Fruit	66.6	15.4	0.98	0.12	57.86	13.70	0.54	0.10
9.Whole milk (regular)	121.8	9.8	4.0	7.4	217.82	34.00	6.41	6.24
10.Milk (low fat)	97.0	11.0	7.4	2.6	87.22	10.27	5.94	2.48
11.Fat (oil, butter)	45.0	0.0	0.0	5.0	37.76	0.00	0.03	4.18

[1] Energy was not referred from the IINMUCAL database. It was calculated from the sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

4.1.4. Development of protein free starch group

Protein free starch group was developed to solve some programing problems from some circumstance, for example, planning low or high protein diets. The definition of "protein free starch" referred to the criteria of Notification of the Ministry of Public Health (No. 182) B.E. 2541 (1998) Re : Nutrition Labelling [44] that any products that contained protein less than 1% could be determined as zero. In

other words, any food items which contained protein less than 1 gram per 100 grams could be determined as "protein free foods" in this study.

Various food items were examined from Thai food composition tables 2015 [72] (section "Cereals and their products", "Starchy roots, tubers and their products"). Energy and nutrient contents per portion of the developed protein free starch group were shown in Table 25. Selection and details were mentioned in APPENDIX O.

4.1.5. Food product database development

Food product database had been developed by DB Browser for SQLite. The nutritional information was collected from various sources during June 2020 to September 2021. Nutritional information was collected for names, net weights, serving sizes, allergy advices, nutrients and %RDI. For enteral nutrition related products, additional information was also collected including osmolarity, density, ingredients, proposes, cautions and recommendations. Totally, nutritional information from 4,628 items was collected and classified into 22 categories as described in Table 26.

Nutrition information of One meal dish (INMU), Dessert (INMU), and Beverage (INMU) categories as mentioned in Table 26 was obtained from "Beverages: nonalcoholic", "Fast foods: franchise foods", and "Mixed foods: ready-to-eat, main dishes, one-plate dishes, desserts, snacks, bakery, and other mixed foods" in the Thai food composition tables 2015 [72]. All of food items in these groups had the same portion size at 100 grams.

Table 24 Energy and nutrients of condiments in the NDPro application

	Weight (g)	Method	INMUCAL ID	Energy (kcal)[1]	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Phosphorus (mg)	Potassium (mg)	Sodium (mg)	Copper (mg)	Iron (mg)	Zinc (mg)
1.Shrimp paste (Ka-pi)	15	RA	12112	21.75	3.47	1.19	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1221.74	0.00	0.00	0.00
2.Sauce, hot chilli	15	RA	12054	16.53	3.77	0.12	0.11	0.02	0.00	3.37	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	193.90	0.00	0.11	0.00
3.Sauce, tomato	15	RA	12005	14.19	3.27	0.21	0.03	0.00	0.15	1.92	0.00	0.90	0.00	0.00	0.12	1.95	2.40	3.30	0.00	237.22	0.00	0.24	0.00
4.Sauce, oyster	15	RA	12067	9.32	1.91	0.40	0.01	0.00	0.12	1.49	0.00	0.00	0.00	0.00	0.06	1.07	2.36	4.59	10.55	457.18	0.00	0.19	0.00
5.Sauce, soybean	5	RA	12181	1.57	0.21	0.18	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	363.77	0.00	0.06	0.00
6.Bouillon cube	10	RA	12184	20.85	2.79	1.15	0.57	0.37	0.55	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1578.15	0.00	0.00	0.00
7.Milk condensed	15	RA	09002	51.35	8.55	1.19	1.38	0.87	0.00	8.48	3.75	38.10	0.04	0.07	0.06	0.15	41.60	30.81	58.08	17.48	0.00	0.03	0.15
8.Sauce, suki	15	RA	17305	20.98	4.10	0.41	0.33	0.09	0.27	3.17	0.30	0.00	0.00	0.00	0.00	0.00	2.04	0.00	0.00	274.05	0.00	0.09	0.00
9.Sauce, chilli, sweet	15	RA	12041	33.18	8.05	0.11	0.06	0.01	0.22	7.04	0.00	0.00	0.00	0.00	0.00	0.00	1.38	0.00	0.00	182.94	0.00	0.05	0.00
10.Refined sugar	5	RA	11001	19.90	4.98	0.00	0.00	0.00	0.00	4.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11.Sugar, coconut	5	RA	11002	19.13	4.75	0.02	0.01	0.00	0.01	4.75	0.00	0.70	0.00	0.00	0.05	0.00	4.00	2.00	0.00	2.80	0.00	0.57	0.00
12.Sauce, fish	5	RA	12010	2.58	0.28	0.36	0.00	0.00	0.00	0.21	0.00	0.26	0.00	0.00	0.00	0.00	1.19	0.00	18.46	379.07	0.00	0.11	0.00
13.Fermented fish, liquid part	15	RA	07231	4.75	0.92	0.10	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	811.92	0.00	0.00	0.00
14.Honey	15	RA	11004	44.61	11.06	0.03	0.03	0.00	0.00	11.03	0.00	0.00	0.00	0.01	0.00	0.75	0.15	1.35	6.98	0.54	0.00	0.29	0.03
15.Chilli paste	15	RA	12024	51.31	6.68	0.61	2.46	0.50	1.17	3.86	3.00	0.46	0.02	0.04	0.00	3.16	15.89	0.00	0.00	342.0	0.00	0.31	0.00
16.Tamarind, ripe, puree	15	RA	12076	7.13	1.70	0.07	0.01	0.00	0.18	0.60	0.00	0.03	0.01	0.00	0.03	0.09	2.43	2.58	0.00	0.75	0.00	0.04	0.00
17.Juice, lime	15	RA	04195	5.28	1.25	0.08	0.00	0.00	0.06	0.25	0.00	0.08	0.00	0.00	0.03	3.75	1.35	1.20	15.15	0.15	0.00	0.02	0.02
18.Sugar syrup	15	RA	11015	35.82	8.96	0.00	0.00	0.00	0.00	8.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.Monosodium glutamate	5	RA	12080	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	610.00	0.00	0.00	0.00
20.Seasoning	5	RA	12084	7.93	1.02	0.57	0.18	0.07	0.03	0.75	0.88	0.01	0.03	0.01	0.11	0.00	0.84	6.68	14.19	829.13	0.00	0.05	0.03
21.Refined salt	5	RA	12091	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1997.00	0.00	0.00	0.00
22.Soybean paste, white	15	RA	03013	17.54	1.47	1.67	0.56	0.09	1.47	0.00	0.00	0.15	0.03	0.01	0.06	0.57	27.00	26.70	0.00	1067.09	0.00	2.28	0.00
23.Soybean paste, black	15	RA	12056	10.23	0.65	0.90	0.45	0.07	0.65	0.00	0.00	0.13	0.00	0.00	0.00	0.49	14.70	0.00	0.00	916.76	0.00	1.79	0.00

RA = Raw; [1] Energy was calculated from sum of multiplying carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively. (not energy referred from database)

Table 25 Energy and nutrients per portion of protein free starch group in
the NDPro application

Nutrients	Contents	Nutrients	Contents	Nutrients	Contents
Energy	73.11 kcal	Cholesterol	0.0 mg	Potassium	184.80 mg
Carbohydrate	18.10 g	Vitamin A	0.0 mcg RE	Phosphorus	7.0 mg
Protein	0.08 g	Thiamin	0.01 mg	Calcium	9.34 mg
Fat	0.05 g	Riboflavin	0.0 mg	Iron	0.27 mg
Saturated fatty acid	0.01 g	Niacin	0.03 mg	Copper	0.0 mg
Dietary fiber	0.30 g	Vitamin C	0.0 mg	Zinc	0.16 mg
Sugar	0.0 g	Sodium	0.91 mg		

Nutrition information of Chili pastes group was obtained from the cookbook by Bureau of Nutrition Department of Health Ministry of Public Health [71]. Although this book mentioned 84 menus of chili pastes, but only 82 menus were added into database. The excluded two menus were "Nam pic nang loy" and "Nam pic na log kung hang" as their macronutrients were mismatch with reported energy as showed in Table 27.

For alcoholic products, alcohol percentage was also added into database apart from nutritional information mentioned previously. Due to the absence of nutrition labels on their containers, their nutrients were obtained from other source. Their nutrients (except for energy) would be determined according to the recommendation by Franz [42] (Table 2). Energy of each product would be resulted from sum of multiplying carbohydrate, protein, fat, and alcohol (obtained from alcohol percentage of products) with 4, 4, 9, and 7, respectively.

Table 26 Categories, amounts, and sources of databases of the NDPro application

Categories	Amounts	Sources
1. One meal dish (INMU)[1]	176 items	Thai food composition tables 2015 [72]
2. Dessert (INMU)	181 items	Thai food composition tables 2015 [72]
3. Beverage (INMU)	30 items	Thai food composition tables 2015 [72]
4. Chili pastes[2]	82 items	Book [73]
5. Bakery products	235 items	Product label
6. Cereal products	98 items	Product label
7. Snack products	966 items	Product label
8. Ice cream products	177 items	Product label
9. Frozen food products	386 items	Product label
10. Semi-finished and ready-to-eat products	387 items	Product label
11. Milk and dairy products	383 items	Product label
12. Grain, nut-based beverage products	136 items	Product label
13. Alcoholic products	292 items	Product label
14. Beverage products (ready-to-eat)	436 items	Product label
15. Beverage products (dried powder)	191 items	Product label
16. Beverage additive products	45 items	Product label
17. Condiment products	264 items	Product label
18. Enteral nutrition products	52 items	Product label
19, Supplement food products	46 items	Product label
20. Parenteral nutrition products (mixed)	24 items	Drug information leaflet
21. Parenteral nutrition products (single components)	27 items	Drug information leaflet
22. Peritoneal dialysate solution products	14 items	Drug information leaflet
Total	4628 items	-

[1] Institute of Nutrition, Mahidol University, Thailand [72]; [2] only 82 menus from 84 menus of chili pastes from the cookbook by Bureau of Nutrition Department of Health Ministry of Public Health [73]. "Nam pic nang loy" and "Nam pic na log kung hang" were excluded due to disagreement between the reported energy and the estimated energy from their reported macronutrients.

Table 27 Energy and macronutrient contents in the two excluded chili pastes [73].

Names	Reported energy (kcal)	Estimated energy (kcal)	Reported carbohydrate (g)	Reported Protein (g)	Reported Fat (g)
Nam pic nang loy	131	321.2	18.1	8.2	24
Nam pic na log kung hang	234	4483.4	31	16.6	477

For enteral nutrition, parenteral nutrition, and peritoneal dialysate solution products, more information would be added into thee NDPro application database apart from the nutritional information mentioned previously. For enteral nutrition products, purpose, ingredient, fatty acids detail, dietary fiber detail, density, osmolarity, and caution were also added into the database if available. The information was obtained from products packaging. If there were any information apart from those mentioned previously, it would be added into the database as "other information". For parenteral nutrition and peritoneal dialysate solution products, all other information apart from mentioned previously would be obtained from drug information leaflets.

4.1.6. Food album development

Food portion image development aimed to develop food photographs to help both dietitians and respondents to recognize food portions during dietary recall. Food album was classified into eight groups including starch, protein free starch, meat, vegetable, fruit, milk, fat, and sugar groups. Various characteristics of each food group were determined to represent frequently consumed foods by Thai people. Additionally, some more food items were selected by developers to properly fulfill "Protein free starch" of the NDPro application. Totally, forty-three food items were included into the developed application. Food items, household units, and portion sizes used in food album development were shown in Table 28.

Each food item contained five buttons for changing portions (½, 1, 2, 3, and 4) excepted for egg and milk. Milk contained only two buttons for ½ and 1 portions while egg contained six buttons to present images of all sizes (one portion per size) according to definition of the standard size and required weight defined by Ministry of Agriculture and Cooperatives [81] (Table 17). Images of foods with portion sizes at ½ and 1 presented the vertical view to show width and height dimensions of such food. Whereas images of foods with portion sizes at 2, 3 and 4 presented the 45 degree angle view to present examples of foods with depth dimension (Figure 18). These images were stored in the NDPro application as URL. Therefore, this function in the NDPro application required internet connection to use this components.

4.1.7. Fatty acid database development

The information of Linoleic acid (18:2), Linolenic acid (18:3), Eicosapentaenoic acid (EPA), Docosahexaenoic acid (DHA), as well as the distribution of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids were obtained from three sources. All of them reported fat values as milligram, but this developed application used the consensus unit as gram. Therefore, fat information had to be converted to gram before added into this application. Mostly, the information of 704 food items were included from "Fatty acids composition and cholesterol in Thai foods 2002" [74]. Additionally, the information of 294 and 18 food items were obtained from "Cholesterol and fatty acid compositions in Thai foods 2004" and "Dietary reference intake for Thais 2020", respectively [32, 75]. Totally, the information of 1,016 food items were included into the NDPro application.

Table 28 Characteristics, representative food items, household units, and portion sizes used in the NDPro application

Characteristics	Selected foods	Household units	Thai FEL (g)	Thai FBDG (g)	NDPro (g)
1. Starch group					
Rice	1. Rice, polished	Ladle	55	60	60
Glutinous rice	2. Rice glutinous, polished	Ladle	35	35	35
Noodle	3. Noodles, rice, fermented (Kanom-jeen)	Ladle	90	-	65
	4. Noodle, rice, small size	Ladle	90	60	60
	5. Noodle, rice, big size	Ladle	90	60	60
	6. Noodles, wheat	Ladle	75	77	75
Bread	7. Bread, Bun	Dish	25	30	30
Starchy root	8. Taro	Ladle	65	60	60
Starchy seed	9. Corn, kernel	Ladle	65	-	65
2. Protein free starch group					
	1. Noodles, mungbean	Ladle	-	120	120
	2. Mungbean sheets[1]	Ladle	-	-	110
3. Meat group					
Meat	1. Pork	Tablespoon	15	15	15
Meat (sea animals)	2. Fish, Pangasius	Tablespoon	15	15	15
	3. Shrimp, sea	Tablespoon	15	15	15
	4. Squid	Tablespoon	15	15	15
	5. Cockle	Tablespoon	15	15	15
Processed meat	6. Meat ball	Tablespoon	15	15	15
	7. Sausage	Tablespoon	15	15	15
	8. Ham	Tablespoon	15	15	15
	9. Fermented pork (Nham)	Tablespoon	15	15	15
Animal's organ	10. Liver, Pork	Tablespoon	15	15	15
Egg[2]	11. Egg, Chicken	Tablespoon	25	25	25
Tofu	12. Tofu, hard	Tablespoon	60	-	60
	13. Tofu, soft	Tablespoon	180	-	180
4. Vegetable group					
Leaf	1. Cabbage, Chinese	Ladle	50-70 (boiled)	40	50
Root	2. Carrot	Ladle	50-70 (boiled)	40	50
Bulb	3. Garlic, bulb	Ladle	70-100 (raw)	-	70
Mushroom	4. Mushroom, straw	Ladle	50-70 (boiled)	40	50
Other	5. Mungbean sprout	Ladle	50-70 (boiled)	40	50
	6. Yardlong bean, green	Ladle	50-70 (boiled)	40	50
	7. Cucumber	Ladle	70-100 (raw)	-	70

Characteristics	Selected foods	Household units	Thai FEL (g)	Thai FBDG (g)	NDPro (g)
5. Fruit group					
	1. Watermelon	Dish	285	120	285
	2. Papaya, ripe	Dish	115	120	115
	3. Grape	Dish	100	120	100
	4. Mango, ripe	Dish	80	120	80
	5. Pineapple	Dish	125	120	125
6. Milk group					
Milk[3]	1. Milk, whole	Glass	240	200	240 (Thai FEL) 200 (Thai FBDG)
Milk powder	2. Milk powder	Tablespoon	30	-	30
7. Fat group					
Oil	1. Palm oil	Teaspoon	5	5	5
Butter	2. Butter	Teaspoon	5	-	5
Salad dressing	3. Salad dressing	Tablespoon	15	-	15
Peanut	4. Peanut	Tablespoon	10 pieces	-	10 pieces
8. Sugar	1. Sugar	Teaspoon	-	-	4

[1] Obtained from the result of weight measurement (APPENDIX O).

[2] Represented by 6 images to present various sizes of chicken eggs available in Thailand.

[3] Because of significant difference between Thai FEL and Thai FBDG, images of the milk group were developed separately between two food exchange lists.

Vegetables and products group from "Fatty acids composition and cholesterol in Thai foods" version 2002 was excluded because their fat values become very low when converting from milligram to gram. The values became zero when rounded.

Although the information of "Fatty acids composition and cholesterol in Thai foods 2004" referred to "Fatty acids composition and cholesterol in Thai foods 2002", there were some food items being different (Table 29). "Cholesterol and fatty acid composition in Thai foods 2004" did not report linolenic acid. Moreover, "Fatty acids composition and cholesterol in Thai foods 2004" reported weight of foods in 1 tablespoon while version 2002 did not report.

(a)

(b)

(c)

No. 0 (Jumbo)	No. 1 (Extra large)	No. 2 (Large)	No. 3 (Medium)
weight > 70 g.	weight > 65 - 70 g.	weight > 60 - 65 g.	weight > 55 - 60 g.

No. 4 (Small) — weight > 50 - 55 g.

No. 5 (Pewee) — weight > 45 - 50 g.
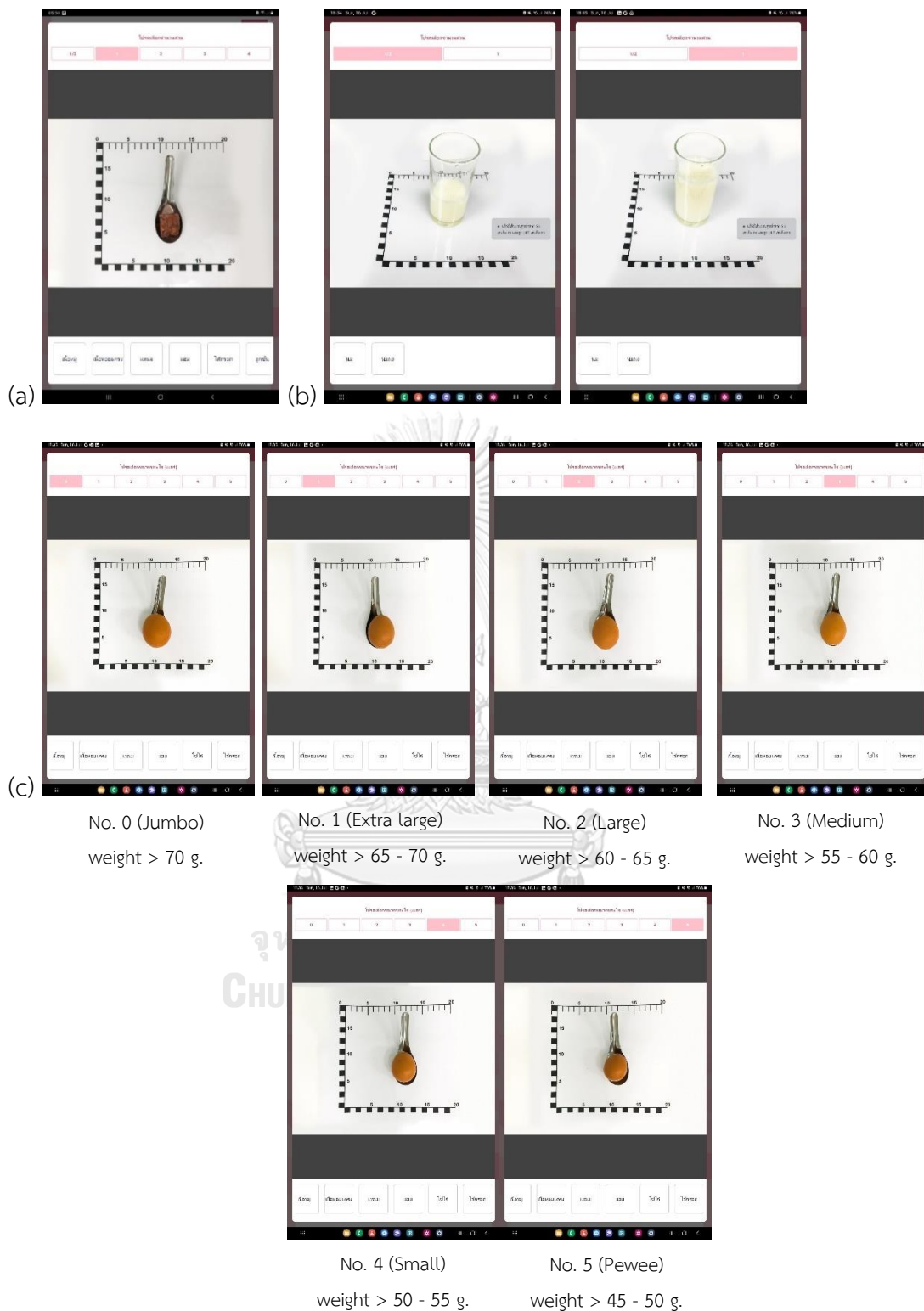
(a) All foods in the Table 28, except for egg and milk, presented in five portions of food images (Figure 18).

(b) Milk presented in two images of 1/2 and 1 portions while

(c) egg was provided in six images of various sizes of chicken eggs available in Thailand.

Figure 17 Examples of food images in food album developed and installed in the

NDPro application

(a)

(b)
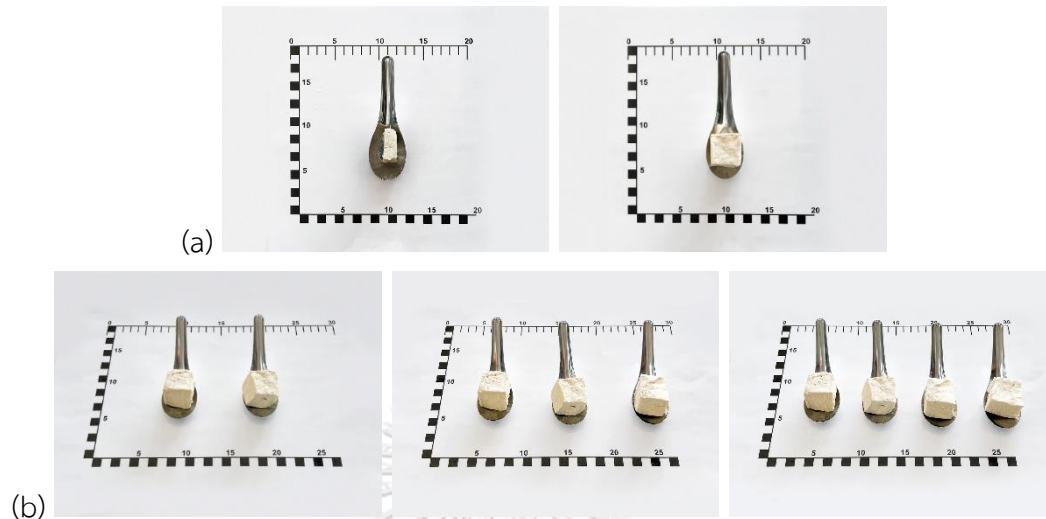
(a) Food images with portion size at ½ and 1 present food with vertical view.

(b) Food images with portion size at 2, 3 and 4 present foods with 45 degree angle view.

Figure 18 Examples of food images with vertical view and 45 degree angle view

Therefore, the information of "Fatty acids composition and cholesterol in Thai foods" version 2002 was used. The information of fat profile in 1 tablespoon from version 2004 was also added into the NDPro application database. In this case, the amounts of linolenic acid defined in version 2002 were converted into amounts in one tablespoon and added into the NDPro application database along as the information form version 2004.

Table 29 The comparison of fatty acid contents in two sources published by Ministry
of Public Health

Food	Amount	Weight (g)	SFA (mg)	MUFA (mg)	PUFA (mg)	18:2 (mg)	18:3 (mg)	EPA (mg)	DHA (mg)
1. Fatty acids composition and cholesterol in Thai foods 2002 [74]									
Chicken, liver	100 g	100	3333	3065	1319	617	15	96	332
2. Fatty acids composition and cholesterol in Thai foods 2004 [75]									
Chicken, liver	100 g	100	3333	3065	1319	617	-	96	332
	1 tbsp	17	567	521	224	105	-	16	56

tbsp = tablespoon

In Fatty acids composition and cholesterol in Thai foods" version 2002, the
"Pork, oil" item was duplicated. It was mentioned in both "Meat, poultry and
products" and "Oils, fats and products" sections. To avoid confusion, the "Pork, oil"
was considered only as "Oils, fats and products". Moreover, the information of
edible fat and oil products were also obtained from Thai DRI 2020 [32]. However,
some of these information referred from "Fatty acids composition and cholesterol in
Thai foods" version 2002 and some items were duplicated. After eliminating
redundancy, only new items from Thai DRI were added into the NDPro application
database.

4.1.8. Folic acid database development

Although folic acid hasn't been available in INMUCAL database, this
application remained including folic acid to support the usage in pregnant women.
The information of folic acid was obtained from "Food composition table of Thai
foods, 2018" [80]. Totally, ninety-two food items were added into the NDPro
application database.

4.2. Nutritional assessment related variables in the NDPro application and their default values

Nutritional assessment related variables in the developed application include sex, height, weight, physical activities, stress factors, energy equations, macronutrient distributions, micronutrient requirement references, and pregnancy and lactation conditions. By default, default values of these variables were assigned to the application automatically once users opened the NDPro application (Figure 19). All default values of the nutritional assessment related variables were shown in Table 32. These default values could be changed though the "Setting" part of the NDPro application.

Figure 19 Default values of the nutritional assessment related variables assigned into the NDPro application

Default values of sex and age were female and 45 years old, respectively. According to the numbers of population in 2020 reported by National Statistical Office (NSO) [82] showed that Thailand had the population of women more than men. For age, the greatest amount was resulted from age 52 years old (550,804 people). However, this number could not be used because it might increase next year and later. For this reason, the largest number fell within the range between 40 to 49 years old and the mid-range number of this range was selected as the default age (Table 30).

Table 30 Population of Thai women in 2020 identified by the age range [82].

Ages	Population (people)	Ages	Population (people)
20 – 29	4,561,059	70 – 79	1,892,855
30 – 39	4,689,121	80 – 89	854,885
40 – 49	5,260,671	90 – 99	166,036
50 – 59	5,112,536	≥100	12,861
60 – 69	3,573,650		

Default weight and height were set according to the study of SizeThailand project [83]. As default sex and age were set as female and 45 years old, respectively, the average height and weight were determined as 157 cm and 60 kg, respectively (Table 31).

Table 31 The average weight and height of Thai women by SizeThailand project [83].

Age ranges (year)	Weight (kg)	Height (cm)
16 – 25	52.70	159.32
26 - 35	56.26	158.28
36 – 45*	**59.79**	**157.27**
46 – 59	60.05	155.56
≥60	58.58	153.49

* The age range selected for setting up the default values

Harris Benedict equation was set as the default energy requirement equation. Apart from energy requirement equations (Table 8), more equations (Table 9) for adults with critical illness were also included into the developed application. If these equations were used, the application could ask users to add more information including Trauma condition, Burn condition, BMI for obesity condition (for Ireton Jones equation (ventilator-dependent)), Body surface area equation, Temperature, Respiratory rate, Tidal volume, Minute ventilation, and Maximum temperature, depending on what equations users selected. The NDPro application provides three equations for calculating body surface areas as shown in Table 10. DuBois-DuBois equation was selected as the default equation. Temperature, respiratory rate, and tidal volume used in Swinamer equation were set as 37.6 °C, 18 breaths/minute, and 0.65 L, respectively, based on results obtained from subjects in Swinamer's study [61]. Also, the default minute ventilation and maximum temperature, used in Penn State equation, were set as 12.4 L/min and 38.1 °C, respectively, according to subjects in study of Penn State equation [54]. Lastly, the default glucose absorption rate using for calculating energy and nutrient contents from peritoneal dialysate solutions was set as 75% [84] (Table 32).

4.3. Behaviors and attitudes of dietitians toward the dietary assessment process and the nutrition counselling service in hospitals

The questionnaires used for collecting for the behaviors and attitudes of dietitians toward the dietary assessment process was validated before collect the data. Their I-CVI and S-CVI scores were 1.0. which indicated both questionnaire and online questionnaire were valid.

Table 32 All default values of the nutritional assessment related variables in the
NDPro application

Variables	Default values
Sex	female
Age	45 years
Height	157 cm
Weight	60 kg
Weight type	Actual body weight
Ideal body weight type for using in Adjust body weight calculation	Ideal body weight type 1
BMI for using in Ideal body weight type 2 calculation	21 kg/m^2
Amputation condition	Absent
Amputation type (if present)	Only palm
Physical activity	Low
Energy equation	Harris Benedict equation
Value for energy calculation by simple equation	30 kcal/kg
Trauma condition (for Ireton Jones equation)	Absent
Burn condition (for Ireton Jones equation (spontaneously breathing))	Absent
BMI for obesity condition (for Ireton Jones equation (ventilator-dependent))	27 kg/m^2
Body surface area equation	DuBois-DuBois equation
Temperature (for Swinamer equation)	37.6 °C
Respiratory rate (for Swinamer equation)	18 breaths/minute
Tidal volume (for Swinamer equation)	0.65 liter
Minute ventilation (for Penn state equation)	12.4 liter/minute

Variables	Default values
Maximum temperature (for Penn state equation)	38.1 °C
Stress factor	Absent
Macronutrient distribution	Carbohydrate 60% Protein 15% Fat 25%
Micronutrient reference	DRI for Thai 2020
Pregnancy trimester 1	Absent
Pregnancy trimester 2	Absent
Pregnancy trimester 3	Absent
Lactation first 6 months	Absent
Lactation after 6 months	Absent
Glucose absorption rate from peritoneal dialysate solution.	75 %

There were seventy-six registered dietitians enrolled in this study. However, only seventy participants could complete the task, indicating 7.89% dropout rate. The average age of participants was 31.2 ± 6.96 years old. Most of them had earned a bachelor's degree (70%) and worked in hospital (87.1%) as dietitians (75.7%). The average year of work experience was 6.9 ± 6.0 yeas while the average year of nutritional consulting experience was 5.8 ± 4.6 years. The most medical diseases or conditions which participants specialized was Diabetes mellitus (89.9%), followed by hypertension (58.0%), obesity and weight management (56.5%), kidney disease (47.8%), cardiovascular disease (46.4%), and cancers (37.7%), respectively. There was only one participant (1.4%) specialized in chronic obstructive pulmonary disease (COPD) (Table 33).

4.3.1. The nutrition counselling routine service in hospitals

When focusing on the nutrition counselling service by the participants working in hospitals, it was shown that most of them worked in medium and large size hospitals with beds more than 250 beds (37.7%), followed by 51 –

100 beds (31.2%), 101 – 250 beds (21.3%), respectively. Only approximately 10% of them worked in the hospitals containing 50 or fewer beds. Overall, the means of numbers of dietitians, nutritionists, and nutritional staffs in their workplace were indicated as 5.9 ± 4.2, 2.6 ± 3.4 and 1.4 ± 4.6 people, respectively. When considering the sizes of hospitals, it showed that hospitals with ≤ 10 beds had an average of 7.6 ± 3.9 dietitians, 3.0 ± 2.1 nutritionists, and 1.2 ± 2.7 nutritional staffs. Hospitals with 11 – 50 beds had an average of 1.0 ± 0.0 dietitians, 3.0 ± 0.0 nutritionists, and 3.0 ± 0.0 nutritional staffs. Hospitals with 51 – 100 beds had an average of 7.7 ± 4.5 dietitians, 1.9 ± 2.0 nutritionists, and 0.5 ± 1.6 nutritional staffs. Hospitals with 101 – 250 beds had an average of 5.9 ± 4.9 dietitians, 2.9 ± 3.2 nutritionists, and 2.4 ± 7.7 nutritional staffs. Hospitals with 251 – 500 beds had an average of 5.3 ± 2.4 dietitians, 3.5 ± 4.4 nutritionists, and 1.6 ± 3.1 nutritional staffs. Hospitals with more than 500 beds had an average of 6.3 ± 4.9 dietitians, 4.0 ± 5.7 nutritionists, and 3.3 ± 8.0 nutritional staffs. The average number of the nutrition consultation was 5.0 ± 4.7 patients per dietitian per day with average time usage as 29.4 ± 11.4 minutes per patient. General people were the majority of their service recipients (84.3%), followed by elderly (78.6%) and patients with weight control (77.1%). The nutrition counselling services were also available for patients with malnutrition, patients with diseases, pregnant women, or patients with dysphagia as 67.1%, 64.3%, 62.9%, and 58.6%, respectively. However, less than 20% of them provided nutrition counselling services for lactating women, school age children, or pre-school children and only 3% of them were available for infants or athletes. (Table 34).

Table 33 Baseline characteristics of participants

Baseline characteristics	Categories	Total[1]
Gender, n (%)	Male	15 (21.4)
	Female	55 (78.6)
Age (year), mean ± SD	31.20 ± 6.96	
Religion, n (%)	Buddhism	66 (94.3)
	Christianity	2 (2.9)
	Islam	1 (1.4)
	No Religion	1 (1.4)
Education, n (%)	Bachelor's degree	49 (70.0)
	Master's Degree	19 (27.1)
	Doctoral Degree	2 (2.9)
Current position, n (%)	Dietitian	53 (75.7)
	Nutritionist	12 (17.1)
	Nutritional specialist	1 (1.4)
	Other	4 (5.7)
Workplace, n (%)	Hospital	61 (87.1)
	University	6 (8.6)
	Health Clinic	1 (1.4)
	Other	2 (2.9)
Work experience, (years), mean ± SD	6.9 ± 6.0	
Experience working as the dietitian consultants, (years), mean ± SD	5.8 ± 4.6	
Areas of specialists (more than one area per person), n (%)	Diabetes mellitus	62 (89.9)
	Hypertension	40 (58.0)
	Weight management	39 (56.5)
	Kidney disease	33 (47.8)
	Cardiovascular disease	32 (46.4)
	Cancers	26 (37.7)
	Other	1 (1.4)

[1]N = 70

Table 34 The nutrition counselling service by participants working in hospitals

Variables	Total[1]	Numbers of staffs in nutrition and dietetics per hospitals, mean ± SD		
		Dietitians	Nutritionists	Nutritional staffs
All hospitals, n (%)	61 (100)	5.9 ± 4.2	2.6 ± 3.4	1.4 ± 4.6
≤ 10 beds	5 (8.2)	7.6 ± 3.9	3.0 ± 2.1	1.2 ± 2.7
11 – 50 beds	1 (1.6)	1.0 ± 0.0	3.0 ± 0.0	3.0 ± 0.0
51 – 100 beds	19 (31.2)	7.7 ± 4.5	1.9 ± 2.0	0.5 ± 1.6
101 – 250 beds	13 (21.3)	5.9 ± 4.9	2.9 ± 3.2	2.4 ± 7.7
251 – 500 beds	15 (24.6)	5.3 ± 2.4	3.5 ± 4.4	1.6 ± 3.1
> 500 beds	8 (13.1)	6.3 ± 4.9	4.0 ± 5.7	3.3 ± 8.0
Numbers of the nutrition consultation (patients per dietitian per day), mean ± SD	5.0 ± 4.7			
Time usage for the nutrition consultation (minutes per patient), mean ± SD	29.4 ± 11.4			
Target groups with diseases or health conditions, n (%)[1,2]				
General	59 (84.3)	Patients, dysphagia	41 (58.6)	
Elderly	55 (78.6)	Lactating women	14 (20.0)	
Patients weight control	54 (77.1)	School age children	13 (18.6)	
Patients, malnutrition	47 (67.1)	Pre-school children	9 (12.9)	
Patients, with diseases	45 (64.3)	Infants	2 (2.9)	
Pregnant women	44 (62.9)	Athletes	2 (2.9)	

[1] N = 61; [2] Some participants provided the service more than one group per dietitian.

4.3.2. Tools used for supporting the dietary assessment in the nutrition counselling routine service in the hospitals

When focusing on the dietary assessment tools used by the participants in the hospitals, it was found that among 70 participants, 55 participants (78.5%) reported using 24 hour dietary recall. Only half of participants (52.7%) applying dietary recall in their routine work reported using tools or technologies to support the assessment. Among the 24-hr dietary recall supporting tools mentioned above, brochures (47.3%) were the most used tools, followed by actual food models (36.4%), photos of actual foods (27.3%), photos of food models (20.0%), and videos (12.7%), respectively. The tools or technology supports were used less than 10% including posters (9.1%), digital posters or images (7.3%), computer programs (5.5%), and smartphone application (1.8%), respectively. Computer programs reported by the participants included the Microsoft power point and the INMUCAL database. Smartphone applications informed by participants include Food choice, Google apps, and MyFitnessPal (Table 35).

Table 35 Tools used for supporting the dietary assessment in the nutrition counselling routine service in the hospitals

Methods/tools	Categories	Total
Methods used to access dietary intake, n (%)	24 hour dietary recall	55 (78.5)
	- No tools or technology support	26 (47.3)
	- Using tools or technology supports	29 (52.7)
	Food observation	13 (18.6)
	Food record	2 (2.9)
Tools or technologies used to aid the 24 hour dietary recall method[1,2], n (%)	Brochure or supporting document	26 (47.3)
	Food models	20 (36.4)
	Photos of actual foods	15 (27.3)
	Photos of food models	11 (20.0)
	Video demonstration	7 (12.7)
	Posters	5 (9.1)
	Digital posters or images	4 (7.3)
	Computer programs[3]	3 (5.5)
	Smartphone applications[4]	1 (1.8)
	Others	2 (3.6)

[1] N = 55; [2] Some participants used more than one tools or technologies; [3] Microsoft power point, INMUCAL database; [4] Food choice, Google apps, MyFitnessPal;

4.3.3. References and time used for dietary assessment by the 24 hour dietary recall method

Among 55 participants who reported using 24 hour dietary recall method, Thai FEL was used as a reference to access food intakes (96.4%). Only 8 participants (14.5%) use Thai FBDG as a reference. One participant reported other references including the Renal food exchange list. When considering abilities of participants to retrieve the information from their references, it was found that only 27.3% could remember all information provided by those FELs. The rest of them (72.7%) reported remembering partially and remembered only about 70% of information. Starch, meat, fruits,

and fat groups had been reported as the most frequently rememberable groups by participants who reported rememberable all information. On other hand, meat and fruit groups had been reported as the most problematic groups from participants who reported rememberable partially. If participants could not recall the reference amounts of foods per serving size of some food groups, most participants (52.5%) decide using the serving size of other similar food items to compensate forgotten food items (Table 36).

4.3.4. Using nutrition information obtained from the dietary assessment by any sources of FEL references

When asking about the dietary assessment process, participants reported the average duration spending for recording, analyzing, and evaluating energy and nutrients after estimating dietary intakes was 15.4 ± 10.2 minutes per case. (Table 36). Macronutrients, including energy, protein, carbohydrate, and fat, were the most frequent nutrients gained from their current references used for nutrient intake analysis, respectively. After getting the results, most of them (87.1%) compared the calculated daily energy and macronutrients intakes with the daily energy and nutrient requirements recommended for healthy people or patients with nutrition related diseases. However, there was approximately 13% of them ignoring this activity as a result of inadequate time, forgetting the DRI or RDI values, no reference values available in the workplaces, or no need to perform. In addition, it was found that almost all participants (94.3%) adjusted the dietary intakes of their patients to meet the requirements after the assessment. Only a few of them did not perform this practice mostly because of inadequate time, no reference values available, and forgetting the DRI or RDI values, respectively. (Table 37).

Table 36 References used for the dietary assessment by the 24 hour dietary recall method

Behaviors	Categories	Total[1]
Using reference sources of FEL for dietary assessment[2] , n (%)	Thai food exchange list	53 (96.4)
	Thai food based dietary guideline	8 (14.5)
	Renal food exchange list	1 (1.8)
Ability to remember the amounts per serving size of food in each food group accurately, n (%)	Not at all	0 (0.0)
	Could remember all[3]	15 (27.3)
	Could remember partially[4]	40 (72.7)
	Percentages of all remembered food items, mean ± SD	70.0 ± 16.2
	Estimating serving sizes when forgetting the reference amounts of foods per serving size	
	Using the serving sizes of other similar food items	21 (52.5)
	Using own experience	11 (27.5)
	Applying the equal serving size to all food items in the same food groups	7 (17.5)
	Using the serving sizes of other food groups, although those serving sizes might be different	0 (0.0)
	Searching the internet	1 (2.5)
Time usage for recording, analyzing, and evaluating energy and nutrient intakes after estimating dietary intakes by the current methods (minutes), mean ± SD		15.4 ± 10.2

[1] N = 55; [2] Some participants used more than one reference; [3] The most frequently rememberable groups were starch, meat, fruits, and fat; 4The most problematic groups were meat and fruits;

4.3.5. Nutrition information management for the nutrition care process

Based on this study it was found that most of fifty-nine participants (84.3%) kept the dietary and nutrition information in either paper-based records or electronic based records. Among 59 participants keeping the record, the medical record folder was the most frequently used method (79.7%), followed by Microsoft excel (27.1%), computer programs (22.0%), and Microsoft word (8.5%), respectively. The examples of computer programs used by participants include INMUCAL, SilT programs, IMED medical software, SoftCon Phoenix HIS, and SSB programs. It was interesting that there was around 15% of participants ignoring this activity mostly as a result of the limited time and a complex procedure. According to the monitoring and evaluation process, only fifty participants, 84.7% of participants keeping record, used the recorded information for monitoring and evaluating the dietary behaviors of their patients. Inadequate time to perform (55.6%) was the most frequent clause reported by the participants who did not perform this practice, followed by no need to perform (44.4%). It was also found that the major obstacles preventing dietitians from using the recorded information for monitoring patients was spending too much time for searching the records (75.7%). Complexity of evaluation (45.9%) and inadequate time to perform (43.2%) were the other two obstacles which participants confronted in this process. Systemic crash from the workplace's system was also reported in one case (5.4%). (Table 38).

Table 37 Using nutrition information obtained from the dietary assessment for the

nutrition care process

Behaviors	Categories	Total[1]
Nutrition information obtained from the current methods used for the dietary assessment[2], n (%)	Total energy	69 (98.6)
	Total protein	63 (90.0)
	Total carbohydrate	52 (74.3)
	Total fat	42 (60.0)
	Minerals	6 (8.6)
	Water	6 (8.6)
	Vitamins	1 (1.4)
	Other	1 (1.4)
Comparing the daily energy and nutrient intakes with daily energy and nutrient requirements recommended for healthy people or patients with nutrition related diseases, n (%)	Yes	61 (87.1)
	Categories of the compared nutrients	
	Energy and macronutrients	58 (95.1)
	Energy, macronutrients, vitamins, and minerals	3 (4.9)
	Time usage (minutes), mean ± SD	12.7 ± 12.3
	No	9 (12.9)
	Inadequate time to perform	6 (66.7)
	Forgetting DRI or RDI values	6 (66.7)
	No DRI or RDI values available in workplaces	3 (33.3)
	No need to perform	3 (33.3)
Adjusting daily dietary intakes to meet the daily nutrient requirements, n (%)	Yes	66 (94.3)
	Time usage (minutes), mean ± SD	10.1 ± 9.1
	No	4 (5.7)
	Inadequate time to perform	3 (75.0)

Behaviors	Categories	Total[1]
	No DRI or RDI values available in the workplaces	2 (50.0)
	Forgetting DRI or RDI values	1 (25.0)
	No need to perform	0 (0.0)

[1] N = 70; [2] Some participants provided information more than one nutrient

4.3.6. Participants' attitudes toward the obtained nutrition information for the nutrition care process

The opinions of participants toward their workloads and currently used methods, tools and technologies were investigated along with their behaviors. Even though almost 78.6% of participants were satisfied with the numbers of patients per day served in their hospitals, they required to improve the service efficiency (38.6%) and more numbers of patients to be served per day (10%). Almost 70% of them required more nutrition information obtained from those methods and tools. Although these dietary assessment tools could provide adequate information, most participants (44.3%) still required more information. Likewise, more than half of participants (74.6%) thought that their currently used methods, tools and technologies were not suitable and had limitations. The most reported reasons included unavailable vitamin and mineral information (65.9%), followed by unsuitable tools or technologies (50.0%) and no record keeping tools available (40.9%), respectively.

Table 38 Nutrition information management for the nutrition care process

Behaviors	Categories	Total
Keeping the dietary and nutrition records for follow ups, n (%)[1]	Yes[3]	59 (84.3)
	Paper-based records	47 (79.7)
	Medical record folders	47 (79.7)
	Electronic based records	34 (57.6)
	Microsoft excel	16 (27.1)
	Computer programs[4]	13 (22.0)
	Microsoft word	5 (8.5)
	Others[5]	3 (5.1)
	No	11 (15.7)
	Inadequate time to perform	7 (63.6)
	A complex procedure	5 (45.5)
	Unrequired information	1 (9.1)
	No need to perform	0 (0.0)
Monitoring and evaluating the dietary histories of patients from the records, n (%)[2]	Yes	50 (84.7)
	No	9 (15.3)
	Inadequate time to perform	5 (55.6)
	No need to perform	4 (44.4)
	Spending a long time to search records	3 (33.3)
	Complexity of evaluation	2 (22.2)
	Recorded information was useless for monitoring	1 (11.1)
Obstacles preventing dietitians from using the recorded information, n (%)[2,6]	Yes	37 (62.7)
	Spending a long time to search records	28 (75.7)
	Complexity of evaluation	17 (45.9)
	Inadequate time to perform	16 (43.2)
	Systemic crash from workplace's system	2 (5.4)
	No	22 (37.3)

[1] N = 70; [2] N = 59; [3] Some participants used more than one method; [4] INMUCAL, SilT programs, IMED medical software, SoftCon Phoenix HIS, and SSB programs; [5] Three participants reported using other nutrition records, two participants reported using health diary and other reported using Hospital Information System (HIS); [6] Some participants chose more than one obstacle.

Furthermore, most participants thought that their currently used methods, tools, and technologies required too much time (54.1%) for analyzing and evaluating nutrient intakes and resulted in error (94.2%). They reported the possible medium chance of errors up to almost 60%. (Table 39) The top five clauses of errors reported by the participants included incompatibility of some foods toward in FEL (73.8%), human errors from poor manual calculation skills (69.2%), limited time (60%), unavailable technology supports for data analysis and verification (60%), forgetting some food items and serving size of some food groups in FEL (58.5%) and human errors from invalid data inputs or functions in calculators (Table 40).
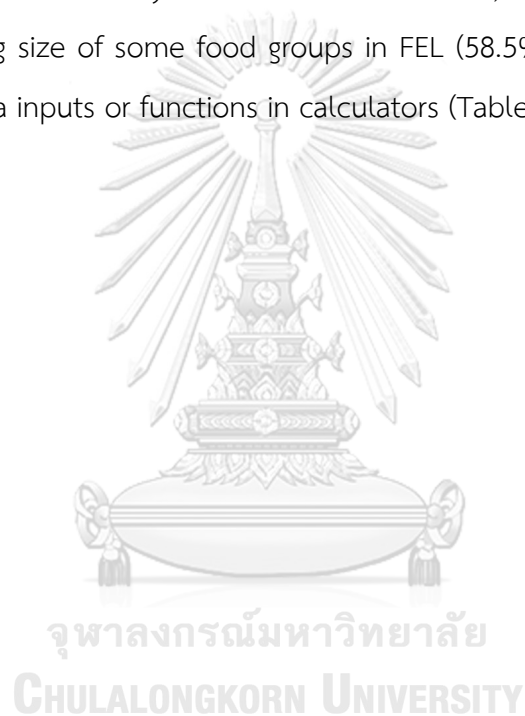
Table 39 Participants' attitudes toward the obtained nutrition information for the nutrition care process

Attitudes	Categories	Total[1]
Numbers of patients served per day, n (%)	Appropriate, but require to improve service efficiency	27 (38.6)
	Appropriate	21 (30.0)
	Too few	11 (15.7)
	Appropriate, but require more patients	7 (10.0)
	Too many	3 (4.3)
	Unsure	1 (1.4)
Information obtained from the currently used methods, tools, or technologies for supporting the nutrition counselling service, n (%)	Adequate, but require more information	31 (44.3)
	Adequate	18 (25.7)
	Inadequate	10 (14.3)
	Unsure	11 (15.7)
Limitations of the currently used dietary assessment methods for supporting the nutrition counselling service, n (%)	Yes	44 (74.6)
	Unavailable vitamin and mineral information	29 (65.9)
	Unsuitable tools and technologies	22 (50.0)
	No record keeping tools available	18 (40.9)
	No, suitable	26 (37.1)
Probability of inaccurate results obtained from the currently used methods, tools or technologies, n (%)	Medium chance	41 (59.4)
	High chance	13 (18.8)
	Low chance	11 (15.9)
	No chance	5 (5.8)
Time usage for analyzing and evaluating energy and nutrient intakes after estimating dietary	Too much	36 (51.4)
	Suitable, but require to speed up	22 (31.4)

Attitudes	Categories	Total[1]
intakes by the current methods, n (%)	Suitable	11 (15.7)
	Unsure	1 (1.4)
Expected time usage for recording, analyzing, and evaluating energy and nutrient intakes after dietary assessment, n (%)	Immediately	46 (65.7)
	Not more than some period	23 (32.9)
	Expected Time (minutes), mean ± SD	12.9 ± 9.0
	Unsure	1 (1.4)

[1] N = 70;

4.3.7. Participants' requirements for technologies supporting the nutrition care process

Lastly, participants were asked for their opinions toward their requirements for technologies supporting the nutrition care process (NPC). Most participants (65.7%) required technologies able to immediately analyze and evaluate the patients' dietary and nutrition information toward the NPC. If tools or technologies could not provide information immediately, participants expected usage time of the tools or technologies toward the nutrition care process within 12.9 ± 9.0 minutes. (Table 39). Accordingly, more than 90% of participants required some technologies to support the dietary assessment and provide real-time dietary and nutrition information for the individualized nutrition care in the NCP. Dietary record keeping, monitoring, and plaining for individuals were also demanded in the requirement. Almost all participants (95.7%) were interested in the mobile application on smartphones or tablets able to support the individualized nutrition care. (Table 41).

Information related to requirement, obstacles, and limitations of participants toward the traditional dietary assessment and data management obtained from this survey were included in the mobile development phase (Phase 3).

Table 40 The possibly clauses of errors of inaccurate results obtained from the currently used methods

Possibly clauses of errors	Total[1], n (%)
1. Incompatibility of some foods toward any food groups in FELs	48 (73.8)
2. Possibly human errors from poor manual calculation skills	45 (69.2)
3. Haste, limited time	39 (60.0)
4. Unavailable technology supports for data analysis and verification	39 (60.0)
5. Forgetting some food items and serving size of some food groups in the FELs	38 (58.5)
6. Possibly human error when using calculators	35 (53.8)
7. Unavailable serving sizes and items of food products, such as snack foods, commercial beverages, medical foods, in the FELs	30 (46.2)
8. Deviation of memory about energy and nutrients in the FELs	26 (40.0)
9. Unavailable serving sizes and items of food products, such as snack foods, commercial beverages, medical foods, in the food groups described in the Nutrition flag	21 (32.3)
10. Unavailable information of energy and nutrient contents in each food groups described in the Nutrition flag	19 (29.2)
11. Forgetting energy or nutrient contents of some food groups in the FELs	18 (27.7)
12. Complexity of FELs and difficulties related to the energy and nutrient contents calculation	10 (15.4)
13. Forgetting energy or nutrient contents in all food groups available in the FELs	9 (13.8)

[1]N = 65

Table 41 Participants' requirements for technologies supporting the nutrition care process

Attitudes	Categories	Total[1]
Requirements for some technologies to support the dietary assessment for the real-time data collection, analysis, and evaluation, n (%)	Very strongly required	32 (45.7)
	Strongly required	24 (34.3)
	Moderately required	8 (11.4)
	Neutral	5 (7.1)
	Not required	1 (1.4)
Requirements for some technologies to support dietary record keeping, monitoring, and plaining for the individualized nutrition care, n (%)	Very strongly required	33 (47.1)
	Strongly required	22 (31.4)
	Moderated required	10 (14.3)
	Neutral	5 (7.1)
Interest in mobile applications on smartphones or tablets providing real-time dietary and nutrition information for the individualized nutrition care in the nutrition care process, n (%)	Very strongly interested	38 (54.3)
	Strongly interested	22 (31.4)
	Moderately interested	7 (10.0)
	Neutral	3 (4.3)

[1] N = 70

4.4. Application development, features, and design

In this study, the NDPro application was developed using Android studio Android studio version 3.3.2 for Windows. Although Application Program Interface (API) 15 was set at the beginning of development to support all devices in the markets, the application's API must be changed into API 19 to meet the requirements of some features of Android studio. The development of application was based on the first draft showed between Figure 6 and Figure 13. It was launched with fourteen components including four main processes of the application and ten supporting components as follows.

4.4.1. Main component

This component was one of the main processes. This component was the first component represented to the user once the application was launched.

4.4.2. Requirement determination component

This component was also one of the main processes. It aimed to collect all information required to determine dietary requirement.

4.4.3. Dietary record component

This component was one of the main processes. It aimed to collect the information involved in dietary intakes from respondents. Seven meals (snack – dawn, snack – morning, snack – afternoon, and snack - night) were available to record dietary intakes. Users could add menus into each meal by clicking the "+" button at the right bottom side of the screen. Then, touching the menu name and holding for a certain second, the application would display a dialog window which users could freely modify food compositions and condiments.

4.4.4. Result displaying component

This component was the last component of the main process. This component showed results of nutrition requirements and dietary intakes from Requirement determination and Dietary record component.

4.4.5. Account registration component

This component was used to create an account to store the results of each step of the nutrition care process.

4.4.6. Account management component

This component stored the created accounts from Account registration component. Users could use this component to access or export records of accounts stored in the NDPro application.

4.4.7. Setting component

This was the component accessible from the Main component. Users could change the default values of nutritional related variables (Table 32). Furthermore, users could also choose either Thai FEL based program or Thai FBDG based functions as well as the alternative version of Thai FEL based application providing energy and nutrient contents in the meat group reallocated. If users selected Thai food exchange list, users could further select for the meat group reallocation.

4.4.8. Nutrition flag determination component

This component was used to determine dietary plan. It supported users to determine dynamically how many portions of each food group should be consumed each day. In this component, fats (MUFA / PUFA) and fats (SFA) are combined into a single fat (all) subgroup to facilitate the programming algorithms of this component (APPENDIX K). Totally 17 subgroups were available for the TFEL-based NDPro application, including a protein-free starch group and refined sugar food items, which differ from the Thai food exchange list used in the Dietary Record component. Similarly, the TFBDG-based NDPro application contains 13 subgroups, including a protein-free starch group and refined sugar food item. There are no differences between this component and the Dietary Record component for the TFBDG-based NDPro application.

4.4.9. Fat profile calculation component

This component was used to access a database of fatty acid and calculate fatty acid intakes. This was the standalone component of the NDPro application, and the results from this component could not be saved.

4.4.10. Folic acid calculation component

This component was used to access a database of folic acid and calculate folic acid intakes. This was also the standalone component of the NDPro application and the results from this component could not be saved.

4.4.11. Database component

This was the component users could access to database of food products. Unlike the fatty acid profile and folic acid databases, information from this component could be used with other components and recorded within the accounts.

4.4.12. Food image component

This component aimed to support users and their respondents to estimate food portions during dietary recall. Food images were presented within a dialog window. Each food item had options to change portions (½, 1, 2, 3, or 4) excepted for egg and milk (see 4.1.6.). These images were stored in the application as URL. Therefore, using this component was required internet connection.

4.4.13. Documentation component

This component aimed to support users to perform documentation. It was the 2-page component which the first page supported users to document plans, problems, notes, and dates of next follow-up. Additionally, the second page assisted users to determine dietary plans which users could decide how many portions should be consumed to follow intervention.

4.4.14. Export component

This component aimed to help users to export the results of dietary recall to documentation. The NDPro application provides Portable Document Format (.pdf) and Excel 97-2003 Workbook (.xls) formats for document exportation. The dialog window for document exportation contained a checkbox that users could instruct the application whether it should insert names and surnames of respondents into exporting files.

The association between these components was presented in Figure 20. Grey boxes referred to the main processes of The NDPro application. First, once users lunched application, users would be experienced with "Main component". Second, users could step further to "Requirement

determination component". Users could access this activity to calculate energy and nutrient requirements. Third, users could step further to "Dietary record component" to insert food items and calculate dietary intakes. Lastly, the results of both requirements and dietary intakes would then be presented "Result displaying component" which was the last main process of application. Along with these main processes, users could also access other additional components to support their professional practices.
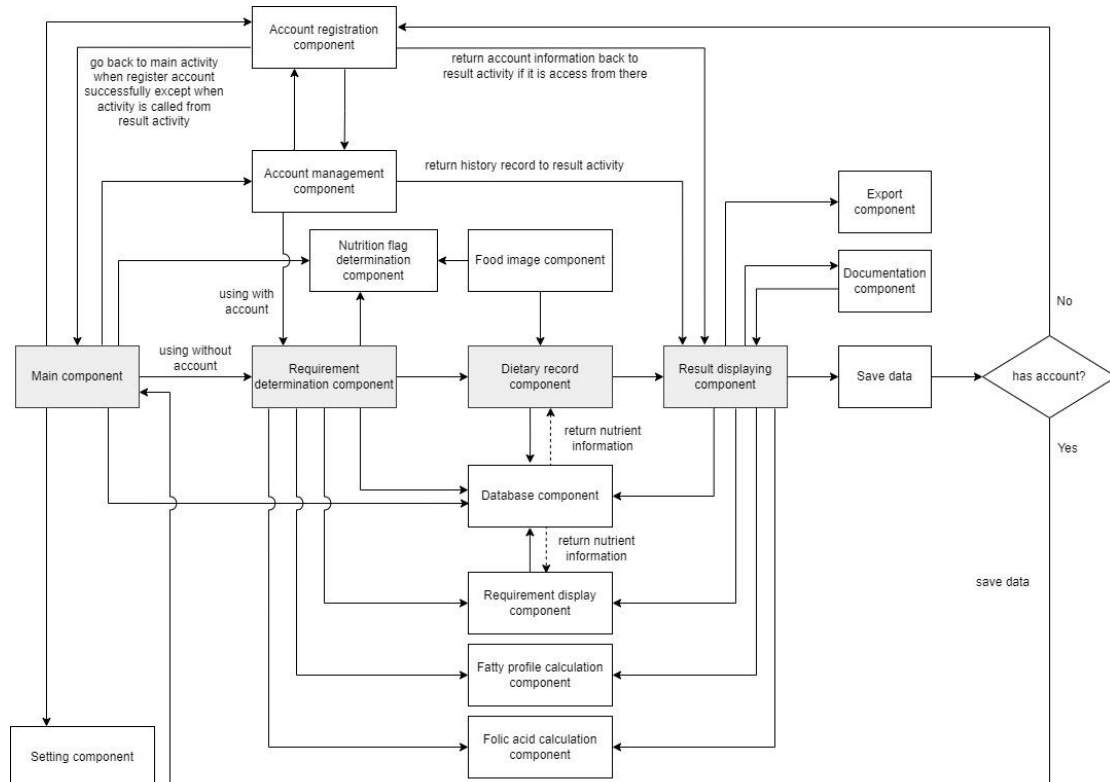
Note: Grey boxes referred to main processes

Figure 20 A workflow of the NDPro application

4.5. Validation of the NDPro application by a researcher

The stability of the NDPro application was accountable with 100% of stability from the triplicate of 24 meals used for testing (Table 42). It was found that the results obtained from using Microsoft Excel and the NDPro application did not differ. After testing using the application in five testers, it had demonstrated its reliability and functionality. With no significant issues identified during this phase, the study is ready to progress to the validation phase.

4.6. Validation of the NDPro application by participants

Seventy-six registered dietitians were enrolled into the validation phase. However, six participants were excluded because they could not complete all steps of the validation process. Totally, seventy participants were included in this study.

The total 70 participants comprised of male (21%) and female (79%). The participants had a mean age of 31.2 ± 7.0 years. Most participants in this study were dietitians (72.9%) and had education level as bachelor's degree level (70.0%). The demographic characteristics of the participants were mentioned in 4.3.1 and summarized in Table 33.

The purpose of this study was to develop and validate the smartphone nutrition application for supporting dietetic professional practice to perform dietary assessment and estimate nutrition requirements providing dietary information and adjustable serving sizes from Thai FEL and Thai FBDG. The validation of reliability investigated energy, carbohydrate, protein, fat, and time usage between calculation manually and the NDPro application.

In this study, participants were asked to estimate portion sizes from six sets of food images prepared by a researcher (three sets based on Thai FEL and three sets based on Thai FBDG). Then, participants calculated the estimated portion sizes manually compared with using the NDPro application. The reliability of the developed application relies on the percentage difference of energy, carbohydrate, protein, and fat compared with the reference foods (Control 1_{FEL} and Control 1_{FBDG}) when the participants filled out the correct serving size estimated by their own (MN_{FEL70} or MN_{FBDG70}). The acceptable results referred to the percentage difference within $\pm 10\%$ from the reference values calculated from the actual serving sizes prepared by a researcher (Control 1_{FEL} or Control 1_{FBDG}) or $\pm 5\%$ from the reference values calculated from the estimated serving sizes assessed by participants (Control 2_{FEL70} or Control 2_{FBDG70}).

Table 42 The stability of the NDPro application

| Days | Thai FEL based NDPro application | | | | Thai FBDG based NDPro application | | | |
| | Stability test 1 (before validation) | | Stability test 2 (during validation) | | Stability test 1 (before validation) | | Stability test 2 (during validation) | |
	Control 1$_{FEL}$ Calculation by Microsoft Excel[2]	NDP$_{FEL}$ Calculation by NDPro application[2]	Control 2$_{FEL}$ Calculation by Microsoft Excel[2]	NDP$_{FEL}$ Calculation by NDPro application[2]	Control 1$_{FBDG}$ Calculation by Microsoft Excel[2]	NDP$_{FBDG}$ Calculation by NDPro application[2]	Control 2$_{FBDG}$ Calculation by Microsoft Excel[2]	NDP$_{FBDG}$ Calculation by NDPro application[2]
Energy (kcal)								
Day 1	2156.60	2156.60	2156.60	2156.60	2139.66	2139.66	2139.66	2139.66
Day 2	1976.28	1976.28	1976.28	1976.28	2162.05	2162.05	2162.05	2162.05
Day 3	2178.11	2178.11	2178.11	2178.11	2042.68	2042.68	2042.68	2042.68
Carbohydrate (g)								
Day 1	304.16	304.16	304.16	304.16	345.69	345.69	345.69	345.69
Day 2	287.12	287.12	287.12	287.12	353.31	353.31	353.31	353.31
Day 3	282.53	282.53	282.53	282.53	325.77	325.77	325.77	325.77
Protein (g)								
Day 1	81.44	81.44	81.44	81.44	71.05	71.05	71.05	71.05
Day 2	83.61	83.61	83.61	83.61	69.47	69.47	69.47	69.47
Day 3	86.60	86.60	86.60	86.60	71.47	71.47	71.47	71.47
Fat (g)								
Day 1	68.39	68.39	68.39	68.39	52.53	52.53	52.53	52.53
Day 2	54.92	54.92	54.92	54.92	52.33	52.33	52.33	52.33
Day 3	78.09	78.09	78.09	78.09	50.41	50.41	50.41	50.41

[1] The results were from triplicate data of twelve meals from the food photographs in each food exchange list prepared by a researcher; [2] Performed by a same researcher;

4.6.1. Validation of the Thai FEL based NDPro application

The results of estimation and calculation food images by all participants using Thai FEL were shown in Table 43 and Table 44, and the results of time usage of validation by participants are showed in 4.6.3. The representative values of Thai FEL (with reallocated meat group), as mentioned in Table 17 to Table 19, installed in the NDPro application were assigned for validation. The results of energy and macronutrients obtained from NDP application were not equal to those found in Control 2_{FEL70} which calculated with the same portion sizes estimated by participants and same database installed in the NDPro application. When looking the portion size estimations of these participants, it was obvious that the estimated portion sizes in each food group by the participants were varied and incorrect. Subgroup analysis was introduced for further investigation before considering reliability.

According to the validation of Thai FEL, the results of energy and all macronutrients derived from the NDPro application (NDP_{FEL70}) showed significant differences compared to calculation manually. The average energy calculated manually (MN_{FEL70}) compared with the NDPro application (NDP_{FEL70}) were indicated as 2,042.06 ± 383.49 vs 2,172.57 ± 403.92 kcal on Day 1 (Reference was 2,156.60 kcal), 1,717.60 ± 319.14 vs 1,881.62 ± 338.72 kcal on Day 2 (Reference was 1,976.28 kcal), and 2,005.91 ± 394.21 vs 2,112.36 ± 398.23 kcal on Day 3 (Reference was 2,178.11 kcal). The average carbohydrate contents of MN_{FEL70} compared with NDP_{FEL70} were indicated as 235.63 ± 40.71 vs 267.13 ± 42.88 g on Day 1 (Reference was 304.16 g), 199.72 ± 36.02 vs 230.24 ± 56.93 g on Day 2 (Reference was 287.12 g), and 240.16 ± 43.66 vs 262.96 ± 40.28 g on Day 3 (Reference was 282.53 g). The average protein contents of MN_{FEL70} compared with NDP_{FEL70} were indicated as 78.50 ± 43.90 vs 78.41 ± 15.12 g on Day 1 (Reference was 81.44 g), 64.90 ± 15.52 vs 72.20 ± 14.30 g on Day 2 (Reference was 83.61 g), and 76.02 ± 19.08 vs 79.91 ± 16.06 g on Day 3 (Reference was 86.6 g).

Table 43 The comparisons of energy and macronutrients assessed from food images and calculated manually or by the Thai FEL based NDPro application

Days	Control 1_{FEL} Reference food[1]	Meals estimated by participants				p-value[5]	p-value[6]
		Control 2_{FEL70} Calculation by Microsoft excel[2]	NDP_{FEL70} Calculation by the Thai FEL based NDPro application[3]	Control 3_{FEL70} Calculation by Microsoft excel with original nutrients from Thai FEL	MN_{FEL70} Calculation manually by participants[4]		
Energy (kcal)							
Day 1	2156.60	2024.62 ± 344.80	2172.57 ± 403.92	1878.67± 320.31	2042.06 ± 383.49	<0.001	<0.001
Day 2	1976.28	1742.71 ± 298.85	1881.62 ± 338.72	1620.32 ± 282.20	1717.60 ± 319.14	<0.001	0.003
Day 3	2178.11	1920.47 ± 343.82	2112.36 ± 398.23	1784.22 ± 317.85	2005.91 ± 394.21	<0.001	<0.001
Carbohydrate (g)							
Day 1	304.16	259.71 ± 34.17	267.13 ± 42.88	238.76 ± 32.83	235.63 ± 40.71	<0.001	0.086
Day 2	287.12	223.02 ± 34.39	230.24 ± 56.93	206.59 ± 34.19	199.72 ± 36.02	<0.001	0.006
Day 3	282.53	263.54 ± 42.45	262.96 ± 40.28	243.54 ± 40.17	240.16 ± 43.66	<0.001	0.249
Protein (g)							
Day 1	81.44	62.44 ± 9.70	78.41 ± 15.12	52.51 ± 8.23	78.50 ± 43.90	0.013	<0.001
Day 2	83.61	54.48 ± 8.17	72.20 ± 14.30	45.11 ± 7.13	64. 90 ± 15.52	<0.001	<0.001
Day 3	86.6	62.21 ± 10.01	79.91 ± 16.06	53.63 ± 8.77	76.02 ± 19.08	0.014	<0.001
Fat (g)							
Day 1	68.39	81.88 ± 26.39	87.93 ± 28.45	79.88 ± 26.50	94.43 ± 33.04	0.024	<0.001
Day 2	54.92	70.38 ± 23.13	75.35 ± 23.92	68.79 ± 23.40	79.58 ± 34.18	0.327	<0.001
Day 3	78.09	68.72 ± 23.75	82.44 ± 29.64	66.85 ± 23.74	87.23 ± 39.85	0.492	<0.001

N = 70; Mean ± SD

[1] Reference based on the results calculated by Microsoft excel from serving size of cooking ingredients estimated by a researcher; [2] Portion size estimated by participants from evaluation form (ND-02/64) were calculated for energy and nutrient using Microsoft excel by a researcher; [3] Results were obtained from estimation and calculation by participants using the Thai FEL based NDPro application; [4] Results were obtained from estimation and calculation manually by participants;

[5] Significant difference between MN_{FEL70} and NDP_{FEL70} (Thai FEL based NDPro application) of each food set within the same day at $p < 0.05$. Wilcoxon signed ranks test was used to calculate the significant difference except Day 2 and Day 3 for energy and Day 1 and Day 3 for carbohydrate, which using Paired t-test with a significance at $p < 0.05$;

[6] Significant difference between MN_{FEL70} and Control 3_{FEL70} of each food set within the same day at $p < 0.05$. Wilcoxon signed ranks test was used to calculate the significant difference except Day 2 and Day 3 for energy, Day2 and Day 3 for carbohydrate, and Day1 for protein, which using Paired t-test with a significance at $p < 0.05$;

Table 44 The accuracy of Thai FEL based NDPro application on energy and macronutrients

Days	Control 1_FEL Meals prepared by researcher and calculated by Microsoft excel	Control 2_FEL70 Meals estimated and calculated by participants by Microsoft excel[1,3]	Control 3_FEL70 Meals estimated and calculated by participants with original nutrients from Thai FEL using Microsoft excel by a researcher[2]	NDP_FEL70 Meals estimated and calculated by participants with Thai FEL based NDPro application	%Difference (Control 1_FEL & NDP_FEL70)[1]	%Difference (Control 1_FEL & MN_FEL70)[1]	%Difference (Control 2_FEL70 & NDP_FEL70)[2]	%Difference (Control 2_FEL70 & MN_FEL70)[2]	MN_FEL70 Meals estimated and manual calculation by participants with original nutrient contents from Thai FEL	%Difference (NDP_FEL70 & MN_FEL70)[2]	p-value (Control 3_FEL70 & MN_FEL70)
Energy (kcal)											
Day 1	2156.60	2024.62 ± 344.80	1878.67 ± 320.31	2172.57 ± 403.92	13.26 ± 13.15	13.86 ± 12.24	9.61 ± 6.64	9.16 ± 11.83	2042.06 ± 383.49	12.57 ± 12.54	<0.001
Day 2	1976.28	1742.71 ± 298.85	1620.32 ± 282.20	1881.62 ± 338.72	14.0 ± 10.87	16.73 ± 12.27	9.63 ± 9.96	8.11 ± 13.14	1717.60 ± 319.14	13.69 ± 26.20	0.003
Day 3	2178.11	1920.47 ± 343.82	1784.22 ± 317.85	2112.36 ± 398.23	14.59 ± 11.29	16.47 ± 10.77	12.03 ± 9.16	10.07 ± 8.69	2005.91 ± 394.21	11.27 ± 12.96	<0.001
Carbohydrate (g)											
Day 1	304.16	259.71 ± 34.17	238.76 ± 32.83	267.13 ± 42.88	15.46 ± 10.32	23.40 ± 11.79	5.60 ± 7.57	11.87 ± 7.94	235.63 ± 40.71	16.30 ± 11.95	0.086
Day 2	287.12	223.02 ± 34.39	206.59 ± 34.19	230.24 ± 56.93	22.97 ± 16.0	30.44 ± 12.55	5.39 ± 18.33	11.30 ± 8.30	199.72 ± 36.02	16.78 ± 22.76	0.006
Day 3	282.53	263.54 ± 42.45	243.54 ± 40.17	262.96 ± 40.28	12.13 ± 10.13	17.19 ± 12.94	3.55 ± 6.87	10.16 ± 7.70	240.16 ± 43.66	11.51 ± 10.65	0.249
Protein (g)											
Day 1	81.44	62.44 ± 9.70	52.51 ± 8.23	78.41 ± 15.12	15.64 ± 10.51	16.48 ± 13.45	27.70 ± 19.31	21.27 ± 16.28	78.50 ± 43.90	20.44 ± 19.60	<0.001
Day 2	83.61	54.48 ± 8.17	45.11 ± 7.13	72.20 ± 14.30	18.33 ± 11.85	25.76 ± 13.39	34.16 ± 16.83	22.29 ± 17.78	64.90 ± 15.52	19.52 ± 15.45	<0.001
Day 3	86.6	62.21 ± 10.01	53.63 ± 8.77	79.91 ± 16.06	16.45 ± 11.40	19.98 ± 15.22	30.11 ± 17.25	27.32 ± 22.21	76.02 ± 19.08	20.01 ± 20.68	<0.001
Fat (g)											
Day 1	68.39	81.88 ± 26.39	79.88 ± 26.50	87.93 ± 28.45	34.30 ± 36.94	42.12 ± 44.78	11.92 ± 9.44	23.54 ± 33.78	94.43 ± 33.04	16.99 ± 21.31	<0.001
Day 2	54.92	70.38 ± 23.13	68.79 ± 23.40	75.35 ± 23.92	41.33 ± 55.21	53.21 ± 55.21	12.74 ± 15.86	24.50 ± 39.40	79.58 ± 34.18	20.13 ± 49.15	<0.001
Day 3	78.09	68.72 ± 23.75	66.85 ± 23.74	82.44 ± 29.64	28.65 ± 25.30	36.70 ± 37.10	24.68 ± 20.17	33.35 ± 38.48	87.23 ± 39.85	19.91 ± 22.65	<0.001

N = 70; Mean ± SD

[1] Reliability compared to Control 1_FEL should be < 10%; [2] Reliability compared to Control 2_FEL70 or NDP_FEL70 should be < 5%; [3] Reliability compared to Control 1_FEL should be < 5%;

Lastly, the average fat contents of MN_{FEL70} compared with NDP_{FEL70} were indicated as 94.43 ± 33.04 vs 87.93 ± 28.45 g on Day 1 (Reference was 68.39 g), 79.58 ± 34.18 vs 75.35 ± 23.92 g on Day 2 (Reference was 54.92 g), and 87.23 ± 39.85 vs 82.44 ± 29.64 g on Day 3 (Reference was 78.09 g).

Comparing NDP_{FEL70} and MN_{FEL70}, it was obvious that only the average fat contents were not significant difference (Table 43). The results of energy and macronutrient contents from NDP_{FEL70} did not range within acceptable range as %difference outside the reference values (±10% when compared with Control 1_{FEL} and ±5% when compared with Control 2_{FEL70} (Table 44)). However, none of them obtained from MN_{FEL70} were equal to those found in Control 3_{FEL70} using the same portion sizes estimated by participants and calculated by Microsoft excel with the original values defined by Thai FEL. Also, the results of energy and macronutrient contents obtained from NDP_{FEL70} were not equal to those found in Control 2_{FEL70} which calculated with the same portion sizes estimated by participants and same database installed in the NDPro application. It indicated that all results obtained from MN_{FEL70} and NDP_{FEL70} could not be compared for reliability (Table 43 and Table 44). However, instead using the NDP_{FEL70} and MN_{FEL70} to investigate the reliability of the Thai FEL based NDPro application in this study, Control 2_{FEL70} and Control 3_{FEL70} were used to substitute NDP and MN, respectively. It was found that the differences of Control 2_{FEL70} (as NDP_{FEL70}) & Control 3_{FEL70} (as MN_{FEL70}) from fat category were less than 5% while those of energy and carbohydrate categories were between 5 - 10 % and those from protein category were more than 10% (Table 45).

When looking at the portion size estimations of these participants and results from Control 1_{FEL}, Control 2_{FEL70}, and Control 3_{FEL70}, it was obvious that the estimated portion sizes and values used for calculation in each food group by the participants were varied and incorrect (Table 46). Subgroup analysis was introduced for further investigation before considering reliability, as mentioned in 4.6.4.
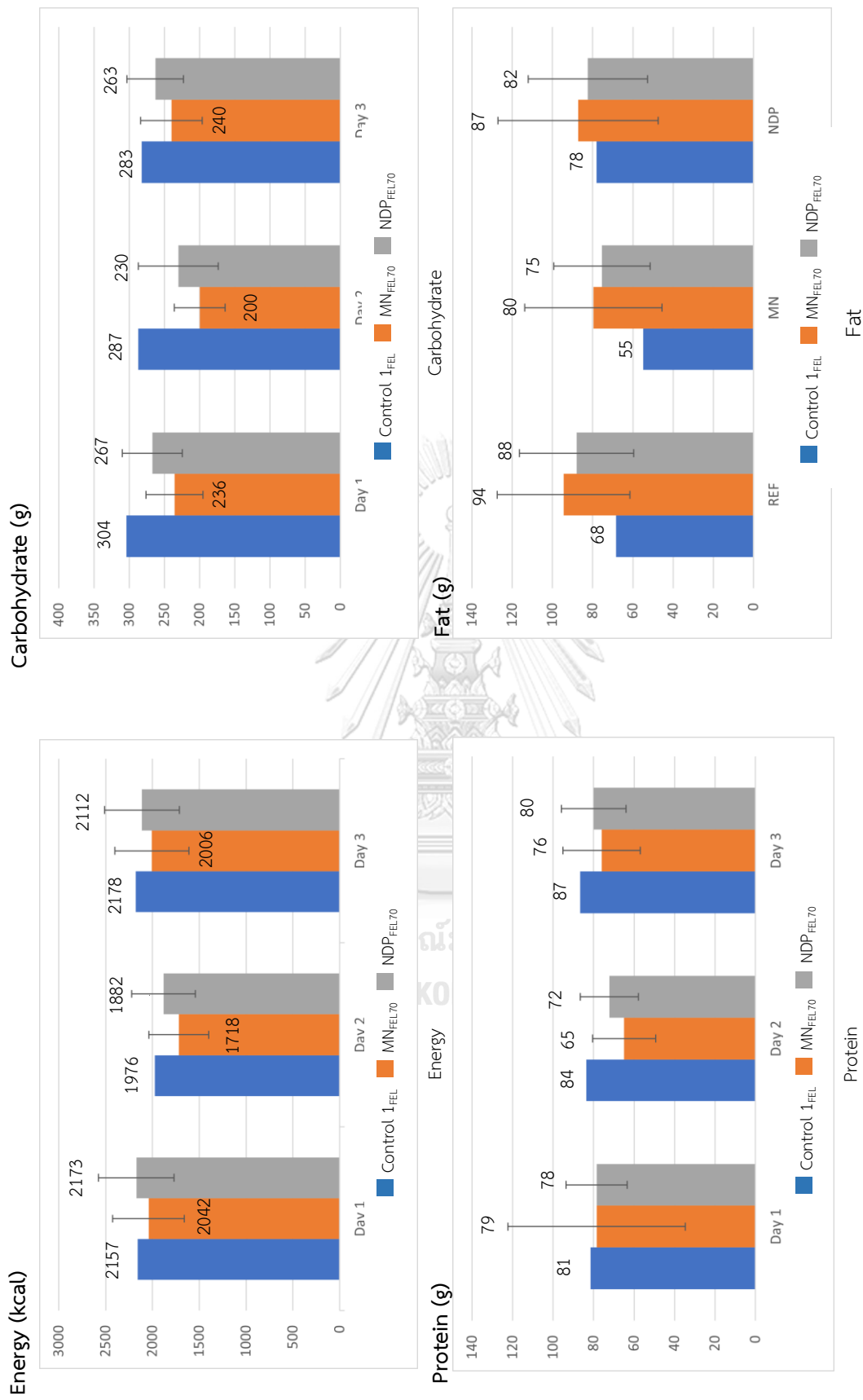
Figure 21 Average energy and macronutrients calculated manually or by the Thai FEL based NDPro application (N = 70)

Table 45 The accuracy based on the portion sizes estimated by participants calculated by Microsoft Excel (Control 2_{FEL70}) and calculated by original nutrients of Thai FEL using Microsoft Excel (Control 3_{FEL70})

Days	Control 1_{FEL} Reference food	Control 2_{FEL70} Meals estimated by participants and calculated by Microsoft excel	Control 3_{FEL70} Meals estimated by participants and calculated with original nutrients from Thai FEL using Microsoft excel by a researcher	p-value[1]	%Difference (Control 2_{FEL70} & Control 3_{FEL70})	%Difference (Control 2_{FEL70} & Control 1_{FEL70})	%Difference (Control 1_{FEL70} & Control 3_{FEL70})
Energy (kcal)							
Day 1	2156.6	2024.62 ± 344.80	1878.67 ± 320.31	<0.001[w]	8.07 ± 3.53	13.59 ± 10.31	17.04 ± 9.72
Day 2	1976.28	1742.71 ± 298.85	1620.32 ± 282.20	<0.001[p]	7.64 ± 2.92	16.21 ± 10.19	19.81 ± 11.62
Day 3	2178.11	1920.47 ± 343.82	1784.22 ± 317.85	<0.001[w]	7.77 ± 3.60	16.71 ± 10.39	20.33 ± 11.20
CHO (g)							
Day 1	304.16	259.71 ± 34.17	238.76 ± 32.83	<0.001[w]	7.64 ± 2.92	16.13 ± 8.88	21.85 ± 10.06
Day 2	287.12	223.02 ± 34.39	206.59 ± 34.19	<0.001[p]	8.21 ± 3.73	22.59 ± 11.46	28.05 ± 11.91
Day 3	282.53	263.54 ± 42.45	243.54 ± 40.17	<0.001[p]	8.33 ± 3.17	12.75 ± 10.39	16.09 ± 11.51
PRO (g)							
Day 1	81.44	62.44 ± 9.69	52.52 ± 8.23	<0.001[w]	19.51 ± 10.42	24.64 ± 8.81	35.74 ± 9.27
Day 2	83.61	54.48 ± 8.17	45.11 ± 7.13	<0.001[w]	21.17 ± 8.65	34.84 ± 9.76	46.05 ± 8.53
Day 3	86.6	62.21 ± 10.01	53.63 ± 8.77	<0.001[w]	16.49 ± 9.18	28.62 ± 10.39	38.07 ± 10.13
FAT (g)							
Day 1	68.39	81.88 ± 26.39	79.88 ± 26.50	<0.001[w]	3.43 ± 5.10	26.13 ± 34.51	24.25 ± 34.51
Day 2	54.92	70.38 ± 23.13	68.79 ± 23.40	<0.001[w]	2.85 ± 3.96	35.39 ± 36.15	33.83 ± 36.06
Day 3	78.09	68.72 ± 23.75	66.85 ± 23.74	<0.001[w]	4.45 ± 6.14	27.26 ± 17.81	28.23 ± 1807

N = 70; Mean ± SD

[1] Significant difference between Control 2_{FEL70} and Control 3_{FEL70} of each food set within the same day at p < 0.05. Wilcoxon signed ranks test was used to calculate the significant difference except Day 2 for energy, Day2 and Day 3 for carbohydrate, which using Paired t-test with a significance at p < 0.05;

4.6.2. Validation based on TFBDG based NDpro application

The results of estimation and calculation food images by participants using Thai FBDG were shown in Table 47 and Table 48 and the results of time usage of validation by participants were described in 4.6.3. The representative values of Thai FBDG, as mentioned in Table 21, were assigned into the NDPro application.

According to the validation based on Thai FBDG in Table 47, the average energy values of MN_{FBDG70} compared with NDP_{FBDG70} were indicated as 1,854.44 ± 327.43 kcal vs 1,957.83 ± 312.53 kcal on Day 1 (Reference was 2,139.66 kcal), 1,662.66 ± 272.70 kcal vs 1,732.46 ± 250.35 kcal on Day 2 (Reference was 2,162.05 kcal), and 1,938.51 ± 336.37 kcal vs 1,950.29 ± 256.51 kcal on Day 3 (Reference was 2,042.68 kcal). The average carbohydrate contents of MN_{FBDG70} compared with NDP_{FBDG70} were indicated as 223.13 ± 40.58 g vs 286.37 ± 41.67 g on Day 1 (Reference was 345.69 g), 198.37 ± 36.22 g vs 253.71 ± 36.24 g on Day 2 (Reference was 353.31 g), and 273.43 ± 48.51 g vs 302.76 ± 40.57 g on Day 3 (Reference was 325.77 g). The average protein contents of MN_{FBDG70} compared with NDP_{FBDG70} were indicated as 62.37 ± 25.51 g vs 64.55 ± 11.71 g on Day 1 (Reference was 71.05 g), 54.31 ± 21.38 g vs 57.81 ± 9.35 g on Day 2 (Reference was 69.47 g), and 62.89 ± 25.27 g vs 64.46 ± 10.98 g on Day 3 (Reference was 71.47 g). Lastly, the average fat contents of MN_{FBDG70} compared with NDP_{FBDG70} were indicated as 81.61 ± 29.91 g vs 61.58 ± 20.48 g on Day 1 (Reference was 52.53 g), 70.11 ± 24.76 g vs 54.02 ± 15.40 g on Day 2 (Reference was 52.33 g), and 64.53 ± 21.55 g vs 53.50 ± 18.67 g on Day 3 (Reference was 50.41 g).

The results of energy and three types of macronutrients from MN_{FBDG70} as mentioned above were significantly different from those of NDP_{FBDG70} ($p < 0.01$) (Table 47). The energy and macronutrient results from NDP_{FBDG70} did not range within acceptable range as %difference outside ±10% when compared with Control 1_{FBDG}. However, the results of energy and two third of the average carbohydrate and protein contents from the TFBDG-based NDPro application became acceptable as NDP_{FBDG70} range within ±5% when compared with Control 2_{FBDG70} (Table 49). Similar to the Thai FEL validation, none of the results of energy and macronutrient contents obtained from either MN_{FBDG70} or NDP_{FBDG70} (Thai FBDG based application) was equal to those found in Control 3_{FBDG70} or Control 2_{FBDG70}, respectively. It also indicated that all results obtained from MN_{FBDG70} and NDP_{FBDG70} could not be used to determine

reliability. Thus, the reliability of the Thai FBDG based NDPro application was determined from Control 2_{FBDG70} and Control 3_{FBDG70} to substitute NDP_{FBDG70} and MN_{FBDG70}, respectively.

Almost all the differences of energy and three macronutrients from Control 2FBDG70 (as NDPFBDG70) & Control 3FBDG70 (as MNFBDG70) were more than 5% which were out of the acceptable range. Only two of three validation of energy category were less than or closed to 5% as 3.61 + 4.49% (Day 3) and 5.09 + 3.07%, (Day1), respectively (Table 48).

Nevertheless, as mentioned in Thai FEL based validation, the portion size estimations, energy and macronutrient values obtained from NDPFBDG70 were not equal to those of Control 2FBDG70, subgroup analysis was introduced for further investigation, as mentioned in 4.6.4.
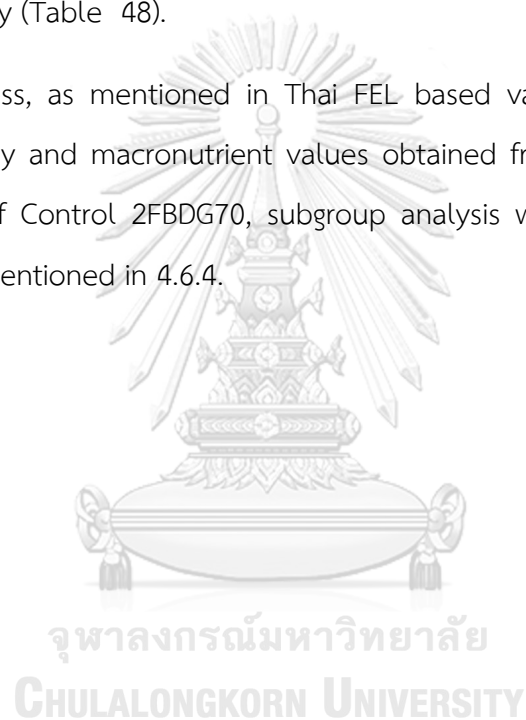
Table 46 Portion size estimations of participants based on Thai food exchange list

Food groups/subgroups	Day 1				Day 2				Day 3			
	Number of portion sizes[1,2]	Min	Max	Reference portion sizes[3]	Number of portion sizes[1,2]	Min	Max	Reference portion sizes[3]	Number of portion sizes[1,2]	Min	Max	Reference portion sizes[3]
Starches	8.75 ± 1.48	6	12	11	7.38 ± 1.43	4.5	11	10	9.34 ± 1.91	4	14.5	10
Meat, very low fat	1.03 ± 0.92	0	3	1.5	1.33 ± 1.49	0	7	2	0.19 ± 0.55	0	3	0
Meat, low fat	1.13 ± 1.25	0	5	0	2.55 ± 1.86	0	5.5	2	0.64 ± 1.04	0	5	1
Meat, medium fat	2.96 ± 1.75	0	9	3.5	1.66 ± 1.47	0	5	1.5	2.19 ± 1.60	0	11	3.5
Meat, high fat	1.59 ± 1.18	0	6	0.5	0.19 ± 0.75	0	6.5	0	3.61 ± 2.14	0	10	2
Vegetables type 1	2.0 ± 1.69	0	11	3	1.37 ± 1.12	0	4	1	2.10 ± 1.51	0	5	3
Vegetables type 2	1.66 ± 1.43	0	6.5	2	1.30 ± 0.99	0	7	4	2.05 ± 1.60	0	7.5	2
Fruits	4.04 ± 0.92	2	7	4	3.66 ± 1.13	0	1	4	3.56 ± 0.89	1	6.5	4
Milk, whole	0.98 ± 0.49	0	4.5	1	0.91 ± 0.25	0	1	1	0.97 ± 0.15	0	1	1
Milk, low fat	0.06 ± 0.23	0	1	0	0.43 ± 0.20	0	1	0	0.01 ± 0.12	0	1	0
Milk, skim	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0
Milk, evaporated	0.0 ± 0.0	0	0	0	0.01 ± 0.06	0	0.5	0	0.0 ± 0.0	0	0	0
Milk, powder, whole	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0
Milk powder, skim	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0
Fat, monounsaturated fatty acid and polyunsaturated fatty acids	11.17 ± 5.16	2	32	7	10.36 ± 4.49	3	27	6	3.36 ± 2.47	0	11	3
Fat, saturated fatty acids	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0	4.30 ± 2.93	1	15	4

[1] N = 70; Mean ± SD

[2] Numbers of portion sizes estimated by participants using Thai FEL; [3] Actual portion sizes prepared by a researcher using Thai FEL.

Table 47 The comparisons of energy and macronutrient assessed from food images and calculated manually or by the Thai FBDG based NDPro application

Days	Control 1_{FBDG} Reference food[1]	Control 2_{FBDG70} Calculation by Microsoft excel[2]	NDP_{FBDG70} Calculation by the Thai FBDG based NDPro application[3]	Control 3_{FBDG70} Calculation by Microsoft excel with original nutrients from Thai FBDG	MN_{FBDG70} Calculation manually by participants[4]	p-value[5]	p-value[6]
Energy (kcal)							
Day 1	2139.66	1911.50 ± 289.34	1957.83 ± 312.53	1822.92 ± 295.13	1854.44 ± 327.43	<0.001	0.283
Day 2	2162.05	1736.24 ± 259.83	1732.46 ± 250.35	1601.29 ± 266.10	1662.66 ± 272.70	<0.001	0.015
Day 3	2042.68	1927.14 ± 251.81	1950.29 ± 256.51	1940.34 ± 275.97	1938.51 ± 336.37	<0.001	0.954
Carbohydrate (g)							
Day 1	345.69	274.49 ± 50.55	286.37 ± 41.67	227.84 ± 34.09	223.13 ± 40.58	<0.001	0.225
Day 2	353.31	255.69 ± 37.98	253.71 ± 36.24	199.73 ± 33.21	198.37 ± 36.22	<0.001	0.691
Day 3	325.77	298.93 ± 41.41	302.76 ± 40.57	278.16 ± 41.32	273.43 ± 48.51	<0.001	0.220
Protein (g)							
Day 1	71.05	61.77 ± 11.68	64.55 ± 11.71	48.25 ± 8.49	62.37 ± 25.51	<0.004	<0.001
Day 2	69.47	57.80 ± 10.09	57.81 ± 9.35	43.78 ± 7.62	54.31 ± 21.38	<0.001	<0.001
Day 3	71.47	63.02 ± 11.53	64.46 ± 10.98	59.11 ± 10.58	62.89 ± 25.27	<0.016	0.563
Fat (g)							
Day 1	52.53	61.13 ± 19.26	61.58 ± 20.48	78.39 ± 23.69	81.61 ± 29.91	<0.001	0.063
Day 2	52.33	53.60 ± 14.83	54.02 ± 15.40	68.74 ± 18.41	70.11 ± 24.76	<0.001	0.662
Day 3	50.41	52.80 ± 17.51	53.50 ± 18.67	64.47 ± 20.56	64.53 ± 21.55	<0.001	0.662

N = 70; Mean ± SD

[1] Reference based on the results calculated by Microsoft excel from serving size of cooking ingredients estimated by a researcher; [2] Portion size estimated by participants from evaluation form (ND-02/64) were calculated for energy and nutrient using Microsoft excel by a researcher; [3] Results were obtained from estimation and calculation by participants using the Thai FBDG based NDPro application; [4] Results were obtained from estimation and calculation manually by participants; [5] Significant difference between MN_{FBDG70} and NDP_{FBDG70} (Thai FBDG based NDPro application) of each food set within the same day at $p < 0.01$. Wilcoxon signed ranks test was used to calculate the significant difference except Day 2 and Day 3 for energy, Day1 Day 2 and Day 3 for carbohydrate; [6] Significant difference between MN_{FBDG70} and Control 3_{FBDG70} of each food set within the same day at $p < 0.01$. Wilcoxon signed ranks test was used to calculate the significant difference except Day1 Day 2 and Day 3 for energy and Day1 Day 2 and Day 3 for carbohydrate.

Table 48 The accuracy based on the portion sizes estimated by participants calculated by Microsoft Excel (Control 2_{FBDG70}) and calculated by original nutrients of Thai FBDG using Microsoft Excel (Control 3_{FBDG70})

Days	Control 2_{FBDG70} Meals estimated by participants and calculated by Microsoft excel	Control 3_{FBDG70} Meals estimated by participants and calculated with original nutrients from Thai FEL using Microsoft excel by a researcher	p-value[1]	%Difference (Control 2_{FBDG70} & Control 3_{FBDG70})	%Difference (Control 2_{FBDG70} & Control 1_{FBDG})	%Difference (Control 3_{FBDG70} & Control 1_{FBDG})
Energy (kcal)						
Day 1	1911.50 ± 289.34	1822.92 ± 295.13	<0.001	5.09 ± 3.07	14.63 ± 9.01	17.60 ± 9.91
Day 2	1736.23 ± 259.82	1601.29 ± 266.10	<0.001	8.78 ± 4.23	20.49 ± 10.58	26.28 ± 11.56
Day 3	1927.14 ± 251.81	1940.34 ± 275.97	0.160	3.61 ± 4.49	10.75 ± 8.20	11.15 ± 9.06
CHO (g)						
Day 1	277.86 ± 40.70	227.84 ± 8.49	<0.001	22.04 ± 3.18	20.17 ± 10.80	34.09 ± 9.86
Day 2	255.69 ± 37.98	199.73 ± 33.21	<0.001	28.41 ± 3.98	27.99 ± 9.74	43.47 ± 9.40
Day 3	298.93 ± 41.41	278.16 ± 41.32	<0.001	8.20 ± 6.44	12.03 ± 9.14	15.58 ± 11.46
PRO (g)						
Day 1	61.77 ± 19.26	48.25 ± 8.49	<0.001	27.78 ± 4.12	17.93 ± 10.82	32.16 ± 11.75
Day 2	57.80 ± 10.09	43.78 ± 7.62	<0.001	32.18 ± 6.77	19.72 ± 10.14	36.98 ± 10.97
Day 3	63.02 ± 11.52	59.11 ± 10.58	<0.001	9.0 ± 9.44	16.60 ± 11.07	18.59 ± 13.13
FAT (g)						
Day 1	61.13 ± 19.26	78.39 ± 23.69	<0.001	22.22 ± 2.04	27.75 ± 28.90	51.24 ± 42.76
Day 2	53.60 ± 14.83	68.74 ± 18.41	<0.001	22.17 ± 3.15	21.71 ± 18.20	35.96 ± 30.38
Day 3	52.80 ± 17.51	64.47 ± 20.56	<0.001	19.46 ± 3.66	23.75 ± 25.63	34.48 ± 35.31

N = 70, Mean ± SD

[1] Significant difference between Control 2_{FBDG70} and Control 3_{FBDG70} of each food set within the same day at $p < 0.05$. Paired t-test with a significance at $p < 0.05$ was used to calculate the significant difference except for Day 1, Day 2 and Day 3 for fat, which using Wilcoxon signed ranks test;

Table 49 The accuracy of Thai FBDG based NDPro application on energy and macronutrients

Days	Control 1_FBDG Meals prepared by researcher and calculated by Microsoft excel	Control 2_FBDG Meals estimated by participants and calculated by Microsoft excel[2]	Control 3_FBDG Meals estimated by participants and calculated with original nutrients from Thai FBDG using Microsoft excel by a researcher[1]	NDP_FBDG70 Meals estimated and calculated by participants with Thai FBDG based NDPro application	%Difference (Control 1_FBDG & NDP_FBDG70)[1]	%Difference (Control 1_FBDG & MN_FBDG70)[1]	%Difference (Control 2_FBDG & NDP_FBDG70)[2]	%Difference (Control 2_FBDG & MN_FBDG70)[2]	MN_FBDG70 Meals estimated and manual calculation by participants with original nutrient contents from Thai FBDG	%Difference (NDP_FBDG70 & MN_FBDG70)	p-value (Control 3_FBDG70 & MN_FBDG70)
Energy (kcal)											
Day 1	2139.66	1911.50 ± 289.34	1822.92 ± 295.13	1957.83 ± 312.53	14.32 ± 8.86	16.77 ± 11.36	4.71 ± 5.59	10.27 ± 8.24	1854.44 ± 327.43	12.84 ± 11.57	0.283
Day 2	2162.05	1736.24 ± 259.83	1601.29 ± 266.10	1732.46 ± 250.35	20.10 ± 11.17	23.52 ± 11.79	2.56 ± 4.68	9.745 ± 8.07	1662.66 ± 272.70	10.18 ± 8.72	0.015
Day 3	2042.68	1927.14 ± 251.81	1940.34 ± 275.97	1950.29 ± 256.51	10.77 ± 7.80	13.32 ± 10.84	3.26 ± 5.78	9.63 ± 9.70	1938.51 ± 336.37	10.48 ± 10.54	0.954
Carbohydrate (g)											
Day 1	345.69	274.49 ± 50.55	227.84 ± 34.09	286.37 ± 41.67	18.13 ± 10.52	35.45 ± 11.74	5.59 ± 7.63	20.46 ± 9.74	223.13 ± 40.58	31.32 ± 25.15	0.225
Day 2	353.31	255.69 ± 37.98	199.73 ± 33.21	253.71 ± 36.24	28.19 ± 10.26	43.85 ± 10.25	2.92 ± 6.28	22.50 ± 9.06	198.37 ± 36.22	30.36 ± 20.59	0.691
Day 3	325.77	298.93 ± 41.41	278.16 ± 41.32	302.76 ± 40.57	11.41 ± 8.58	18.14 ± 12.23	3.88 ± 6.59	9.76 ± 9.89	273.43 ± 48.51	14.18 ± 15.95	0.220
Protein (g)											
Day 1	71.05	61.77 ± 11.68	48.25 ± 8.49	64.55 ± 11.71	15.57 ± 10.54	27.89 ± 25.53	7.49 ± 13.18	27.99 ± 30.39	62.37 ± 25.51	26.66 ± 20.39	<0.001
Day 2	69.47	57.80 ± 10.09	43.78 ± 7.62	57.81 ± 9.35	18.54 ± 10.90	30.13 ± 22.56	4.92 ± 9.31	24.44 ± 25.55	54.31 ± 21.38	23.47 ± 15.34	<0.001
Day 3	71.47	63.02 ± 11.53	59.11 ± 10.58	64.46 ± 10.98	14.64 ± 10.76	27.23 ± 25.37	5.0 ± 9.31	22.74 ± 27.91	62.89 ± 25.27	23.11 ± 22.08	0.563
Fat (g)											
Day 1	52.53	61.13 ± 19.26	78.39 ± 23.69	61.58 ± 20.48	29.87 ± 30.26	62.16 ± 49.30	5.38 ± 9.40	39.74 ± 26.98	81.61 ± 29.91	28.66 ± 20.51	0.063
Day 2	52.33	53.60 ± 14.83	68.74 ± 18.41	54.02 ± 15.40	22.52 ± 19.03	43.03 ± 39.14	4.09 ± 10.33	37.31 ± 30.55	70.11 ± 24.76	26.33 ± 16.44	0.662
Day 3	50.41	52.80 ± 17.51	64.47 ± 20.56	53.50 ± 18.67	24.72 ± 28.10	35.38 ± 36.79	6.63 ± 23.29	30.70 ± 23.02	64.53 ± 21.55	25.90 ± 25.97	0.662

N = 70; Mean ± SD

[1] Realiability compared to Control 1_FBDG should be < 10%; [2] Realiability compared to Control 2_FBDG70 should be < 5%; [3] Realiability compared to Control 1_FBDG should be < 5%;

Energy (kcal)

Carbohydrate (g)

Protein (g)

Fat (g)
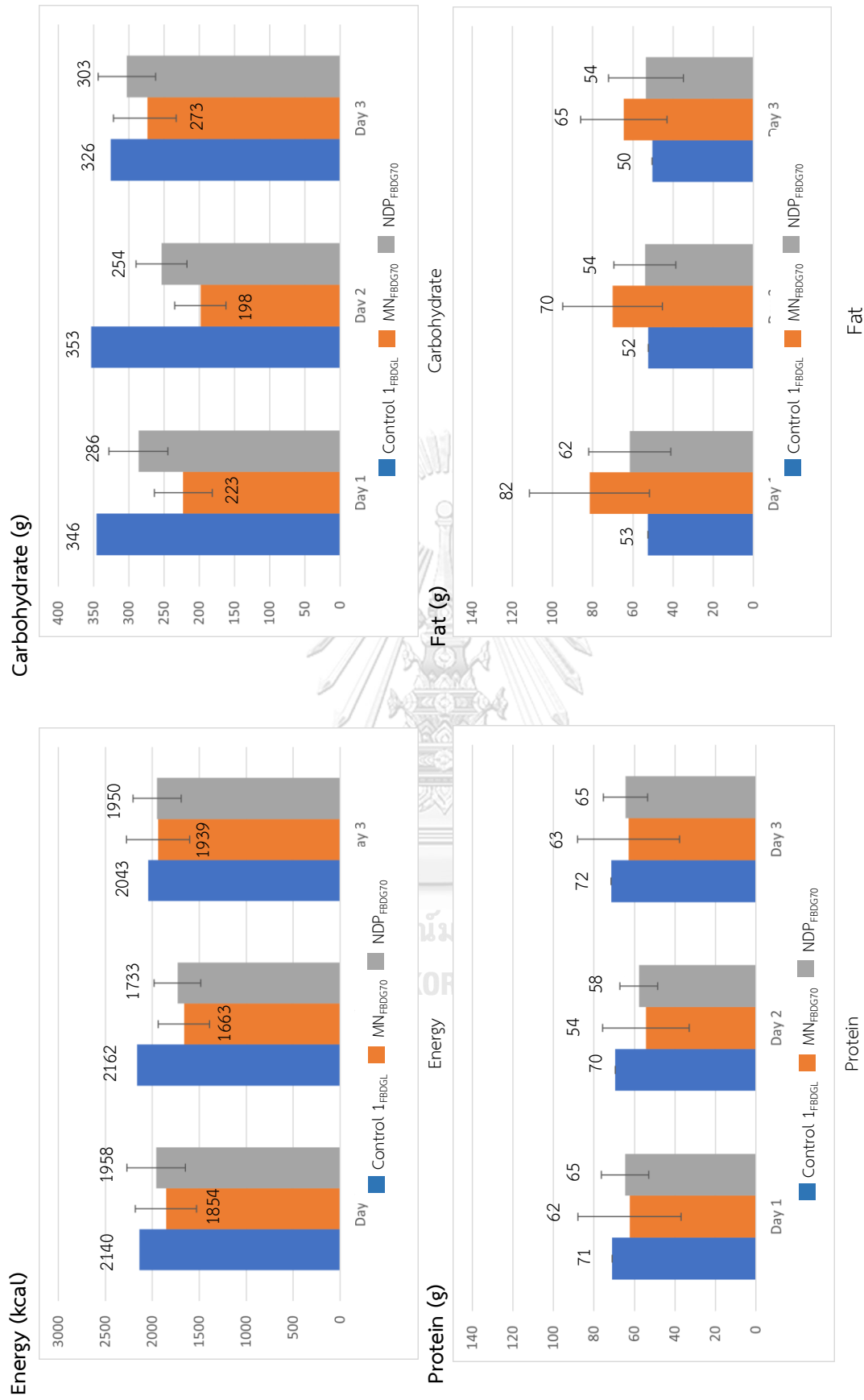
Figure 22 Average energy and macronutrients calculated manually or by the Thai FBDG based NDPro application (N = 70)

Table 50 Portion size estimations of participants based on Thai food based dietary guidelines

Food groups/subgroups	Day 1				Day 2				Day 3			
	Numbers of portion sizes [1,2]	Min	Max	Reference portion sizes [3]	Numbers of portion sizes [1,2]	Min	Max	Reference portion sizes [3]	Numbers of portion sizes [1,2]	Min	Max	Reference portion sizes [3]
Cereals: rice or noodles	7.13 ± 1.63	2	11	10	7.50 ± 1.46	4	12	11	2.77 ± 1.80	1	12	6
Cereal: sticky rice	0.06 ± 0.48	0	4	0	0.0 ± 0.0	0	0	0	1.56 ± 0.85	0	4	2
Cereal: bread	1.0 ± 0.33	0	2	1	0.0 ± 0.0	0	0	0	5.18 ± 2.12	0	9	3
Meat: meat fish poultry	7.30 ± 2.34	2	14	7	6.0 ± 1.86	2	12	6	7.65 ± 2.58	3	17	9
Meat: soybean curd nut	0.0 ± 0.0	0	0	0	1.69 ± 1.16	0	4	1	0.01 ± 0.12	0	1	0
Meat: egg	1.23 ± 0.77	0	4	2	1.27 ± 0.61	0	2	2	0.0 ± 0.0	0	0	0
Vegetables	3.25 ± 1.08	1	5.5	5	2.36 ± 1.44	0	11	5	4.10 ± 1.85	0	10	5
Fruits	4.20 ± 0.95	1	7	4	3.22 ± 1.04	0.5	6	4	5.58 ± 1.38	0.5	9	4
Milk, whole	0.95 ± 0.15	0.5	1	1	0.96 ± 0.14	0.5	1	1	0.94 ± 0.17	0.5	1	1
Milk, low fat	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0	0.0 ± 0.0	0	0	0
Fat/oil	9.87 ± 4.39	2	26	7	8.05 ± 3.41	3	18	7	7.41 ± 3.92	2	30	7

[1] N = 70; Mean ± SD

[2] Numbers of portion sizes estimated by participants using Thai FBDG; [3] Actual portion sizes prepared by a researcher using Thai FBDG;

4.6.3. Time usage of validation

Overall, the processing time used for estimation and calculation foods displayed on food photographs by the NDPro application based on Thai FEL were 12.57 ± 2.97 minutes on day 1, 9.45 ± 2.40 minutes on day 2, and 9.28 ± 2.13 minutes on day 3, while those by calculation manually were 18.87 ± 5.89 minutes on day 1, 14.27 ± 4.03 minutes on day 2, and 13.59 ± 3.86 minutes on day 3. Average reduction time were approximately 4 – 6 minutes. The processing time used by the developed application based on Thai FBDG were 9.19 ± 2.11 minutes on day 1, 7.21 ± 1.61 minutes on day 2, and 7.51 ± 1.54 minutes on day 3, while those by calculation manually were 16.13 ± 4.71 minutes on day 1, 13.41 ± 3.58 minutes on day 2, and 12.76 ± 3.53 minutes on day 3. Average reduction time were approximately 5 – 7 minutes. The developed application showed better performance as lower difference and time usage than calculation manually in every validation.

Table 51 Time usage of participants to estimate portion sizes from food images and calculate nutrient intakes manually or using the NDPro application

Time	Thai food exchange list			Thai food based dietary guidelines		
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Food estimation time (minutes)						
	5.19 ± 2.03	4.11 ± 1.47	4.05 ± 1.27	3.56 ± 1.27	2.94 ± 1.0	3.15 ± 1.0
Calculation time (minutes)						
Manual	13.67 ± 4.89	10.16 ± 3.12	9.55 ± 3.08	12.57 ± 3.94	10.47 ± 3.13	9.6 ± 2.97
NDPro	7.38 ± 1.84*	5.34 ± 1.55*	5.24 ± 1.23*	5.62 ± 1.31*	4.27 ± 1.0*	4.36 ± 0.96*
Difference	6.38 ± 4.43	5.02 ± 2.58	4.35 ± 2.52	6.96 ± 3.60	6.20 ± 2.80	5.25 ± 2.60
p-value*	<0.001[a]	<0.001[a]	<0.001[a]	<0.001[a]	<0.001[a]	<0.001[a]
Total time (minutes)						
Manual	18.87 ± 5.89	14.27 ± 4.03	13.59 ± 3.86	16.13 ± 4.71	13.41 ± 3.58	12.76 ± 3.53
NDPro	12.57 ± 2.97*	9.45 ± 2.40*	9.28 ± 2.13*	9.19 ± 2.11*	7.21 ± 1.61*	7.51 ± 1.54*
Difference	6.38 ± 4.43	5.02 ± 2.58	4.35 ± 2.52	6.96 ± 3.60	6.20 ± 2.80	5.25 ± 2.60
p-value*	<0.001[a]	<0.001[a]	<0.001[a]	<0.001[a]	<0.001[b]	<0.001[a]

N = 70; Mean ± SD

* significant different time used from the manual calculation in the same day at $p < 0.001$; [a] Wilcoxon signed ranks test; [b] Paired t-test;

Time usage

(minutes)

Thai food exchange list
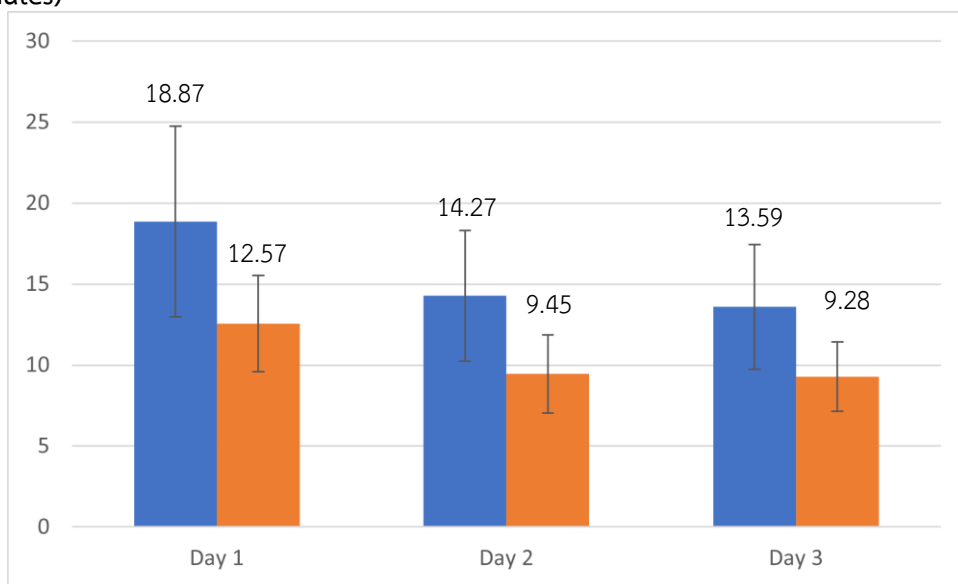
Time usage

(minutes)
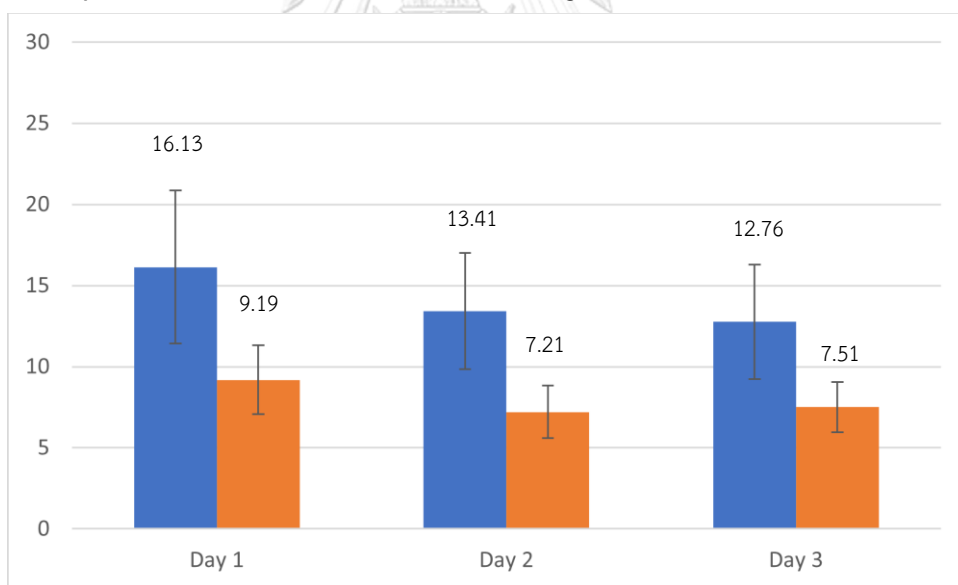
Thai food based dietary guideline

Figure 23 Time usage of participants to estimate and calculate food images (N = 70)

4.6.4. Subgroup analysis of application validation by participants

In this study, the participants were asked to estimate portions from food photographs just once. The analysis of both calculating manually and using the NDPro application shared these estimated portions. Interestingly, the results differed when using the NDPro application (NPD) versus Microsoft Excel (Control 2). Further examination revealed a variety of human errors during validation. Unfortunately, the tablets used to record data were broken after validating with only 30 participants. Although it did not affect recorded data on papers and outcomes of the experiment, the input data used for checking the accuracy of output data recorded within the tablets had been lost. Therefore, subgroup analysis was only possible with data from those 30 participants.

The results of subgroup analysis based on the estimated portions were shown in Table 52 - Table 54 for Thai FEL based validation and Table 55 - Table 57 for Thai FBDG based validation. The results of subgroup analysis based on subgroups of each food exchange lists were shown in Table 59 – Table 60. Most participants exhibited discrepancies between their firstly estimated and inserted portions in the NDPro application, resulting in inconsistent results. The Inserted portions had approximately 70% match for Thai FEL validation, and approximately 80 to 90% match for Thai FBDG validation. The results of the analysis based on food exchange subgroup of TFEL-based validation indicated that only 10 - 30% of the participants could accurately estimate serving sizes in each subgroup, while approximately 70 - 100% of the participants could correctly insert serving sizes. In the case of TFBDG-based validation, their abilities to estimate serving sizes correctly were not much different. Only 20 - 40% of the participants could accurately estimate serving sizes in each subgroup, with approximately 70 - 100% of the participants correctly inserting serving sizes.

For Thai FEL based validation, there was no participants had 100% match inserted portions. Only a few participants had 100% match for Thai FBDG based

validation. Therefore, further subgroup analysis was performed, excluding the participants with any human error in portion insertion. The subgroup analysis, consisting of participants with 100% match between estimated and inserted portions, was presented in Table 58. Once human error did not exist, all results were ranged within acceptable range as they were equal to those calculated using Microsoft Excel (Control 2_{FBGD30}), indicating that the NDPro application was functioning correctly. Carbohydrate, protein, and fat contents obtained from the Thai FBDG based NDPro application significantly differed from calculation manually by those participants, while energy did not significantly differ from calculation manually ($p < 0.05$). However, as the results of energy and macronutrient contents from MN_{FBDG30} were not equal to those from Control 3_{FBDG30}, it indicated that human error may occur in some participant by using the incorrect values to calculate energy or macronutrients. Thus, the reliability was investigated from the differences of energy and three macronutrients from NDP_{FBDG30} & Control 3_{FBDG30}. The results were parallel to those of Control 2_{FBDG} (as NDP_{FBDG}) & Control 3_{FBDG} (as MN_{FBDG}) (Table 48). All macronutrient contents in all validation from NDP_{FBDG30} & Control 3_{FBDG30} were more than 5% which were out of the acceptable range. While two of three validation of energy category were less than 5% as $3.15 \pm 2.27\%$ (Day 1) and $2.94 \pm 2.36\%$, (Day 3).

Table 52 Subgroup analysis of validation based on Thai food exchange list: Day 1

| | Correct portion sizes | | | | | Calculation methods | | | | | | | | | | | |
| | | Distribution of participants | | Average estimate accuracy (%)[1] | Average insertion accuracy (%)[2] | Calculation manually | | | | NDPro application | | | | Microsoft excel | | | |
	Estimation accuracy (%)[1]	N	%			Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)
Day 1	91 - 100	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	81 - 90	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	71 - 80	1	3	77	69	1425.0 ± 0.0	270.0 ± 0.0	61.0 ± 0.0	72.0 ± 0.0	1956.30 ± 0.0	280.21 ± 0.0	69.22 ± 0.0	62.21 ± 0.0	1932.63 ± 0.0	290.71 ± 0.0	57.98 ± 0.0	59.88 ± 0.0
	61 - 70	1	3	69	62	2540.0 ± 0.0	325.0 ± 0.0	116.0 ± 0.0	86.0 ± 0.0	2748.92 ± 0.0	401.61 ± 0.0	102.78 ± 0.0	81.42 ± 0.0	2256.14 ± 0.0	332.27 ± 0.0	82.60 ± 0.0	66.44 ± 0.0
	51 - 60	7	23	54	70	1937.71 ± 167.38	237.36 ± 30.28	74.21 ± 6.34	75.07 ± 5.30	2057.15 ± 262.05	266.78 ± 40.62	77.66 ± 13.25	75.60 ± 9.43	1892.34 ± 234.66	254.33 ± 32.11	64.21 ± 14.0	68.81 ± 9.47
	41 - 50	9	30	46	65	2022.92 ± 217.14	227.0 ± 31.56	77.28 ± 12.08	88.31 ± 24.32	2138.34 ± 235.82	259.88 ± 32.18	80.84 ± 14.45	81.83 ± 12.90	1984.79 ± 244.0	258.35 ± 29.88	63.43 ± 12.43	77.62 ± 17.50
	31 - 40	11	37	36	62	2079.14 ± 297.61	224.59 ± 34.0	78.20 ± 21.37	107.09 ± 30.41	2248.43 ± 302.90	258.94 ± 41.44	83.72 ± 13.79	97.63 ± 20.98	2120.55 ± 243.60	260.05 ± 28.02	65.50 ± 9.81	91.03 ± 18.14
	21 - 30	1	3	23	46	3192.50 ± 0.0	308.0 ± 0.0	83.0 ± 0.0	186.50 ± 0.0	2645.17 ± 0.0	396.24 ± 0.0	101.32 ± 0.0	184.03 ± 0.0	3224.36 ± 0.0	354.57 ± 0.0	75.06 ± 0.0	167.44 ± 0.0
	11 - 20	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0 - 10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reference values			-	-	2156.6	304.16	81.44	68.39	2156.6	304.16	81.44	68.39	2156.6	304.16	81.44	68.39

N = 30, Mean ± SD; [1] The percentages of estimated portions by participants whose estimates within ±10% difference from the actual serving sizes.

[2] The comparison of the similarity between estimated portions and portions recorded in the NDPro application by participants.

Table 53 Subgroup analysis of validation based on Thai food exchange list: Day 2

	Correct portion sizes					Calculation methods												
	Estimation accuracy (%)[1]	Distribution of participants		Average estimate accuracy (%)[1]	Average insertion accuracy (%)[2]	Calculation manually				NDPro application				Microsot excel			
		N	%			Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)
Day 2	91 - 100	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	81 - 90	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	71 - 80	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	61 - 70	1	3	62	77	2084.50 ± 0.0	253.50 ± 0.0	73.80 ± 0.0	83.50 ± 0.0	2195.51 ± 0.0	272.19 ± 0.0	72.11 ± 0.0	91.06 ± 0.0	2224.64 ± 0.0	272.86 ± 0.0	75.22 ± 0.0	92.61 ± 0.0
	51 - 60	9	30	54	76	1820.72 ± 335.89	212.67 ± 47.73	77.37 ± 23.85	72.92 ± 28.12	2018.49 ± 286.28	249.93 ± 41.71	76.61 ± 14.29	79.21 ± 17.52	1933.44 ± 273.66	253.22 ± 40.15	60.66 ± 7.13	75.40 ± 16.76
	41 - 50	10	33	46	75	1662.85 ± 321.87	191.80 ± 40.42	62.50 ± 10.76	72.80 ± 32.93	1847.45 ± 320.38	219.72 ± 44.19	72.91 ± 44.19	75.29 ± 18.62	1669.46 ± 304.70	217.75 ± 44.79	52.71 ± 8.37	65.37 ± 16.63
	31 - 40	9	30	36	69	1543.11 ± 292.75	181.42 ± 20.80	60.86 ± 7.88	72.75 ± 35.42	1660.84 ± 281.51	194.71 ± 20.52	68.04 ± 11.26	67.82 ± 20.43	1597.65 ± 213.49	198.21 ± 16.13	51.46 ± 5.61	66.63 ± 17.57
	21 - 30	1	3	23	77	1737.50 ± 0.0	218.0 ± 0.0	55.50 ± 0.0	71.50 ± 0.0	1828.32 ± 0.0	234.78 ± 0.0	67.38 ± 0.0	68.91 ± 0.0	1723.65 ± 0.0	234.48 ± 0.0	49.68 ± 0.0	65.29 ± 0.0
	11 - 20	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0 - 10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reference values					1976.28	287.12	83.61	54.92	1976.28	287.12	83.61	54.92	1976.28	287.12	83.61	54.92

N = 30, Mean ± SD; [1] The percentages of estimated portions by participants whose estimates within ±10% difference from the actual serving sizes.

[2] The comparison of the similarity between estimated portions and portions recorded in the NDPro application by participants.

Table 54 Subgroup analysis of validation based on Thai food exchange list: Day 3

	Correct portion sizes					Calculation methods											
	Estimation accuracy (%)[1]	Distribution of participants		Average estimate accuracy (%)[1]	Average insertion accuracy (%)[2]	Calculation manually				NDPro application				Microsot excel			
		N	%			Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)
Day 3	91 – 100	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	81 – 90	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	71 – 80	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	61 – 70	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	51 – 60	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	41 – 50	11	37	44	70	2007.89 ± 364.92	241.25 ± 19.23	73.0 ± 16.37	80.05 ± 31.05	2093.46 ± 281.74	265.33 ± 18.70	76.33 ± 9.36	80.87 ± 27.12	1907.97 ± 302.42	264.77 ± 24.19	60.49 ± 8.89	67.56 ± 26.60
	31 – 40	10	33	33	66	2037.70 ± 432.93	236.10 ± 61.63	79.85 ± 26.23	97.15 ± 29.57	2347.23 ± 511.52	268.37 ± 53.34	88.68 ± 19.94	102.23 ± 42.47	2077.83 ± 334.06	264.21 ± 52.29	69.35 ± 11.77	82.74 ± 22.28
	21 – 30	8	25	25	70	1948.34 ± 373.62	261.0 ± 32.66	72.47 ± 8.35	73.47 ± 49.34	2088.76 ± 348.03	278.33 ± 34.60	78.60 ± 11.35	73.58 ± 23.23	1882.30 ± 340.48	270.41 ± 47.30	59.97 ± 5.51	62.42 ± 20.99
	11 – 20	1	3	17	92	1754.0 ± 0.0	184.50 ± 0.0	69.50 ± 0.0	78.0 ± 0.0	1795.88 ± 0.0	220.48 ± 0.0	64.11 ± 0.0	73.13 ± 0.0	1696.46 ± 0.0	224.98 ± 0.0	55.17 ± 0.0	64.07 ± 0.0
	0 – 10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reference values					2178.11	282.53	86.6	78.09	2178.11	282.53	86.6	78.09	2178.11	282.53	86.6	78.09

N = 30, Mean ± SD; [1] The percentages of estimated portions by participants whose estimates within ±10% difference from the actual serving sizes.

[2] The comparison of the similarity between estimated portions and portions recorded in the NDPro application by participants.

Table 55 Subgroup analysis of validation based on Thai food based dietary guidelines: Day 1

	Correct portion sizes					Calculation methods												
	Estimation accuracy (%)	Distribution of participants		Average estimate accuracy (%)[1]	Average insertion accuracy (%)[2]	Calculation manually				NDPro application				Microsot excel			
		N	%			Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)
Day 1	91 – 100	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	81 – 90	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	71 – 80	3	10	73	91	1672.30 ± 60.45	194.35 ± 13.79	54.63 ± 1.49	87.33 ± 8.60	1788.88 ± 339.07	262.84 ± 42.54	62.49 ± 10.96	54.18 ± 13.98	1766.94 ± 344.41	254.77 ± 46.78	63.55 ± 10.23	54.86 ± 13.06
	61 – 70	9	30	64	82	1768.01 ± 493.34	207.64 ± 49.60	53.41 ± 23.95	94.73 ± 30.62	2026.90 ± 456.47	287.78 ± 50.56	60.93 ± 8.36	70.22 ± 29.37	1990.32 ± 363.79	281.44 ± 34.27	59.75 ± 9.12	69.51 ± 26.68
	51 – 60	11	37	55	81	1857.62 ± 260.28	215.77 ± 42.41	63.56 ± 12.24	91.96 ± 22.27	2032.55 ± 357.83	288.93 ± 50.87	72.13 ± 15.22	65.38 ± 16.46	1891.07 ± 375.89	268.12 ± 57.10	64.92 ± 15.16	62.11 ± 16.22
	41 – 50	6	20	45	88	1777.0 ± 270.79	210.70 ± 31.75	58.36 ± 17.89	67.16 ± 20.47	1852.55 ± 119.35	266.45 ± 28.91	64.89 ± 9.10	58.59 ± 11.18	1807.97 ± 144.34	264.91 ± 29.36	58.80 ± 10.25	57.02 ± 13.32
	31 – 40	1	3	36	64	1310.50 ± 0.0	232.0 ± 0.0	56.85 ± 0.0	50.55 ± 0.0	1709.71 ± 0.0	292.48 ± 0.0	46.88 ± 0.0	39.14 ± 0.0	1545.18 ± 0.0	258.83 ± 0.0	42.15 ± 0.0	37.92 ± 0.0
	21 – 30	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11 – 20	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0 - 10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reference values					2139.66	345.69	71.05	52.53	2139.66	345.69	71.05	52.53	2139.66	345.69	71.05	52.53

N = 30, Mean ± SD; [1] The percentages of estimated portions by participants whose estimates within ±10% difference from the actual serving sizes.

[2] The comparison of the similarity between estimated portions and portions recorded in the NDPro application by participants.

Table 56 Subgroup analysis of validation based on Thai food based dietary guidelines: Day 2

	Correct portion sizes					Calculation methods												
	Estimation accuracy (%)	Distribution of participants		Average estimate accuracy (%)[1]	Average insertion accuracy (%)[2]	Calculation manually				NDPro application				Microsot excel			
		N	%			Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)
Day 2	91 - 100	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	81 - 90	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	71 - 80	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	61 - 70	1	3	70	100	2107.30 ± 0.0	232.19 ± 0.0	52.49 ± 0.0	107.79 ± 0.0	2228.40 ± 0.0	287.62 ± 0.0	61.25 ± 0.0	92.54 ± 0.0	2228.40 ± 0.0	287.62 ± 0.0	61.25 ± 0.0	92.54 ± 0.0
	51 - 60	3	10	60	97	1744.67 ± 153.0	227.22 ± 33.72	52.59 ± 6.0	66.58 ± 4.83	1814.37 ± 152.11	266.26 ± 11.62	61.69 ± 0.68	55.85 ± 11.79	1811.60 ± 153.86	265.77 ± 11.72	61.53 ± 0.95	55.84 ± 11.81
	41 - 50	8	27	50	85	1558.09 ± 235.87	166.29 ± 33.99	51.39 ± 9.14	78.66 ± 30.51	1675.30 ± 296.41	246.44 ± 50.86	57.70 ± 10.38	50.98 ± 11.51	1639.01 ± 230.83	240.80 ± 43.19	56.76 ± 6.89	49.87 ± 10.51
	31 - 40	14	47	40	90	1645.78 ± 282.69	193.44 ± 35.91	45.06 ± 12.43	77.89 ± 18.63	1735.48 ± 258.29	247.17 ± 38.40	54.68 ± 7.10	58.68 ± 14.51	1749.0 ± 240.80	249.74 ± 32.04	53.78 ± 7.93	59.43 ± 13.83
	21 - 30	4	13	30	95	1563.85 ± 221.66	209.96 ± 37.08	58.24 ± 12.46	54.20 ± 16.10	1562.58 ± 75.47	249.82 ± 6.08	54.94 ± 6.10	38.18 ± 6.50	1562.58 ± 92.31	249.82 ± 7.31	54.94 ± 6.89	38.18 ± 6.99
	11 - 20	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0 - 10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reference values					2162.05	353.31	69.47	52.33	2162.05	353.31	69.47	52.33	2162.05	353.31	69.47	52.33

N = 30, Mean ± SD; [1] The percentages of estimated portions by participants whose estimates within ±10% difference from the actual serving sizes.

[2] The comparison of the similarity between estimated portions and portions recorded in the NDPro application by participants.

Table 57 Subgroup analysis of validation based on Thai food based dietary guidelines: Day 3

| | Correct portion sizes | | | | | Calculation methods | | | | | | | | | | | |
| | | Distribution of participants | | Average estimate accuracy (%)[1] | Average insertion accuracy (%)[2] | Calculation manually | | | | NDPro application | | | | Microsot excel | | | |
	Estimation accuracy (%)	N	%			Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)	Energy (kcal)	CHO (g)	PRO (g)	FAT (g)
Day 3	91 – 100	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	81 – 90	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	71 – 80	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	61 – 70	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	51 – 60	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	41 – 50	11	37	50	85	1949.3286 ± 267.95	275.29 ± 38.96	62.77 ± 7.91	66.41 ± 16.04	1984.07 ± 255.20	313.02 ± 45.43	68.63 ± 9.18	50.83 ± 8.70	1947.73 ± 232.67	303.29 ± 36.25	65.65 ± 10.24	52.44 ± 8.61
	31 – 40	10	33	40	90	1977.38 ± 484.07	287.98 ± 63.23	57.67 ± 25.22	61.52 ± 29.78	1917.47 ± 176.61	304.97 ± 27.56	63.20 ± 8.69	49.41 ± 18.06	1958.17 ± 289.95	314.56 ± 51.93	62.08 ± 10.36	50.17 ± 17.69
	21 – 30	7	23	30	91	1892.84 ± 337.93	265.96 ± 44.56	60.41 ± 10.16	61.59 ± 20.41	2016.42 ± 240.69	324.63 ± 37.99	63.49 ± 14.15	51.54 ± 16.83	1930.13 ± 292.83	307.13 ± 57.50	61.99 ± 14.84	50.34 ± 16.57
	11 – 20	2	7	20	65	2078.50 ± 703.57	279.60 ± 38.33	74.45 ± 24.39	97.40 ± 14.99	1944.53 ± 256.24	302.16 ± 35.67	75.65 ± 5.19	48.17 ± 10.30	2017.58 ± 75.71	281.23 ± 30.92	75.04 ± 6.34	50.85 ± 13.06
	0 – 10	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reference values					2042.68	325.77	71.47	50.41	2042.68	325.77	71.47	50.41	2042.68	325.77	71.47	50.41

N = 30, Mean ± SD; [1] The percentages of estimated portions by participants whose estimates within ±10% difference from the actual serving sizes.

[2] The comparison of the similarity between estimated portions and portions recorded in the NDPro application by participants.

Table 58 The Thai FBDG based validation from participants with 100% match between the estimated and inserted portions

Days	N[1]	Control 1[FBDG] Reference[2]	Estimation from participants, mean (SD)				p-Value[6] (MN[FBDG30] & NDP[FBDG30])	% Difference, NDPro compared with reference by researcher[7] (Control 1[FBDG30] & NDP[FBDG30])	% Difference, NDPro compared with result from estimated serving sizes by participants[8] (Control 2[FBDG30] & NDP[FBDG30])	% Difference, NDPro compared with result from calculation by Microsoft excel with original nutrients from Thai FBDG[9] (Control 3[FBDG30] & NDP[FBDG30])	p-Value[6] (Control 3[FBDG30] & NDP[FBDG30])
			Control 2[FBDG30] Estimation by dietitians, and calculation by excel[3]	MN[FBDG30] Estimation and calculation by participants[3]	Control 3[FBDG30] Calculation by Microsoft excel with original nutrients from Thai FBDG	NDP[FBDG30] Estimation by participants, and calculation by NDPro[5]					
Energy (kcal)											
Day1	6	2139.66	2021 ± 332.38	1999.32 ± 406.24	1963.08 ± 346.88	2021 ± 332.38	0.60	13.83 ± 7.0	0.0% (Equal)	3.15 ± 2.27	0.046
Day2	13	2162.05	1720.50 ± 237.99	1654.55 ± 213.48	1607.14 ± 250.21	1720.50 ± 237.99	0.116	20.90 ± 10.0	0.0% (Equal)	7.31 ± 2.47	0.001
Day3	10	2042.68	1996.06 ± 213.33	1978.65 ± 406.81	2021.03 ± 203.53	1996.06 ± 213.33	0.878	9.27 ± 4.40	0.0% (Equal)	2.94 ± 2.36	0.074
Carbohydrate (g)											
Day1	6	345.69	272.26 ± 34.94	210.90 ± 32.81	222.62 ± 27.44	272.26 ± 34.94	0.028	21.24 ± 10.11	0.0% (Equal)	22.24 ± 1.24	0.028
Day2	13	353.31	246.40 ± 26.10	204.86 ± 34.76	193.52 ± 22.75	246.40 ± 26.10	0.003	30.26 ± 7.39	0.0% (Equal)	7.31 ± 2.47	0.001
Day3	10	325.77	318.03 ± 33.38	267.06 ± 54.08	297.67 ± 22.95	318.03 ± 33.38	0.005	7.67 ± 6.77	0.0% (Equal)	6.72 ± 4.83	0.005
Protein (g)											
Day1	6	71.05	67.84 ± 8.3	65.98 ± 25.44	52.32 ± 5.54	67.84 ± 8.3	0.345	9.51 ± 7.23	0.0% (Equal)	29.50 ± 2.84	0.027
Day2	13	69.47	56.13 ± 7.22	46.48 ± 10.67	42.49 ± 5.99	56.13 ± 7.22	0.007	19.21 ± 10.39	0.0% (Equal)	27.53 ± 3.30	0.001
Day3	10	71.47	67.88 ± 11.63	57.95 ± 15.01	63.22 ± 8.26	67.88 ± 11.63	0.047	13.83 ± 8.97	0.0% (Equal)	8.06 ± 9.75	0.017
Fat (g)											
Day1	6	52.53	73.48 ± 27.67	98.48 ± 33.66	94.44 ± 32.13	73.48 ± 27.67	0.046	39.89 ± 52.67	0.0% (Equal)	22.73 ± 2.44	0.028
Day2	13	52.33	56.71 ± 15.32	76.71 ± 23.34	72.68 ± 18.77	56.71 ± 15.32	0.002	22.70 ± 19.36	0.0% (Equal)	22.14 ± 1.44	0.001
Day3	10	50.41	50.27 ± 11.19	63.29 ± 13.95	62.90 ± 14.63	50.27 ± 11.19	0.013	16.75 ± 13.46	0.0% (Equal)	19.81 ± 3.12	0.005

N = 30, Mean ± SD; [1] The total numbers in the table in each day indicated only participants with 100% match between the estimated and inserted portions; [2] Reference based on the results calculated by Microsoft excel from serving size of cooking ingredients estimated by researcher; [3] Portion size estimated by participants from evaluation form (ND-02/64) were calculated for energy and nutrient using Microsoft excel by researcher; [4] Results were obtained from estimation and calculation manually by participants; [5] Results were obtained from estimation and calculation by participants using NDPro application; [6] Wilcoxon signed ranks test compared between NDP[FBDG30] and MN[FBDG30]; [7] The reference values calculated from the actual serving sizes prepared by a researcher; [8] The reference values calculated from the estimated serving sizes assessed by participants and calculated by Microsoft excel; [9] The reference values calculated from the estimated serving sizes assessed by participants and calculated by Microsoft excel with original nutrients from Thai FBDG;

Table 59 The percentage participants estimating portion sizes accurately[1] and the percentages of participants inserting serving sizes in the Thai TFEL-based NDPro application accurately[2]

	Starches	Very low fat meat	Low fat meat	Medium fat meat	High fat meat	Vegetables type 1	Vegetables type 2	Fruits	Whole Milk (regular)	Milk (low fat)	Milk (skim milk)	Milk (evaporated)	Milk powder (regular)	Milk powder (none fat)	Fat (PUFA/MUFA)	Fat (SFA)
Accurate estimations (%)																
Day 1	33%	13%	50%	3%	37%	17%	23%	20%	90%	90%	100%	100%	100%	100%	13%	100%
Day 2	30%	7%	20%	7%	93%	23%	3%	37%	73%	93%	100%	97%	100%	100%	3%	100%
Day 3	67%	73%	7%	0%	3%	7%	23%	17%	93%	97%	100%	100%	100%	100%	0%	27%
Accurate insertion (%)																
Day 1	97%	33%	50%	7%	37%	73%	77%	60%	90%	97%	100%	100%	97%	100%	60%	63%
Day 2	97%	40%	17%	33%	90%	87%	93%	93%	93%	100%	100%	100%	100%	100%	53%	63%
Day 3	87%	83%	73%	27%	10%	97%	83%	77%	90%	97%	100%	100%	100%	100%	100%	10%

N = 30

[1] The percentages of accurate estimations was calculated based on the number of participants whose estimates within ±10% difference from the actual serving sizes.

[2] The percentages of accurate insertion was calculated from the numbers of participants who inserted the serving size exactly equal to the recorded serving sizes in ND-02/64

Table 60 The percentages of participants estimating portion sizes accurately[1] and the percentages of participants inserting serving sizes

in the Thai FBDG-based NDPro application accurately[2]

	Starches	Rice glutinous	Bread	Meat	Tofu	Egg	Vegetables	Fruits	Milk	Milk, low fat	Fat
Accurate estimation (%)											
Day 1	20%	100%	83%	20%	100%	37%	13%	40%	93%	100%	17%
Day 2	7%	100%	100%	37%	23%	43%	0%	23%	90%	100%	20%
Day 3	0%	37%	7%	23%	97%	100%	13%	7%	87%	100%	30%
Accurate insertion (%)											
Day 1	77%	97%	87%	80%	93%	80%	70%	67%	80%	97%	87%
Day 2	97%	100%	100%	93%	80%	93%	77%	83%	90%	100%	90%
Day 3	77%	93%	80%	87%	97%	100%	87%	77%	93%	100%	77%

N = 30

[1] The percentages of accurate estimations was calculated based on the number of participants whose estimates within ±10% difference from the actual serving sizes.

[2] The percentages of accurate insertion was calculated from the numbers of participants who inserted the serving size exactly equal to the recorded serving sizes in ND-02/64
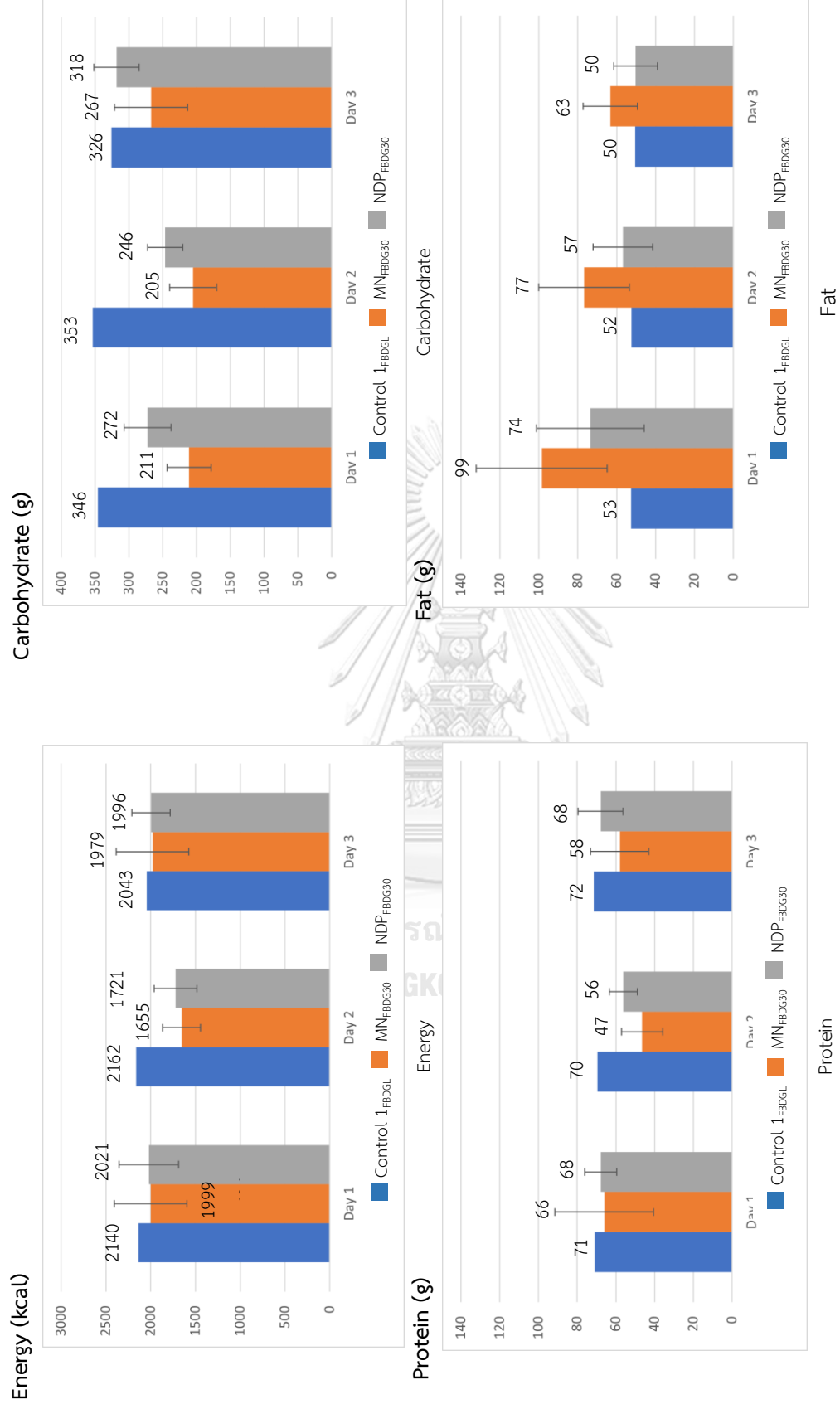
Figure 24 The comparison of energy and macronutrient contents obtained from the reference and participants with 100% match between estimated and inserted portions based on Thai FBDG

4.6.5. Acceptability and commentaries of dietitians toward the developed application

The results of participant's impression toward the developed application based on short version of the user experience questionnaire (UEQ-S) was summarized in Table 61. The questionnaire used to collect the information was valid with the item level (I-ICV) and scale -level (S-CVI) of 1.00. Overall, participants had positive impressions toward the developed application. Their impressions were indicated as Enjoyable, Understandable, Creative, Easy to learn, Valuable, Exciting, Interesting, Fast, Inventive, Supportive, Good, Pleasing, Leading edge, Pleasant, Secure, Motivating, Meet expectations, Efficient, Clear, Practical, Organized, Attractive, Friendly, and Innovative. Only one impression, between Complicated vs Easy was unpredictable, had average score approximately four, indicated as Neutral.

The results of acceptability and commentaries of participants toward developed application was summarized in Table 62. Participants were asked to rate if each application's component being useful on them. The score ranges from 1 (Strongly disagree) to 5 (Strongly agree). Overall, all components of the developed application were accepted by participants. All components had an average score approximately four, indicated as agree.

Some participants commented more about further improvement of application in the future. An example of their commentaries including these below.

1. "Application should reduce its complexity, each component should be accessible though button rather than ⋮ symbol of menu bar"
2. "Application should be also lunched in iOS platform"
3. "Username and password should be available to enhance security"
4. "Application should export or print documents of multiple accounts at once"
5. "More food images of the food album component should be available"
6. "Patients should be able to send their information to dietitian's application directly"

7. "The information of "One-meal dish database" in this application present serving size as 100 grams. It is difficult to use, the information of weight per dish should be available."

8. "Personal Data Protection Act (PDPA) of patients should be concerned"

9. "The database of NDPro application should be updated regularly"

10. "Database of glycemic index (GI) and glycemic load (GL) should be available"

11. "The information of "Enteral product category" did not have serving size as 100 grams or glass, the serving size as spoon should also be available"

12. "Small text, it's hard to read"

Table 61 Subjective impressions of users toward the NDPro application based on short version of the UEQ-S [77]

Characteristics	Scores	Characteristics	Scores
Not interesting (-3) vs Interesting (+3)	+2.16 ± 1.10	Easy to learn (-3) vs Difficult to learn (+3)	-1.00 ± 1.85
Inefficient (-3) vs Efficient (+3)	+2.10 ± 1.01	Clear (-3) vs Confusing (+3)	-1.17 ± 1.70
Conservative (-3) vs Innovative (+3)	+2.07 ± 0.94	Fast (-3) vs Slow (+3)	-1.17 ± 1.73
Obstructive (-3) vs Supportive (+3)	+2.00 ± 1.13	Attractive (-3) vs Unattractive (+3)	-1.30 ± 1.42
Unpleasant (-3) vs Pleasant (+3)	+1.91 ± 1.15	Secure (-3) vs Not secure (+3)	-1.30 ± 1.68
Annoying (-3) vs Enjoyable (+3)	+1.83 ± 1.12	Creative (-3) vs Dull (+3)	-1.30 ± 2.01
Impractical (-3) vs Practical (+3)	+1.81 ± 1.11	Motivating (-3) vs Demotivating (+3)	-1.40 ± 1.28
Unlikable (-3) vs Pleasing (+3)	+1.81 ± 1.22	Organized (-3) vs Cluttered (+3)	-1.51 ± 1.53
Boring (-3) vs Exciting (+3)	+1.73 ± 1.23	Meet expectations (-3) vs Does not meet expectations (+3)	-1.53 ± 1.25
Usual (-3) vs Leading edge (+3)	+1.66 ± 1.19	Inventive (-3) vs Conventional (+3)	-1.60 ± 1.55
Not understandable (-3) vs Understandable (+3)	+1.31 ± 1.39	Friendly (-3) vs Unfriendly (+3)	-1.64 ± 1.36
Unpredictable (-3) vs Predictable (+3)	+0.73 ± 1.39	Valuable (-3) vs Inferior (+3)	-1.77 ± 1.78
Complicated (-3) vs Easy (+3)	+0.16 ± 1.46	Good (-3) vs Bad (+3)	-2.00 ± 1.38

N = 70, Mean ± SD

Attribute 1		Attribute 2
Not interesting	2.16 ± 1.10	Interesting
Inefficient	2.10 ± 1.01	Efficient
Conservative	2.07 ± 0.94	Innovative
Obstructive	2.00 ± 1.13	Supportive
Unpleasant	1.91 ± 1.15	Pleasant
Annoying	1.83 ± 1.12	Enjoyable
Impractical	1.81 ± 1.11	Practical
Unlikable	1.81 ± 1.22	Pleasing
Boring	1.73 ± 1.23	Exciting
Usual	1.66 ± 1.19	Leading edge
Not understandable	1.31 ± 1.39	Understandable
Unpredictable	0.73 ± 1.39	Predictable
Complicated	0.16 ± 1.46	Easy
Easy to learn	-1.00 ± 1.85	Difficult to learn
Clear	-1.17 ± 1.70	Confusing
Fast	-1.17 ± 1.73	Slow
Attractive	-1.30 ± 1.42	Unattractive
Secure	-1.30 ± 1.68	Not secure
Creative	-1.30 ± 2.01	Dull
Motivating	-1.40 ± 1.28	Demotivating
Organized	-1.51 ± 1.53	Cluttered
Meet expectations	-1.53 ± 1.25	Does not meet expectations
Inventive	-1.60 ± 1.55	Conventional
Friendly	-1.64 ± 1.36	Unfriendly
Valuable	-1.77 ± 1.78	Inferior
Good	-2.00 ± 1.38	Bad

Figure 25 Subjective impressions of users toward the NDPro application by the UEQ-S (N = 70)

Table 62 Acceptability of participants toward the NDPro application

Application components			Scores
1. Account registration component			4.50 ± 0.61
2. Account management component			4.56 ± 0.61
3. Requirement determination component			
3.1. Nutritional assessment related variables determination			4.59 ± 0.55
3.2. Weight adjustment			4.59 ± 0.63
4. Nutrition flag determination component			
4.1. Requirement conclusion			4.50 ± 0.63
4.2. Nutrition flag determination			4.36 ± 0.89
5. Dietary record component			4.19 ± 0.84
6. Result displaying component			4.30 ± 0.79
7. Documentation component			4.33 ± 0.68
8. Food image component			4.53 ± 0.65
9. Database component			
9.1. One meal dish (INMU)	4.40 ± 0.86	9.2. Grain, nut-based beverage products	4.51 ± 0.70
9.2. Desserts (INMU)	4.50 ± 0.70	9.13. Alcoholic products	4.50 ± 0.76
9.3. Beverages (INMU)	4.50 ± 0.78	9.14. Beverage products (ready-to-eat)	4.61 ± 0.57
9.4. Chili pastes	4.37 ± 0.87	9.15. Beverage products (dried powder)	4.63 ± 0.57
9.5. Bakery products	4.59 ± 0.65	9.16. Beverage additive products	4.60 ± 0.60
9.6. Cereal products	4.53 ± 0.72	9.17. Condiment products	4.54 ± 0.65
9.7. Snack products	4.37 ± 0.62	9.18. Enteral nutrition products	4.67 ± 0.58
9.8. Ice cream products	4.47 ± 0.76	9.19. Dietary supplement products	4.33 ± 0.70
9.9. Frozen food products	4.56 ± 0.72	9.20. Parenteral nutrition products (mixed)	4.16 ± 0.99
9.10. Semi-processed and ready-to-eat products	4.63 ± 0.59	9.21. Parenteral nutrition products (single components)	4.21 ± 0.85
9.11. Milk and dairy products	4.61 ± 0.60	9.22. Peritoneal dialysate solution products	4.60 ± 0.65
11. Fat profile calculation component			4.40 ± 0.88
12. Folic acid calculation component			4.26 ± 0.90
13. Export component			4.63 ± 0.66
14. Overall score			4.43 ± 0.67

N = 70, Mean ± SD

Chapter 5

DISCUSSION

Mobile Application requirement

According to the survey of behavior and attitude of dietitians toward nutrition care process, this study revealed that most participants (78.5%) used a 24-hour dietary recall for dietary assessment. Only half of the participants reported using tools or technology in the dietary assessment process. Certainly, based on the survey results, it was clear that the vast majority of participants (over 90%) reported that they required some technology to support dietary assessment, recording, and monitoring. Furthermore, almost all participants (95.7%) expressed an interest in using the developed application to support the nutrition care process. These findings are consistent with the study conducted by J. Chen et al., which investigated the use of smartphone health apps and other mobile health (mHealth) technologies in dietetic practice. The study found that 62% of dietitians utilized health apps, primarily as information resources (74%) and for patient self-monitoring (60%) [85]. Similarly, the study by Justine Karduck and Karen Chapman-Novakofski, focusing on clinicians working with patients with diabetes and obesity, demonstrated that health-related smartphone apps were widely used and recommended for self-monitoring of dietary and physical activity behaviors. These apps were perceived to be superior to traditional methods, with a majority of clinicians agreeing that they could lead to better patient outcomes [86]. Collectively, these studies, as well as the findings of this study, provided strong support for the importance of the mobile application as a tool to support the nutrition care process and address the needs of nutrition professionals.

Reliability of NDPro databases

The NDPro was designed to support dietary assessment with both Thai FEL based or Thai FBDG based recommendations. All scientific information including three sources of nutrition requirement references (Thai DRI 2020, Thai RDI 1998, IOM 2005), all equations and factors used to calculate nutrition requirement, the representative values of energy and nutrient contents of each food group for either Thai FEL or Thai FBDG based application, the developed protein free starch subgroup, the commercial food products and the nutrition related food products, the developed fatty acid and folic acid databases, and food photographs were passed the validation process and acceptable for both I-CVI and S-CVI. Based on the databases reported in 4.1 and 4.3, the NDPro application provided databases beyond those of commonly used Thai FEL and Thai FBDG. Dietitians could perform dietary assessment or planning by estimating from the traditional food groups along with 5759 items of foods, condiments, specific kinds of food products, enteral and parenteral nutrition products, and dialysate. All of twenty-two categories of the food products and the nutrition related products providing 4,628 the items (Table 26) installed in the NDPro application could be assessed easily in the first page once the application launched. Also, the fifteen items of energy, macronutrients, and micronutrients available in the nutrition facts of a variety of commercial food products were installed in the databases for dietitians to use for dietary assessment and planning. Beside energy and nutrient contents, the cautions of allergy defined in each product were displayed along with other nutrition information as supporting information for dietitians to reconsider along with patients' histories in food allergy before recommendation types of those commercial food products. The %Thai RDI were also displayed along with the nutrient contents indicating the intensities of energy and nutrients in each commercial food product for dietitians to select for individuals and adjust until meet the nutrition requirement. It was obvious that the

high acceptability of the participants on the database components was detected in twenty-two categories ranging from 4.16 to 4.67 (Table 62).

Besides specific brands of 264 condiments in the item 17 as mentioned in Table 26, the NDPro application also provided 23 undefined brand condiments commonly consumed in Thailand derived from the INMUCAL databases. Sodium and sugar contents in these condiments presented in the database could support dietitians for dietary assessing and planning for low sodium and low sugar diets. Moreover, the 82 recipes of the traditional types of chili pastes, difficult to estimate amounts of ingredients and salt contents, were available for dietitian to apply for reducing sodium in diet. The importance of a reliable and comprehensive database within the NDPro application is further supported by an international survey conducted by Vasiloglou et al. The study found that inaccurate databases for food composition (52.0%) and the lack of local food composition support (48.2%) were the most common barriers preventing healthcare professionals from using nutrition apps. These findings emphasize the value of the database in NDPro, which provides accurate food composition information for precise dietary assessment and planning. According to thee finding of this study, NDPro has been expected to enhance acceptance and adoption among healthcare professionals [87].

Moreover, fatty acid or folate requirements and suggestion along with lists of food items were available for in depth of the nutrition counselling as a separated function. High quality of fat intake indicated by the proper ratio of fatty acid in food based on the DRI recommendation was related to the CVD prevention [88]. Folate is also an important nutrient for pregnant women and the young woman teenagers for prevention anemia and neural tubule [89]. However, sometime these nutrients were ignored because of the limited time and information in practice. The NDPro databases included fatty acid profiles of 1,016 items of fish, meat, and other food groups from three reliable sources and 92 items of the food sources of folate from "Food composition table of Thai foods" to solve this problem [80]. The high

acceptability of the participants on the database components of fatty acid profiles and folic acid components was indicated as scores of 4.40 ± 0.88 and 4.26 ± 0.90, respectively.

Although alcoholic products were not recommended to drink in patients, it was possible that some patients may approach any kinds of alcoholic drinking beverages. Alcohol beverages can provide 7 kilocalories per gram, almost twice of energy from carbohydrate in the equal weight. These alcoholic product databases will enhance dietitians to cover all intakes providing energy and monitoring patients' drinking habits for the intervention and monitoring in the NCP.

Nowadays, oral nutrition supplement (ONS), enteral nutrition as well as parenteral nutrition play the important roles in some groups of people, such as elderly or chronic diseases related to nutrition, for prevention of malnutrition and disease management. Medical product databases covering 117 items across three categories included 52 items of the commercial enteral nutrition products, 51 items of parenteral nutrition, and 14 items of dialysate solution products. Besides energy and nutrient contents in those products, the NDPro application offered information of ingredients, unique physical properties, food allergen, product preparation, and cautions of individual medical products in the offline databases to dietitians for avoiding time searching the information. However, dietitian skills are still play the major role for using the information and reducing service time. The pop-up messages designed in the NDPro application help users to understand the terms or some definition, and give more scientific information such as equations, recommendations, or references, for dietitians to choose the proper function to perform. In addition, the NDPro application provided functions for recording intervention, planning, and follow up along the ADIME process. The personal health information, histories of dietary intakes, food and nutrition diagnosis, prescriptions, and planning for continuous monitoring eating habits and self-adherence of patients could be retrieved from the NDPro databases from the front pages.

It was reported that the mobile applications support dietitians in some countries, such as MyFitnessPal®, Monash University Low FODMAP Diet® [85]. In Thailand, the "DISC" application was the early professional application designed for supporting Thai dietitians' work in the field of kidney disease covering both dietary assessment and monitoring [17, 18]. However, there had no professional mobile application imitating the nutrition care process covering the dietary assessment process based on both Thai FEL and Thai FBDG with Thai food and nutrition related databases in the same application as developed in this study. The NDPro databases developed in this study based on approximately 6,000 food items from the reliable Thai food databases and food products available in Thailand.

The representative values of energy and nutrients used in the TFEL based and TFBDG based NDPro application

One of the main features of the NDPro application was designed for assessing the energy and amounts of carbohydrate, protein, and total fat using either the traditional Thai FEL and Thai FBDG based application or the Thai FEL-INMUCAL and Thai FBDG-INMUCAL based application the This study also introduced the representative values of nineteen nutrients as mentioned in 4.1.2. for the Thai FEL-INMUCAL and Thai FBDG-INMUCAL based NDPro application. The results from Table 17, Table 19, and Table 21 showed that most of the representative values of energy, carbohydrate, protein, total fat per serving size in each food group were closed to the original values recommended by Thai FEL and Thai FBDG. It was expected that the representative values set up in this study would obtain the results of energy and three macronutrients closed to those from the original recommended values. However, it was found that based on nutrient contents derived from the INMUCAL databases, some food items defined in the low fat meat subgroup by Thai FEL contained fat more than the definition of low fat meat. The representative values of energy and fat content of this subgroup based on the recommended food

items before reallocation might not right (Table 18). After reallocation the meat subgroups based on fat content, the representative values of energy, protein, and fat contents were reasonable (Table 19). Thus, the NDPro application provided optional function for users to get the better results. It was observed the representative values of energy, carbohydrate, and protein contents of the cereal group of Thai FBEG-INMUCAL based were higher the those of original one.

In the TFBDG-based NDPro application, the representative values of the Milk (whole milk) subgroup were not close to the original values. It provided 217.82 kcal of energy, 34.0 g of carbohydrates, 6.41 g of protein, and 6.24 g of fat per serving size, compared to the original values of 121.8 kcal of energy, 9.8 g of carbohydrates, 4.0 g of protein, and 7.4 g of fat (Table 23). When considering the sources of the representative values in APPENDIX L, the major sources of abnormality resulted from yoghurt and drinking yoghurt included under this subgroup. Although their recommended portions of 400 g provide 6–7 g of protein, which was equivalent to one glass of whole milk, they also provided 30–40 g of carbohydrates (3–4 times that of whole milk). Therefore, it should exclude the items of yoghurt and drinking yoghurt from the milk subgroup and set up the new subgroups separately for yogurt and drinking yogurt. Therefore, the milk subgroup should provide 127.38 kcal of energy, 9.45 g of carbohydrates, 6.41 g of protein, and 7.11 g of fat, and the yogurt and drinking yogurt subgroup should provide 237.57 kcal of energy, 39.39 g of carbohydrates, 6.68 g of protein, and 5.92 g of fat per serving size.

Furthermore, the representative values of the Cereal (cooked rice or noodles) subgroup in the TFBDG-based NDPro application were more than those of the original values of 83.05 kcal of energy, 17.9 g of carbohydrate, 1.4 g of protein, and 0.65 g of fat per serving size. In contrast to the TFEL-based NDPro application, the TFEL representative values were more closely matched the original TFEL reference values. For both food exchange lists, the outmatch food items most likely result from the items of noodles. Their serving sizes were assigned as 70 – 90 g providing 20 – 30 g of

carbohydrate, but the representative values of TFEL-based NDPro application resulted from more food items such as chestnut, jackfruit seed, horn chestnut. These food items contained carbohydrate more closely matched to the original TFEL reference values, making the TFEL-based NDPro application had the representative values more closer to the original TFEL reference values. Moreover, the serving size of "Corn" was assigned for its serving size as 65 g in TFEL while 80 g in TFBDG, which provides carbohydrate close to the original TFEL reference. These indicated that both TFBDG and TFEL food exchange lists should be revised for the serving size of noodles in the starch subgroup. For TFBDG food databases, more food items should be added to the calculation of representative values and the serving size of corn should be revised in further development.

The representative values of other sixteen nutrients including saturated fat, cholesterol, dietary fiber, sugar, five vitamins (vitamin A, thiamin, riboflavin, niacin, vitamin C) and seven minerals (calcium, phosphorus, potassium, sodium, cupper, iron, zinc) were also set up and installed in the NDPro application for estimating those nutrients. It was important to note that the inclusion of micronutrients in the developed representative values should be interpreted with caution. Micronutrient contents can vary significantly across different foods even though within the same subgroup, and the representative values provided in this study serve as an initial attempt to test the feasibility of incorporating micronutrients into a food exchange list. The users of the NDPro application should be aware of the limitations associated with the micronutrients. The developed representative values may not accurately reflect the precise micronutrient content of foods. Therefore, there were the messages to remind the dietitians for using the results. It is crucial for dietitians and users to have the caution when utilizing these values and consider them as the estimation rather than exact measurements.

To improve the accuracy and reliability of the representative values in future versions of the NDPro application, the current representative values in this study

were calculated based on only foods defined in the Thai FEL or Thai FBDG. In the future, establishment of subgroups with food items containing similar nutrient contents assessing from the INMUCAL database need to be considered for setting up the new representative values for the new version of NDPro application. By continuously updating and refining the representative values, the NDPro application can provide more comprehensive and reliable information for assessing the nutrient intakes.

Validation of the TFEL based and TFBDG based NDPro application

The NDPro application was developed though Android studio version 3.3.2 for Windows. Although Application Program Interface (API) 15 was set at the beginning of development to support all devices in the market, the application's API must be changed into API 19 to meet the requirement of some features of Android studio. After validation in the precaution phase by testers, the researcher rechecked the results of the developed application in Microsoft Excel using the data recorded during validation. The recheck did not reveal any conflict result, indicating that the application is functioning correctly.

In this validation, there were three controls established for checking the accuracy of the results performed by the participants as follows.

Control 1 used as the reference values, calculated by actual portion sizes prepared by the researcher and databases installed in the NDPro application, using for checking the accuracy of the results performing by the participants with the NDPro application which may be interfered by the portion size estimation and data insertion.

Control 2 used for checking the accuracy of the results obtained from the NDPro application performing by the participants which may be interfered by the data insertion.

Control 3 used for checking the accuracy of the results obtained from the participants' manually calculation which may be interfered by the portion size estimation, memory, calculation skill.

The developed application was validated by seventy registered dietitians who had experience of counseling and nutrition care process for more than 1 year. The results of validation indicated that the energy and macronutrients analysis from food photographs using the NDPro application was significantly required less time usage than calculation manually. When calculating the estimated portion sizes recorded by the participants in ND-02/64 by the original nutrient values based on Thai FEL and Thai FBDG (Control 3_{FEL70} or Control 3_{FBDG70}), it was found that the results of energy and macronutrient contents did not match to those obtained from MN_{FEL70} or MN_{FBDG70}, respectively. This suggested that some participants may have made calculation errors or forgotten the reference values of the original food exchange lists. Because of both Control 1 and Control 2 were calculated using the new representative values, albeit derived differently (Control 1 from actual portion sizes by researchers and Control 2 from estimated portion sizes by participants), the difference values of energy and macronutrient contents between Control 1 and Control 2 (Control 1_{FEL} & Control 2_{FEL70} and Control 1_{FBDG} & Control 2_{FBDG70}) confirmed the incorrect estimated serving size occurring in this study in both Thai FEL and Thai FBDG validation (Table 45 and Table 48). Although the results obtained from the NDPro application (NDP_{FEL70} and $NDP_{TFBDG70}$) may contain some human errors, they still reflected the practical usage of the application. For the TFEL-based validation, significant differences were observed from the NDPro application for energy, carbohydrate, and protein, except for fat when compared with calculation manually. The results did not fall within the acceptable range (when compared with both

Control 1_{FEL} and Control 2_{FEL70}). For TFBDG-based validation, however, the energy and macronutrient results from NDP_{FBDG70} did not range within acceptable range as %difference outside ±10% when compared with Control 1_{FBDG}, but became acceptable as NDP_{FBDG70} range within ±5% when compared with Control 2_{FBDG70}. There are two primary reasons why the TFEL-based application did not meet the acceptable range, while the TFBDG-based application yielded more satisfactory results. Firstly, the food subgroups belonging to the TFEL-based NDPro application was more complex than those of the TFBDG-based NDPro application (17 subgroups in the TFEL-based NDPro application and 12 subgroups in the TFBDG-based NDPro application along with the protein free starch subgroup). More complexity might have contributed to a higher likelihood of errors or inconsistencies during the validation process. Secondly, it may be possible that learning effect occurred, as participants were asked to validate foods using the TFEL-based NDPro application before the TFBDG-based NDPro application for each validation process.

To compare the quality of the new representative values of the food exchange lists developed in this study, the results calculated from the estimated portion sizes recorded by the participants in ND-02/64 with the new representative values from both food exchange lists using Microsoft Excel were set as Control 2_{FEL70} or Control 2_{FBDG70} for checking the accuracy of the results obtained from the NDPro application (NDP_{FEL70} and NDP_{FBDG70}). Also, the results calculated from the estimated portion sizes by participants with the original nutrient values from both food exchange lists were set as Control 3_{FEL70} or Control 3_{FBDG70}. The comparison between NDPro and Control 2 revealed significant differences in the results of the NDPro application across almost all Thai FEL and Thai FBDG based validations (Table 43 and Table 44 for Thai FEL, Table 47 and Table 49 for Thai FBDG). According to the unequal results of all energy and macronutrient contents from Control 2_{FEL70} & NDP_{FEL70}, Control 3_{FEL70} & MN_{FEL70}, Control 2_{FBDG70} & NDP_{FBDG70}, and Control 3_{FBDG70} & MN_{FBDG70} as mentioned in 4.6.1 and 4.6.2, the reliability test could not depend upon

the participants alone. Therefore, the results of reliability obtained from Control 2_{FEL70} as the accurate values of NDP_{FEL70} and Control 3_{FEL70} as the accurate values of MN_{FEL70}.

According to the testing by researcher as mentioned in 4.5, it was found that the results obtained from using Microsoft Excel and the NDPro application did not differ. Therefore, the accuracy of the comparison between NDP and Control 2 depends on the participants accurately inputting their estimated portions into the developed application without any errors. Human errors were the important issues need to be minimized by intensive training and improving skills of the future participants before collecting the data. This circumstance could indicate by the subjective impressions of participants toward the NDPro application as understandable, easy to learn, and easy were +1.31 ± 1.39, -1.00 ± 1.85, and +0.16 ± 1.46, respectively (Table 61). Most participants had mismatch portions between the first estimation recorded in the Evaluation form for recording dietary intake assessment (ND-02/64) and those recorded in the developed application.

Based on the results of the energy and nutrient estimates obtained from Control 1 (the reference values) and Control 3 (substitute to MN) in both Thai FEL and Thai FBDG-based validations, there were the greater differences of Control 1 & Control 3. Especially in the protein and fat categories, the difference of Control 1_{FEL} & Control 3_{FEL70} were up to 46.05 ± 8.53 g and 33.83 ± 36.06 g, respectively whereas those of Control 1_{FBDG} & Control 3_{FBDG70} were up to 36.98 ± 10.97 g and 51.24 ± 42.76 g, respectively (Table 45 and Table 48). It was obvious that besides the sources of the values used for calculating energy and macronutrients, the incorrect estimation may affect the results. The differences of energy, carbohydrate, protein, and fat in the Thai FEL validation (Control 2_{FEL70} & Control 3_{FEL70}; same portion sizes) dropped down to approximately 7 - 8%, 7 – 8%, 16 – 20%, and 2 – 5%, respectively. While the differences of energy, carbohydrate, protein, and fat from Control 2_{FBDG} & Control

3_{FBDG} (same portion sizes) in the Thai FBDG validation fall to approximately 3 - 9%, 8 – 28%, 9 – 32%, and 19 – 22%, respectively (Table 45 and Table 48).

According to the Thai FEL based validation, only fat estimates falling within the acceptable range of less than 5% difference (Control 2_{FEL70} & Control 3_{FEL70}; range 2.85 ± 3.96 to 4.45 ± 6.14) demonstrated the reliability between two methods. Regarding to the fat analysis, for the Thai FEL based validation, the major sources of fat included meat, milk, and fat groups. It should be noted that the unit of the meat group assigned in the NDPro application was different from the original unit of Thai FEL. Specifically, the portion size of the meat group based on the Thai FEL was assigned as one tablespoon in the NDPro application, while it was two tablespoons in the original Thai FEL [10]. This change was made to facilitate the usage of the overall functions of the developed application, and participants were warned by the researcher before starting each validation. If users mistakenly inputted the numbers of portion sizes into the application, all nutrient contents under the meat groups calculated by the NDPro application would be approximately double compared to those from manual calculation. However, when considering the results based on the Thai FEL, although the protein contents result of obtained from the NDPro application significantly differed from those by calculation manually, the difference did not reach double. This suggested that the inaccuracy might not due to the difference unit as mentioned above.

However, the energy and carbohydrate contents calculated by the NDPro application (Control 2_{FEL70} & Control 3_{FEL70}) approximately 7 - 8% more than those using the original Thai FEL values (Table 45). It might be the representative values of the NDPro database derived from the INMUCAL food databases provided carbohydrate contents in the vegetable group, meat group, and fat containing group which the original Thai FEL values defined as zero. Moreover, it was showed that the greater difference between the protein contents calculated using the representative values from the Thai FEL NDPro databases and those using the original Thai FEL

values were more than 10%. Most of the protein contents in meat subgroups of the reallocated meat subgroup NDPro databases were closed to the original values except the low fat meat subgroup provided 8.34 g protein instead of 7 g protein per serving size (2 tablespoon). It might be possible that the greater difference of protein contents might be human errors from overestimation of the meat serving sizes along with the low fat meat subgroup defined. For instance, one or two serving sizes of the low fat meats were used to prepare the menu on only Day 2 and Day 3 but the participants estimated up to approximately 5 serving sizes all three day of validations (Table 46).

For the reliability of the Thai FBDG based NDPro application, the results were obtained from Control 2_{FBDG70} (as the accurate values of NDP_{FBDG70}) and Control 3_{FBDG70} (as the accurate values of MN_{FBDG70} and the NDP_{FBDG30} and Control 3_{FBDG30} subgroups (Table 49, Table 58 and Figure 24). The results from the NDP_{FBDG30} subgroup, including only the participants with a 100% match between estimated and inserted portions, also showed significantly differed from those of Control 3_{FBDG30}. Compared to the results from the original Thai FBDG (Control 3), the energy seemed to only one category reliable in the Thai FBDG NDP application The rest of them need to be reconsidered add more food items used to set up the representative values The comparison between Control 1_{FBDG30} and NDP_{FBDG30} revealed that most of their differences more than 10% which was out of the acceptable range. It is important to note that the accuracy between the NDP_{FBDG30} and Control 1_{FBDG30} depended upon the accurate estimation of portion sizes by the participants. If participants can estimate portion sizes from food photographs correctly, equal to the reference portions, the results of NDP_{FBDG30} and Control 1_{FBDG30} would be equal. This suggested that there was considerable human error during the estimation by participants.

According to the results of the portion estimation by participants in Table 46 and Table 50, it suggested that the inaccuracy of estimations was also not related to

the milk group, but primarily rather to the estimation of the fat group. The reference values of fat were set approximately 7 portions per day. Although the average portion estimation range closely to the reference as approximately 8 to 11 portions for Thai FEL, and 7 to 10 portions for Thai FBDG. the maximum of value of fat estimation could be overestimated up to 26 to 32 portions per day for Thai FEL, and 18 to 30 portions per day for Thai FBDG. This study found that Thai dietitians tended to underestimate low-energy nutrients, such as carbohydrates and protein, while overestimation toward high-energy nutrients, such as fat. This finding was consistent with previous research by Japur and Diez-Garcia, who found that the nutrition students in Brazil also tended to underestimate low-energy foods and overestimate high-energy foods [90]. Thai dietitians tended to overestimate fat group in both Thai FEL and Thai FBDG based validation. In addition, the degree of overestimation was relatively lower in the validation of the Thai FBDG compared with Thai FEL.

Additionally, it was found that the degree of overestimation of fat analysis using Thai FBDG was greater than that using Thai FEL. The study design might be one factor influencing the observed difference. In each validation, participants were first asked to estimate the Thai FEL based food photographs before estimating the Thai FBDG based food photographs. During the second round of the estimation, participants had the opportunity to use the NDPro application to estimate the food image again with the different set of Thai FBDG based food images, Moreover, participants were able to review their feedback results from the validation of the Thai FEL before saving their results. Any abnormal feedback results could have affected their estimation during the second round, which might led to improved accuracy and result the lower percentage difference [91]. Therefore, in future studies, a crossover study design and hiding feedback from participants may be necessary to remove the learning effects during the validation of the NDPro application.

The results of the subgroup analysis revealed the clauses of inaccuracy in this study (Table 59 and Table 60). Some subgroups showed 100% accuracy as no

corresponding food subgroup was present in the food photographs, and most participants could avoid estimation mistakes. However, estimation mistakes remained found in the milk (evaporated) subgroup. When excluding these missing food subgroups, the finding in this study was consistent with Ayob et al. that less than one-third of the dietitians able to estimate the serving sizes within 10% of the reference [78]. Approximately 70 - 100% of the participants could correctly insert the serving sizes. However, it was observed that dividing the meat group into many subgroups based on fat contents could affect the accuracy of participant's insertion. This may be attributed to increased complexity and the close similarity of names for each subgroup, leading to incorrect insertion. Neither the accuracy of insertions for vegetable subgroup and milk subgroup in the TFEL-based NDPro application nor those for starch subgroup and meat subgroup in the TFBDG-based NDPro application was affected by the division of subgroups. It may be possible that the low number of vegetable subgroups (only 2 subgroups) had a negligible impact on the insertion accuracy, and the participants were warned that milk in food photographs prepared with whole milk (normal fat), which was placed at the first position in the milk group, preventing it from the error of insertion. Moreover, the division of subgroups in the starch and meat groups in the TFBDG-based NDPro application was more specific, including cooked rice noodles, sticky rice, and bread for the starch group, and meat, soybean curd, nuts, and eggs for the meat group. These specific subgroup divisions may be key factors in the future development of food exchange lists to prevent insertion errors.

The accurate estimation of participants can be challenging, as it requires a certain level of expertise and skill. This is where the role of intensive training and improving the skill of dietitians becomes crucial. Intensive training and continuous improving skills for dietitians can significantly contribute to improving their ability to accurately estimate portion sizes and make precise assessments [92, 93]. The effect of training was also observed in this study, according to the results of the subgroup

analysis based on the food exchange list subgroup (Table 59 and Table 60). The percentages of the insert accuracy tended to be higher in the second and third validations when compared to the first validation for both food exchange lists. This will not only enhance the accuracy of the NDPro application but also improve the effectiveness of dietary assessments, leading to better outcomes of dietitians to support dietetic professional practice.

Based on the findings of this study, the NDPro application demonstrated better performance compared to calculation manually. Moreover, the development of new representative values of energy, carbohydrate and fat for Thai FEL in this study hold potential for further application development while those of macronutrients not energy need to be improved.

Acceptability of the NDPro application

The developed application was successfully accepted by registered dietitians in both databases and functions in application (Table 62). However, the developed application also has possible areas for further development. During validation phase, the researcher also had the opportunity to discuss with participants individually about the limitations of NDPro application. Although the current version of the NDPro application could impressed users in many aspects (Table 61), improving the features friendly to users and easy to use should be performed in the future. Integration of all collective information both from questionnaire and interview were summarized into draft for further development as shown in Figure 26 and Figure 27 and described below.

Firstly, the developed application appeared to be complicated, as evidenced by the results of the UEQ-S questionnaire. While participants generally had positive impressions toward the developed application, the rating for the impression between Complicated vs Easy was lowest (Table 61). This indicated that the current version

of the NDPro application was still considered to be complicated for some participants. Additionally, the developed application design enforced users to perform dietary recall in every cases and users could only save their record after they finish recording food intakes in the dietary recall process (Figure 20). Although the dietary recall process was an important part of the nutrition care process, in some cases it may not be required for nutrition information in some visits, such as focusing on food insecurity [94]. Therefore, the current design of the NDPro application may not be suitable in this case. Future development aims to make the application simpler and allows users to save their records even though they do not perform dietary recall. According to redesigning draft and its workflow in Figure 26 and Figure 27, it is possible to achieve be redesigned. The Documentation component could become the main component. On the other hand, the Dietary record component reduces its importance becoming the optional information. Additionally, navigation bars and graphic icons should also be included into the redesigned application to reduce complexity of the new version of the NDPro application.

Second, the NDPro application is currently only available on the Android platform and do not support data sharing between devices. Although the NDPro application can export files in Excel/PDF format, dietitians typically require comprehensive databases containing all dietary and nutrition information of all patients served in the workplaces, rather than files that record only those for individual patients by individual dietitian. Future development aims to cover devices on both PC, Android, and iOS platforms. If budget or time is limited, the development of a web-based application might be the most suitable option to achieve this purpose. Cheaper alternative options might include using Google App Script to communicate with Google Sheets in Google Drive without cost [95].

Thirdly, smartphone keyboards may not be the ideal tool for recording information. Text entry on smartphones was often slower and more error-prone

compared to traditional desktop keyboards, even with the assistance of word prediction algorithms. To overcome this challenge, one possible solution is to utilize the templates. Future development should include a wide range of templates that could potentially meet the needs of dietitians, and also allow users to create their own custom templates.

Fourth, some participants had expressed concerns about the compatibility of the NDPro application with the Personal Data Protection Act, B.E. 2562 (2019) or PDPA law [96]. Unfortunately, the application was designed and developed before the PDPA law came into full effect on 1 June 2022. The current version of application was designed to keep records of names, hospitals, hospital numbers (HN), gender, ages, religion, allergic profile, food intolerances profile, medical diagnosis, and details of food and nutrition intakes and NCP in each visit. To ensure compliance with the PDPA law, features such as username and password, or PIN code should be incorporated into the NDPro application. Additionally, barcode scanner might be useful tool to help users insert HN more precisely. Further research and development are required to evaluate the feasibility of these ideas.

Lastly, an uncommon crash was detected in some participants. Typically, an application crashes when it performs an operation that is not allowed by the operating system, causing the system to stop functioning. In this study, an uncommon crash occurred when participants long pressed the menu name in the Dietary record component. However, when the researcher asked the participants to redo the action, the crash did not recur. Fortunately, this crash was rare and unlikely to occur in most cases, and it was suspected to be related to the operating system. In this study, the application was developed using Java, one of the world's most popular languages according to the Stack Overflow developer survey 2021 [97], providing the advantage of a larger community and available tools. Nevertheless, Kotlin has become the suggested official language for Android development. It offers benefits such as expressive and concise coding, safer code, interoperability, and

structured concurrency for Android development [98]. These benefits are consistent with the report from Meta (Facebook) after they shifted their Android codebase for Facebook, Messenger, and Instagram from Java to Kotlin. They reported better efficiency in handling crashes, especially Null Pointer Exceptions, while using shorter code lengths (approximately 11 percent) compared to their Java codebase [99]. Therefore, it is recommended that Kotlin should be used for further development or any other dietary applications if its disadvantages can be ignored.

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

Page 1

Page 2

a)

b)

First minor page

c)

Second minor page

d)

Third minor page

Figure 26 A recommended draft for further development
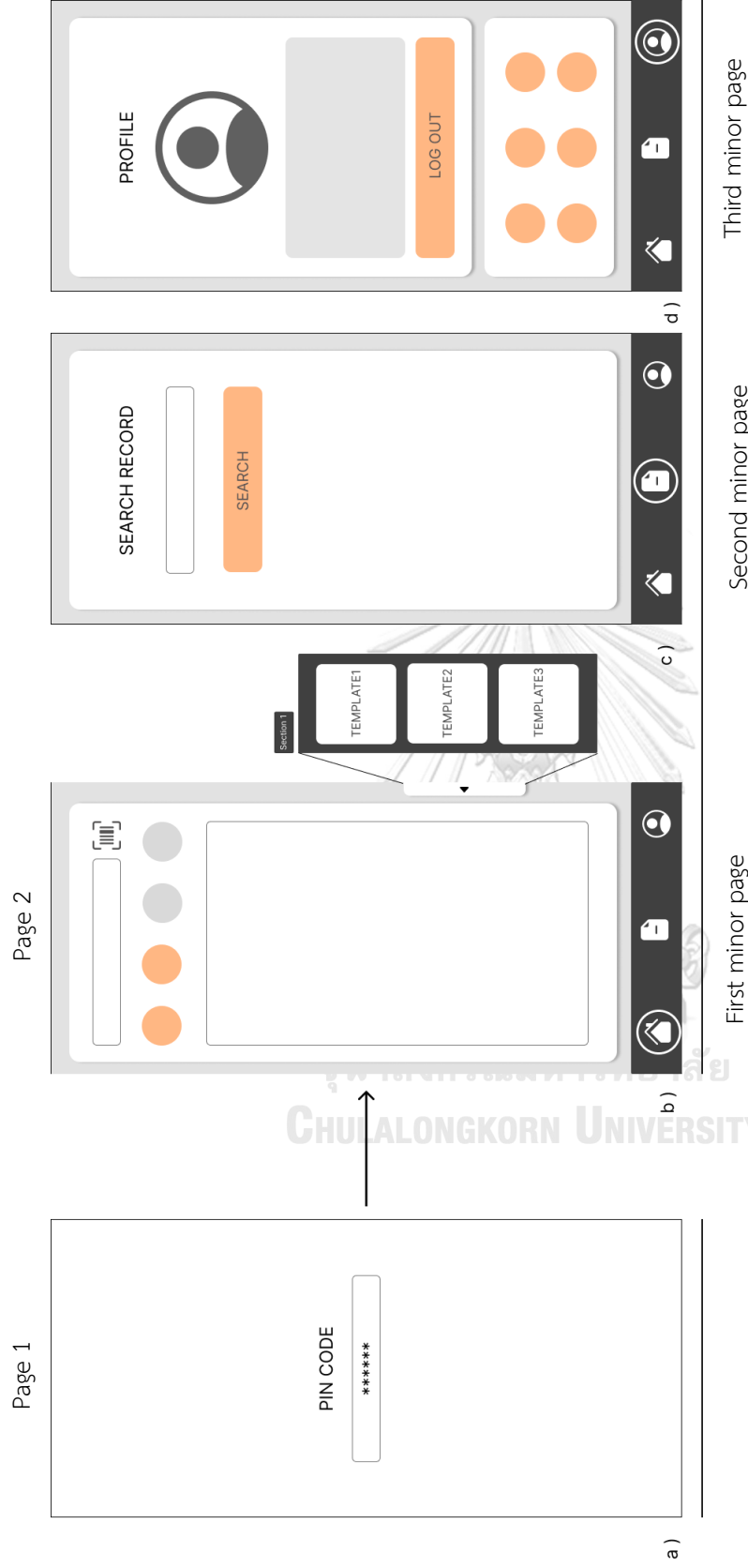
A recommended draft for further development will merge all components of the current version of the NDPro application into two pages. (a) First main page will be used for the username and password, or pin code box to enhance security. (b - d) Second main page will contain three minor pages with navigation at the bottom. (b) First minor page will emphasize recording documentation. Application will collect it as required information. There is a textbox for inserting a hospital number (HN) and a barcode scanner to support inserting precisely. Next part will contain circle icons for optional informations such as requirement determination, dietary assessment, and biochemistry assessment. These icons will be presented in grey color if there is no data inserted and become colored when information added. The rest of this page will be a textbox for inserting information. At the right side of the screen, there is a hidden tool to open template to support recording. Users can also create own template. (c) Second minor page for searching previous dietary record. (d) Third minor page for dietitians to record patients' profiles and data management, and other standalone functions such as the fatty acid profile calculation component.

Figure 27 A recommended workflow for further development of a new version of the NDPro application

Note: Grey boxes refer to main process

Chapter 6

CONCLUSION

6.1. Conclusion

This study successfully developed the mobile application named "NDPro" in android platform and could perform in either smartphone or tablets. The NDPro application was designed for assessing the energy and amounts of carbohydrate, protein, and total fat and other sixteen nutrients using either the traditional Thai FEL and Thai FBDG based application or the Thai FEL-INMUCAL and Thai FBDG-INMUCAL based application. This application could support dietetic professional practice to estimate nutrition requirement, perform dietary assessment and planning with adjustable serving sizes functions. It had potential to analyze energy and nutrients by both Thai FEL and Thai FBDG based application. The validation of both Thai FEL and Thai FBDG based application resulted in a significant reduction in time usage. Average reduction time were approximately 4 – 6 minutes by Thai FEL based validation and 5 – 7 minutes by Thai FBDG based validation. The participants had positive impression toward the NDPro application based on short version of the user experience questionnaire (UEQ-S). All components of the application were rated more than 4.0 and the average "Overall score" was 4.43 ± 0.67, indicated as accepted. The results of macronutrients from NDPro application significantly differed from those by calculation manually because of the difference of some representative values in some food subgroups. The reliability of the NDPro application on macronutrient analysis need to be pursued. Establishment of the new representative values of food subgroups with selected food items containing similar nutrient contents assessing from the INMUCAL database is required for further study. Human errors were the important issues in this study and need to be minimized by intensive training and improving skills before using the application.

6.2. Study limitation

In this study the method used to obtain energy and nutrient intake did not the usual method used by the participants. The participants might not be familiar to assess the dietary intakes though food images.

6.3. Recommendation for further study

Future studies should consider the crossover design to validate accuracy of the new version of the Thai FEL and Thai FBDG based NDPro application. The recommended design and workflow for the further study are shown in Figure 25 and Figure 26 and as follows.

1. Future development should make the new version of NDPro application simpler and provide the functions allowing users to save their records without performing dietary recall. The Documentation component could become the main component and the Dietary record component shift to the optional information.

2. The NDPro application should serve all of PC, Android, and iOS platforms. A web-based application and Google App Script communicating with Google Sheets in Google Drive may be the cheaper alternative options.

3. Future development should include a wide range of templates that could potentially meet the needs of dietitians, and allow users to create their own custom templates.

4. To compliance with the Personal Data Protection Act, B.E. 2562 (2019) for the consumer protection, the username and password, or PIN codes should be incorporated into the NDPro application. Barcode scanner for inserting HN may be applied.

5. Kotlin can be a substitute programing language for JAVA for preventing the crash in the new version of the NDPro application.

REFERENCES

1. Skipper, A., *Nutrition care process and model part I: the 2008 update.* Journal of the American Dietetic Association, 2008.

2. Rutishauser, I.H., *Dietary intake measurements.* Public health nutrition, 2005. **8**(7a): p. 1100-1107.

3. Alemayehu, A.A., Y. Abebe, and R.S. Gibson, *A 24-h recall does not provide a valid estimate of absolute nutrient intakes for rural women in southern Ethiopia.* Nutrition, 2011. **27**(9): p. 919-924.

4. Poslusna, K., et al., *Misreporting of energy and micronutrient intake estimated by food records and 24 hour recalls, control and adjustment methods in practice.* British Journal of Nutrition, 2009. **101**(S2): p. S73-S85.

5. Thompson, F.E. and A.F. Subar, *Dietary assessment methodology,* in *Nutrition in the Prevention and Treatment of Disease.* 2017, Elsevier. p. 5-48.

6. Biro, G., et al., *Selection of methodology to assess food intake.* European journal of clinical nutrition, 2002. **56**(2): p. S25-S32.

7. Byrd-Bredbenner, C. and J. Schwartz, *The effect of practical portion size measurement aids on the accuracy of portion size estimates made by young adults.* Journal of human nutrition and dietetics, 2004. **17**(4): p. 351-357.

8. Steyn, N.P., et al., *How well do adolescents determine portion sizes of foods and beverages?* Asia Pacific journal of clinical nutrition, 2006. **15**(1): p. 35.

9. Ervin, R.B. and H. Smiciklas-Wright, *Accuracy in estimating and recalling portion sizes of foods among elderly adults.* Nutrition Research, 2001. **21**(5): p. 703-713.

10. Samasut, R., *Thai food exchange list.* Thai J Parenter Enter Nutr, 2004. **15**: p. 33-45.

11. Nutrition Division Department of Health Ministry of Public Health, *Nutrition flag: Healthy eating for Thais.* 2001: Bangkok.

12. Sranacharoenpong, K., *The Development of Thai Food Based Dietary Guidance: Quantification of Food for Daily Consumption.* 1998: Mahidol University.

13. Thompson, F.E., et al., *Need for technological innovation in dietary assessment.*

Journal of the Academy of Nutrition and Dietetics, 2010. **110**(1): p. 48-51.

14. Handel, M.J., *mHealth (mobile health)-using apps for health and wellness.* Explore (New York, NY), 2011. **7**(4): p. 256.

15. Chen, J., et al., *Designing health apps to support dietetic professional practice and their patients: qualitative results from an international survey.* JMIR mHealth and uHealth, 2017. **5**(3): p. e40.

16. Chen, J. and M. Allman-Farinelli, *Impact of training and integration of apps into dietetic practice on dietitians' self-efficacy with using mobile health apps and patient satisfaction.* JMIR mHealth and uHealth, 2019. **7**(3): p. e12349.

17. Panit, J., *Using Dietary Assessment Scanning Calgulator to Decrease Phosphorus Intake in Patients with Chronic Kidney Disease.* 2017, Mahidol University.

18. Panthong, V., *Using Dietary Assessment Scanning Calculator to Decrease Protein Intake in Patients with Chronic Kidney Disease*, in *Mahidol University*. 2017.

19. Grodner, M., S. Escott-Stump, and S. Dorner, *Nutritional Foundations and Clinical Applications-E-Book: A Nursing Approach*. 2015: Elsevier Health Sciences.

20. American Heart Association. *Portion Size Versus Serving Size. Mar 20, 2015*. 2015; Available from: https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/nutrition-basics/portion-size-versus-serving-size.

21. Sirichakwal, P.P., K. Sranacharoenpong, and K. Tontisirin, *Food based dietary guidelines (FBDGs) development and promotion in Thailand.* Asia Pacific journal of clinical nutrition, 2011. **20**(3): p. 477.

22. Godwin, S.L., E. Chambers Iv, and L. Cleveland, *Accuracy of reporting dietary intake using various portion-size aids in-person and via telephone.* Journal of the American Dietetic Association, 2004. **104**(4): p. 585-594.

23. Howat, P.M. and G. Church, *The use of photo imagery as a teaching tool.* Topics in Clinical Nutrition, 1995. **10**(2): p. 82-90.

24. Amougou, N., et al., *Development and validation of two food portion photograph books to assess dietary intake among adults and children in Central Africa.* British Journal of Nutrition, 2016. **115**(5): p. 895-902.

25. Vilela, S., et al., *Validation of a picture book to be used in a pan-European*

dietary survey. Public health nutrition, 2018. **21**(9): p. 1654-1663.

26. Naska, A., et al., *Evaluation of a digital food photography atlas used as portion size measurement aid in dietary surveys in Greece.* Public health nutrition, 2016. **19**(13): p. 2369-2376.

27. Whitney, E.N., S.R. Rolfes, and L.W. Turner, *Understanding Nutrition: Study Guide.* 2011: Wadsworth/Cengage Learning.

28. Ross, C., et al., *Modern Nutrition In Health and Disease, 2014.* 2014, Wolters Kluwer business, Lippincott Williams & Wilkins.

29. McRorie Jr, J.W., *Evidence-based approach to fiber supplements and clinically meaningful health benefits, part 2: what to look for and how to recommend an effective fiber therapy.* Nutrition today, 2015. **50**(2): p. 90.

30. Grodner, M., S.L. Roth, and B.C. Walkingshaw, *Nutritional Foundations and Clinical Applications-E-Book: A Nursing Approach.* 2013: Elsevier Health Sciences.

31. Dietary Guidelines Advisory Committee. (2015), *Dietary guidelines for Americans 2015-2020.* 2017: Skyhorse Publishing Inc.

32. Committees of Dietary reference intake for Thais, *Dietary reference intake for Thais 2020.* 2020: Nutrition Division Department of Health Ministry of Public Health,.

33. Health Department Ministry of Public Health, *Dietary Reference Intake for Thais.* 2003: Bangkok.

34. Burke, L., V. Deakin, and V. Deakin, *Clinical sports nutrition.* 2000: McGraw-Hill Beijing, Boston.

35. Inker, L.A., et al., *KDOQI US commentary on the 2012 KDIGO clinical practice guideline for the evaluation and management of CKD.* American Journal of Kidney Diseases, 2014. **63**(5): p. 713-735.

36. Kopple, J.D., *National kidney foundation K/DOQI clinical practice guidelines for nutrition in chronic renal failure.* American journal of kidney diseases, 2001. **37**(1): p. S66-S70.

37. Mahan, L.K. and J.L. Raymond, *Krause's Food & the Nutrition Care Process.* 2016: Elsevier.

38. Nestel, P.J., et al., *Relation of diet to cardiovascular disease risk factors in subjects with cardiovascular disease in Australia and New Zealand: analysis of the Long-Term Intervention with Pravastatin in Ischaemic Disease trial.* The American journal of clinical nutrition, 2005. **81**(6): p. 1322-1329.

39. Thomsen, C., et al., *Differential effects of saturated and monounsaturated fats on postprandial lipemia and glucagon-like peptide 1 responses in patients with type 2 diabetes.* The American journal of clinical nutrition, 2003. **77**(3): p. 605-611.

40. Feldman, E., et al., *Position paper on trans fatty acids.* American Journal of Clinical Nutrition, 1996. **63**(5): p. 663-670.

41. Kris-Etherton, P.M., *Trans-fats and coronary heart disease.* Critical reviews in food science and nutrition, 2010. **50**(S1): p. 29-30.

42. Franz, M., *Alcohol and diabetes. Part 2: its metabolism and guidelines for its occasional use.* Diabetes Spectrum, 1990. **3**(4): p. 211-216.

43. Thai FDA, *Thai Recommended Daily Intakes–Thai RDI.* 1998, Nonthaburi.

44. Ministry of Public Health, *Notification of the Ministry of Public Health (No. 182) B.E. 2541 (1998) Re : Nutrition Labelling.* 1998.

45. Ministry of Public Health, *Notification of the Ministry of Public Health (No. 392) B.E. 2561 (2018) Re : Nutrition Labelling.* 2018.

46. Wheeler, M.L., et al., *Choose your foods: exchange lists for diabetes, 2008: description and guidelines for use.* Journal of the American Dietetic Association, 2008. **108**(5): p. 883-888.

47. Mifflin, M.D., et al., *A new predictive equation for resting energy expenditure in healthy individuals.* The American journal of clinical nutrition, 1990. **51**(2): p. 241-247.

48. Nelson, K.M., et al., *Prediction of resting energy expenditure from fat-free mass and fat mass.* The American journal of clinical nutrition, 1992. **56**(5): p. 848-856.

49. Levine, J.A., *Nonexercise activity thermogenesis (NEAT): environment and biology.* American Journal of Physiology-Endocrinology and Metabolism, 2004. **286**(5): p. E675-E685.

50. Tentolouris, N., et al., *Diet-induced thermogenesis and substrate oxidation are*

not different between lean and obese women after two different isocaloric meals, one rich in protein and one rich in fat. Metabolism, 2008. **57**(3): p. 313-320.

51. Harris, J.A. and F.G. Benedict, *A biometric study of basal metabolism in man.* 1919: Carnegie institution of Washington.

52. Owen, O.E., et al., *A reappraisal of the caloric requirements of men.* The American journal of clinical nutrition, 1987. **46**(6): p. 875-885.

53. Owen, O.E., et al., *A reappraisal of caloric requirements in healthy women.* The American journal of clinical nutrition, 1986. **44**(1): p. 1-19.

54. Frankenfield, D.C., et al., *Validation of several established equations for resting metabolic rate in obese and nonobese people.* Journal of the American Dietetic Association, 2003. **103**(9): p. 1152-1159.

55. Barak, N., E. Wall-Alonso, and M.D. Sitrin, *Evaluation of stress factors and body weight adjustments currently used to estimate energy expenditure in hospitalized patients.* Journal of Parenteral and Enteral Nutrition, 2002. **26**(4): p. 231-238.

56. National Academy Press: Washington DC USA, *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids.* Vol. 5. 2005.

57. World Health Organization, *The Asia-Pacific perspective: redefining obesity and its treatment.* 2000.

58. WHO Expert Consultation, *Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies.* Lancet (London, England), 2004. **363**(9403): p. 157.

59. Schofield, W., *Predicting basal metabolic rate, new standards and review of previous work.* Human nutrition. Clinical nutrition, 1985. **39**: p. 5-41.

60. Ireton-Jones, C. and J.D. Jones, *Improved equations for predicting energy expenditure in patients: the Ireton-Jones equations.* Nutrition in Clinical Practice, 2002. **17**(1): p. 29-31.

61. SWINAMER, D.L., et al., *Predictive equation for assessing energy expenditure in*

mechanically ventilated critically ill patients. Critical care medicine, 1990. **18**(6): p. 657-661.

62. Frankenfield, D., J.S. Smith, and R.N. Cooney, *Validation of 2 approaches to predicting resting metabolic rate in critically ill patients.* Journal of Parenteral and Enteral Nutrition, 2004. **28**(4): p. 259-264.

63. Du Bois, D. and E.F. Du Bois, *A formula to estimate the approximate surface area if height and weight be known. 1916.* Nutrition (Burbank, Los Angeles County, Calif.), 1916. **5**(5): p. 303-11; discussion 312-3.

64. Mosteller, R.D., *Simplified calculation of body-surface area.* The New England journal of medicine, 1987. **317**(17): p. 1098.

65. Boyd, E., *The growth of the surface area of the human body.* The growth of the surface area of the human body, 1935.

66. National Statistical Office, *The 2017 Household Survey on the Use of Information and Communication Technology.* 2017: Ministry of Digital Economy and Society.

67. Mescoloto, S.B., S. Caivano, and S.M.A. Domene, *Evaluation of a mobile application for estimation of food intake.* Revista de Nutrição, 2017. **30**(1): p. 91-98.

68. Ahmed, M., et al., *Validation of a tablet application for assessing dietary intakes compared with the measured food intake/food waste method in military personnel consuming field rations.* Nutrients, 2017. **9**(3): p. 200.

69. Maringer, M., et al., *Food identification by barcode scanning in the Netherlands: a quality assessment of labelled food product databases underlying popular nutrition applications.* Public health nutrition, 2019. **22**(7): p. 1215-1222.

70. Torp, C.E., *Method of software validation.* Nordtest Report TR, 2003. **535**.

71. Charney, P. and A. Malone, *ADA pocket guide to nutrition assessment.* 2009: American Dietetic Association.

72. Judprasong, K., et al., *Thai Food Composition Tables.* 2015, Institute of Nutrition, Mahidol University, Bangkok, Thailand.

73. Bureau of Nutrition Department of Health Ministry of Public Health, *84 Menu of chili paste and vegetable for health.* 2019.

74. Nutrition Division Department of Health Ministry of Public Health, *Fatty acids composition and cholesterol in Thai foods*. 2002.

75. Nutrition Division Department of Health Ministry of Public Health, *Cholesterol and fatty acid compositions in Thai foods*. 2004.

76. Hamwi, G.J., *Therapy: changing dietary concepts.* Diabetes mellitus: diagnosis and treatment, 1964. **1**: p. 73-78.

77. Schrepp, M., A. Hinderks, and J. Thomaschewski, *Design and evaluation of a short version of the user experience questionnaire (UEQ-S).* International Journal of Interactive Multimedia and Artificial Intelligence, 4 (6), 103-108., 2017.

78. Ainaa Fatehah, A., et al., *Feasibility of reviewing digital food images for dietary assessment among nutrition professionals.* Nutrients, 2018. **10**(8): p. 984.

79. Institute of Nutrition Mahidol University, *Nutrients calculation software: INMUCAL-Nutrients V.4.0.* 2018.

80. Bureau of Nutrition Department of Health Ministry of Public Health, *Food Composition Table of Thai Foods*. 2018.

81. National Bureau of Agricultural Commodity and Food Standards of Ministry of Agriculture and Cooperatives, *Thai agricultural standard TAS 6702-2010 Hen Egg*. 2010.

82. National Statistical Office. *Number of Population from Registration by Age, Sex and Province: 2020*. 2020 [cited 2021 18th May 2021]; Available from: http://statbbi.nso.go.th/staticreport/page/sector/en/01.aspx.

83. Supiya Charoensiriwath, C.T., Pongsak Tiyanunti, Suketiong pupat, Parut Bunporn, Apattha phitong, Jantima Jansaksri, *SizeThailand project.*

84. Heimbürger, O., et al., *A quantitative description of solute and fluid transport during peritoneal dialysis.* Kidney international, 1992. **41**(5): p. 1320-1332.

85. Chen, J., et al., *The use of smartphone health apps and other mobile h ealth (mHealth) technologies in dietetic practice: a three country study.* Journal of Human Nutrition and Dietetics, 2017. **30**(4): p. 439-452.

86. Karduck, J. and K. Chapman-Novakofski, *Results of the clinician apps survey, how clinicians working with patients with diabetes and obesity use mobile health apps.* Journal of nutrition education and behavior, 2018. **50**(1): p. 62-69. e1.

87. Vasiloglou, M.F., et al., *What healthcare professionals think of "nutrition & diet" apps: an international survey.* Nutrients, 2020. **12**(8): p. 2214.

88. Joint, F. and W.E. Consultation, *Fats and fatty acids in human nutrition.* Report of an expert consultation, 2008: p. 10-14.

89. Beth Burke, K.L.D., Annie Latimer, Patricia Mersereau, Kevin Moran, Joe Mulinare, Christine Prue, Jennifer Steen, Margaret Watkins, *Preventing Neural Tube Birth Defects: A Prevention Model and Resource Guide.* 2009.

90. Japur, C. and R. Diez-Garcia, *Food energy content influences food portion size estimation by nutrition students.* Journal of human nutrition and dietetics, 2010. **23**(3): p. 272-276.

91. Zhang, L., et al., *A systematic review and meta-analysis of validation studies performed on dietary record apps.* Advances in Nutrition, 2021. **12**(6): p. 2321-2332.

92. Bolland, J.E. and R. Joan Yuhas Ward PhD, *Improved accuracy of estimating food quantities up to 4 weeks after training.* Journal of the American Dietetic Association, 1990. **90**(10): p. 1402-1404.

93. Arroyo, M., et al., *A short training program improves the accuracy of portion-size estimates in future dietitians.* Archivos latinoamericanos de nutricion, 2007. **57**(2): p. 163-167.

94. Wetherill, M.S., K.C. White, and C. Rivera, *Food insecurity and the nutrition care process: practical applications for dietetics practitioners.* Journal of the Academy of Nutrition and Dietetics, 2018. **118**(12): p. 2223.

95. Google Apps Script. *Web Apps*. 2022 [cited 6 December 2022; Available from: https://developers.google.com/apps-script/guides/web.

96. *Royal Thai Government Gazette. The Personal Data Protection Act B.E. 2562 (2019).* 2019 [cited 2022 1 December]; Available from: http://www.ratchakitcha.soc.go.th/DATA/PDF/2562/A/069/T_0052.PDF.

97. Stack Overflow. *Stack overflow developer survey (2021).* 2021 3 December 2022]; Available from: https://insights.stackoverflow.com/survey/2021#developer-profile-demographics.

98.   Android Developers. *Android's Kotlin-first approach*. 2022 3 December 2022]; Available from: https://developer.android.com/kotlin/first.

99.   Omer Strulovich. *From zero to 10 million lines of Kotlin*. 2022 4 December 2022]; Available from: https://engineering.fb.com/2022/10/24/android/android-java-kotlin-migration/.

APPENDIX A

Documentary proof of the research ethics review committee's approval for research involving humans, Chulalongkorn University

งานวิจัยและนวัตกรรม สศ
จุฬาลงกรณ์มหาวิทยาลัย
วันที่: 27 ก.ค. 2564 เวลา 10:47
เลขรับที่: 01030

คณะสหเวชศาสตร์
จุฬาลงกรณ์มหาวิทยาลัย
เลขรับที่: 4943
22 ก.ค. 2564 เวลา 17:36

AF01-06 (TH)

คณะสหเวชศาสตร์
จุฬาลงกรณ์มหาวิทยาลัย
เลขรับที่: 5008
27 ก.ค. 2564 เวลา 10:42

บันทึกข้อความ

ส่วนงาน ภาควิชาโภชนาการและการกำหนดอาหาร คณะสหเวชศาสตร์ **โทรศัพท์** 02-218-1116

ที่ ..อว.64.21.54/299/2564   **วันที่** 20 กรกฎาคม พ.ศ. 2564

เรื่อง   ขอเสนอโครงการวิจัยเพื่อรับการพิจารณาจริยธรรมการวิจัย

เรียน   ประธานกรรมการพิจารณาจริยธรรมการวิจัยในคน กลุ่มสหสถาบัน ชุดที่ 1 จุฬาลงกรณ์มหาวิทยาลัย

สิ่งที่ส่งมาด้วย   1. บันทึกข้อความและใบคำขอรับการพิจารณาจริยธรรมการวิจัย จำนวน 7 ชุด
                   2. โครงการวิจัยฉบับสมบูรณ์ และเอกสารอื่น ๆ ที่เกี่ยวข้อง จำนวน 7 ชุด

ด้วย ข้าพเจ้า ธนะศักดิ์ ตันติชัยยกุล นิสิตบัณฑิตศึกษา หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชา อาหารและโภชนาการ (หลักสูตรนานาชาติ) ภาควิชาโภชนาการและการกำหนดอาหาร คณะสหเวชศาสตร์ ขอเสนอ โครงการวิจัย เรื่อง การพัฒนาและทดสอบการใช้งานแอพพลิเคชั่นทางโภชนาการสำหรับการส่งเสริมการปฏิบัติการ กำหนดอาหารวิชาชีพ (Development and validation of smartphone nutrition application for supporting dietetic professional practice) เพื่อเสนอขอรับการพิจารณาจริยธรรมการวิจัย โครงการวิจัยนี้ ได้ผ่านการ พิจารณา Relevant & Scientific Merit โดยกลไกที่เกี่ยวข้องระดับคณะ/สถาบัน/หน่วยงานที่เกี่ยวข้องแล้ว

จึงเรียนมาเพื่อโปรดพิจารณาดำเนินการต่อไปด้วย19

....
(นายธนะศักดิ์ ตันติชัยยกุล)
นิสิตบัณฑิตศึกษา
ผู้วิจัยหลัก
วันที่ ...20.../...ก.ค...../...2564...

....
(ผศ.ดร.ทิพยเนตร อริยปิติพันธ์)
อาจารย์ที่ปรึกษาวิทยานิพนธ์

วันที่ ...20.../...ก.ค..../...2564........

....
(ผศ.ดร.ทิพยเนตร อริยปิติพันธ์)
หัวหน้าภาควิชาโภชนาการและการกำหนดอาหาร
วันที่ ...20.../...ก.ค..../...2564........

รับรองคำขอรับการพิจารณาจริยธรรมการวิจัย

วันที่····29·ก.ค.··2564····เวลา····12:34
(รศ.ดร.ปาลนี อัมรานนท์)
คณบดี
วันที่............./............./..............

<center>ใบคำขอรับการพิจารณาจริยธรรมการวิจัย</center>

1. ชื่อโครงการ (ไทย) การพัฒนาและทดสอบการใช้งานแอพพลิเคชั่นทางโภชนาการสำหรับการส่งเสริมการ
ปฏิบัติการกำหนดอาหารวิชาชีพ
ชื่อโครงการ (อังกฤษ) Development and validation of smartphone nutrition application for
supporting dietetic professional practice

2. ชื่อผู้วิจัยหลัก นายธนะศักดิ์ ตันติชัยกุล ตำแหน่ง นิสิตระดับบัณฑิตศึกษา หลักสูตรวิทยาศาสตรมหาบัณฑิต
สาขาวิชาอาหารและโภชนาการ (หลักสูตรนานาชาติ)
หน่วยงาน/สถาบันที่สังกัด ภาควิชาโภชนาการและการกำหนดอาหาร คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
โทรศัพท์ 02-218-1065 มือถือ 088-193-5854 E-mail Address : au_onetwocall@hotmail.com

3. ในการดำเนินการวิจัยโครงการนี้ ท่านมีผลประโยชน์ทับซ้อน/ความขัดแย้งกับผู้ใด (Conflict of interest)
☑ ไม่มี ☐ มี โปรดระบุ.................................

4. มีโครงการวิจัยที่กำลังดำเนินการอยู่ ☑ ไม่มี ☐ มี โปรดระบุจำนวน.....................................เรื่อง

5. กลุ่มประชากร/กลุ่มตัวอย่างที่ศึกษา

5.1 **กลุ่มผู้ด้อยโอกาส/เปราะบาง**

( ) ผู้ป่วยโรคจิต ( ) ผู้ต้องขัง/ถูกควบคุม
( ) เด็กอายุต่ำกว่า 18 ปี ( ) สตรีมีครรภ์
( ) ผู้สูงอายุที่มีความจำบกพร่อง ( ) ผู้สมองเสื่อม
( ) ผู้พิการ ( ) ชนกลุ่มน้อย/ต่างศาสนา/เชื้อชาติ
( ) ผู้มีปัญญาอ่อน ( ) ผู้อพยพ
( ) ผู้รักเพศเดียวกัน ( ) แรงงานข้ามชาติ
( ) ผู้ติดสารเสพติด ( ) ทหารเกณฑ์
( ) ผู้ป่วยโรค (ระบุ)........... ( ) ผู้ขายบริการทางเพศ
( ) อื่นๆ ....

5.2 **กลุ่มไม่เปราะบาง ระบุ** <u>นักกำหนดอาหารที่ขึ้นทะเบียนและรับใบอนุญาตเป็นผู้ประกอบโรคศิลปะ</u>
<u>สาขาการกำหนดอาหารและนักโภชนาการที่มีการประเมินอาหารที่บริโภค</u>

6. สถานที่เก็บข้อมูล จำนวน ....1........ แห่ง ระบุ .... คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย............
ระบุสถานที่เก็บข้อมูลที่มีคณะกรรมการพิจารณาจริยธรรมของหน่วยงาน ..... ไม่มี ....
....

7. แหล่งทุนวิจัย ระบุชื่อ .... ไม่มี ....
....
☐ อยู่ในระหว่างการพิจารณา ☐ ได้รับอนุมัติแล้ว
จำนวน/ทุนที่ได้รับ ..... ไม่มี .... บาท

8. โครงร่างวิทยานิพนธ์/โครงการวิจัยได้ผ่านการพิจารณาของคณะกรรมการ (โปรดระบุ) ....
.........คณะกรรมการบริหารคณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย การประชุมครั้งที่ 27/2561.................

<center>V4.0/2563_{2/4}</center>

AF01-06 (TH)

เมื่อวันที่ ....19 กรกฎาคม 2562...

9. หน่วยงาน/สถาบันอื่นในการทำวิจัย (ทำวิจัยร่วมกันหลายแห่ง) ....-.......................................

10. แบบฟอร์มตรวจสอบความครบถ้วนของเอกสาร สิ่งที่ส่งมาด้วย	นักวิจัย ตรวจสอบ	เจ้าหน้าที่ ☒ เอกสารที่ขาด
10.1 บันทึกข้อความและใบคำขอรับการพิจารณาจริยธรรมการวิจัย (AF 01-06 โครงการวิจัย/วิทยานิพนธ์)	☑	☐
10.2 เอกสารข้อมูลสำหรับผู้มีส่วนร่วมในการวิจัยและหนังสือแสดงความยินยอม เข้าร่วมงานวิจัย (หมายเหตุ: ส่งฉบับภาษาท้องถิ่น/ภาษาอื่นที่เกี่ยวข้อง (ที่ไม่ใช่ ภาษาไทย) ตามกลุ่มผู้มีส่วนร่วมในการวิจัยด้วย)	☑	☐
10.3 หนังสือขออนุมัติยกเว้นเอกสารข้อมูลฯ หรือยกเว้นการลงนามฯ (AF02-06)	☐	☐
10.4 แผนการดำเนินงานตลอดโครงการวิจัย (ตารางกำหนดช่วงระยะเวลากิจกรรมการวิจัยทุกขั้นตอนระบุเดือนและปี รวมทั้ง ช่วงเวลาการเสนอขอรับการพิจารณาจริยธรรมการวิจัย)	☑	☐
10.5 ประวัติและคุณสมบัติ ซึ่งแสดงว่ามีความสามารถดำเนินการวิจัยนี้ได้	☑	☐
10.6 โครงการวิจัย (Research Proposal) ฉบับสมบูรณ์ (ถ่ายเอกสารหน้า-หลัง)	☑	☐
10.7 งบประมาณที่ใช้ทำงานวิจัยหรืองบประมาณที่ได้รับ	☑	☐
10.8 เครื่องมือวิจัย/โปรแกรมดำเนินการทดลอง/คู่มือ ที่ผ่านการพิจารณา จากผู้ทรงคุณวุฒิแล้ว 1) แบบสอบถามพฤติกรรมและทัศนคติของนักกำหนดอาหารต่อการบันทึกอาหาร การประมวลผลและการวิเคราะห์ผลพลังงานและสารอาหารจากข้อมูลการ ประเมินอาหารที่บริโภคในกระบวนการให้คำปรึกษาด้านโภชนาการและการ กำหนดอาหาร (2) แบบประเมินความคิดเห็นของนักกำหนดอาหารต่อการใช้งานโปรแกรม ประยุกต์ NDPro	☑	☐
10.9 เอกสารอื่น ๆ เป็นต้นว่า ใบประชาสัมพันธ์ แผ่นพับความรู้ ระบุ 10.9.1 แผ่นพับประชาสัมพันธ์โครงการ 10.9.2 ใบสมัครเข้าร่วมโครงการ 10.9.3 แผนภูมิแสดงการเข้าร่วมวิจัย 10.9.4 ND-01-64 คำชี้แจงการใช้แบบบันทึกการประเมินอาหารที่บริโภคและการ ประมวลผลพลังงานและสารอาหาร 10.9.5 ND-02-64 แบบบันทึกการประเมินอาหารตามหมวดอาหารในตาราง รายการอาหารแลกเปลี่ยนไทยและธงโภชนาการ 10.9.6 ND-03-64 แบบบันทึกการกำหนดพลังงานและสารอาหารให้พลังงานตาม หมวดอาหารในตารางรายการอาหารแลกเปลี่ยนไทยและธงโภชนาการ 10.9.7 ND-04-64 แบบบันทึกปริมาณอาหารที่บริโภคและผลการประมวล พลังงานและสารอาหารตามหลักการของรายการอาหารแลกเปลี่ยนไทย	☑	☐

AF01-06 (TH)

10.9.8 ND-05-64 แบบบันทึกปริมาณอาหารที่บริโภคและผลการประมวล		
พลังงานและสารอาหารตามหลักการของธงโภชนาการ		
10.9.9 ND-06-64 แบบบันทึกผลการประมวลพลังงานและสารอาหารที่ได้รับจาก		
อาหารที่บริโภคต่อวันด้วยโปรแกรมประยุกต์ NDPro		
		☐ เอกสารครบ

11. นำส่งเอกสาร 7 ชุดที่ สำนักงานคณะกรรมการฯ อาคารจามจุรี 1 ชั้น 2 และส่งไฟล์ที่เสนอพิจารณาครั้งแรก

(ข้อ 10.1-10.9) ไปยัง Email: ser@chula.ac.th

12. ข้าพเจ้ารับทราบและยินดีปฏิบัติตามเงื่อนไขของคณะกรรมการฯ ดังนี้

    12.1 เป็นการผิดจริยธรรม หากดำเนินการเก็บข้อมูลกับผู้มีส่วนร่วมในการวิจัยก่อนได้รับการอนุมัติจาก
คณะกรรมการพิจารณาจริยธรรมการวิจัยฯ

    12.2 หากใบรับรองโครงการวิจัยหมดอายุ การดำเนินการวิจัยต้องยุติการเก็บข้อมูล เมื่อต้องการต่ออายุต้อง
ขออนุมัติใหม่ล่วงหน้า ไม่ต่ำกว่า 1 เดือน พร้อมส่งรายงานความก้าวหน้าการวิจัย

    12.3 ต้องดำเนินการวิจัยตามที่ระบุไว้ในโครงการวิจัยอย่างเคร่งครัด

    12.4 ใช้เอกสารข้อมูลสำหรับผู้มีส่วนร่วมในการวิจัยและหนังสือแสดงความยินยอมของผู้มีส่วนร่วมในการวิจัย
เครื่องมือที่ใช้ในการวิจัย และเอกสารเชิญเข้าร่วมวิจัย (ถ้ามี) **เฉพาะที่ประทับตราคณะกรรมการฯ เท่านั้น**

    12.5 หากเกิดเหตุการณ์ไม่พึงประสงค์ร้ายแรงในสถานที่เก็บข้อมูลที่ขออนุมัติจากคณะกรรมการ ฯ ต้องรายงาน
คณะกรรมการภายใน 5 วันทำการ

    12.6 หากมีการเปลี่ยนแปลงการดำเนินการวิจัย ให้ส่งคณะกรรมการฯ พิจารณารับรองก่อนดำเนินการ

    12.7 หากยุติโครงการวิจัยก่อนกำหนดต้องแจ้งคณะกรรมการฯ ภายใน 2 สัปดาห์พร้อมคำอธิบาย

    12.8 **โครงการวิจัยไม่เกิน 1 ปี ส่งแบบรายงานสิ้นสุดโครงการวิจัย (AF 01-15) และบทคัดย่อผลการวิจัย**
ภายใน 30 วัน เมื่อโครงการวิจัยเสร็จสิ้น สำหรับโครงการวิจัยที่เป็นวิทยานิพนธ์ให้ส่งบทคัดย่อผลการวิจัย
ภายใน 30 วัน หลังจากส่งวิทยานิพนธ์ให้มหาวิทยาลัย หากไม่ส่งตามกำหนดจะถือว่าสิ้นสุดโครงการวิจัยนั้น

    12.9 โครงการวิจัยที่มีการดำเนินการหลายระยะ จะรับรองโครงการเป็นระยะ ๆ เมื่อดำเนินการวิจัยในระยะแรก
เสร็จสิ้นแล้ว ให้ดำเนินการส่งรายงานความก้าวหน้า พร้อมโครงการวิจัยและเอกสารที่เกี่ยวข้องในระยะถัดไป

13. ความประสงค์รับใบรับรอง

        ☐ ภาษาไทย   ☑ ภาษาอังกฤษ (Mr.Thanasak Tantichaiyakul)

....
(ผศ.ดร.ทิพยเนตร อริยปิติพันธ์)   (นายธนะศักดิ์ ตันติชัยกุล)
อาจารย์ที่ปรึกษาวิทยานิพนธ์   ผู้วิจัยหลัก
วันที่ ...20.../...ก.ค../...2564......   วันที่ ...20.../...ก.ค../...2564......

APPENDIX B

Information sheet and consent form (ND-01/64)

เอกสารข้อมูลสำหรับผู้มีส่วนร่วมในการวิจัยและหนังสือแสดงยินยอมเข้าร่วมการวิจัย

ชื่อโครงการวิจัย การพัฒนาและทดสอบการใช้งานแอพพลิเคชั่นทางโภชนาการสำหรับการส่งเสริม
การปฏิบัติการกำหนดอาหารวิชาชีพ

ผู้วิจัยหลัก นายธนะศักดิ์ ตันติชัยยกุล ตำแหน่ง นิสิตระดับบัณฑิตศึกษา หลักสูตรวิทยาศาสตร
มหาบัณฑิต สาขาวิชาอาหารและโภชนาการ (หลักสูตรนานาชาติ)

สถานที่ติดต่อผู้วิจัย อาคารจุฬาพัฒน์ 3 ชั้น 1 ภาควิชาโภชนาการและการกำหนดอาหาร
คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ถนนพระราม 1 เขตปทุมวัน
กทม. 10330

เบอร์โทรศัพท์ 088-193-5854 อีเมล์ au_onetwocall@hotmail.com

ผู้ร่วมวิจัย (อาจารย์ที่ปรึกษา)

1. ผศ.ดร. ทิพยเนตร อริยปิติพันธ์ (อาจารย์ที่ปรึกษาวิทยานิพนธ์หลัก)
อาคารจุฬาพัฒน์ 3 ชั้น 1 ภาควิชาโภชนาการและการกำหนดอาหาร
คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ถนนพระราม 1 เขตปทุมวัน กทม. 10330
เบอร์โทรศัพท์ 02-218-1099, 081-731-7076 อีเมล์ tipayanate@gmail.com

2. อาจารย์ ดร.ภาคภูมิ สมบูรณ์ (อาจารย์ที่ปรึกษาร่วม)
อาคาร 1 ชั้น 2 คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ถนนพระราม 1 เขตปทุม
วัน กทม. 10330
เบอร์โทรศัพท์ 081-968-0507 อีเมล์ Panpum.s@bu.ac.th

เรียน ผู้มีส่วนร่วมในการวิจัยทุกท่าน

ด้วยผู้วิจัยเล็งเห็นว่าท่านเป็นผู้ที่มีประสบการณ์และปฏิบัติงานด้านโภชนาการและการ
กำหนดอาหาร ความคิดเห็นขอท่านจะมีประโยชน์ต่อการพัฒนาโปรแกรมประยุกต์สำหรับการส่งเสริม
การปฏิบัติงานทางวิชาชีพการกำหนดอาหาร จึงขอเรียนเชิญท่านเข้าร่วมการวิจัย ก่อนตัดสินใจเข้า
ร่วมในการวิจัย โปรดทำความเข้าใจว่างานวิจัยนี้เกี่ยวข้องกับอะไรและทำเพราะเหตุใด กรุณาใช้เวลา
ในการอ่านข้อมูลต่อไปนี้อย่างรอบคอบ หากมีข้อความใดที่อ่านแล้วไม่เข้าใจหรือไม่ชัดเจน โปรด
สอบถามเพิ่มเติมกับผู้วิจัยได้ตลอดเวลา ผู้วิจัยจะอธิบายจนกว่าจะเข้าใจอย่างชัดเจน

ข้อมูลเกี่ยวกับโครงการวิจัย

1. เหตุผลความเป็นมา

ความก้าวหน้าของเทคโนโลยียุคปัจจุบันส่งผลให้การทำงานด้านการประมวลผลบนอุปกรณ์สมาร์ทโฟนเป็นไปได้อย่างรวดเร็ว มีการพัฒนาโปรแกรมประยุกต์ (application) ต่างๆ มาอำนวยความสะดวกในการทำงานในวิชาชีพทางการแพทย์ให้รองรับการบริการที่รวดเร็วและถูกต้องยิ่งขึ้น ในประเทศไทยยังมีโปรแกรมประยุกต์บนอุปกรณ์สมาร์ทโฟนที่พัฒนาขึ้นเพื่อส่งเสริมการปฏิบัติงานของนักกำหนดอาหารวิชาชีพค่อนข้างจำกัด

การให้คำแนะนำด้านโภชนาการและการกำหนดอาหารเป็นบทบาทหน้าที่หลักของนักกำหนดอาหารวิชาชีพ ประกอบด้วยการประเมินการบริโภคอาหารที่ได้รับต่อวันและกำหนดความต้องการพลังงานและสารอาหารให้เหมาะสมกับช่วงวัย เพศ สภาวะของร่างกายและโรคประจำตัวของแต่ละคน เพื่อให้สามารถส่งเสริมสุขภาพ ป้องกัน บำบัดและควบคุมโรคที่เกี่ยวข้องกับโรคโภชนาการได้อย่างมีประสิทธิผล การประเมินการบริโภคอาหารแบบรวดเร็วในประเทศไทยปัจจุบันนิยมใช้ข้อมูลจากรายการอาหารแลกเปลี่ยนไทยหรือธงโภชนาการ อย่างไรก็ตาม การประเมินดังกล่าวมีข้อจำกัดในการจัดชนิดและปริมาณอาหารแต่ละชนิดให้ถูกต้องแม่นยำ ต้องใช้เวลาในการคำนวณ และไม่มีข้อมูลจุลโภชนสาร (วิตามินและเกลือแร่)

งานวิจัยนี้เป็นการพัฒนาโปรแกรมเพื่อช่วยประเมินการบริโภคอาหารที่ได้รับต่อวันและกำหนดความต้องการพลังงานและสารอาหารในแต่ละบุคคล เป็นโปรแกรมบนฐานปฏิบัติการ Android สามารถประยุกต์ใช้ได้ทั้งบนอุปกรณ์สมาร์ทโฟนและแทปเล็ต ประกอบไปด้วยส่วนต่างๆ (function) ที่สามารถประเมินการบริโภคอาหารที่ได้รับต่อวันจากฐานข้อมูลที่อ้างอิงรายการอาหารแลกเปลี่ยน ธงโภชนาการ ผลิตภัณฑ์อาหารที่จำหน่ายในท้องตลาดทั่วไปและอาหารทางการแพทย์ สามารถกำหนดความต้องการพลังงานและสารอาหารโดยอ้างอิงข้อมูลทางวิชาการที่นักกำหนดมีการใช้งานในปัจจุบัน ครอบคลุมพลังงาน สารอาหารให้พลังงาน วิตามินและเกลือแร่ เพื่อให้เกิดประโยชน์ในการบันทึกและประมวลผลพลังงานและสารอาหารจากการประเมินอาหารที่บริโภค รวมทั้งการจัดเก็บและติดตามพฤติกรรมการบริโภคจากการให้คำปรึกษาทางโภชนาการ

2. การให้ข้อมูลและขอความยินยอม

เอกสารข้อมูลสำหรับผู้มีส่วนร่วมในการวิจัยและหนังสือแสดงยินยอมเข้าร่วมการวิจัยฉบับนี้ นายธนะศักดิ์ ตันติชัยยกุล (ผู้วิจัยหลัก) เป็นผู้ให้รายละเอียดแก่ท่าน ผู้วิจัยจะติดต่อประสานงานเพื่ออบรม เก็บข้อมูลและตอบข้อซักถาม การตัดสินใจเข้าร่วมงานวิจัยนี้ ท่านมีเวลาอย่างเพียงพอในการตัดสินใจโดยอิสระ หากตัดสินใจเข้าร่วมงานวิจัยแล้ว ขอให้ท่านลงนามในหนังสือแสดงความยินยอมข้างท้าย

3. รายละเอียด คุณสมบัติและการคัดกรองผู้เข้าร่วมการวิจัยตามเกณฑ์การคัดเข้า-คัดออก

ผู้เข้าร่วมการวิจัยเป็นนักกำหนดอาหารวิชาชีพหรือนักโภชนาการ เพศชายและเพศหญิง จำนวน 76 คน

<u>เกณฑ์การคัดเข้า</u>

1) เป็นนักกำหนดอาหารวิชาชีพที่ขึ้นทะเบียนและรับใบอนุญาตเป็นผู้ประกอบโรคศิลปะสาขาการกำหนดอาหารของกองประกอบโรคศิลปะ กระทรวงสาธารณสุข หรือนักกำหนดอาหารวิชาชีพที่สอบผ่านการรับรองเป็นนักกำหนดอาหารวิชาชีพ (Certifies Dietitian of Thailand; CDT) ของสมาคมนักกำหนดอาหารแห่งประเทศไทย

2) มีประสบการณ์การให้คำปรึกษาทางโภชนาการ การประเมินและประมวลผลอาหารที่บริโภคในสถานพยาบาล มากกว่า 1 ปี

<u>เกณฑ์การคัดออก</u>

1) ประกอบอาชีพที่ไม่มีการใช้กระบวนการให้คำปรึกษาทางโภชนาการ

2) ไม่สามารถใช้อุปกรณ์สมาร์ทโฟนหรือแทปเล็ตได้ไม่ว่าจากความบกพร่องทางร่างกายหรือขาดทักษะการใช้งาน

3) การมองเห็นผิดปกติ ยกเว้น สายตาสั้น สายตายาว สายตาเอียง ที่มีการใส่แว่นตาแก้ไขผิดปกติแล้ว

4) มีโรคที่เกี่ยวข้องกับสมองและระบบประสาทที่มีผลต่อความจำ การตัดสินใจและการคิดคำนวณ

5) ไม่สามารถเข้าร่วมกิจกรรมได้ครบทั้ง 4 ครั้ง

<u>วิธีการได้มาและการเข้าถึงผู้มีส่วนร่วมในการวิจัย</u>

1) ผู้วิจัยจะติดต่อฝ่ายโภชนาการของโรงพยาบาลในภาครัฐและเอกชน จำนวน 40 แห่ง ในเขตกรุงเทพมหานครและปริมณฑลทางไปรษณีย์และอีเมล์ เพื่อเชิญชวนผู้ที่มีคุณสมบัติจากโรงพยาบาลที่สุ่มเลือกเข้าร่วมการวิจัย ผู้วิจัยแนบเอกสารประชาสัมพันธ์รับสมัครผู้ร่วมวิจัย จำนวน 1 ฉบับ, เอกสารข้อมูลสำหรับผู้มีส่วนร่วมในการวิจัย จำนวน 1 ฉบับ และแบบคัดกรองอาสาสมัครเข้าร่วมโครงการ จำนวน 5 ฉบับ กรณีส่งทางไปรษณีย์ ผู้เข้าร่วมวิจัยจะได้รับซองเอกสารติดแสตมป์ที่จ่าหน้าส่งกลับให้ผู้วิจัย หรือสมัครออนไลน์ด้วยวิธีการสแกน QR code บนเอกสารประชาสัมพันธ์รับสมัครผู้ร่วมวิจัย จะมีการติดตามการสมัครทางโทรศัพท์ร่วมด้วย

2) ผู้วิจัยจะแจ้งตอบรับให้ผู้สมัครเข้าร่วมการวิจัยทราบทางอีเมล และจัดทำเอกสารขออนุญาตทำวิจัยส่งให้กับหัวหน้าองค์กร/หน่วยงานของผู้เข้าร่วมวิจัย

4. กิจกรรมในส่วนที่ผู้มีส่วนร่วมในการวิจัยเกี่ยวข้อง

4.1 ผู้วิจัยจะติดต่อผู้เข้าร่วมวิจัยเพื่อเข้าไปส่งมอบหนังสือแสดงความยินยอม, เอกสารข้อมูล สำหรับผู้มีส่วนร่วมในงานวิจัย, แทปเล็ตที่ติดตั้งโปรแกรมประยุกต์ NDPro กรณีที่แทปเล็ตที่ ให้ผู้เข้าร่วมวิจัยยืมไปเกิดความเสียหายขึ้นระหว่างการวิจัย ผู้เข้าร่วมวิจัยไม่จำเป็นต้อง รับผิดชอบต่อความเสียหายที่เกิดขึ้น อย่างไรก็ตาม ขอให้ผู้เข้าร่วมวิจัยใช้แทปเล็ตที่ได้รับด้วย ความระมัดระวัง

4.2 หลังจากผู้เข้าร่วมการวิจัยตัดสินใจเข้าร่วมการวิจัยและได้รับการคัดกรองแล้วว่ามีคุณสมบัติ เหมาะสม ผู้วิจัยจะขอให้ผู้เข้าร่วมวิจัยลงนามในหนังสือแสดงความยินยอมข้างท้าย

4.3 ผู้วิจัยจะส่งลิงค์ Google form ให้ผู้เข้าร่วมวิจัยสำหรับเข้าถึง "แบบสอบถามพฤติกรรมและ ทัศนคติของนักกำหนดอาหารต่อการบันทึกอาหาร การประมวลผลและการวิเคราะห์ผล พลังงานและสารอาหารจากข้อมูลการประเมินอาหารที่บริโภคในกระบวนการให้คำปรึกษา ด้านโภชนาการ" ทางอีเมล์หรือไลน์ตามแต่ตกลงกัน ผู้เข้าร่วมวิจัยทำแบบสอบถามออนไลน์ ด้วยตนเองและตอบคำถามตามสิ่งที่ได้ปฏิบัติจริงในงานประจำ

แบบสอบถามชุดนี้ไม่มีการให้ระบุชื่อผู้ตอบแบบสอบถาม ประกอบด้วยคำถาม 3 ส่วน ส่วนที่ 1 ข้อมูลทั่วไป (10 ข้อ) ส่วนที่ 2 พฤติกรรมการบันทึกอาหาร การประมวลผล และการวิเคราะห์ผลเพื่อนำไปใช้ในการให้คำปรึกษาด้านโภชนาการและการกำหนดอาหาร (15 ข้อ) ส่วนที่ 3 ทัศนคติต่อการบันทึกอาหาร การประมวลและการวิเคราะห์ผลเพื่อนำไปใช้ ในการให้คำปรึกษาด้านโภชนาการและการกำหนดอาหาร (10 ข้อ) ใช้เวลาในการตอบ แบบสอบถามประมาณ 15 นาที

4.4 ผู้วิจัยจะติดต่อผู้เข้าร่วมวิจัยท่านเพื่อนัดวันอบรม   ฝึกทักษะและประเมินประสิทธิภาพของ โปรแกรมประยุกต์ NDPro บนอุปกรณ์แทปเล็ตในการบันทึกอาหาร ประมวลและวิเคราะห์ ผลพลังงานและสารอาหารจากอาหารที่บริโภคแบบรวดเร็ว

4.5 การประเมินประสิทธิภาพของโปรแกรมประยุกต์ NDPro ในการบันทึกอาหาร ประมวลและ วิเคราะห์ผลพลังงานและสารอาหารจากอาหารที่บริโภคแบบรวดเร็ว การประเมินจะทำการ ทดสอบตัวต่อตัวระหว่างผู้ประเมินกับผู้วิจัย โดยผู้วิจัยจะทำหน้าที่กำกับควบคุมขั้นตอนตอบ ข้อซักถามเกี่ยวกับการประเมิน การดำเนินการใช้เวลาทั้งสิ้น 4 วัน ดังนี้

4.5.1 **วันที่ 1 การสอนและฝึกทักษะการใช้โปรแกรมประยุกต์ NDPro** (คาดว่าใช้เวลาไม่ เกิน 2 ชั่วโมง)

4.5.1.1 ผู้วิจัยจะเตรียมคู่มือการใช้งานส่วนต่างๆ ในโปรแกรมประยุกต์ NDPro (แบบย่อ ที่ใช้งานง่าย) และส่งให้ผู้เข้าร่วมวิจัยทางอีเมล์หรือไลน์ก่อนเริ่มการอบรม

4.5.1.2 ผู้วิจัยให้คำแนะนำการใช้งานส่วนต่างๆ ในโปรแกรมที่แสดงบนหน้าจอทั้งหมด
อย่างเป็นขั้นตอน จนผู้เข้าร่วมวิจัยสามารถใช้งานโปรแกรมประยุกต์ NDPro ได้
อย่างถูกต้อง รวมทั้งตอบข้อซักถามการใช้งาน (ใช้เวลา 1 ชั่วโมง)

4.5.1.3 ผู้เข้าร่วมวิจัยฝึกทักษะใช้งานส่วนต่างๆ ของโปรแกรมที่แสดงบนหน้าจอทั้งหมด
มีผู้วิจัยให้คำปรึกษา (ใช้เวลา 1 ชั่วโมง) และฝึกทักษะใช้งานโปรแกรมด้วย
ตนเอง 1-2 วันก่อนทำการเก็บข้อมูล

4.5.2 **วันที่ 2 การประเมินประสิทธิภาพของโปรแกรมประยุกต์ NDPro ครั้งที่ 1** (คาดว่า
ใช้เวลาไม่เกิน 1 ชั่วโมง)

4.5.2.1 ผู้วิจัยอธิบายขั้นตอนการใช้โปรแกรมประยุกต์ NDProและเปิดโอกาสให้ซักถาม
จนผู้ร่วมวิจัยเข้าใจดีแล้ว จึงเริ่มประเมินประสิทธิภาพของโปรแกรม NDPro ตาม
ขั้นตอนในเอกสารที่ท่านได้รับ

4.5.2.2 ผู้วิจัยจะเริ่มเปิดฟังก์ชั่นนาฬิกาจับเวลาจากแอพพลิเคชั่น "นาฬิกา" จาก
อุปกรณ์ iPhone 13 สำหรับให้ผู้ประเมินจดบันทึกเวลาในแต่ละขั้นตอน

4.5.2.3 ผู้เข้าร่วมวิจัยประเมินประสิทธิภาพของโปรแกรมประยุกต์ NDPro โดยการ
ประเมินอาหารที่บริโภคจากรูปภาพอาหาร 4 มื้อ (ชุดที่ 1) และประมวลผลโดย
การประเมินด้วยตนเองและโดยการใช้โปรแกรมประยุกต์ NDPro ปฏิบัติตาม
ขั้นตอน 5 ขั้นตอน ที่ระบุในเอกสาร ND-01-64 (คาดว่าไม่เกิน 1 ชั่วโมง เวลาที่
ใช้ขึ้นกับผู้เข้าร่วมวิจัยแต่ละราย หากการจับเวลาคลาดเคลื่อน จะมีผลกระทบต่อ
การวิเคราะห์ข้อมูล)

4.5.2.4 การประเมินจะเสร็จสิ้นเมื่อผู้ประเมินกรอกผลลัพธ์ในเอกสาร ND-02-64 ถึง
ND-06-64 เสร็จ

4.5.3 **วันที่ 3 การประเมินประสิทธิภาพของโปรแกรมประยุกต์ NDPro ครั้งที่ 2** (เวลาที่
ใช้ขึ้นกับผู้เข้าร่วมวิจัยแต่ละราย คาดว่าไม่เกิน 1 ชั่วโมง)

4.5.3.1 ผู้วิจัยจะเริ่มเปิดฟังก์ชั่นนาฬิกาจับเวลาจากแอพพลิเคชั่น "นาฬิกา" จาก
อุปกรณ์ iPhone 13 สำหรับให้ผู้ประเมินจดบันทึกเวลาในแต่ละขั้นตอน

4.5.3.2 ผู้เข้าร่วมวิจัยเริ่มประเมินประสิทธิภาพของโปรแกรมประยุกต์ NDPro ครั้งที่ 2
ตามขั้นตอนตามที่ระบุในเอกสาร ND-01-64

4.5.3.3 การประเมินจะเสร็จสิ้นเมื่อผู้ประเมินกรอกผลลัพธ์ในเอกสาร ND-02-64 ถึง
ND-06-64

4.5.4 **วันที่ 4 การประเมินประสิทธิภาพของโปรแกรมประยุกต์ NDPro ครั้งที่ 3 และประเมินความคิดเห็นต่อการใช้งานโปรแกรมประยุกต์ NDPro** (เวลาที่ใช้ขึ้นกับผู้เข้าร่วมวิจัยแต่ละราย คาดว่าไม่เกิน 1 ชั่วโมง)

4.5.4.1 ผู้วิจัยจะเริ่มเปิดฟังก์ชั่นนาฬิกาจับเวลาจากแอพพลิเคชั่น "นาฬิกา" จากอุปกรณ์ iPhone 13 สำหรับให้ผู้ประเมินจดบันทึกเวลาในแต่ละขั้นตอน

4.5.4.2 ผู้เข้าร่วมวิจัยเริ่มประเมินประสิทธิภาพของโปรแกรมประยุกต์ NDPro ครั้งที่ 3 ตามขั้นตอนตามที่ระบุในเอกสาร ND-01-64

4.5.4.3 การประเมินจะเสร็จสิ้นเมื่อผู้ประเมินกรอกผลลัพธ์ในเอกสาร ND-02-64 ถึง ND-06-64

4.5.4.4 ผู้วิจัยจะส่งลิงค์ Google form ให้ผู้เข้าร่วมวิจัยสำหรับเข้าถึง "แบบประเมินความคิดเห็นของนักกำหนดอาหารต่อการใช้งานโปรแกรมประยุกต์ NDPro" แบบสอบถามนี้ไม่มีการให้ระบุชื่อผู้ตอบแบบสอบถาม ประกอบด้วยคำถาม 2 ส่วน โดยส่วนที่ 1 ข้อมูลทั่วไป (10 ข้อ) ส่วนที่ 2 ความคิดเห็นของนักกำหนดอาหารต่อลักษณะและประโยชน์ที่ได้รับจากส่วนต่างๆ ของโปรแกรมประยุกต์ NDPro (6 ข้อ) (ใช้เวลาประมาณ 10 - 20 นาที)

5. ความเสี่ยง/อันตรายและและความไม่สะดวกต่าง ๆ ที่อาจเกิดขึ้นจากการเข้าร่วมการวิจัย

ไม่มีความเสี่ยงทางสุขภาพและผลกระทบทางจิตใจที่เกิดจากการเข้าร่วมในโครงการวิจัยนี้ อุปกรณ์สมาร์โฟนที่ใช้ติดตั้งโปรแกรมประยุกต์ NDPro ที่อยู่ในสภาพดี มีการตรวจสอบการชำรุดก่อนการใช้งาน อุปกรณ์สมาร์ทโฟนหรือแทปเล็ตที่ผู้วิจัยจัดหาให้จะทำความสะอาดและพ่นแอลกอฮอล์ความเข้มข้น ร้อยละ 70 ก่อนส่งมอบให้ใช้งานเพื่อป้องกันการแพร่ระบาดของเชื้อโควิด-19

6. ประโยชน์ในการเข้าร่วมการวิจัย

ผลจากการวิจัยนี้จะมีประโยชน์ต่อวงการวิชาชีพนักกำหนดอาหารในการพัฒนาเครื่องมือ (tool) ที่ทันสมัยมาใช้ในการเพิ่มประสิทธิภาพการทำงานของนักกำหนดอาหารทั้งในและนอกสถานที่ ผู้ที่มารับคำปรึกษาทางโภชนาการจากนักกำหนดอาหารได้รับบริการได้รวดเร็วมากขึ้นและได้รับข้อมูลเชิงประจักษ์จากการประเมินและติดตามพฤติกรรมการบริโภคอาหารและสารอาหารเบื้องต้น ซึ่งจะก่อให้เกิดประโยชน์ต่อการทำงานของนักกำหนดอาหารวิชาชีพ ผู้ที่ท่านให้คำปรึกษาและหน่วยงานในอนาคต

7. การปกป้องรักษาข้อมูลความลับของผู้มีส่วนร่วมในการวิจัย

ผู้วิจัยจะเก็บรักษาข้อมูลของผู้มีส่วนร่วมในการวิจัยเป็นความลับและป้องกันไม่ให้ข้อมูลและตัวตนของท่านถูกเปิดเผยสู่สาธารณชน แบบสอบถามในงานวิจัยนี้จะใช้เลขรหัสประจำตัวเท่านั้น

หากมีการเสนอผลการวิจัยจะเสนอเป็นภาพรวม ข้อมูลใดที่สามารถระบุถึงตัวผู้มีส่วนร่วมในการวิจัยได้จะไม่ปรากฏในรายงาน

8. หลังเสร็จสิ้นการวิจัย เมื่อตีพิมพ์ผลงานวิจัยแล้ว เอกสารบันทึกข้อมูลที่เกี่ยวข้องกับผู้มีส่วนร่วมในการวิจัยทั้งหมดจะถูกทำลาย

9. การเข้าร่วมและการสิ้นสุดการเข้าร่วมโครงการวิจัย

การเข้าร่วมโครงการวิจัยนี้เป็นไปโดยสมัครใจ ท่านสามารถปฏิเสธที่จะเข้าร่วมหรือถอนตัวจากการวิจัยได้ตลอดเวลาโดยไม่ต้องให้เหตุผล การขอถอนตัวออกจากโครงการวิจัยจะไม่สูญเสียประโยชน์ที่พึงได้รับและไม่มีผลกระทบใดๆ ต่อผู้เข้าร่วมวิจัย

10. การขอบคุณผู้มีส่วนร่วมในการวิจัย

การเข้าร่วมวิจัยนี้ไม่มีค่าชดเชยการเสียเวลาให้กับท่าน ทีมผู้วิจัยขอขอบคุณท่านที่ให้ความอนุเคราะห์และสละเวลาอันมีค่าเข้าร่วมงานวิจัยนี้ ในฐานะที่ท่านเป็นผู้มีส่วนร่วมในการวิจัย หลังจากมีปรับปรุงแก้ไขและการทดสอบการใช้งานโปรแกรมประยุกต์ NDPro เป็นที่เรียบร้อยพร้อมนำมาใช้งานจริงได้แล้ว ผู้วิจัยจะส่งตัวติดตั้งโปรแกรมประยุกต์ NDPro รุ่นทดลอง (version trial) ให้ผู้เข้าร่วมวิจัยใช้เป็นเวลานาน 3 เดือน และสามารถส่งข้อเสนอแนะลักษณะการใช้งาน (function) ที่ต้องการให้มีในโปรแกรมประยุกต์ NDPro หากผู้วิจัยทราบความต้องการจะพยายามพัฒนาให้สอดคล้องกับความต้องการของท่านมากขึ้นในอนาคต

หากท่านมีข้อสงสัย โปรดสอบถามเพิ่มเติมจากผู้วิจัยได้ตลอดเวลา และหากผู้วิจัยมีข้อมูลเพิ่มเติมที่เป็นประโยชน์หรือโทษเกี่ยวกับการวิจัย ผู้วิจัยจะแจ้งให้ท่านทราบอย่างรวดเร็ว เพื่อให้ผู้เข้าร่วมการวิจัยทบทวนว่ายังสมัครใจจะอยู่ในงานวิจัยต่อไปหรือไม่

หากได้รับการปฏิบัติไม่ตรงตามข้อมูลดังกล่าว ท่านสามารถร้องเรียนได้ที่ คณะกรรมการพิจารณาจริยธรรมการวิจัยในคน กลุ่มสหสถาบัน ชุดที่ 1 จุฬาลงกรณ์มหาวิทยาลัย 254 อาคารจามจุรี 1 ชั้น 2 ถนนพญาไท เขตปทุมวัน กรุงเทพฯ 10330 โทรศัพท์ 0-2218-3202, 0-2218-3049 E-mail: eccu@chula.ac.th

ข้าพเจ้าได้รับการอธิบายจากผู้วิจัย **และเข้าใจข้อมูลดังกล่าวข้างต้นทุกประการแล้ว จึง
ลงนามเข้าร่วมการวิจัยนี้ด้วยความสมัครใจ** และได้รับเอกสารไว้ 1 ชุดแล้ว

ลงชื่อ..   ลงชื่อ..

(นายธนะศักดิ์ ตันติชัยยกุล)   (..)

ผู้วิจัยหลัก   ผู้เข้าร่วมการวิจัย

วันที่......./.........../...................   วันที่......./.........../...................

ลงชื่อ..

(ผศ.ดร.ทิพยเนตร อริยปิติพันธ์)

พยาน

ขอขอบคุณในการร่วมมือของท่านมา ณ ที่นี้

APPENDIX C

Evaluation form for recording dietary intake assessment (ND-02/64)

แบบบันทึกการประเมินอาหารตามหมวดอาหารในตารางรายการอาหารแลกเปลี่ยนไทยและธงโภชนาการ

(เวลาที่เริ่มประเมิน _____ น.   เวลาที่สิ้นสุดการประเมิน _____ น.)

ตารางที่ 1 ตารางบันทึกปริมาณอาหารที่บริโภคตามหลักการของรายการอาหารแลกเปลี่ยนไทย

หมวดอาหาร	จำนวนส่วน			
	มื้อเช้า	มื้อกลางวัน	มื้อบ่าย	มื้อเย็น
1. หมวดข้าวแป้ง (สุก)				
2. หมวดผัก (สุก)	-	-	-	-
ประเภท ก				
ประเภท ข				
3. หมวดผลไม้				
4. หมวดเนื้อสัตว์ (สุก)	-	-	-	-
ไม่มีมันเลย (ไขมันต่ำมาก)				
เนื้อล้วน (ไขมันต่ำ)				
ไขมันปานกลาง				
ไขมันสูง				
5. หมวดนม			-	-
นมธรรมดา				
นมพร่องมันเนย				
นมขาดมันเนย				
นมระเหย				
นมผง				
นมผงขาดมันเนย				
6. หมวดไขมัน	-	-	-	-
น้ำมัน				
ผลิตภัณฑ์ที่มาจากไขมัน				

ตารางที่ 2 ตารางบันทึกปริมาณอาหารที่บริโภคตามหลักการของธงโภชนาการ

(เวลาที่เริ่มประเมิน _____ น.   เวลาที่สิ้นสุดการประเมิน _____ น.)

หมวดอาหาร	จำนวนส่วน			
	มื้อเช้า	มื้อกลางวัน	มื้อบ่าย	มื้อเย็น
1. หมวดข้าวแป้ง	-	-	-	-
ข้าวสวย/เส้น (สุก)				
ข้าวเหนียว (สุก)				
ขนมปัง				
2. หมวดเนื้อสัตว์	-	-	-	-
เนื้อสัตว์ (สุก)				
ถั่ว				
ไข่				
3. หมวดผัก (สุก)				
4. หมวดผลไม้				
5. หมวดนม	-	-	-	-
นมธรรมดา				
นมไขมันต่ำ				
6. หมวดไขมัน: น้ำมัน				

APPENDIX D

Evaluation form for recording energy and amounts of macronutrients per serving size

(ND-03/64)

แบบบันทึกการกำหนดพลังงานและสารอาหารให้พลังงานตามหมวดอาหารในตาราง รายการอาหารแลกเปลี่ยนไทยและธงโภชนาการ

ตารางที่ 1 ตารางกำหนดคุณค่าอาหารในหมวดอาหารตามรายการอาหารแลกเปลี่ยนไทย

หมวดอาหาร	ปริมาณต่อ 1 ส่วน	คาร์โบไฮเดรต (กรัม)	โปรตีน (กรัม)	ไขมัน (กรัม)	พลังงาน (กิโลแคลอรี)
1. หมวดข้าวแป้ง	ไม่แน่นอน ขึ้นกับชนิดอาหาร				
2. หมวดผัก (สุก)					
ประเภท ก	50-70 กรัม				
ประเภท ข	50-70 กรัม				
3. หมวดผลไม้	ไม่แน่นอน ขึ้นกับชนิดผลไม้				
4. หมวดเนื้อสัตว์ (สุก)					
ไม่มีมันเลย (ไขมันต่ำมาก)	30 กรัม (2 ช้อนโต๊ะ)				
เนื้อล้วน (ไขมันต่ำ)	30 กรัม (2 ช้อนโต๊ะ)				
ไขมันปานกลาง	30 กรัม (2 ช้อนโต๊ะ)				
ไขมันสูง	30 กรัม (2 ช้อนโต๊ะ)				
5. หมวดนม					
นมธรรมดา	240 มิลลิลิตร				
นมพร่องมันเนย	240 มิลลิลิตร				
นมขาดมันเนย	240 มิลลิลิตร				
นมระเหย	120 มิลลิลิตร				
นมผง	30 กรัม (4 ช้อนโต๊ะ)				
นมผงขาดมันเนย	30 กรัม (4 ช้อนโต๊ะ)				
6. หมวดไขมัน					
น้ำมัน	1 ช้อนชา (5 กรัม)				
ผลิตภัณฑ์ที่มาจากไขมัน	ไม่แน่นอน ขึ้นกับชนิดผลิตภัณฑ์อาหาร				

อ้างอิง: Samasut, R., Thai food exchange list. Thai J Parenter Enter Nutr, 2004. 15: p. 33-45.

ตารางที่ 2 ตารางกำหนดคุณค่าอาหารในหมวดอาหารตามธงโภชนาการ

หมวดอาหาร	ปริมาณต่อ 1 ส่วน	คาร์โบไฮเดรต (กรัม)	โปรตีน (กรัม)	ไขมัน (กรัม)	พลังงาน (กิโลแคลอรี)
1. หมวดข้าวแป้ง					
ข้าวสวย/เส้น (สุก)	1 ทัพพี (60 กรัม)				
ข้าวเหนียว (สุก)	1/2 ทัพพี (35 กรัม)				
ขนมปัง	1 แผ่น (30 กรัม)				
2. หมวดเนื้อสัตว์					
เนื้อสัตว์ (สุก)	1 ช้อนโต๊ะ (15 กรัม)				
ถั่ว	2 ช้อนโต๊ะ (30 กรัม)				
ไข่	1/2 ฟอง (25 กรัม)				
3. หมวดผัก (สุก)	1 ทัพพี (ไม่แน่นอนขึ้นกับชนิดผัก)				
4. หมวดผลไม้	1 ส่วน (ไม่แน่นอนขึ้นกับชนิดผลไม้)				
5. หมวดนม					
นมธรรมดา	1 แก้ว (200 มล.)				
นมไขมันต่ำ	1 แก้ว (200 มล.)				
6. หมวดไขมัน: น้ำมัน	1 ช้อนชา (5 กรัม)				

อ้างอิง: Sirichakwal, P.P., K. Sranacharoenpong, and K.J.A.P.j.o.c.n. Tontisirin, Food based dietary guidelines (FBDGs) development and promotion in Thailand. 2011. 20(3): p. 477-483.

APPENDIX E

Evaluation form for recording dietary intake and calculating total energy and amounts of macronutrients based on Thai food exchange lists (ND-04/64)

แบบบันทึกปริมาณอาหารที่บริโภคและผลการประมวลพลังงานและสารอาหารตามหลักการของรายการอาหารแลกเปลี่ยนไทย

วันที่ _____ เวลาเริ่มต้น _____ น. เวลาสิ้นสุด _____ น.

หมวดอาหาร	จำนวนส่วน				
	มื้อเช้า	มื้อกลางวัน	มื้อบ่าย	มื้อเย็น	รวม
1. หมวดข้าวแป้ง					
2. หมวดผัก (สุก)	-	-	-	-	-
ประเภท ก					
ประเภท ข					
3. หมวดผลไม้					
4. หมวดเนื้อสัตว์ (สุก)	-	-	-	-	-
ไม่มีมันเลย (ไขมันต่ำมาก)					
เนื้อล้วน (ไขมันต่ำ)					
ไขมันปานกลาง					
ไขมันสูง					
5. หมวดนม			-	-	-
นมธรรมดา					
นมพร่องมันเนย					
นมขาดมันเนย					
นมระเหย					
นมผง					
นมผงขาดมันเนย					
6. หมวดไขมัน	-	-	-	-	-
น้ำมัน					
ผลิตภัณฑ์ที่มาจากไขมัน					

สรุปผลพลังงานและสารอาหารที่ได้รับจากอาหารที่บริโภคต่อวัน

พลังงานทั้งหมด .... กิโลแคลอรีต่อวัน โปรตีน .... กรัมต่อวัน

คาร์โบไฮเดรต .... กรัมต่อวัน ไขมัน .... กรัมต่อวัน

215

หมวดอาหาร	การประเมินผลพลังงานและสารอาหาร (พลังงาน / คาร์โบไฮเดรต / โปรตีน / ไขมัน)				
	มื้อเช้า	มื้อกลางวัน	มื้อบ่าย	มื้อเย็น	รวม
1. หมวดข้าวแป้ง					
2. หมวดเนื้อสัตว์ (สุก)	-	-	-	-	-
เนื้อมันน้อย (ไขมันต่ำมาก)					
เนื้อล้วน (ไขมันต่ำ)					
ไขมันปานกลาง					
ไขมันสูง					
3. หมวดผัก (สุก)	-	-	-	-	-
ประเภท ก					
ประเภท ข					
4. หมวดผลไม้					
5. หมวดนม	-	-	-	-	-
นมธรรมดา					
นมพร่องมันเนย					
นมขาดมันเนย					
นมระเหย					
นมผง					
นมเปรี้ยวรสมันเนย					
6. หมวดไขมัน	-	-	-	-	-
น้ำมัน					
ผลิตภัณฑ์ที่มาจากไขมัน					

APPENDIX F

Evaluation form for recording dietary intake and calculating total energy and amounts of macronutrients based on Thai food-based dietary guidelines (ND-05/64)

แบบบันทึกปริมาณอาหารที่บริโภคและผลการประมวลพลังงานและสารอาหารตามหลักการของ ธงโภชนาการ

วันที่ _____ เวลาเริ่มต้น _____ น. เวลาสิ้นสุด _____ น.

หมวดอาหาร	จำนวนส่วน				
	มื้อเช้า	มื้อกลางวัน	มื้อบ่าย	มื้อเย็น	รวม
1. หมวดข้าวแป้ง					
ข้าวสวย/เส้น (สุก)					
ข้าวเหนียว (สุก)					
ขนมปัง					
2. หมวดเนื้อสัตว์					
เนื้อสัตว์ (สุก)					
ถั่ว					
ไข่					
3. หมวดผัก (สุก)					
4. หมวดผลไม้					
5. หมวดนม					
นมธรรมดา					
นมไขมันต่ำ					
6. หมวดไขมัน: น้ำมัน					

สรุปผลพลังงานและสารอาหารที่ได้รับจากอาหารที่บริโภคต่อวัน

พลังงานทั้งหมด .... กิโลแคลอรีต่อวัน โปรตีน .... กรัมต่อวัน

คาร์โบไฮเดรต .... กรัมต่อวัน   ไขมัน .... กรัมต่อวัน

หมวดอาหาร	การประเมินผลพลังงานและสารอาหาร (พลังงาน / คาร์โบไฮเดรต / โปรตีน / ไขมัน)				
	มื้อเช้า	มื้อกลางวัน	มื้อบ่าย	มื้อเย็น	ระหว่าง
1. หมวดข้าวแป้ง	-	-	-	-	-
ข้าวสวย/ข้าวเหนียว (สุก)					
ข้าวเหนียว ฯ (สุก)					
ขนมปัง					
2. หมวดเนื้อสัตว์	-	-	-	-	-
เนื้อสัตว์ ฯ (สุก)					
ตับ					
ไข่					
3. หมวดผัก (สุก)					
4. หมวดผลไม้					
5. หมวดนม	-	-	-	-	-
นมธรรมดา					
นมไขมันต่ำ					
6. หมวดไขมัน: น้ำมัน					

APPENDIX G

Evaluation form for recording results from calculating total energy and amounts of macronutrients by using the NDPro application (ND-06/64)

แบบบันทึกผลการประมวลพลังงานและสารอาหารที่ได้รับจากอาหารที่บริโภคต่อวัน ด้วยโปรแกรมประยุกต์ NDPro

5.1 ประมวลผลจากฐานข้อมูลอาหารตามรายการอาหารแลกเปลี่ยนด้วยโปรแกรมประยุกต์ NDPro

วันที่ _____

เวลาเริ่มต้น _____ น.   เวลาสิ้นสุด _____ น.

สรุปผลพลังงานและสารอาหารที่ได้รับจากอาหารที่บริโภคต่อวัน

พลังงานทั้งหมด .... กิโลแคลอรีต่อวัน   โปรตีน   .... กรัมต่อวัน

คาร์โบไฮเดรต   .... กรัมต่อวัน   ไขมัน   .... กรัมต่อวัน

5.2 ประมวลผลจากฐานข้อมูลอาหารตามธงโภชนาการด้วยโปรแกรมประยุกต์ NDPro

วันที่ _____

เวลาเริ่มต้น _____ น.   เวลาสิ้นสุด _____ น.

สรุปผลพลังงานและสารอาหารที่ได้รับจากอาหารที่บริโภคต่อวัน
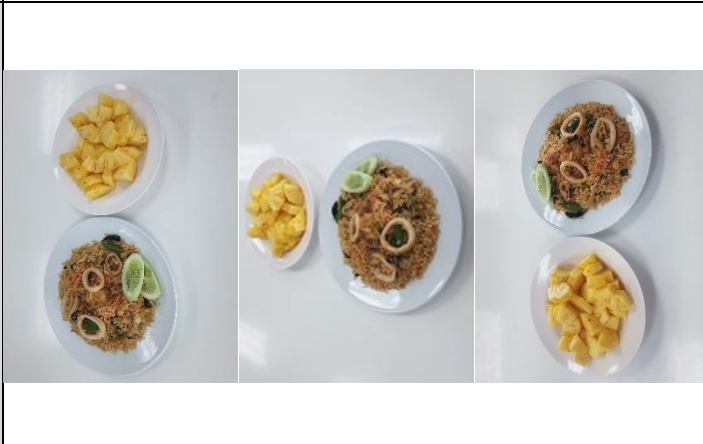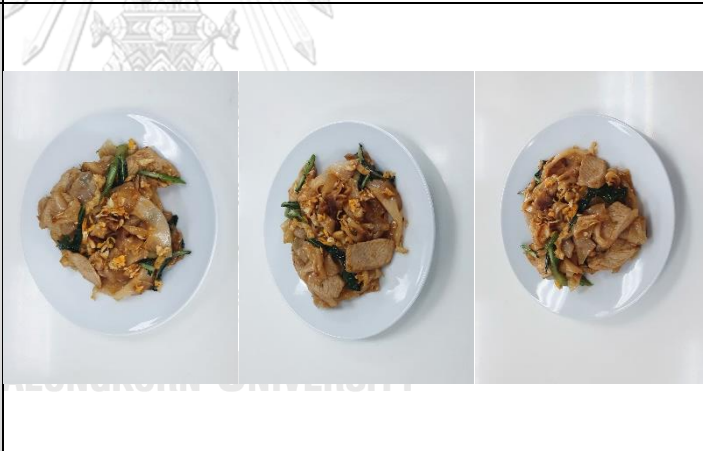
พลังงานทั้งหมด .... กิโลแคลอรีต่อวัน   โปรตีน   .... กรัมต่อวัน

คาร์โบไฮเดรต   .... กรัมต่อวัน   ไขมัน   .... กรัมต่อวัน
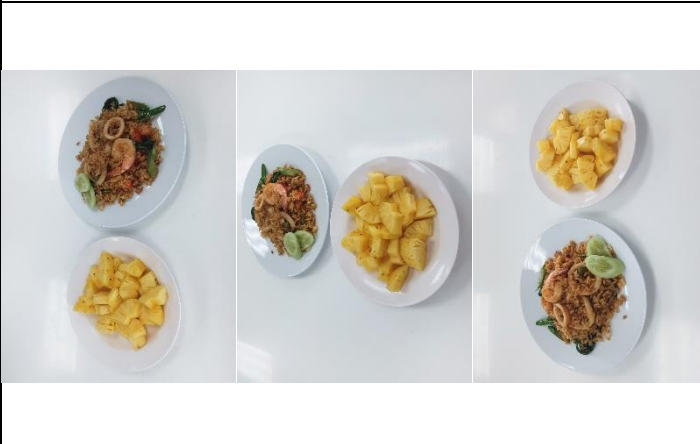
APPENDIX H

Food images used for application validation
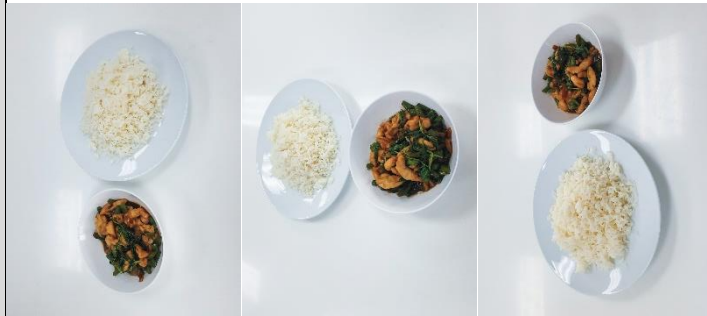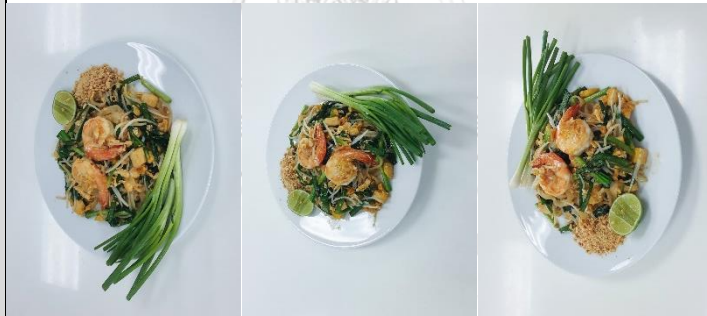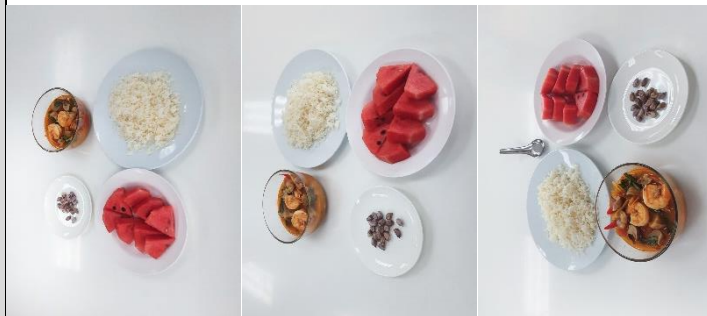
1. Set 1 (Thai food exchange list)

Energy: 2009.34 kcal	Carbohydrate: 287.62 g	Protein: 78.74 g	Fat: 60.44 g
Breakfast	Lunch	Light meal	Dinner
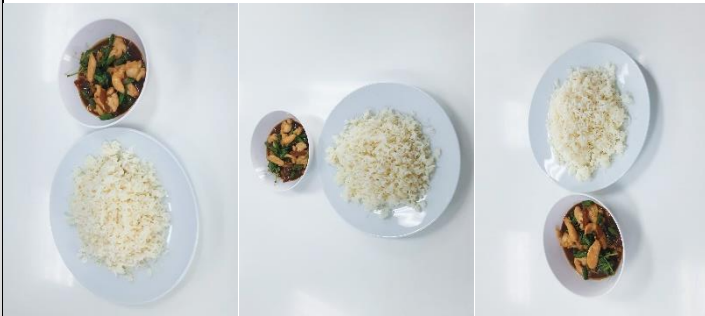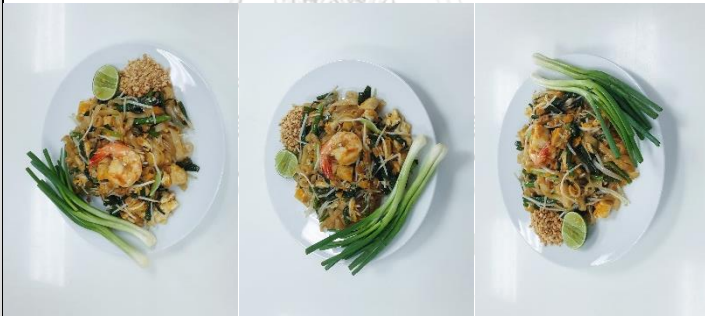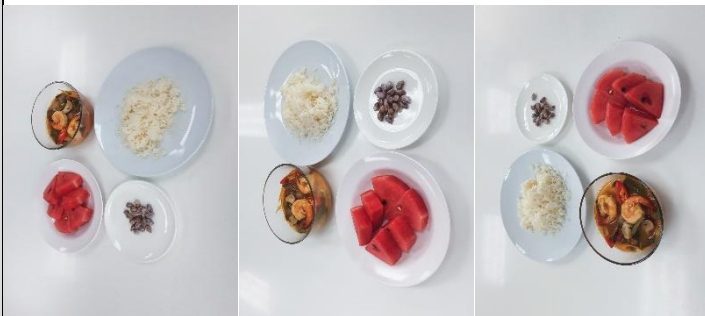
2. Set 1 (Thai food based dietary guidelines)

Energy: 1875.11 kcal	Carbohydrate: 274.98 g	Protein: 67.19 g	Fat: 56.28 g
Breakfast	Lunch	Light meal	Dinner

3. Set 2 (Thai food exchange list)

Energy: 1920.67 kcal	Carbohydrate: 288.54 g	Protein: 74.78 g	Fat: 51.93 g
Breakfast	Lunch	Light meal	Dinner

2. Set 1 (Thai food based dietary guidelines)

Energy: 2022.21 kcal	Carbohydrate: 301.89 g	Protein: 64.23 g	Fat: 61.97 g
Breakfast	Lunch	Light meal	Dinner

5. Set 3 (Thai food exchange list)

Energy: 2006.73 kcal	Carbohydrate: 251.74 g	Protein: 78.54 g	Fat: 76.21 g
Breakfast	Lunch	Light meal	Dinner

6. Set 3 (Thai food based dietary guidelines)

Energy: 2001.86 kcal	Carbohydrate: 292.55 g	Protein: 60.87 g	Fat: 65.38 g
Breakfast	Lunch	Light meal	Dinner

APPENDIX I

Questionnaire of behavior and attitude of dietitians toward nutrition care process

แบบสอบถามพฤติกรรมและทัศนคติของนักกำหนดอาหารต่อการบันทึกอาหาร การประมวลผล และการวิเคราะห์ผลพลังงานและสารอาหารจากข้อมูลการประเมินอาหารที่บริโภคในกระบวนการให้คำปรึกษาด้านโภชนาการและการกำหนดอาหาร

<u>คำชี้แจง</u>

        แบบสอบถามนี้เป็นส่วนหนึ่งของวิทยานิพนธ์ เรื่อง Development and validation of smartphone nutrition application for supporting dietetic professional practice ซึ่งมีวัตถุประสงค์เพื่อพัฒนาแอพพลิเคชั่นบนมือถือสำหรับคำนวณพลังงานและสารอาหารให้นักกำหนดอาหารได้นำไปใช้ในการประเมินพลังงานและสารอาหารที่ได้รับต่อวันและวางแผนการกำหนดอาหารในการให้โภชนบำบัดแก่ผู้ป่วยและดูแลโภชนาการแก่บุคคลทั่วไปได้อย่างรวดเร็วและถูกต้อง โดยแบบสอบถามนี้มีวัตถุประสงค์ คือ เพื่อสำรวจพฤติกรรมและทัศนคติของนักกำหนดอาหารต่อการบันทึกและประมวลผลพลังงานและสารอาหารจากข้อมูลอาหารที่ได้จากการประเมินการบริโภคด้วยวิธีการที่ใช้งานปัจจุบันเพื่อนำไปประกอบการพัฒนาแอพพลิเคชั่นให้เหมาะสมกับการใช้งานต่อไป

        ผู้วิจัยขอขอบพระคุณทุกท่านที่กรุณาให้ความอนุเคราะห์ในการตอบแบบสอบถาม ข้อมูลของท่านจะถือเป็นความลับและทางผู้วิจัยจะนำไปใช้เพื่อประโยชน์ทางวิชาการเท่านั้น

<div align="right">

นายธนะศักดิ์ ตันติชัยยกุล

นิสิตหลักสูตรวิทยาศาสตรมหาบัณฑิต

สาขาวิชาอาหารและโภชนาการ(นานาชาติ)

คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

</div>

แบบสอบถาม ประกอบด้วย 3 ส่วน ดังนี้

ส่วนที่ 1 ข้อมูลทั่วไป

ส่วนที่ 2 พฤติกรรมการบันทึกอาหาร การประมวลผลและการวิเคราะห์ผลเพื่อนำไปใช้ในการให้
คำปรึกษาด้านโภชนาการและการกำหนดอาหาร

ส่วนที่ 3 ทัศนคติต่อการบันทึกอาหาร การประมวลผลและการวิเคราะห์ผลเพื่อนำไปใช้ในการให้
คำปรึกษาด้านโภชนาการและการกำหนดอาหาร

ส่วนที่ 1 ข้อมูลทั่วไป

โปรดทำเครื่องหมาย ✓ ลงใน ☐ หรือเติมข้อความลงในช่องว่าง หากข้อความใดมีคำว่า "โปรด
ระบุ" กรุณาให้ข้อมูลเพิ่มเติม

1. เพศ

    ☐ ชาย ☐ หญิง

2. อายุ .... ปี

3. ศาสนา

    ☐ พุทธ ☐ คริสต์ ☐ อิสลาม ☐ อื่นๆ โปรด
    ระบุ ....

4. ระดับการศึกษาสูงสุด

    ☐ ต่ำกว่าปริญญาตรี

    ☐ ปริญญาตรี สาขา (โปรดระบุ) ....

    ☐ ปริญญาโท สาขา (โปรดระบุ) ....

    ☐ ปริญญาเอก สาขา (โปรดระบุ) ....

    ☐ อื่นๆ (โปรด
    ระบุ)...

5. ตำแหน่งงานของท่าน

    ☐ นักกำหนดอาหาร ☐ นักโภชนาการ ☐ โภชนากร

    ☐ ผู้เชี่ยวชาญด้านอาหาร (โปรดระบุ) ....

    ☐ นิสิต : ระดับ ☐ ปริญญาตรี สาขา (โปรดระบุ) ....

    ☐ ปริญญาโท สาขา (โปรดระบุ) ....

    ☐ ปริญญาเอก สาขา (โปรดระบุ) ....

❒ อื่นๆ (โปรดระบุ) ....

6. สถานที่ทำงานปัจจุบัน

❒ โรงพยาบาล (โปรดระบุ)
....

❒ คลินิกสุขภาพ

❒ คลินิกเสริมความงาม

❒ โรงเรียน

❒ มหาวิทยาลัย (โปรดระบุ)..

❒ อื่นๆ โปรดระบุ...

(กรณีที่ตอบ "โรงพยาบาล" ให้ทำข้อ 7 ต่อ)

(กรณีที่ไม่ได้ตอบ "โรงพยาบาล" ให้ข้ามไปทำข้อ 8)

7. ประเภทโรงพยาบาลที่ท่านทำงาน

❒ โรงพยาบาลมหาวิทยาลัย   จำนวน............................เตียง

❒ โรงพยาบาลศูนย์   จำนวน............................เตียง

❒ โรงพยาบาลทั่วไป   จำนวน............................เตียง

❒ โรงพยาบาลชุมชน   จำนวน............................เตียง

❒ โรงพยาบาลเอกชน   จำนวน............................เตียง

หมายเหตุ

1. โรงพยาบาลชุมชน (รพช.) มีเตียงสำหรับผู้ป่วยตั้งแต่ 10 ถึง 150 เตียง

2. โรงพยาบาลทั่วไปในระดับอำเภอ มีเตียงสำหรับผู้ป่วยตั้งแต่ 200 - 500 เตียง

3. โรงพยาบาลในระดับจังหวัดหรือโรงพยาบาลศูนย์ มีเตียงสำหรับผู้ป่วยมากกว่า 500 เตียงขึ้นไป

---

8. สถานที่ที่ท่านปฏิบัติงานมีนักกำหนดอาหาร นักโภชนาการและโภชนากรจำนวนเท่าไร? (โปรด
ระบุตามตำแหน่งงานที่ได้รับจากหน่วยงานที่ปฏิบัติหน้าที่)

❒ นักกำหนดอาหาร   จำนวน...............................คน

❒ นักโภชนาการ   จำนวน...............................คน

❒ โภชนากร   จำนวน...............................คน

9. ท่านมีประสบการณ์ทำงาน .... ปี และมีประสบการณ์ในการให้คำปรึกษาทางโภชนาการ
และการกำหนดอาหาร .... ปี

10. ท่านมีความเชี่ยวชาญในการให้คำปรึกษาทางโภชนาการและการกำหนดอาหารในโรคใด?
(สามารถเลือกตอบได้มากกว่า 1 ข้อ)

☐ โรคเบาหวาน ☐ โรคความดันโลหิตสูง ☐ โรคหัวใจและหลอดเลือด

☐ โรคไต ☐ โรคมะเร็ง ☐ โรคอ้วนและการควบคุมน้ำหนัก

☐ อื่นๆ โปรดระบุ..

ส่วนที่ 2 พฤติกรรมของนักกำหนดอาหารในการบันทึกอาหาร การประมวลผลและการวิเคราะห์
ผลพลังงานและสารอาหารในกระบวนการให้คำปรึกษาด้านโภชนาการและการกำหนดอาหาร

11. ในการปฏิบัติหน้าที่ของท่าน ท่านให้คำปรึกษาด้านโภชนาการและการกำหนดอาหารแก่บุคคล
กลุ่มใดบ้าง? (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

☐ บุคคลทั่วไป ☐ ผู้สูงอายุ

☐ หญิงตั้งครรภ์ ☐ หญิงให้นมบุตร

☐ เด็กทารก ☐ เด็กก่อนวัยเรียน

☐ เด็กวัยเรียน ☐ นักกีฬา

☐ บุคคลที่ต้องการลดน้ำหนักหรือควบคุมน้ำหนัก

☐ บุคคลที่มีภาวะขาดสารอาหาร

☐ บุคคลที่มีอยู่ในสภาพที่ไม่สามารถรับประทานอาหารได้ปกติ

☐ บุคคลที่มีโรคเฉพาะ ซึ่งจำเป็นต้องได้รับคำปรึกษาด้านโภชนาการและการกำหนดอาหาร
โปรดระบุโรค...

☐ อื่นๆ โปรดระบุ...

12. ท่านให้คำปรึกษาด้านโภชนาการและการกำหนดอาหาร โดยเฉลี่ยประมาณ .... คนต่อวัน

13. ในการให้คำปรึกษาด้านโภชนาการและการกำหนดอาหารในแต่ละครั้ง ท่านใช้เวลาโดยเฉลี่ย
ประมาณ .... นาทีต่อคน

14. ท่านใช้วิธีใดประเมินการบริโภคอาหารในการปฏิบัติงานประจำ? (โปรดเลือกวิธีที่ท่านใช้บ่อยที่สุด
เพียงข้อเดียวเท่านั้น)

☐ การสัมภาษณ์อาหารที่บริโภคแบบทบทวนความจำย้อนหลัง 24 ชั่วโมง (24 hour dietary
recall)

☐ การสังเกตอาหารที่บริโภค (กรณีที่ตอบข้อเลือกนี้ ให้ข้ามไปตอบคำถามข้อ 20)

❑ การจดบันทึกอาหารที่บริโภค (food record) (กรณีที่ตอบข้อเลือกนี้ ให้ข้ามไปตอบคำถาม ข้อ 20)

❑ อื่นๆ โปรดระบุ ....

15. ท่านใช้อุปกรณ์ประกอบการสอนหรือเทคโนโลยีเข้ามาช่วยในการสัมภาษณ์อาหารที่บริโภคแบบทบทวนความจำย้อนหลัง 24 ชั่วโมงหรือไม่?

❑ ไม่ได้นำมาใช้ เป็นการให้คำปรึกษาด้วยปากเปล่า

❑ นำมาใช้

กรณีตอบว่า "นำมาใช้" โปรดระบุ (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

❑ แผ่นพับ/เอกสารประกอบการสอน   ❑ โปสเตอร์

❑ ภาพถ่ายอาหารจริง   ❑ ภาพถ่ายหุ่นจำลองอาหารแลกเปลี่ยน

❑ หุ่นจำลองอาหาร (Food model)   ❑ วิดีโอสาธิต

❑ โปสเตอร์หรือภาพผ่านสื่ออิเล็กทรอนิกส์คอมพิวเตอร์

❑ แอพพลิเคชั่นบนสมาร์ทโฟน โปรดระบุ..

❑ โปรแกรมคอมพิวเตอร์ โปรดระบุ ....

❑ อื่นๆ โปรดระบุ...

16. ท่านเทียบเคียงปริมาณอาหารที่บริโภคโดยอ้างอิงหลักการและข้อมูลหน่วยบริโภค (serving size) จากแหล่งใด? (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

❑ ธงโภชนาการ (กรมอนามัย กระทรวงสาธารณสุข, 2001)

❑ รายการอาหารแลกเปลี่ยนไทย (รุจิรา สัมมะสุต, 2004)

❑ อื่นๆ โปรดระบุ...

17. ท่านสามารถจดจำปริมาณอาหารต่อหน่วยบริโภค (serving size) ของรายการอาหารที่แสดงในแต่ละหมวดอาหารจากแหล่งข้อมูลที่ท่านเลือกใช้ในข้อ 16 ได้ทั้งหมดหรือไม่?

❑ จดจำไม่ได้เลย

❑ จดจำได้ทั้งหมด

❑ จดจำได้บางส่วน ประมาณร้อยละ .... ของรายการทั้งหมด

โปรดระบุ (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

☐ จดจำได้บางหมวด โปรดระบุหมวดที่จำได้ทั้งหมด

....

☐ จดจำได้บางรายการ โปรดระบุตัวอย่างรายการอาหาร 5 อันดับแรก

....

☐ จดจำไม่ได้บางหมวด โปรดระบุหมวดที่จำไม่ได้ทั้งหมด

....

☐ จดจำไม่ได้บางรายการ โปรดระบุตัวอย่างรายการอาหาร 5 อันดับแรก

....

☐ อื่นๆ โปรดระบุ

....

<u>(กรณีที่ตอบ "จำได้ทั้งหมด" ให้ข้ามข้อ 18 ไปทำข้อ 19)</u>

18. หากท่านจดจำปริมาณต่อหน่วยบริโภค (serving size) ของอาหารบางรายการไม่ได้ ท่านแก้ไข
ปัญหาในการประมาณหน่วยบริโภคของอาหารชนิดนั้นอย่างไร?

☐ ใช้ปริมาณต่อหน่วยบริโภคของอาหารอื่นที่มีลักษณะคล้ายคลึงกัน

☐ ใช้ปริมาณต่อหน่วยบริโภคของอาหารอื่นที่จดจำได้ แม้ปริมาณต่อหน่วยบริโภคแตกต่างกัน

☐ ใช้ปริมาณต่อหน่วยบริโภคเท่ากันหมด หากอาหารนั้นอยู่ในหมวดเดียวกัน

☐ ใช้ปริมาณต่อหน่วยบริโภคโดยกะประมาณด้วยประสบการณ์ของตนเอง

☐ อื่นๆ โปรดระบุ

....

19. ท่านใช้เวลาในการบันทึกอาหาร การประมวลผลและการวิเคราะห์ผลพลังงานและสารอาหาร
หลังจากได้ข้อมูลการบริโภคอาหารด้วยวิธีที่ท่านใช้ในปัจจุบันเพื่อนำมาประกอบการให้คำปรึกษา
ทางโภชนาการและการกำหนดอาหาร โดยเฉลี่ยประมาณ .... นาทีต่อครั้ง

<u>หมายเหตุ</u>

- คำว่า *"การบันทึกอาหาร"* หมายถึง *ขั้นตอนหลังจากได้ข้อมูลจากการประมาณการบริโภคอาหารแต่ละ
ชนิดเป็นหน่วยบริโภคและนำค่ามาเก็บไว้เพื่อนำไปคำนวณต่อไป เช่น เขียนลงบนกระดาษ พิมพ์ลงในมือ
ถือหรือโปรแกรมในคอมพิวเตอร์ เป็นต้น*

- คำว่า *"การประมวลผล"* หมายถึง *ขั้นตอนหลังจากบันทึกข้อมูลหน่วยบริโภคเรียบร้อยแล้วและทำการ
คำนวณพลังงานและสารอาหารจากอาหารที่บริโภคในแต่ละหมวดต่อมื้อและต่อวัน*

- *คำว่า "การวิเคราะห์ผล" หมายถึง ขั้นตอนหลังจากการคำนวณพลังงานและสารอาหารที่ได้รับต่อวัน*
  เรียบร้อยแล้วและนำมาพิจารณาว่าพลังงานและสารอาหารที่ได้รับต่อวันเหมาะสมและเพียงพอตาม
  สภาวะหรือโรคของผู้ที่ถูกประเมินการบริโภคอาหารหรือไม่ เพื่อนำไปประกอบการวินิจฉัยทาง
  โภชนาการและให้คำปรึกษาวางแผนการกำหนดอาหารต่อไป

20. ข้อมูลโภชนาการที่ท่านได้รับจากวิธีที่ใช้ประมวลผลพลังงานและสารอาหารในปัจจุบันมี
    อะไรบ้าง? (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

    ☐ พลังงานทั้งหมดจากอาหาร ☐ คาร์โบไฮเดรตทั้งหมดในอาหาร

    ☐ โปรตีนทั้งหมดในอาหาร ☐ ไขมันทั้งหมดในอาหาร

    ☐ วิตามินในอาหาร โปรดระบุ ....

    ☐ เกลือแร่ในอาหาร โปรดระบุ ....

    ☐ น้ำจากอาหาร

    ☐ อื่นๆ โปรดระบุ...

21. ท่านมีการวิเคราะห์ผลเปรียบเทียบพลังงานและปริมาณสารอาหารที่ได้รับต่อวันกับพลังงานและ
    ปริมาณสารอาหารที่ควรได้รับต่อวันว่าเพียงพอต่อความต้องการของร่างกายหรือเหมาะสมกับโรค
    ที่เกี่ยวข้องทางโภชนาการหรือไม่?

    ☐ ไม่มี เนื่องจาก (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

    　　☐ ไม่มีเวลาเพียงพอ

    　　☐ ไม่มีข้อมูล DRI* หรือ RDI** ในที่ปฏิบัติงานให้เปรียบเทียบ

    　　☐ จำข้อมูล DRI* หรือ RDI** ไม่ได้

    　　☐ ไม่มีความจำเป็น

    　　☐ อื่นๆ โปรดระบุ...

    　　DRI* หมายถึง ปริมาณสารอาหารอ้างอิงที่ควรได้รับประจำวัน (dietary reference intake)
    　　RDI** หมายถึง ปริมาณสารอาหารที่แนะนำให้บริโภคต่อวัน (recommended dietary intake)

    ☐ มี ใช้เวลาในการประมวลผลโดยเฉลี่ยนานประมาณ .... นาที

    　　ข้อมูลที่เปรียบเทียบ ☐ พลังงาน สารอาหารให้พลังงาน

    　　　　　　　　　　　 ☐ พลังงาน สารอาหารให้พลังงาน วิตามิน เกลือแร่

    　　　　　　　　　　　 ☐ อื่นๆ โปรดระบุ...

22. ท่านมีการปรับเปลี่ยนชนิดและปริมาณอาหารที่แนะนำให้บริโภคต่อวันเพื่อให้ได้พลังงานและ
สารอาหารใกล้เคียงกับที่ควรได้รับต่อวันหรือไม่? (เช่น ปรับลดหรือเพิ่มความต้องการพลังงาน
หรือสารอาหารสำหรับผู้ที่ต้องการลดน้ำหนัก การเปลี่ยนชนิดของหมวดเนื้อสัตว์ไขมันสูงเป็น
หมวดเนื้อสัตว์ไขมันต่ำเพื่อลดไขมัน เป็นต้น

   ☐ ไม่มี เนื่องจาก (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

      ☐ ไม่มีเวลาเพียงพอ

      ☐ ไม่มีข้อมูล DRI* หรือ RDI** ในที่ปฏิบัติงานให้เปรียบเทียบ

      ☐ จำข้อมูล DRI* หรือ RDI** ไม่ได้

      ☐ ไม่มีความจำเป็น

      ☐ อื่นๆ โปรดระบุ...

   ☐ มี ใช้เวลาในการเลือกชนิดอาหารและประมวลผลโดยเฉลี่ยนานประมาณ .... นาที

   DRI หมายถึง ปริมาณสารอาหารอ้างอิงที่ควรได้รับประจำวัน (dietary reference intake)*

   *RDI** หมายถึง ปริมาณสารอาหารที่แนะนำให้บริโภคต่อวัน (recommended dietary intake)*

23. ท่านมีระบบการจัดเก็บประวัติการบริโภคอาหารของผู้ที่ท่านให้คำปรึกษาเพื่อติดตามการบริโภค
อาหารในครั้งถัดไปหรือไม่?

   ☐ ไม่มี (กรณีตอบ "ไม่มี" ให้ข้ามข้อ 24 และข้อ 25 ไปตอบส่วนที่ 3)

      โปรดระบุเหตุผล (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

      ☐ ขั้นตอนยุ่งยาก   ☐ ไม่มีเวลาเพียงพอ

      ☐ ไม่มีความจำเป็น   ☐ ไม่ต้องการใช้ข้อมูล

      ☐ อื่นๆ โปรดระบุ...

   ☐ มี โดยจัดเก็บข้อมูลโดยวิธีต่อไปนี้ (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

      ☐ แฟ้มประวัติ   ☐ ไฟล์ Microsoft excel

      ☐ ไฟล์ Microsoft word

      ☐ ใช้โปรแกรมจัดเก็บ โปรดระบุ...

      ☐ อื่นๆ โปรดระบุ..

24. ท่านมีการติดตามประวัติการบริโภคอาหารของผู้ที่ท่านให้คำปรึกษา โดยนำข้อมูลจากฐานข้อมูล
ที่เก็บไว้ตามที่ระบุในข้อ 23 มาใช้หรือไม่?

   ☐ ไม่มี (กรณีตอบ "ไม่มี" ให้ข้ามข้อ 25 ไปตอบส่วนที่ 3)

โปรดระบุเหตุผล (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

❏ ใช้เวลาค้นข้อมูลนาน

❏ ขั้นตอนยุ่งยากในการนำข้อมูลมาประมวลผล

❏ ไม่มีเวลาเพียงพอในการให้คำปรึกษา

❏ ข้อมูลประวัติเก่าไม่มีประโยชน์ในการให้คำปรึกษา เนื่องจาก....................................

❏ ไม่มีความจำเป็น เนื่องจาก...

❏ อื่นๆ โปรดระบุ...

❏ มี

25. ท่านมีอุปสรรคในการนำฐานข้อมูลที่จัดเก็บมาใช้เพื่อติดตามประวัติการบริโภคอาหารของผู้ที่ท่าน
ให้คำปรึกษาหรือไม่?

❏ ไม่มี

❏ มี โปรดระบุอุปสรรค (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

❏ ใช้เวลาค้นข้อมูลนาน

❏ ขั้นตอนยุ่งยากในการนำข้อมูลมาประมวลผล

❏ ไม่มีเวลาเพียงพอในการให้คำปรึกษา

❏ อื่นๆ โปรดระบุ...

**ส่วนที่ 3 ทัศนคติของนักกำหนดอาหารต่อการบันทึกอาหาร การประมวลผลและการวิเคราะห์ผล
พลังงานและสารอาหารในกระบวนการให้คำปรึกษาด้านโภชนาการและการกำหนดอาหาร**

26. ท่านคิดว่าจำนวนคนที่ท่านให้คำปรึกษาด้านโภชนาการและการกำหนดอาหารโดยเฉลี่ยต่อวัน
เป็นอย่างไร?

❏ เหมาะสม

❏ เหมาะสม แต่ต้องการให้บริการผู้ป่วยได้จำนวนมากขึ้น

❏ เหมาะสม แต่ต้องการให้บริการมีประสิทธิภาพมากขึ้น
(โปรดระบุสิ่งที่ต้องการเพิ่มประสิทธิภาพ) ....

❏ มากเกินไป ปัญหาที่เกิดขึ้น คือ ....

❏ น้อยเกินไป ปัญหาที่เกิดขึ้น คือ ....

❏ อื่นๆ โปรดระบุ ....

27. ท่านคิดว่าวิธีการที่ท่านใช้บันทึกอาหาร ประมวลผลและวิเคราะห์ผลพลังงานและสารอาหารใน
ปัจจุบันมีข้อจำกัดในการนำไปใช้ประกอบการให้คำปรึกษาทางโภชนาการและการกำหนดอาหาร
แก่บุคคลกลุ่มต่างๆ ในข้อ 11 หรือไม่?

☐ เหมาะสมในการนำไปใช้งาน เนื่องจาก ....

☐ มีข้อจำกัดในการนำไปใช้งาน

โปรดระบุข้อจำกัด (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

☐ เครื่องมือ/อุปกรณ์ที่ให้ใช้ในปัจจุบันไม่เหมาะสม

โปรดระบุ ....

☐ ไม่มีข้อมูลสารอาหารกลุ่มวิตามินและเกลือแร่

☐ ไม่มีเครื่องมือช่วยในการจัดเก็บข้อมูลต่างๆ

โปรดระบุ ....

☐ อื่นๆ โปรดระบุ...

28. ท่านคิดว่าผลลัพธ์จากการคำนวณพลังงานและสารอาหารที่ท่านได้รับจากวิธีที่ใช้ในปัจจุบันมี
ข้อมูลเพียงพอในการวางแผนการให้คำปรึกษาทางโภชนาการและการกำหนดอาหารแก่บุคคล
กลุ่มต่างๆ หรือไม่? (สามารถเลือกตอบได้มากกว่า 1 ข้อ)

☐ เพียงพอ

☐ เพียงพอ แต่ต้องการข้อมูลมากขึ้น โปรดระบุ ....
(มีต่อหน้า 10)

☐ ไม่เพียงพอ ข้อมูลสารอาหารไม่เพียงพอสำหรับการกำหนดอาหารให้เหมาะสมกับสภาวะ
หรือโรค

โปรดระบุ ....

☐ ไม่แน่ใจ

29. ท่านคิดว่าขั้นตอนการประมวลผลและวิเคราะห์พลังงานและสารอาหารหลังจากได้ข้อมูลการ
บริโภคอาหารตามวิธีที่ท่านใช้ในปัจจุบัน ใช้เวลานานหรือไม่?

☐ ใช้เวลานานไป   ☐ ใช้เวลาเหมาะสม

☐ ใช้เวลาน้อย   ☐ ใช้เวลาเหมาะสม แต่ต้องการให้เร็วมากขึ้น

☐ อื่นๆ โปรดระบุ ....

30. ท่านคาดหวังระยะเวลาที่ใช้ในขั้นตอนการบันทึกอาหาร การประมวลผล และการวิเคราะห์ผล พลังงานและสารอาหารหลังจากได้ข้อมูลการบริโภคอาหารเป็นอย่างไร?

❏ ควรใช้เวลานานไม่เกิน .... นาที

❏ ทราบผลทันทีหลังจากได้รับข้อมูล

❏ อื่นๆ โปรดระบุ ....

31. ท่านคิดว่าการประมวลและวิเคราะห์ผลพลังงานและสารอาหารหลังจากได้ข้อมูลการบริโภค อาหารตามวิธีที่ท่านใช้อยู่ในปัจจุบันมีโอกาสผิดพลาดได้หรือไม่?

❏ ไม่มีโอกาสผิดพลาดเลย (กรณีตอบข้อเลือกนี้ให้ข้ามข้อ 32 ไปตอบข้อที่ 33)

❏ มีโอกาสผิดพลาดน้อย

❏ มีโอกาสผิดพลาดปานกลาง   ❏ มีโอกาสผิดพลาดมาก

❏ อื่นๆ โปรดระบุ ....

32. ท่านคิดว่าการประมวลและวิเคราะห์ผลพลังงานและสารอาหารในข้อที่ 31 อาจเกิดความ ผิดพลาดได้จากสาเหตุใดได้บ้าง?

❏ อาหารบางชนิดที่ได้จากการซักประวัติไม่สามารถนำไปเทียบเคียงกับรายการอาหารในหมวด ต่างๆ ที่ระบุในรายการอาหารแลกเปลี่ยน

❏ ไม่สามารถใช้รายการอาหารในธงโภชนาการประมาณปริมาณอาหารที่บริโภคที่มาจากกลุ่ม ผลิตภัณฑ์อาหาร เช่น ขนมขบเคี้ยว เครื่องดื่ม อาหารทางการแพทย์ เป็นต้น

❏ ไม่มีข้อมูลพลังงานและสารอาหารใช้ในการประมวลผลหน่วยบริโภคของอาหารในแต่ละ หมวดในธงโภชนาการ

❏ การจัดจำชนิดอาหารและปริมาณต่อหน่วยบริโภคของอาหารในหมวดอาหารต่างๆ ได้ไม่ หมด

❏ การจัดจำพลังงานหรือสารอาหารในหมวดอาหารแลกเปลี่ยนไม่ได้

❏ การจัดจำพลังงานหรือสารอาหารในบางหมวดอาหารแลกเปลี่ยนไม่ได้

❏ การจัดจำพลังงานหรือสารอาหารในหมวดอาหารแลกเปลี่ยนอาหารคลาดเคลื่อน

❏ ผู้ประมวลผลคำนวณเลขด้วยตัวเองผิดพลาด

❏ ผู้ประมวลผลกดเครื่องคิดเลขผิดพลาด

❏ รายการอาหารแลกเปลี่ยนมีความซับซ้อน การคำนวณพลังงานและสารอาหารยากลำบาก

❏ ไม่สามารถใช้รายการอาหารแลกเปลี่ยนในการกะประมาณปริมาณอาหารที่บริโภคซึ่งมาจาก
กลุ่ม ผลิตภัณฑ์อาหาร เช่น ขนมขบเคี้ยว เครื่องดื่ม อาหารทางการแพทย์ เป็นต้น

❏ บางครั้งต้องใช้เวลาอย่างรวดเร็วในการประมวลและวิเคราะห์ผล

❏ ไม่มีเทคโนโลยีเข้ามาช่วยในการประมวลผลและตรวจสอบข้อมูลที่บันทึกย้อนกลับ

❏ อื่นๆ โปรดระบุ ....

33. ท่านประสงค์ให้มีเทคโนโลยีมาช่วยท่านในการบันทึกอาหาร การประมวลผลและการวิเคราะห์ผล
ข้อมูลอาหารที่ท่านได้จากการซักประวัติและแสดงผลการประเมินการบริโภคอาหารแบบ
realtime หรือไม่?

❏ ต้องการมากที่สุด

❏ ต้องการมาก

❏ ต้องการปานกลาง

❏ เฉยๆ

❏ ไม่ต้องการ

❏ ไม่แน่ใจ

34. ท่านประสงค์ให้มีเทคโนโลยีมาช่วยท่านในการบันทึกประวัติและติดตามการบริโภคอาหาร
รวมทั้งวางแผนกำหนดอาหารสำหรับผู้ที่ท่านให้คำปรึกษาทางโภชนาการและกำหนดอาหาร
รายบุคคลหรือไม่?

❏ ต้องการมากที่สุด

❏ ต้องการมาก

❏ ต้องการปานกลาง

❏ เฉยๆ

(มีต่อหน้า 12)

❏ ไม่ต้องการ

❏ ไม่แน่ใจ
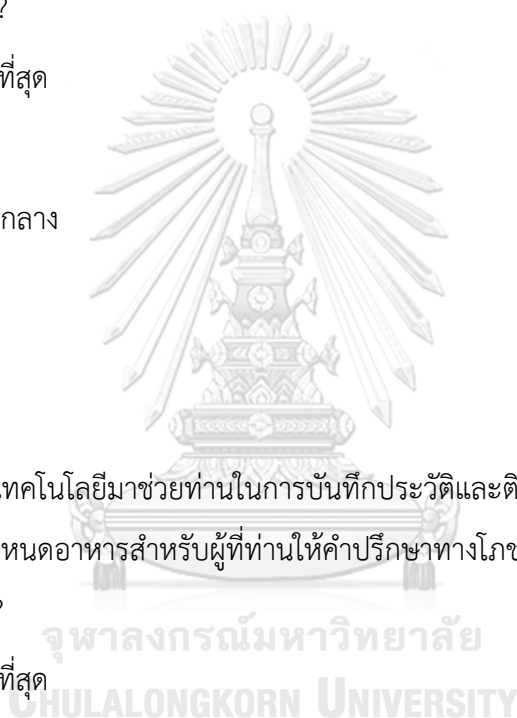
35. ในอนาคตหากมีแอปพลิเคชั่นบนโทรศัพท์มือถือหรือแท็บเล็ตมาช่วยท่านในการบันทึกอาหาร
การประมวลผล การวิเคราะห์ผลและการจัดทำฐานข้อมูลประวัติเพื่อติดตามการบริโภคอาหาร
ของผู้ที่ท่านให้คำปรึกษาทางโภชนาการและกำหนดอาหาร รวมทั้งการแสดงผลการประเมินการ
บริโภคอาหารรายบุคคลแบบ realtime ท่านสนใจจะทดลองใช้งานเทคโนโลยีดังกล่าวหรือไม่?

❏ สนใจมากที่สุด

❏ สนใจมาก

❏ สนใจปานกลาง

❏ เฉยๆ

❏ ไม่สนใจ

❏ ไม่แน่ใจ

ขอขอบพระคุณท่านที่ให้ความร่วมมือ

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

APPENDIX J

Questionnaire of acceptability and commentaries toward the developed application

แบบประเมินความคิดเห็นของนักกำหนดอาหารต่อการใช้งานโปรแกรมประยุกต์ NDPro

คำชี้แจง

      แบบสอบถามนี้เป็นส่วนหนึ่งของวิทยานิพนธ์ เรื่อง Development and validation of smartphone nutrition application for supporting dietetic professional practice ซึ่งมีวัตถุประสงค์เพื่อพัฒนาโปรแกรมประยุกต์ (application) "NDPro" ที่ใช้งานบนมือถือหรือแท็บเล็ตสำหรับสนับสนุนการทำงานของนักกำหนดอาหารและนักโภชนาการ โดยนำไปใช้ในการบันทึกอาหารประมวลและวิเคราะห์ผลจากอาหารที่บริโภค แสดงผลการประเมินการบริโภคอาหารรายบุคคลและจัดทำฐานข้อมูลประวัติเพื่อติดตามการให้คำปรึกษาด้านโภชนาการและการกำหนดอาหารได้รวดเร็วและมีข้อมูลสารอาหารมากกว่ารายการอาหารแลกเปลี่ยนและธงโภชนาการ โดยการคำนวณพลังงานและสารอาหารให้พลังงานจากอาหารที่ควรได้รับต่อวันนำข้อมูลทางวิชาการที่ปัจจุบันนักกำหนดอาหารและนักโภชนาการนำใช้ในการปฏิบัติงานประจำ ส่วนวิธีการประเมินการบริโภคอาหารอ้างอิงรายการอาหาร หน่วยบริโภควิธีการคำนวณพลังงานและสารอาหารให้พลังงานจากอาหารที่ระบุในรายการอาหารแลกเปลี่ยนไทยและธงโภชนาการ สำหรับการคำนวณพลังงานและสารอาหารเพื่อให้ได้ข้อมูลสารอาหารมากขึ้นใช้ข้อมูลอาหารและสารอาหารอ้างอิงจากฐานข้อมูลอาหารของกรมอนามัยกระทรวงสาธารณสุข ฐานข้อมูลที่รวบรวมและใช้ในโปรแกรม INMUCAL ของสถาบันโภชนาการมหาวิทยาลัยมหิดล และจากการสำรวจผลิตภัณฑ์อาหารในท้องตลาดปัจจุบัน

      ทางผู้วิจัยขอขอบพระคุณทุกท่านที่กรุณาให้ความอนุเคราะห์ในการตอบแบบสอบถามความพึงพอใจต่อการใช้งานโปรแกรมประยุกต์ NDPro ข้อมูลของท่านจะถือเป็นความลับและทางผู้วิจัยจะนำไปใช้เพื่อประโยชน์ทางวิชาการเท่านั้น

<div align="right">

นายธนะศักดิ์ ตันติชัยยกุล
นิสิตหลักสูตรวิทยาศาสตรมหาบัณฑิต
สาขาวิชาอาหารและโภชนาการ (นานาชาติ)
คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

</div>

แบบสอบถาม ประกอบด้วย 2 ส่วน ดังนี้

ส่วนที่ 1 ข้อมูลทั่วไป

ส่วนที่ 2 ความคิดเห็นของของนักกำหนดอาหารต่อลักษณะของโปรแกรมประยุกต์ NDPro และประโยชน์ที่ได้รับ

ส่วนที่ 1 ข้อมูลทั่วไป

โปรดทำเครื่องหมาย ✓ ลงใน ❒ หรือเติมข้อความลงในช่องว่าง หากข้อความใดมีคำว่า "โปรดระบุ" กรุณาให้ข้อมูลเพิ่มเติม

1. เพศ

   ❒ ชาย   ❒ หญิง

2. อายุ .... ปี

3. ศาสนา

   ❒ พุทธ   ❒ คริสต์   ❒ อิสลาม   ❒ อื่นๆ โปรดระบุ ....

4. ระดับการศึกษาสูงสุด

   ❒ ต่ำกว่าปริญญาตรี

   ❒ ปริญญาตรี สาขา (โปรดระบุ) ....

   ❒ ปริญญาโท สาขา (โปรดระบุ) ....

   ❒ ปริญญาเอก สาขา (โปรดระบุ) ....

   ❒ อื่นๆ (โปรดระบุ)..

5. ตำแหน่งงานของท่าน

   ❒ นักกำหนดอาหาร   ❒ นักโภชนาการ   ❒ โภชนากร

   ❒ ผู้เชี่ยวชาญด้านอาหาร (โปรดระบุ) ....

   ❒ นิสิต : ระดับ   ❒ ปริญญาตรี สาขา (โปรดระบุ) ....

                      ❒ ปริญญาโท สาขา (โปรดระบุ) ....

                      ❒ ปริญญาเอก สาขา (โปรดระบุ) ....

   ❒ อื่นๆ (โปรดระบุ) ....

6. สถานที่ทำงานปัจจุบัน

   ❒ โรงพยาบาล (โปรดระบุ)   ❒ คลินิกสุขภาพ

....

☐ คลินิกเสริมความงาม   ☐ โรงเรียน

☐ มหาวิทยาลัย (โปรดระบุ) ....

☐ อื่นๆ โปรดระบุ..

<u>(กรณีที่ตอบ "โรงพยาบาล" ให้ทำข้อ 7 ต่อ)</u>

<u>(กรณีที่ไม่ได้ตอบ "โรงพยาบาล" ให้ข้ามไปทำข้อ 8)</u>

7. ประเภทโรงพยาบาลที่ท่านทำงาน

☐ โรงพยาบาลมหาวิทยาลัย   จำนวน..............................เตียง

☐ โรงพยาบาลศูนย์   จำนวน..............................เตียง

☐ โรงพยาบาลทั่วไป   จำนวน..............................เตียง

☐ โรงพยาบาลชุมชน   จำนวน..............................เตียง

☐ โรงพยาบาลเอกชน   จำนวน..............................เตียง

<u>หมายเหตุ</u>

1. โรงพยาบาลชุมชน (รพช.) มีเตียงสำหรับผู้ป่วยตั้งแต่ 10 ถึง 150 เตียง

2. โรงพยาบาลทั่วไปในระดับอำเภอ มีเตียงสำหรับผู้ป่วยตั้งแต่ 200 - 500 เตียง

3. โรงพยาบาลในระดับจังหวัดหรือโรงพยาบาลศูนย์ มีเตียงสำหรับผู้ป่วยมากกว่า 500 เตียงขึ้นไป

---

8. สถานที่ที่ท่านปฏิบัติงานมีนักกำหนดอาหาร นักโภชนาการและโภชนากรจำนวนเท่าไร? (โปรด
ระบุตามตำแหน่งงานที่ได้รับจากหน่วยงานที่ปฏิบัติหน้าที่)

☐ นักกำหนดอาหาร   จำนวน................................คน

☐ นักโภชนาการ   จำนวน................................คน

☐ โภชนากร   จำนวน................................คน

9. ท่านมีประสบการณ์ทำงาน .... ปี และมีประสบการณ์ในการให้คำปรึกษาทางโภชนาการ
และการกำหนดอาหาร .... ปี

10. ท่านมีความเชี่ยวชาญในการให้คำปรึกษาทางโภชนาการและการกำหนดอาหารในโรคใด?
(สามารถเลือกตอบได้มากกว่า 1 ข้อ)

☐ โรคเบาหวาน   ☐ โรคความดันโลหิตสูง   ☐ โรคหัวใจและหลอดเลือด

☐ โรคไต   ☐ โรคมะเร็ง   ☐ โรคอ้วนและการควบคุมน้ำหนัก

❏ อื่นๆ โปรดระบุ...

ส่วนที่ 2 ความคิดเห็นของนักกำหนดอาหารต่อลักษณะและประโยชน์ที่ได้รับจากส่วนต่างๆ ของโปรแกรมประยุกต์ NDPro

โปรดทำเครื่องหมาย ✓ ลงในช่องที่ตรงกับความคิดเห็นของท่านมากที่สุด

1. โปรดเลือกลักษณะของโปรแกรมประยุกต์ NDPro ให้ตรงกับลักษณะที่ท่านคิดมากที่สุด

<u>ตัวอย่าง</u>

	-3	-2	-1	0	+1	+2	+3	
ลักษณะ 1	◯	◯	◯	✓	◯	◯	◯	ลักษณะ 2

	-3	-2	-1	0	+1	+2	+3	
1.1. น่ารำคาญ (annoying)	◯	◯	◯	◯	◯	◯	◯	น่าสนุก (enjoyable)
1.2. เข้าใจได้ยาก (not understandable)	◯	◯	◯	◯	◯	◯	◯	เข้าใจได้ง่าย (understandable)
1.3. สร้างสรรค์ (creative)	◯	◯	◯	◯	◯	◯	◯	ธรรมดา (dull)
1.4. เรียนรู้ได้ง่าย (easy to learn)	◯	◯	◯	◯	◯	◯	◯	เรียนรู้ได้ยาก (difficult to learn)
1.5. มีคุณค่า (valuable)	◯	◯	◯	◯	◯	◯	◯	ไม่มีคุณค่า (inferior)
1.6. น่าเบื่อ (boring)	◯	◯	◯	◯	◯	◯	◯	น่าตื่นเต้น (exciting)
1.7. ไม่น่าสนใจ (not interesting)	◯	◯	◯	◯	◯	◯	◯	น่าสนใจ (interesting)
1.8. คาดเดาได้ยาก (unpredictable)	◯	◯	◯	◯	◯	◯	◯	คาดเดาได้ง่าย (predictable)
1.9. รวดเร็ว (fast)	◯	◯	◯	◯	◯	◯	◯	ช้า (slow)

	-3	-2	-1	0	+1	+2	+3	
1.10. แปลกใหม่ (inventive)	◯	◯	◯	◯	◯	◯	◯	จำเจ (conventional)
1.11. เป็นอุปสรรค (obstructive)	◯	◯	◯	◯	◯	◯	◯	ช่วยสนับสนุน (supportive)
1.12. ดี (good)	◯	◯	◯	◯	◯	◯	◯	แย่ (bad)
1.13. ซับซ้อน (complicated)	◯	◯	◯	◯	◯	◯	◯	เรียบง่าย (easy)
1.14. ไม่ถูกใจ (unlikable)	◯	◯	◯	◯	◯	◯	◯	ถูกใจ (pleasing)
1.15. พบได้ทั่วไป (usual)	◯	◯	◯	◯	◯	◯	◯	แปลกใหม่ (leading edge)
1.16. ไม่ชอบ (unpleasant)	◯	◯	◯	◯	◯	◯	◯	ชอบ (pleasant)
1.17. ปลอดภัย (secure)	◯	◯	◯	◯	◯	◯	◯	ไม่ปลอดภัย (not secure)
1.18. สร้างแรงจูงใจ (motivating)	◯	◯	◯	◯	◯	◯	◯	ไม่สร้างแรงจูงใจ (demotivating)
1.19. ตรงตามความคาดหวัง (meets expectations)	◯	◯	◯	◯	◯	◯	◯	ผิดหวัง (does not meet expectations)
1.20. ไร้ประสิทธิภาพ (inefficient)	◯	◯	◯	◯	◯	◯	◯	มีประสิทธิภาพ (efficient)
1.21. ชัดเจน (clear)	◯	◯	◯	◯	◯	◯	◯	สับสน (confusing)
1.22. ใช้ไม่ได้จริง (impractical)	◯	◯	◯	◯	◯	◯	◯	ใช้ได้จริง (practical)
1.23. เป็นระเบียบ (organized)	◯	◯	◯	◯	◯	◯	◯	ไม่เป็นระเบียบ (cluttered)
1.24. ดึงดูดใจ (attractive)	◯	◯	◯	◯	◯	◯	◯	ไม่น่าดึงดูดใจ (unattractive)

1.25. เป็นมิตร (friendly)	○ ○ ○ ○ ○ ○ ○	ไม่เป็นมิตร (unfriendly)
1.26. ล้าหลัง (conservative)	○ ○ ○ ○ ○ ○ ○	ล้ำหน้า (innovative)

2. ท่านคิดว่าการใช้งานส่วนต่างๆ (function) ของโปรแกรมประยุกต์ NDPro มีประโยชน์ต่อการ
ปฏิบัติหน้าที่ของท่านหรือไม่? (หน้าจอภาพการใช้งานแสดงในเอกสารประกอบด้านหลัง)

ส่วนต่างๆ ของโปรแกรมประยุกต์ NDPro	มีประโยชน์ มากที่สุด	มีประโยชน์ มาก	มีประโยชน์ ปานกลาง	มีประโยชน์ น้อย	มีประโยชน์ น้อยที่สุด
2.1 การสร้างบัญชีผู้ถูกซักประวัติรายบุคคล เพื่อบันทึกข้อมูลส่วนตัวและติดตามผล สามารถสร้างบัญชีของผู้ถูกซักประวัติ แต่ละคน สำหรับบันทึกผลลัพธ์และ ติดตามย้อนหลัง					
2.2 การค้นหาและจัดการบัญชี ผู้ใช้สามารถค้นหาบัญชีผู้ถูกซักประวัติ ที่เคยถูกสร้าง มีความสามารถในการ ค้นหา, แก้ไข และลบประวัติเก่า					
2.3 การกรอกข้อมูลพื้นฐานในการประเมิน ภาวะโภชนาการ เช่น น้ำหนัก ส่วนสูง อายุ เพศ ระดับกิจกรรมทางกาย ระดับ Stress factor และวิธีคำนวนความ ต้องการพลังงานและสารอาหาร เป็นต้น โดยมีคำอธิบายหลักการและ ที่มากำกับ					
2.4 การเลือกใช้น้ำหนักตัว ได้แก่ Adjust body weight, actual body weight, และ ideal body weight รวมถึงการ ปรับน้ำหนักตัวในกรณีที่มีความพิการ ของอวัยวะ					
2.5 ความสามารถในการคำนวณพลังงาน และสารอาหารตามปริมาณสารอาหาร อ้างอิงที่ควรได้รับประจำวันเป็น รายบุคคล (Dietary Reference Intake หรือ DRI)					

ส่วนต่างๆ ของโปรแกรมประยุกต์ NDPro	มีประโยชน์มากที่สุด	มีประโยชน์มาก	มีประโยชน์ปานกลาง	มีประโยชน์น้อย	มีประโยชน์น้อยที่สุด
2.6 ความสามารถในการคำนวณพลังงานและสารอาหารที่ควรได้รับโดยระบุหน่วยบริโภคตามคำแนะนำในธงโภชนาการ					
2.7 การบันทึกการรับประทานอาหารโดยสามารถบันทึกข้อมูลการรับประทานอาหารจากการสัมภาษณ์และสามารถเห็นการเปลี่ยนแปลงพลังงานและสารอาหารที่ได้รับระหว่างการบันทึกข้อมูลทันที					
2.8 ความสามารถในการแสดงผลการประเมินการบริโภคอาหาร โดยจัดเรียงพลังงานและสารอาหารจากมากไปน้อยหรือจากน้อยไปมากเพื่อความสะดวกในการวางแผนการให้คำปรึกษา					
2.9 สามารถบันทึกผลการบริโภคอาหารปัญหาทางโภชนาการ และวางแผนการกำหนดอาหารตามหลัก Nutrition care process กำหนดการพบแพทย์ครั้งต่อไป และการตั้งค่าที่ผู้ใช้งานตั้งในการปฏิบัติงานแต่ละครั้ง ผู้ใช้งานสามารถเรียกดูข้อมูลที่บันทึกไว้สำหรับการปฏิบัติงานครั้งต่อไปได้					
2.10 รูปภาพอาหารแลกเปลี่ยนหมวดต่างๆ ที่ใช้ประกอบร่วมกับอุปกรณ์ระหว่างการซักประวัติการบริโภคอาหารสามารถนำมาช่วยในการประเมินอาหารที่ยากต่อการประมาณการ					

ส่วนต่างๆ ของโปรแกรมประยุกต์ NDPro	มีประโยชน์ มากที่สุด	มีประโยชน์ มาก	มีประโยชน์ ปานกลาง	มีประโยชน์ น้อย	มีประโยชน์ น้อยที่สุด
2.11 มีฐานข้อมูลพลังงานและสารอาหาร สามารถเปิดดูข้อมูลหรือนำมาใช้ใน การคำนวนได้ (โปรดระบุจาก หมวดหมู่ต่อไปนี้)					
2.11.1 หมวดรายการอาหารจานเดียว					
2.11.2 หมวดรายการอาหารว่าง					
2.11.3 หมวดรายการเครื่องดื่ม					
2.11.4 หมวดน้ำพริก					
2.11.5 หมวดผลิตภัณฑ์เบเกอรี่และขนม อบ					
2.11.6 หมวดผลิตภัณฑ์จากธัญพืช					
2.11.7 หมวดผลิตภัณฑ์ไอศครีม					
2.11.8 หมวดผลิตภัณฑ์อาหารแช่เย็น และแช่แข็ง					
2.11.9 หมวดผลิตภัณฑ์อาหารกึ่ง สำเร็จรูปและผลิตภัณฑ์อาหาร พร้อมบริโภค					
2.11.10 หมวดนมและผลิตภัณฑ์					
2.11.11 หมวดผลิตภัณฑ์เครื่องดื่มจากถั่ว และธัญพืช					
2.11.12 หมวดผลิตภัณฑ์เครื่องดื่ม แอลกอฮอล์					
2.11.13 หมวดผลิตภัณฑ์เครื่องดื่มทั่วไป					
2.11.14 หมวดผลิตภัณฑ์เครื่องดื่มชนิดผง					

ส่วนต่างๆ ของโปรแกรมประยุกต์ NDPro	มีประโยชน์ มากที่สุด	มีประโยชน์ มาก	มีประโยชน์ ปานกลาง	มีประโยชน์ น้อย	มีประโยชน์ น้อยที่สุด
2.11.15 หมวดผลิตภัณฑ์เพิ่มเติมสำหรับ เครื่องดื่มชนิดผง					
2.11.16 หมวดเครื่องปรุง					
2.11.17 หมวดผลิตภัณฑ์อาหารทาง การแพทย์					
2.11.18 หมวดผลิตภัณฑ์น้ำยาล้างไต					
2.12 สามารถคำนวนปริมาณและสัดส่วน ของกรดไขมันจากอาหารเพื่อให้ได้ ตามปริมาณสารอาหารอ้างอิงที่ควร ได้รับประจำวันสำหรับคนไทย (Dietary Reference Intake for Thais หรือ Thai DRI)					
2.13 สามารถคำนวนปริมาณโฟเลตจาก อาหารเพื่อให้ได้ตามปริมาณ สารอาหารอ้างอิงที่ควรได้รับ ประจำวันสำหรับคนไทย					
2.14 สามารถพิมพ์ผลการบริโภคอาหาร ปัญหาทางโภชนาการ และวางแผน การกำหนดอาหารตามหลัก Nutrition care process เป็นไฟล์ Portable Document Format (PDF) หรือไฟล์ Microsoft excel ได้					
2.15 โดยภาพรวม แอพพลิเคชั่นมีประโยชน์ ต่อการปฏิบัติหน้าที่ของท่าน					

3. ท่านมีความคิดเห็นว่าแนวทางการพัฒนาขั้นต่อไปของโปรแกรมประยุกต์ NDPro นี้ควรเป็น

อย่างไร?

....

....

....

4. หากโปรแกรมประยุกต์ NDPro พัฒนาเสร็จสมบูรณ์ ท่านคิดว่าท่านจะนำมาใช้เป็นเครื่องมือช่วย

ในการปฏิบัติงานให้คำปรึกษาด้านโภชนาการและการกำหนดอาหารของท่านหรือไม่?

☐ ใช้   ☐ ไม่ใช้   ☐ ไม่แน่ใจ

<u>กรณีตอบว่า "ไม่ใช้" หรือ "ไม่แน่ใจ"</u> โปรดระบุเหตุผล เพื่อผู้พัฒนาจะได้นำไปพัฒนาต่อไป

....

....

....

....

5. หากโปรแกรมประยุกต์ NDPro พัฒนาเสร็จสมบูรณ์ ท่านจะแนะนำให้นักกำหนดอาหารหรือนัก

โภชนาการที่ท่านรู้จักนำมาใช้หรือไม่?

☐ แนะนำ   ☐ ไม่แนะนำ   ☐ ไม่แน่ใจ

<u>กรณีตอบว่า "ไม่แนะนำ" หรือ "ไม่แน่ใจ"</u> โปรดระบุเหตุผล เพื่อผู้พัฒนาจะได้นำไปพัฒนา

ต่อไป

....

....

....

....

6. ข้อเสนอแนะอื่นๆ

....

....

....

ขอขอบพระคุณท่านที่ให้ความร่วมมือ

APPENDIX K

Food items and nutrients used to determine new food exchange list (Thai food exchange list)

1. Starch group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Rice polished, steamed	55	RA	01015	17.11	1.26	0.13	0.05	0.11	0.00	0.00	0.00	0.02	0.01	0.83	0.00	11.14	48.55	10.39	1.77	0.11	0.04	0.29
Rice glutinous, polished, steamed	35	RA	01053	18.62	1.59	0.07	0.03	0.10	0.04	0.00	0.00	0.02	0.04	0.82	0.00	4.43	4.51	4.20	1.13	0.37	0.03	0.38
Noodles, rice, fermented (Kanom-jeen)	90	RA	01006	21.34	1.29	0.28	0.07	0.26	0.00	-	0.00	0.54	0.01	0.46	0.14	42.15	8.64	9.20	14.36	0.31	0.02	0.19
Noodles, rice, small size, fresh	90	BO	01004	31.14	2.42	0.56	0.15	0.27	0.00	-	0.00	0.00	0.01	0.36	0.00	56.69	42.33	13.07	7.13	0.98	0.03	0.29
Noodles, rice, fine thread, soaked	100	BO	01084	25.57	1.92	0.45	0.19	0.44	-	0.00	0.00	0.04	0.00	0.19	0.00	9.91	71.44	28.76	17.58	0.58	0.07	0.36
Instant noodle, dried	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potato, boiled	100	RA	02006	16.30	1.90	0.10	0.03	-	0.72	0.00	-	0.06	0.02	1.30	11.0	3.30	-	44.00	7.00	0.80	0.09	0.19
Taro, boiled	65	RA	02004	18.72	1.24	0.20	0.04	2.26	0.29	0.00	2.03	0.05	0.03	0.39	2.60	8.67	-	31.20	31.20	0.59	0.12	0.16
Jackfruit, seeds, boiled	50	RA	03032	17.40	2.50	0.10	0.03	-	-	0.00	-	0.04	0.03	0.20	4.00	-	-	36.50	18.50	0.35	-	-
Horn chestnut, boiled	60	RA	03045	17.76	2.16	0.06	-	-	-	0.00	0.00	0.16	0.02	-	5.40	-	-	53.40	13.80	2.76	-	-
Corn, whole kernel, yellow, boiled	65	RA	01024	23.21	2.15	0.78	0.18	3.25	0.19	0.00	5.64	0.06	0.05	0.59	3.25	10.35	-	59.80	6.50	0.78	-	-
Chestnut, chinese, roasted	30	RA	03003	16.11	0.90	0.60	0.16	-	-	0.00	0.15	0.05	0.03	0.45	1.50	1.20	143.1	17.70	8.70	0.33	0.12	0.27
Bean, boiled (karen food)	75	RA	03123	18.30	6.90	0.75	-	6.60	-	0.00	-	0.03	0.01	0.55	0.00	-	-	97.50	78.00	0.75	-	-
Bread, whole wheat	25	RA	01048	11.81	2.97	1.35	0.57	1.49	1.80	2.50	0.00	0.05	0.06	0.66	0.00	103.75	34.25	61.24	20.85	0.47	0.08	0.52
Noodles, wheat, fresh	75	BO	01032	28.62	6.66	1.73	0.50	0.00	-	-	7.14	0.01	0.02	-	0.00	321.86	-	47.28	9.73	1.06	-	-
Macaroni, cooked, unenrich	75	RA	01045	23.15	4.35	0.70	0.13	1.35	0.42	0.00	0.00	0.02	0.02	0.30	0.00	0.75	33.00	43.50	5.25	0.38	0.08	0.38
Median values	Energy : 87.08 kcal[2]			18.62	2.15	0.45	0.13	0.44	0.19	0.00	0.00	0.04	0.02	0.46	0.00	10.13	38.29	36.50	9.73	0.58	0.07	0.29

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BO = Boiling, ND = No Data (no information of those food items appeared in the databases); "-" = Databases did not provide the nutrients content in those food items.

2. Vegetable group type 1

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Cabbage, chinese, white, raw	100	RA	04075	1.48	1.72	0.10	0.02	2.12	0.00	0.00	1.15	0.07	0.21	1.11	25.36	29.11	218.60	31.53	57.00	0.42	0.05	0.17
Lettuce, raw	100	RA	04076	2.26	1.40	0.13	0.02	1.42	0.73	0.00	114.33	0.04	0.10	0.28	13.79	23.95	189.86	24.93	49.19	1.05	0.04	0.18
Water morning glory, thai, red stem, raw	100	RA	04092	4.45	1.78	0.19	0.05	3.84	0.00	0.00	49.00	0.07	0.14	0.98	13.00	22.66	366.74	35.25	25.67	1.29	0.04	0.18
Water fern, raw	100	RA	04101	4.58	1.87	0.19	0.03	7.00	-	0.00	234.09	0.02	0.20	1.29	2.40	68.64	357.59	55.16	31.63	3.21	-	-
Mustard, chinese, green, leaves, boiled	70	RA	04078	2.03	1.19	0.14	-	1.33	0.07	0.00	84.76	0.03	0.05	0.42	18.90	10.50	135.10	28.00	60.20	0.63	0.06	0.07
Water lily, raw	100	RA	04126	2.39	0.33	0.11	0.01	1.68	0.00	0.00	3.63	0.02	0.01	0.08	9.00	6.55	-	9.00	8.00	0.35	-	-
Spinach, raw	100	RA	04225	1.97	2.37	0.57	-	2.38	0.33	-	210.0	0.07	0.48	0.41	16.00	3.62	344.00	52.00	56.58	56.0	0.09	0.85
Young pumpkin, tip	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sweet basil, leaves, raw	100	RA	04065	6.50	2.89	0.22	0.01	3.94	0.00	0.00	214.29	0.11	0.20	0.90	15.93	26.02	398.09	63.11	154.9	2.84	0.16	0.85
Cabbage, raw	100	RA	04009	4.86	1.46	0.17	0.03	1.62	2.95	0.00	7.53	0.04	0.08	0.44	19.05	24.97	235.95	35.60	33.77	0.31	0.03	0.12
Cauliflower, boiled, drained without salt	70	RA	04006	2.88	1.29	0.32	0.05	1.61	1.46	0.00	0.70	0.03	0.04	0.29	31.01	10.50	99.40	22.40	11.20	0.22	0.01	0.12
Celery, raw	100	RA	04082	4.59	1.55	0.18	0.05	2.63	3.39	0.00	146.49	0.03	0.18	0.69	33.03	124.60	351.57	37.33	151.33	2.73	0.06	0.49
Tomato	100	RA	04121	4.38	1.00	0.35	0.04	1.06	-	0.00	34.00	0.07	0.04	0.60	22.57	11.46	188.29	23.18	8.64	0.35	0.10	0.16
Yellow berried nightshade / thai eggplant, raw	100	RA	04123	6.95	1.48	0.16	0.05	2.72	2.89	0.00	3.18	0.07	0.04	0.69	5.34	10.55	246.74	29.72	19.60	0.55	0.14	0.23
Turmeric, white, raw	100	RA	04019	5.14	0.37	0.25	-	-	-	0.00	-	0.02	0.01	0.50	8.72	8.40	195.44	52.90	6.70	0.49	0.02	0.15
Cucumber, large, raw	100	RA	04032	2.84	0.42	0.08	-	0.70	-	0.00	0.29	0.01	0.02	0.13	8.30	8.24	105.18	17.87	12.95	0.18	0.01	0.09
Cucumber, raw	100	RA	04030	4.34	0.78	0.10	0.02	0.99	2.02	0.00	2.23	0.04	0.05	0.31	10.84	7.67	166.38	26.12	21.03	0.26	0.05	0.15

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Watermelon, young, raw	100	RA	04033	2.20	0.40	0.10	0.01	-	0.00	0.00	-	0.03	0.03	0.30	28.00	-	-	8.00	2.00	0.40	-	-
Gourd, wax / winter melon, raw	100	RA	04109	4.33	0.42	0.08	0.02	1.71	0.00	0.00	0.53	0.01	0.02	0.40	30.20	7.00	132.73	16.80	14.03	0.25	0.02	0.10
Gourd, bottle, raw	100	RA	04049	3.99	0.46	0.07	0.01	1.51	0.00	0.00	0.17	0.02	0.03	0.33	10.90	4.88	119.34	8.33	8.80	0.26	0.08	0.13
Marrow	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gourd, angled, raw	100	RA	04062	4.83	0.81	0.07	0.02	1.18	0.00	0.00	0.47	0.05	0.04	0.21	4.65	4.33	107.30	29.23	10.00	0.25	0.06	0.15
Pepper, hot, green, raw	100	RA	04256	5.33	1.27	0.27	0.03	3.63	0.00	0.00	-	0.09	0.02	-	18.33	-	-	-	-	0.50	-	-
Chilli pepper, raw	100	RA	04106	5.86	1.38	0.19	0.02	3.19	0.00	0.00	4.44	0.22	0.08	1.11	52.33	8.67	183.11	36.50	10.00	0.50	0.07	0.20
Koon	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Crawdaisy, leaves, raw	100	RA	04051	3.30	1.80	0.30	0.02	-	0.00	0.00	263.50	0.09	0.19	0.60	27.00	-	-	34.00	63.00	2.50	-	-
Banana young stem, raw	100	RA	04164	2.00	0.80	0.20	0.05	1.95	0.00	0.00	0.00	0.02	0.24	0.30	2.00	1.36	-	3.00	25.00	0.40	-	-
Median values	Energy : 24.06 kcal[2]			4.34	1.28	0.18	0.02	1.71	0.00	0.00	4.44	0.04	0.05	0.42	15.97	10.50	189.86	29.23	21.03	0.45	0.05	0.16

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BO = Boiling, RE = Ready to eat, ND = No Data (no information of those food items appeared in the databases)

3. Vegetable group type 2

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Pumpkin, flesh (without skin), boiled	70	RA	04310	9.78	0.68	0.22	-	1.21	-	0.00	-	-	-	-	8.13	5.37	122.34	22.66	8.52	0.28	0.07	0.16
Onion, raw	100	RA	04136	5.60	1.40	0.10	0.01	1.50	3.19	0.00	0.00	0.02	0.02	0.40	22.0	4.00	76.00	27.00	24.00	0.41	0.04	0.20
Stinkbean, seeds, raw	100	RA	04163	15.50	8.00	4.00	0.94	-	-	0.00	39.50	0.11	0.01	1.00	6.00	-	83.00	-	76.00	0.70	-	-

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Carrot, raw	100	RA	04167	7.20	1.61	0.23	0.03	3.38	4.17	0.00	372.63	0.03	0.08	0.39	18.9	80.24	305.53	67.33	35.03	0.58	0.10	0.22
Cassia, leaves, raw	100	RA	04023	12.66	6.12	0.63	0.22	4.85	0.00	0.00	20.00	0.37	0.56	3.01	49.87	28.82	499.73	116.49	115.18	2.39	0.20	-
Pak-waan, raw	100	RA	04096	8.30	6.00	0.60	0.20	5.20	0.00	0.00	272.92	0.12	0.16	3.60	168.0	8.00	162.47	68.00	24.00	1.30	0.13	-
Soybean sprout, cooked	70	RA	04038	3.29	3.36	0.49	-	0.28	0.16	0.00	1.05	0.07	0.06	0.28	1.40	3.50	133.00	9.80	12.60	0.56	0.05	0.42
Sugar pea / garden pea, young pods, boiled	70	RA	04045	5.32	0.91	0.00	0.00	1.61	2.70	0.00	3.91	0.08	0.05	0.42	19.60	0.70	79.80	14.00	11.20	0.14	0.05	0.35
Yardlong bean, green, boiled	70	RA	04040	5.67	2.03	0.07	0.02	2.52	1.17	0.00	3.85	0.07	0.08	0.63	13.30	2.80	187.60	25.90	38.50	0.49	0.03	0.21
Mungbean sprout, boiled	70	RA	04036	5.53	1.54	0.07	-	0.91	3.22	0.00	0.70	0.05	0.04	0.35	2.10	11.20	114.10	28.00	4.20	0.28	0.14	0.56
Snap bean, pods, raw	100	RA	04047	4.50	1.90	0.10	0.02	-	0.00	0.00	9.00	0.07	0.09	0.60	32.0	1.65	-	45.00	78.00	3.80	-	-
Winged bean, pod, boiled	70	RA	04043	4.13	0.98	0.07	0.02	-	0.00	0.00	7.76	0.13	0.06	0.49	-	2.21	-	25.20	27.30	0.07	-	-
Beetroot	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Garlic, leaves and stem, raw	100	RA	04013	9.50	2.60	0.50	0.09	-	0.00	0.00	127.83	0.11	0.14	0.60	39.00	-	-	46.00	58.00	0.60	-	0.49
Climbing wattle / acacia (Cha-om), raw	100	RA	04027	5.14	10.53	0.52	0.22	4.21	0.00	0.00	120.74	0.37	0.48	1.94	47.95	42.08	438.05	166.07	41.00	2.61	0.07	0.59
Sesbania, young leaves (tips), boiled	70	RA	04359	3.27	2.69	0.51	-	2.97	0.20	0.00	72.98	0.06	0.05	0.16	-	-	89.04	-	55.21	1.05	-	0.49
Coconut heart top stem, raw	100	RA	04187	5.90	2.04	0.70	0.15	2.87	-	0.00	0.67	0.03	0.08	1.90	5.50	46.25	289.91	44.14	111.95	0.11	0.10	0.85
Horse tamarind, young leaves (tips), raw	100	RA	04002	10.26	9.07	0.33	0.09	6.10	0.00	0.00	254.73	0.30	0.46	1.58	12.60	33.45	357.96	113.53	129.13	2.99	-	1.30
Neem, leaves and tips, raw	100	RA	04094	16.21	6.29	0.62	0.16	16.1	0.00	0.00	336.00	0.08	0.07	3.89	81.96	22.09	740.12	139.2	101.97	3.46	0.40	0.85
Cowslip creeper, flowers, boiled	70	RA	04314	3.54	1.91	0.28	-	2.16	0.97	0.00	15.84	0.04	0.03	1.73	-	-	204.78	-	28.51	0.69	-	0.45
Sesbania yellow, flowers, raw	100	RA	04029	8.32	3.10	0.47	0.20	5.08	0.31	0.00	17.13	0.20	0.26	2.80	32.27	-	-	59.00	48.67	5.15	-	-
Cabbage, chinese, flowers, raw	100	RA	04073	2.20	3.20	0.50	0.06	-	0.00	0.00	97.08	0.14	0.27	0.50	24.00	-	-	30.00	32.00	0.40	-	-
Pepper, sweet, variety	-	-	-	6.04	1.21	0.45	0.05	1.34	2.74	0.00	12.87	0.10	0.05	0.40	141.1	7.90	173.00	29.30	8.00	0.05	0.09	0.00
Pak-tiew, raw	100	RA	04088	15.12	2.28	1.34	0.54	-	0.00	0.00	170.41	0.09	0.31	1.03	18.79	27.41	301.71	37.19	45.43	1.85	-	-
Water mimosa, raw	100	RA	04070	6.44	4.17	0.40	0.17	4.75	0.00	0.00	277.72	0.13	0.33	1.97	25.24	13.34	267.71	61.50	54.20	2.58	0.06	0.33
Kale, chinese, boiled	70	RA	04320	2.18	1.68	0.14	-	-	-	0.00	-	-	-	-	25.94	-	-	-	-	0.35	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Coral, leaves, raw	100	RA	04211	9.33	5.44	0.80	-	-	0.00	0.00	10.95	0.25	0.17	1.20	51.50	-	-	70.50	56.50	1.85	-	-
Indian mulberry, leaves, raw	100	RA	04058	10.50	5.00	1.20	0.00	-	0.00	0.00	203.83	0.30	0.14	7.20	3.00	-	-	86.00	469.00	1.40	-	-
Water lily, root, raw	100	RA	02030	15.20	1.00	0.00	0.00	1.20	0.00	0.00	0.00	0.11	0.04	0.40	25.00	32.73	-	51.00	19.00	0.50	-	-
Corn baby, raw	100	RA	04180	4.48	2.58	0.18	0.06	1.62	0.00	0.00	1.45	0.09	0.13	0.69	30.33	2.81	157.25	50.08	9.95	0.34	0.09	0.52
Taking kalum	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Broccoli, raw	100	RA	04168	5.75	2.71	0.10	-	2.35	1.53	0.00	7.07	0.05	0.18	1.65	94.93	26.35	297.95	62.70	38.37	0.98	0.05	0.40
Ivygourd, raw	100	RA	04087	3.62	3.26	0.17	0.03	2.39	0.00	0.00	345.00	0.11	0.17	0.76	20.69	16.92	169.66	71.98	59.84	1.25	0.13	0.35
Eggplant, raw	100	RA	04213	7.18	1.54	0.50	-	4.58	0.00	0.00	12.14	0.11	0.06	0.60	23.03	11.09	283.83	52.40	29.73	0.56	0.08	0.18
Yellow berried nightshade / thai eggplant, raw	100	RA	04123	6.95	1.48	0.16	0.05	2.72	2.89	0.00	3.18	0.07	0.04	0.69	5.34	10.55	246.74	29.72	19.60	0.55	0.14	0.23
Gourd / cucumber, bitter (Chinese variety), raw	100	RA	04113	4.04	0.84	0.13	0.01	2.75	0.00	0.00	1.44	0.05	0.03	0.22	50.50	5.64	193.09	27.50	16.50	0.57	0.03	0.13
Papaya, unripe	100	RA	04116	5.40	0.62	0.10	0.03	2.62	3.54	0.00	1.30	0.03	0.02	0.34	29.62	5.71	203.12	17.70	16.96	0.33	0.01	0.04
Bamboo shoot, boiled	70	RA	04129	2.45	1.05	0.35	0.08	0.98	0.00	0.00	0.00	0.01	0.02	0.07	0.00	4.20	521.50	12.60	11.20	0.00	0.08	0.49
Mushroom, abalone, boiled 2 min	70	RA	04334	4.54	1.79	0.22	-	3.84	-	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Mushroom, oyster, raw	100	RA	04220	6.35	2.12	0.28	0.05	-	0.94	0.00	-	0.05	0.16	5.82	10.33	37.75	232.61	67.33	2.66	1.94	0.06	0.16
Median values		Energy : 34.38 kcal [2]		5.83	2.08	0.31	0.06	2.67	0.00	0.00	12.51	0.09	0.08	0.69	23.52	10.82	204.78	48.04	33.52	0.58	0.08	0.35

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, ND = No Data (no information of those food items appeared in the databases)

☐ Light orange color refers to surrogate in case that no unspecified food item (variety item) in INMUCAL database. (APPENDIX M)

4. Fruit group

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Banana (Nam-wa variety), ripe	45	RA	05003	13.31	0.35	0.07	0.03	1.08	8.31	-	1.47	0.02	0.01	0.44	5.81	1.70	108.37	11.70	3.05	0.23	0.03	0.06
Banana (Khai variety), ripe	45	RA	05006	11.82	0.61	0.05	0.03	0.88	9.68	-	7.92	0.04	0.03	0.37	3.38	9.71	109.34	9.68	2.14	0.13	0.05	0.08
Banana (Horm variety), ripe	50	RA	05004	11.97	0.59	0.06	0.02	0.77	9.58	-	2.59	-	0.02	0.40	13.5	2.07	173.49	23.00	7.17	0.26	0.06	0.06
Banana, silver bluggoe (Hug-mook variety), ripe	50	RA	05005	13.95	0.40	0.15	0.11	2.55	9.00	-	11.25	-	0.06	0.00	5.00	-	179.50	25.50	2.50	0.16	-	0.00
Rambutan	85	RA	05008	15.23	0.82	0.12	0.02	1.38	15.20	-	0.00	0.01	0.07	0.66	38.68	11.68	67.29	14.62	12.75	0.43	0.13	0.11
Rose apple, variety	-	-	-	18.00	1.08	0.04	0.00	2.14	15.50	0.00	4.01	0.06	0.10	0.79	57.5	10.58	186.70	29.58	6.90	0.88	0.08	0.15
Watermelon, red flesh variety	285	RA	05010	23.97	2.30	0.20	0.00	0.98	23.22	-	131.92	0.09	0.06	0.57	19.41	12.06	303.79	31.97	29.67	0.57	0.14	0.19
Durian, variety	-	-	-	10.15	1.13	1.52	0.41	1.19	7.50	0.00	9.01	0.14	0.07	0.69	13.0	8.32	178.64	14.27	2.79	0.21	0.07	0.14
Guava, common, different varieties	120	RA	05015	12.96	0.66	0.09	0.03	4.40	7.48	-	1.52	0.05	0.07	1.32	207.6	11.28	209.52	16.80	3.64	0.31	0.06	0.10
Mango, unripe, variety	-	-	-	18.98	0.67	0.20	0.06	2.59	8.82	0.00	10.08	0.04	0.04	0.35	32.00	2.97	126.00	12.70	12.51	0.28	0.09	0.08
Mango, ripe, variety	-	-	-	16.09	0.48	0.10	0.02	0.87	10.94	0.00	78.69	0.06	0.05	0.76	20.00	20.81	112.63	12.40	20.00	0.26	0.07	0.07
Papaya, ripe	115	RA	05042	10.77	0.68	0.09	0.05	2.21	10.58	-	26.67	0.03	0.05	0.37	72.83	24.43	255.04	18.26	14.44	0.46	0.04	0.10
Pineapple	125	RA	05058	16.26	0.62	0.06	0.02	2.03	16.04	-	9.06	0.11	0.05	0.38	12.50	3.24	139.39	12.81	9.42	0.34	0.07	0.18
Tangelo / tangerine / mandarin	150	RA	05061	14.62	1.26	0.26	0.04	2.35	16.50	-	17.37	0.07	0.05	0.53	26.00	41.58	251.50	29.50	37.93	0.70	0.11	0.14
Pomelo, different varieties	130	RA	05062	13.00	1.20	0.16	0.07	1.96	13.26	-	2.25	0.05	0.02	0.48	62.11	6.00	199.55	24.78	11.74	0.20	0.07	0.07
Apple, red variety	100	RA	05085	14.26	0.21	0.14	0.01	2.26	10.09	-	6.93	0.02	0.03	0.16	1.50	57.50	114.52	9.86	13.20	0.28	0.06	0.05
Grape, variety	-	-	-	13.92	0.51	0.12	0.01	1.14	12.91	0.00	2.38	0.03	0.03	0.20	2.56	5.81	178.00	18.38	6.25	0.32	0.22	0.04
Apple, dried	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fig	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plums, raw	3 large	RA	05138	22.95	1.41	0.56	0.03	2.81	19.94	0.00	34.17	0.06	0.05	0.84	19.10	0.00	315.57	32.16	12.06	0.34	0.11	0.20
Raisin	2 tbsp	RA	05074	14.22	0.58	0.12	0.02	0.72	10.75	0.00	0.00	0.00	0.01	0.10	0.00	2.20	136.40	24.60	12.00	0.62	0.06	0.04
Juice, apple, variety	-	-	-	16.20	0.00	0.00	0.00	0.00	14.88	0.00	0.00	0.00	0.01	0.00	11.52	19.80	186.00	0.00	0.00	0.29	0.00	0.00
Juice, grape, 100%	80	RA	14009	8.17	0.15	0.00	0.00	0.00	10.14	-	-	0.02	0.02	-	0.00	10.43	14.33	9.12	6.63	0.17	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Juice, orange, 100%	120	RA	14024	9.72	0.78	0.10	0.00	0.41	13.88	-	-	0.04	0.03	0.23	18.27	15.52	110.10	16.40	8.84	0.26	-	-
Juice, pineapple, fresh	120	RA	14007	12.96	0.24	0.00	0.00	-	9.92	0.00	0.50	0.08	0.04	0.24	9.60	1.99	-	10.80	15.60	0.12	-	-
Juice, plums canned purple juice pack solids and liquids	80	RA	14057	12.12	0.41	0.02	0.00	0.72	11.38	0.00	40.00	0.02	0.05	0.38	2.24	0.80	123.20	12.00	8.00	0.27	0.04	0.09
Juice, mixed fruit, 100%, berry mix formula (Tipco brand)	80	RA	14103	8.00	0.00	0.00	0.00	0.00	8.00	0.00	144.00	0.09	0.00	-	9.60	10.00	-	-	12.80	0.24	-	-
Median values	Energy : 58.99 kcal[2]			13.92	0.61	0.10	0.02	1.17	10.75	0.00	7.92	0.04	0.04	0.38	13.00	9.85	173.49	15.51	9.42	0.28	0.07	0.08

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, ND = No Data (no information of those food items appeared in the databases)

Light orange color refers to surrogate in case that no unspecified food item (variety item) in INMUCAL database. (APPENDIX M)

5. Whole milk (regular) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk, UHT, different flavours	240	RA	09084	11.34	7.69	8.53	3.38	0.00	22.20	17.58	74.12	0.07	0.51	0.22	-	137.73	273.60	212.16	258.40	0.21	0.02	0.82
	Energy : 152.85 kcal[2]																					

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

6. Milk (low fat) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk, low fat, UHT, different flavours	240	RA	09268	12.33	7.13	2.98	1.78	0.00	19.08	-	31.20	0.05	0.50	-	-	146.40	-	-	428.80	0.17	-	-
Energy : 104.66 kcal[2]																						

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

7. Milk (skim milk) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Cow milk, fluid, non fat	240	RA	09012	11.52	8.16	0.24	-	-	11.52	4.70	143.84	0.10	0.38	0.24	2.40	122.09	367.86	220.80	264.00	0.24	0.03	0.99
Energy : 80.88 kcal[2]																						

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

8. Milk (evaporated) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Evaporated Milk	120	RA	09013	11.4	8.28	9.6	6.46	0	11.4	34.85	81.6	0.05	0.38	0.24	1.2	127.39	364.16	242.4	306	0.24	0.02	0.93
	Energy : 165.12 kcal[2]																					

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

9. Milk powder (regular) group

Food items	Energy	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk powder, variety	Energy : 140.05 kcal[1]	17.35	4.50	5.85	2.06	0.75	12.75	5.49	133.33	0.12	0.26	1.50	16.36	52.50	194.55	114.29	165.38	1.87	0.09	1.13

[1] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

☐ Light orange color refers to surrogate in case that no unspecified food item (variety item) in INMUCAL database. (APPENDIX M)

10. .Milk powder (none fat) group

Food items		Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Low fat milk powder, variety	Energy : 91.52 kcal[1]	13.10	9.48	0.14	0.09	0.00	10.11	5.48	297.45	0.12	0.51	1.02	7.50	116.10	387.60	298.20	337.05	1.29	0.01	1.46

[1] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

Light orange color refers to surrogate in case that no unspecified food item (variety item) in INMUCAL database. **(APPENDIX M)**

11. Fat/oil group type 1 (Unsaturated (mono- and poly-) fatty acids group)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Oil, olive	5	RA	10021	0.00	0.00	5.00	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.00	0.05	0.03	0.00	0.00
Oil, rice bran	5	RA	10024	0.00	0.00	5.00	1.03	0.00	0.00	0.00	-	0.00	-	-	0.00	-	-	-	0.00	0.00	-	-
Oil, peanut	5	RA	10003	0.00	0.00	5.00	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Peanut butter, chunk style with salt	5	RA	03121	1.08	1.20	2.50	0.38	0.40	0.42	0.00	0.00	0.01	0.01	0.68	0.00	24.30	37.25	15.95	2.25	0.10	0.03	0.14
Peanut butter, smooth	5	RA	03120	1.20	1.10	2.48	0.48	0.29	0.33	0.00	0.00	0.01	0.01	0.66	0.00	23.80	29.60	16.75	2.70	0.11	0.03	0.13
Peanut, mature seeds, raw	4.25[3]	RA	03018	0.66	1.26	1.64	0.34	0	0.16	0	0.06	0.06	0.01	0.09	0.34	0.73	0	19.34	2.13	0.44	0	0
Cashew nut, raw	9.88[4]	RA	03090	1.36	1.14	2.27	0	0.44	0.31	0	0	0.04	0.02	0.09	0.1	0.62	0	22.03	1.09	0.01	0	0
Oil, soybean	15	RA	10004	0.00	0.00	4.90	0.75	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	-	-	0.00	0.00	-	-
Oil, corn	15	RA	10014	0.00	0.00	5.00	0.72	0.00	-	0.00	-	0.00	0.00	-	0.00	-	-	-	-	-	-	-
Safflower oil	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil, sunflower seed	5	RA	10048	0.00	0.00	5.00	0.50	0.00	-	0.00	-	0.00	-	-	-	-	-	-	-	-	-	-
Mayonnaise	15	RA	10016	2.47	0.23	7.48	1.40	0.00	1.71	3.44	3.94	0.00	0.00	-	0.00	82.46	-	2.71	-	0.09	-	-
Salad dressing, variety	-	-	-	3.36	0.27	3.95	1.16	0.25	2.51	3.24	4.05	0.01	0.00	0.00	0.00	121.35	0.00	0.00	2.29	0.11	0.00	0.00

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Sunflower, seeds, dried, raw	15	RA	03144	2.54	3.51	7.82	-	1.67	0.29	-	-	0.17	0.01	-	-	5.40	-	-	23.55	0.48	-	-
Pumpkin, seed kernels, raw	15	RA	03176	1.41	2.53	4.87	-	1.01	-	-	-	-	-	-	-	2.46	53.46	90.89	3.54	0.78	0.25	0.82
Median values	Energy : 49.03 kcal[2]			0.87	0.25	4.95	0.70	0.00	0.29	0.00	0.00	0.00	0.00	0.09	0.00	3.93	0.03	15.95	2.13	0.09	0.00	0.00

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

[3] Weight was obtained from weight measurement (measure 3 times, results were 4.58, 4.36, and 3.82, respectively).

[4] Weight was obtained from weight measurement (measure 3 times, results were 9.93, 9.67, and 10.04, respectively).

RA = Raw, ND = No Data (no information of those food items appeared in the databases)

Light orange color refers to surrogate in case that no unspecified food item (variety item) in INMUCAL database. (APPENDIX M)

12. Fat/oil group type 2 (Saturated fatty acid group)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Oil, lard	5	RA	10007	0.00	0.00	5.00	1.96	0.00	0.00	4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Oil, chicken	5	RA	10025	0.00	0.00	4.99	1.49	0.00	0.00	4.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pork, cured, bacon, raw	1 medium	RA	06166	0.26	2.57	8.10	2.71	0.00	0.20	13.46	2.24	0.06	0.02	0.82	0.00	135.05	40.39	29.38	1.02	0.08	0.01	0.24
Shortening	5	RA	10044	0.00	0.00	4.84	2.73	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butter, salted	5	RA	10008	0.00	0.03	4.18	2.69	0.00	0.00	12.43	28.81	0.00	0.00	0.06	0.00	25.16	-	0.60	0.91	0.01	-	-
Butter, unsalted	5	RA	10009	0.02	0.04	4.15	2.95	0.00	-	12.55	30.18	0.00	-	-	0.00	0.65	-	-	1.05	0.01	-	-
Coconut milk, UHT, commercial packed	15	RA	10039	0.84	0.31	2.71	2.57	0.00	0.30	0.00	-	-	-	-	-	18.38	-	-	0.75	0.33	-	-
Milk cream	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Median values				0.00	0.03	4.84	2.69	0.00	0.00	8.59	2.24	0.00	0.00	0.03	0.00	9.51	0.00	0.30	0.83	0.01	0.00	0.01

Energy : 43.71 kcal[2]

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, ND = No Data (no information of those food items appeared in the databases)

13. Fat/oil group (all, median value) (all items from unsaturated and saturated fatty acids group)

Food items	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fat/oil group (all items) (median value)	0.02	0.04	4.90	1.03	0.00	0.18	0.00	0.00	0.00	0.00	0.06	0.00	3.93	0.00	2.71	1.02	0.06	0.00	0.00

Energy : 44.31 kcal[1]

[1] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

14. Very low fat meat group (without reallocation) (2 tablespoons)

Food Items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, striped snakehead fish, boiled	30	RA	07104	0.57	5.61	2.58	0.79	0.00	0.00	36.30	-	0.02	0.05	0.96	0.00	10.80	79.50	44.40	9.00	0.06	0.03	0.06
One eyed fish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fish, grouper, steamed	30	RA	07127	0.46	7.01	0.31	0.35	0.00	0.00	26.26	-	0.02	0.01	0.37	0.00	51.10	73.55	57.90	31.82	0.16	0.00	0.20
Parrot fish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fish, giant seaperch, steamed	30	RA	07122	0.43	6.88	0.96	0.53	0.00	0.00	28.87	5.41	0.02	0.02	0.47	0.00	21.30	78.06	56.40	14.25	0.18	0.64	0.24
Fish, short bodied mackerel, boiled	30	RA	07143	0.14	6.94	1.68	0.66	0.00	0.00	28.20	0.88	0.02	0.04	1.53	0.00	30.30	64.80	80.10	27.90	0.33	0.03	0.21
Yellow tail fish	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fish, brown spotted trevally, raw	40	RA	07317	0.00	8.96	0.28	-	0.00	-	-	-	-	-	-	-	-	-	113.60	16.80	-	-	-
Fish, false trevally, raw	40	RA	07077	0.00	7.76	0.36	-	-	0.00	20.40	-	0.02	0.02	2.60	-	-	-	81.60	6.40	0.20	-	-
Fish, orante threadfin bream, raw	40	RA	07047	0.00	7.56	0.48	0.16	0.00	0.00	22.80	12.80	0.00	0.00	0.00	0.00	29.20	93.60	28.00	18.00	0.28	-	-
Fish, gunther's walking catfish, boiled	30	RA	07109	0.00	5.46	4.65	1.42	0.00	0.00	29.10	-	0.03	-	-	0.00	13.50	106.20	46.20	6.60	0.21	0.00	0.15
Barracuda	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fish, whisker sheatfish, raw	40	RA	07046	0.14	6.39	0.79	0.29	0.00	0.00	-	-	0.00	0.02	0.56	-	-	-	34.80	12.60	0.26	-	-
Fish, java tilapia, raw	40	RA	07039	0.00	7.52	1.12	0.35	-	0.00	36.00	10.40	0.01	0.05	1.24	-	21.44	-	68.80	21.60	0.16	0.59	0.45
Fish, bluespot gray mullet, boiled	30	RA	07281	0.00	7.71	0.66	0.30	0.00	-	20.61	3.11	0.10	0.03	1.39	-	26.42	70.91	-	11.62	0.17	-	-
Fish, mackerel spanish, piece, raw	40	RA	07044	0.14	8.50	1.44	0.66	0.00	0.00	26.40	-	0.01	0.06	0.92	-	58.00	114.00	94.80	4.00	0.16	0.00	0.16
Fish ball, boiled	30	RA	07006	0.27	3.84	0.03	0.01	0.00	0.00	-	10.50	0.00	0.01	0.00	0.00	127.40	-	20.10	29.70	0.45	-	-
Beef ball, blanched	30	RA	06169	2.04	4.14	0.48	0.24	0.00	0.00	9.00	0.00	0.00	0.00	-	0.00	207.60	45.00	48.30	9.30	0.30	-	-
Dollfus' octopus, raw	40	RA	07080	0.00	5.32	0.24	-	-	0.00	-	19.33	0.00	0.04	0.80	-	-	-	41.20	16.80	0.64	-	-
Scallop / radiated, raw	40	RA	07120	1.32	8.92	0.16	-	0.00	0.00	16.76	-	0.02	0.01	-	-	81.74	-	55.20	5.60	0.24	-	-
Cockle / ark shell, blanched	30	RA	07060	1.02	2.90	0.18	0.13	0.00	0.00	9.49	3.92	0.07	0.04	0.51	1.20	128.07	40.80	16.20	14.16	4.05	0.05	0.59
Clam, undulated surf, raw	40	RA	07059	1.80	4.12	0.20	0.11	0.00	0.00	55.98	-	0.00	0.06	-	0.80	21.80	-	44.80	37.60	2.28	-	-
Shrimp, sea, raw	40	RA	07001	0.36	7.04	0.36	0.20	0.00	0.00	76.80	8.40	0.02	0.03	0.92	0.40	73.60	132.4	73.60	31.60	0.64	0.27	0.56

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Shrimp, common, raw	40	RA	07003	0.16	6.48	0.52	0.28	0.00	0.00	74.80	18.79	0.02	0.05	0.80	0.70	51.50	64.37	116.80	64.40	0.88	0.09	0.39
Shrimp, lanchester's freshwater, raw	40	RA	07005	0.00	6.16	1.08	0.39	-	0.00	56.42	3.60	0.03	0.29	1.16	-	54.93	-	98.80	450.00	5.96	-	-
Crab, serraed mud, meat, boiled	30	RA	07115	0.00	5.28	0.57	0.16	0.00	0.00	-	20.50	0.01	0.11	0.48	0.00	99.30	63.30	55.20	83.70	0.51	0.39	0.93
Crab, ricefield, steamed	30	RA	07064	0.55	3.71	0.54	0.18	-	0.00	-	-	-	-	-	-	-	-	-	0.84	-	-	-
Chicken, breast, boiled	30	RA	06104	0.00	8.58	2.61	0.87	0.00	0.00	24.60	1.50	0.02	0.07	2.01	0.00	24.00	30.30	51.30	2.10	0.18	0.03	0.15
Chicken, tenderloin, raw	40	RA	06187	0.00	9.96	0.56	-	0.00	0.00	-	7.16	0.05	0.01	-	0.00	-	-	-	2.16	0.12	-	-
Meat, drumstick, skinless	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Median values (per 2 tbsp)	Energy : 32.92 kcal[2]			0.14	6.88	0.54	0.30	0.00	0.00	27.30	7.16	0.02	0.03	0.86	0.00	51.10	72.23	55.20	14.25	0.26	0.04	0.23
Median values (per 1 tbsp)	Energy : 16.46 kcal[2]			0.07	3.44	0.27	0.15	0.00	0.00	13.65	3.58	0.01	0.02	0.43	0.00	25.55	36.11	27.60	7.12	0.13	0.02	0.11

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BO = Boiling, ND = No Data (no information of those food items appeared in the databases)

15. Low fat meat group (without reallocation) (2 tablespoons)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Chicken, meat, raw	40	RA	06008	0.56	6.92	4.96	1.59	0.00	0.00	32.40	1.20	0.02	0.05	1.82	0.00	36.00	75.20	54.80	4.00	0.20	0.02	0.40
Chicken, wing, boiled	30	RA	06096	0.00	6.18	5.94	1.79	0.00	0.00	53.70	1.50	0.01	0.04	0.96	0.00	35.40	46.80	34.50	5.70	0.27	0.03	0.48
Chicken, drumstick, boiled	30	RA	06097	0.00	7.05	3.72	1.20	0.00	0.00	49.50	0.90	0.02	0.06	0.86	0.00	44.70	64.50	40.20	3.30	0.30	0.03	0.51
Duck, meat, raw	40	RA	06121	0.00	5.36	6.48	1.74	0.00	0.00	-	2.16	0.04	0.10	2.16	0.00	33.63	-	49.20	6.00	0.68	-	-

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Soybean milk, no sugar	240	RA	14028	14.40	6.72	7.68	3.50	0.00	1.22	0.00	75.21	0.05	0.02	0.70	0.00	120.0	300.83	-	33.60	0.72	0.34	1.07
Soybean milk with milk powder, UHT	240	RA	14014	13.01	6.96	8.02	2.94	1.56	19.92	0.00	1.35	0.08	0.08	-	0.00	84.20	-	-	57.23	0.97	0.03	-
Median values (per 2 tbsp)			Energy : 84.29 kcal²	0.28	6.82	6.21	1.77	0.00	0.00	32.40	1.35	0.03	0.06	0.96	0.00	40.35	69.85	44.70	5.85	0.49	0.03	0.50
Median values (per 1 tbsp)			Energy : 42.15 kcal2	0.14	3.41	3.11	0.88	0.00	1.22	16.20	0.68	0.02	0.03	0.48	0.00	20.18	34.93	22.35	2.93	0.25	0.02	0.25

¹ Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

² Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

16. Medium fat meat group (without reallocation) (2 tablespoons)

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Wild boar, meat, raw	40	RA	06049	0.00	6.72	3.32	0.98	0.00	0.00	14.39	2.00	0.16	0.04	1.60	0.00	36.33	126.98	48.00	4.80	0.00	0.05	0.32
Pork, tenderloin, grilled	30	RA	06252	0.81	10.17	1.45	0.58	0.06	0.67	16.75	0.23	0.61	0.15	2.05	0.00	301.00	174.00	107.90	2.89	0.61	0.05	0.47
Pork, spare ribs, boiled	30	RA	06113	0.27	7.74	5.64	2.37	0.00	0.00	19.50	0.00	0.12	0.11	0.09	0.00	21.90	39.00	45.00	1.80	0.39	0.03	0.45
Pork, ham, whole separable lean only, raw	40	RA	06290	0.00	8.16	2.96	-	0.00	-	-	-	-	-	-	-	47.60	-	-	2.00	0.28	-	-
Pork, tenderloin, boiled	30	RA	06119	0.00	10.02	0.66	0.35	0.00	0.00	21.00	0.00	0.27	0.13	0.09	0.00	8.10	66.00	45.00	1.20	0.33	0.06	0.45
Pork, rips, fatless	ND	ND		ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Duck, meat, raw	40	RA	06121	0.00	5.36	6.48	1.74	0.00	0.00			0.04	0.10	2.16	0.00	33.63	ND	49.20	6.00	0.68	ND	ND
Old chicken, meat	ND	ND		ND	ND		ND	ND	ND			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Egg, duck, whole, raw	50	RA	08004	0.52	6.96	6.10	1.68	0.00	0.33	278.11	99.05	0.14	0.22	0.06	0.00	64.94	71.96	106.71	33.35	1.08	0.04	0.57
Egg, hen, whole, raw	50	RA	08011	0.61	6.55	4.21	1.47	0.00	0.31	195.84	117.5	0.04	0.17	0.04	0.00	68.67	64.82	83.48	24.70	0.67	0.02	0.47

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Soybean curd (tofu), white, hard	60	RA	03010	1.97	7.73	4.31	1.00	2.90	0.00	-	0	0.03	0.01	0.11	0.12	42.27	96.32	102.26	32.73	1.14	0.26	0.84
Soybean curd (tofu), white, soft, packed in a pouch	180	RA	03064	5.03	9.24	5.59	1.51	2.71	0.00	-	-	0.09	0.07	1.52	0.36	41.35	312.33	111.03	56.34	2.11	0.25	1.43
Median values (per 2 tbsp)	Energy : 70.88 kcal[2]			0.39	7.74	4.26	1.47	0.00	0.00	20.25	0.23	0.12	0.11	0.11	0.00	41.81	84.14	83.48	5.40	0.64	0.05	0.47
Median values (per 1 tbsp)	Energy : 35.44 kcal[2]			0.20	3.87	2.13	0.74	0.00	0.00	10.13	0.11	0.06	0.05	0.05	0.00	20.91	42.07	41.74	2.70	0.32	0.02	0.24

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, ND = No Data (no information of those food items appeared in the databases)

17. High fat meat group (without reallocation) (2 tablespoons)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, striped catfish, boiled	30	RA	07152	0.28	5.81	3.24	1.34	0.00	0.00	20.40	-	0.00	0.06	0.21	0.00	17.70	73.50	44.70	6.90	0.21	0.00	0.03
Duck, meat skin and giblets, raw	40	RA	06023	0.00	6.40	11.44	-	-	0.00	30.40	-	0.04	0.10	2.24	-	37.93	-	75.20	6.00	0.72	-	-
Pork, loin, boiled	30	RA	06118	0.03	9.90	2.37	0.95	0.00	0.00	18.00	0.00	0.17	0.08	0.12	0.00	15.90	39.00	45.00	3.00	0.45	0.03	0.39
Ground pork	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sausage, pork, cooked	30	RA	06147	0.43	5.56	8.18	2.65	0.00	0.33	25.80	8.40	0.08	0.05	1.84	0.00	244.20	102.60	44.70	2.70	0.36	0.02	0.74
Sausage, chinese (Kun-chieng), pork, dried	40	RA	06051	2.64	8.52	11.72	4.03	0.00	2.64	28.40	5.71	0.18	0.10	1.88	0.00	347.11	-	86.40	9.60	1.20	-	-
Pork, crispy sliced	40	RA	06152	16.48	14.14	5.14	-	-	0.00	35.20	-	0.04	-	-	0.00	575.20	-	-	6.60	0.76	-	-
Ham, pork, boiled	30	RA	06084	0.51	9.66	1.08	0.49	0.00	0.00	17.40	-	0.19	0.09	0.84	0.00	23.70	69.00	51.00	2.70	0.60	0.03	0.54
Pork, loin with milk, grilled	30	RA	06251	3.20	8.06	3.11	1.01	0.08	3.04	17.33	3.31	0.54	0.04	2.17	0.00	179.89	139.57	82.87	10.88	0.58	0.05	0.31
Pork, spare ribs, boiled	30	RA	06113	0.27	7.74	5.64	2.37	0.00	0.00	19.50	0.00	0.12	0.11	0.09	0.00	21.90	39.00	45.00	1.80	0.39	0.03	0.45

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Sausage, pork, steamed (Moo-yor)	40	RA	06058	1.14	5.96	9.86	3.07	0.00	0.00	-	0.00	0.10	0.04	1.60	0.00	302.74	140.42	97.70	6.01	1.14	-	-
Fermented pork (Nham)	40	RA	06072	4.11	5.93	5.46	1.48	-	0.00	0.00	-	0.11	0.05	1.73	-	427.40	-	60.06	6.82	0.59	-	-
Pork, skin, raw	40	RA	06064	0.12	7.92	10.64	3.16	0.00	0.00	13.60	52.00	0.02	0.02	0.40	0.00	-	-	18.40	30.40	0.84	-	-
Beef, longissimus dorsi, raw	40	RA	06281	0.57	8.19	0.45	0.23	0.00	-	16.94	7.08	0.02	0.01	2.24	0.03	22.07	157.78	95.20	1.27	0.65	0.00	0.65
Chicken, whole, boiled	30	RA	06100	0.00	6.87	4.98	1.62	0.00	0.00	36.90	2.10	0.02	0.06	1.44	0.00	37.80	101.10	42.60	3.60	0.24	0.02	0.45
Median values (per 2 tbsp)	Energy : 80.91 kcal[2]		06xx[2]	0.47	7.83	5.30	1.55	0.00	0.00	19.50	3.31	0.09	0.06	1.60	0.00	37.93	101.10	51.00	6.00	0.60	0.03	0.45
Median values (per 1 tbsp)	Energy : 40.45 kcal[2]			0.23	3.92	2.65	0.77	0.00	0.00	9.75	1.66	0.04	0.03	0.80	0.00	18.97	50.55	25.50	3.00	0.30	0.01	0.23

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BO = Boiling, RE = Ready to eat, ND = No Data (no information of those food items appeared in the databases)

18. Very low fat meat group (with reallocation) (2 tablespoons)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, grouper, steamed	30	RA	07127	0.27	3.84	0.03	0.01	0.00	0.00	-	10.50	0.00	0.01	0.00	0.00	127.40	-	20.10	29.70	0.45	-	-
Fish, giant seaperch, steamed	30	RA	07122	1.32	8.92	0.16	-	0.00	0.00	16.76	-	0.02	0.01	-	-	81.74	-	55.20	5.60	0.24	-	-
Fish, brown spotted trevally, raw	40	RA	07317	1.02	2.90	0.18	0.13	0.00	0.00	9.49	3.92	0.07	0.04	0.51	1.20	128.07	40.80	16.20	14.16	4.05	0.05	0.59
Fish, false trevally, raw	40	RA	07077	1.80	4.12	0.20	0.11	0.00	0.00	55.98	-	0.00	0.06	-	0.80	21.80	-	44.80	37.60	2.28	-	-
Fish, orante threadfin bream, raw	40	RA	07047	0.00	5.32	0.24	-	-	0.00	-	19.33	0.00	0.04	0.80	-	-	-	41.20	16.80	0.64	-	-
Fish, whisker sheatfish, raw	40	RA	07046	0.00	8.96	0.28	-	0.00	-	-	-	-	-	-	-	-	-	113.60	16.80	-	-	-
Fish, bluespot gray mullet, boiled	30	RA	07281	0.46	7.01	0.31	0.35	0.00	0.00	26.26	-	0.02	0.01	0.37	0.00	51.10	73.55	57.90	31.82	0.16	0.00	0.20
Fish ball, boiled	30	RA	07006	0.00	7.76	0.36	-	-	0.00	20.40	-	0.02	0.02	2.60	-	-	-	81.60	6.40	0.20	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Beef ball, blanched	30	RA	06169	0.36	7.04	0.36	0.20	0.00	0.00	76.80	8.40	0.02	0.03	0.92	0.40	73.60	132.40	73.60	31.60	0.64	0.27	0.56
Dollfus' octopus, raw	40	RA	07080	0.57	8.19	0.45	0.23	0.00	-	16.94	7.08	0.02	0.01	2.24	0.03	22.07	157.78	95.20	1.27	0.65	0.00	0.65
Scallop / radiated, raw	40	RA	07120	0.00	7.56	0.48	0.16	0.00	0.00	22.80	12.80	0.00	0.00	0.00	0.00	29.20	93.60	28.00	18.00	0.28	-	-
Cockle / ark shell, blanched	30	RA	07060	2.04	4.14	0.48	0.24	0.00	0.00	9.00	0.00	0.00	0.00	-	0.00	207.60	45.00	48.30	9.30	0.30	-	-
Clam, undulated surf, raw	40	RA	07059	0.16	6.48	0.52	0.28	0.00	0.00	74.80	18.79	0.02	0.05	0.80	0.70	51.50	64.37	116.80	64.40	0.88	0.09	0.39
Shrimp, sea, raw	40	RA	07001	0.55	3.71	0.54	0.18	-	0.00	-	-	-	-	-	-	-	-	-	0.84	-	-	-
Shrimp, common, raw	40	RA	07003	0.00	9.96	0.56	-	0.00	0.00	-	7.16	0.05	0.01	-	0.00	-	-	-	2.16	0.12	-	-
Crab, serraed mud, meat, boiled	30	RA	07115	0.00	5.28	0.57	0.16	0.00	-	-	20.50	0.01	0.11	0.48	0.00	99.30	63.30	55.20	83.70	0.51	0.39	0.93
Crab, ricefield, steamed	30	RA	07064	0.00	7.71	0.66	0.30	0.00	0.00	20.61	3.11	0.10	0.03	1.39	-	26.42	70.91	-	11.62	0.17	0.59	0.45
Chicken, tenderloin, raw	40	RA	06187	0.00	10.02	0.66	0.35	0.00	0.00	21.00	0.00	0.27	0.13	0.09	0.00	8.10	66.00	45.00	1.20	0.33	0.06	0.45
Pork, tenderloin, boiled	30	RA	06119	0.14	6.39	0.79	0.29	0.00	0.00	-	-	0.00	0.02	0.56	-	-	-	34.80	12.60	0.26	-	-
Beef, longissimus dorsi, raw	40	RA	06281	0.43	6.88	0.96	0.53	0.00	0.00	28.87	5.41	0.02	0.02	0.47	0.00	21.30	78.06	56.40	14.25	0.18	0.64	0.24
Median values (per 2 tbsp)	Energy : 32.81 kcal[2]			0.22	6.95	0.46	0.23	0.00	0.00	21.00	7.16	0.02	0.02	0.53	0.00	51.30	70.91	55.20	14.21	0.32	0.09	0.45
Median values (per 1 tbsp)	Energy : 16.41 kcal[2]			0.11	3.47	0.23	0.11	0.00	0.00	10.50	3.58	0.01	0.01	0.27	0.00	25.65	35.45	27.60	7.10	0.16	0.05	0.23

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

19. Low fat meat group (with reallocation) (2 tablespoons)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, striped snakehead fish, boiled	30	RA	07104	0.00	6.16	1.08	0.39	-	0.00	56.42	3.60	0.03	0.29	1.16	-	54.93	-	98.80	450.00	5.96	-	-
Fish, short bodied mackerel, boiled	30	RA	07143	0.51	9.66	1.08	0.49	0.00	0.00	17.40	-	0.19	0.09	0.84	0.00	23.70	69.00	51.00	2.70	0.60	0.03	0.54
Fish, java tilapia, raw	40	RA	07039	0.00	7.52	1.12	0.35	-	0.00	36.00	10.40	0.01	0.05	1.24	-	21.44	-	68.80	21.60	0.16	-	-
Fish, mackerel spanish, piece, raw	40	RA	07044	0.14	8.50	1.44	0.66	0.00	0.00	26.40	-	0.01	0.06	0.92	-	58.00	114.00	94.80	4.00	0.16	0.00	0.16
Shrimp, lanchester's freshwater, raw	40	RA	07005	0.81	10.17	1.45	0.58	0.06	0.67	16.75	0.23	0.61	0.15	2.05	0.00	301.00	174.00	107.90	2.89	0.61	0.05	0.47
Chicken, breast, boiled	30	RA	06104	0.14	6.94	1.68	0.66	0.00	0.00	28.20	0.88	0.02	0.04	1.53	0.00	30.30	64.80	80.10	27.90	0.33	0.03	0.21
Pork, tenderloin, grilled	30	RA	06252	0.03	9.90	2.37	0.95	0.00	0.00	18.00	0.00	0.17	0.08	0.12	0.00	15.90	39.00	45.00	3.00	0.45	0.03	0.39
Pork, ham, whole separable lean only, raw	40	RA	06290	0.57	5.61	2.58	0.79	0.00	0.00	36.30	-	0.02	0.05	0.96	0.00	10.80	79.50	44.40	9.00	0.06	0.03	0.06
Pork, loin, boiled	30	RA	06118	0.00	8.58	2.61	0.87	0.00	0.00	24.60	1.50	0.02	0.07	2.01	0.00	24.00	30.30	51.30	2.10	0.18	0.03	0.15
Ham, pork, boiled	30	RA	06084	0.00	8.16	2.96	-	0.00	-	-	-	-	-	-	-	47.60	-	-	2.00	0.28	-	-
Median values (per 2 tbsp)	Energy : 47.76 kcal[2]			0.09	8.33	1.57	0.66	0.00	0.00	26.40	1.19	0.02	0.07	1.16	0.00	27.15	69.00	68.80	3.50	0.31	0.03	0.21
Median values (per 1 tbsp)	Energy : 23.88 kcal[2]			0.04	4.17	0.78	0.33	0.00	0.00	13.20	0.60	0.01	0.03	0.58	0.00	13.58	34.50	34.40	1.75	0.15	0.02	0.11

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

20. Medium fat meat group (with reallocation) (2 tablespoons)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, gunther's walking catfish, boiled	30	RA	07109	3.20	8.06	3.11	1.01	0.08	3.04	17.33	3.31	0.54	0.04	2.17	0.00	179.89	139.57	82.87	10.88	0.58	0.05	0.31
Chicken, meat, raw	40	RA	06008	0.28	5.81	3.24	1.34	0.00	0.00	20.40	-	0.00	0.06	0.21	0.00	17.70	73.50	44.70	6.90	0.21	0.00	0.03
Chicken, drumstick, boiled	30	RA	06097	0.00	6.72	3.32	0.98	0.00	0.00	14.39	2.00	0.16	0.04	1.60	0.00	36.33	126.98	48.00	4.80	0.00	0.05	0.32
Wild boar, meat, raw	40	RA	06049	0.00	7.05	3.72	1.20	0.00	0.00	49.50	0.90	0.02	0.06	0.86	0.00	44.70	64.50	40.20	3.30	0.30	0.03	0.51
Egg, hen, whole, raw	50	RA	08011	0.61	6.55	4.21	1.47	0.00	0.31	195.84	117.5	0.04	0.17	0.04	0.12	68.67	64.82	83.48	24.70	0.67	0.02	0.47
Soybean curd (tofu), white, hard	60	RA	03010	1.97	7.73	4.31	1.00	2.90	0.00	-	-	0.03	0.01	0.11	0.00	42.27	96.32	102.26	32.73	1.14	0.26	0.84
Fish, striped catfish, boiled	30	RA	07152	0.00	5.46	4.65	1.42	0.00	0.00	29.10	-	0.03	-	-	0.00	13.50	106.20	46.20	6.60	0.21	0.00	0.15
Chicken, whole, boiled	30	RA	06100	0.56	6.92	4.96	1.59	0.00	0.00	32.40	1.20	0.02	0.05	1.82	0.00	36.00	75.20	54.80	4.00	0.20	0.02	0.40
Pork, loin with milk, grilled	30	RA	06251	0.00	6.87	4.98	1.62	0.00	0.00	36.90	2.10	0.02	0.06	1.44	0.00	37.80	101.10	42.60	3.60	0.24	0.02	0.45
Median values (per 2 tbsp)	Energy : 66.51 kcal[2]			0.28	6.87	4.21	1.34	0.00	0.00	30.75	2.05	0.03	0.06	1.15	0.00	37.80	96.32	48.00	6.60	0.24	0.02	0.40
Median values (per 1 tbsp)	Energy : 33.25 kcal[2]			0.14	3.44	2.11	0.67	0.00	0.00	15.38	1.03	0.01	0.03	0.58	0.00	18.90	48.16	24.00	3.30	0.12	0.01	0.20

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

21. High fat meat group (with reallocation) (2 tablespoons)

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Pork, crispy sliced	40	RA	06152	16.48	14.14	5.14	-	-	0.00	35.20	-	0.04	-	-	0.00	575.20	-	-	6.60	0.76	-	-
Fermented pork (Nham)	40	RA	06072	4.11	5.93	5.46	1.48	-	0.00	0.00	-	0.11	0.05	1.73	-	427.40	-	60.06	6.82	0.59	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Soybean curd (tofu), white, soft, packed in a pouch	180	RA	03064	5.03	9.24	5.59	1.51	2.71	0.00	-	0.00	0.09	0.07	1.52	0.36	41.35	312.33	111.03	56.34	2.11	0.25	1.43
Pork, spare ribs, boiled	30	RA	06113	0.27	7.74	5.64	2.37	0.00	0.00	19.50	0.00	0.12	0.11	0.09	0.00	21.90	39.00	45.00	1.80	0.39	0.03	0.45
Pork, spare ribs, boiled	30	RA	06113	0.27	7.74	5.64	2.37	0.00	0.00	19.50	0.00	0.12	0.11	0.09	0.00	21.90	39.00	45.00	1.80	0.39	0.03	0.45
Chicken, wing, boiled	30	RA	06096	0.00	6.18	5.94	1.79	0.00	0.00	53.70	1.50	0.01	0.04	0.96	0.00	35.40	46.80	34.50	5.70	0.27	0.03	0.48
Egg, duck, whole, raw	50	RA	08004	0.52	6.96	6.10	1.68	0.00	0.33	278.11	99.05	0.14	0.22	0.06	0.00	64.94	71.96	106.71	33.35	1.08	0.04	0.57
Duck, meat, raw	40	RA	06121	0.00	5.36	6.48	1.74	0.00	0.00	-	-	0.04	0.10	2.16	0.00	33.63	-	49.20	6.00	0.68	-	-
Soybean milk, no sugar	240	RA	14028	14.40	6.72	7.68	3.50	0.00	1.22	0.00	75.21	0.05	0.02	0.70	0.00	120.00	300.83	-	33.60	0.72	0.34	1.07
Soybean milk with milk powder, UHT	240	RA	14014	13.01	6.96	8.02	2.94	1.56	19.92	0.00	-	0.08	0.08	-	0.00	84.20	-	-	57.23	0.97	-	-
Sausage, pork, cooked	30	RA	06147	0.43	5.56	8.18	2.65	0.00	0.33	25.80	8.40	0.08	0.05	1.84	0.00	244.20	102.60	44.70	2.70	0.36	0.02	0.74
Sausage, pork, steamed (Moo-yor)	40	RA	06058	1.14	5.96	9.86	3.07	0.00	0.00	-	0.00	0.10	0.04	1.60	0.00	302.74	140.42	97.70	6.01	1.14	-	-
Pork, skin, raw	40	RA	06064	0.12	7.92	10.64	3.16	0.00	0.00	13.60	52.00	0.02	0.02	0.40	0.00	-	-	18.40	30.40	0.84	-	-
Duck, meat skin and giblets, raw	40	RA	06023	0.00	6.40	11.44	-	-	0.00	30.40	-	0.04	0.10	2.24	-	37.93	-	75.20	6.00	0.72	-	-
Sausage, chinese (Kun-chieng), pork, dried	40	RA	06051	2.64	8.52	11.72	4.03	0.00	2.64	28.40	5.71	0.18	0.10	1.88	0.00	347.11	-	86.40	9.60	1.20	-	-
Median values (per 2 tbsp)	Energy : 88.23 kcal[2]			0.52	6.96	6.48	2.37	0.00	0.00	22.65	3.61	0.08	0.08	1.52	0.00	74.57	87.28	54.63	6.60	0.72	0.03	0.57
Median values (per 1 tbsp)	Energy : 44.11 kcal[2]			0.26	3.48	3.24	1.19	0.00	0.00	11.33	1.80	0.04	0.04	0.76	0.00	37.29	43.64	27.31	3.30	0.36	0.02	0.29

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

APPENDIX L

Food items and nutrients used to determine new food exchange list (Food based dietary guideline)

1. Cereal (cooked rice, noodles) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Rice polished, steamed	60	RA	01015	18.66	1.37	0.15	0.05	0.12	0.00	0.00	0.00	0.03	0.01	0.90	0.00	12.15	52.97	11.33	1.93	0.12	0.04	0.31
Noodles, rice, small size, fresh	55	RA	01004	28.84	2.24	0.52	0.14	0.25	0.00	-	0.00	0.00	0.01	0.33	0.00	52.49	39.19	12.10	6.60	0.91	0.03	0.27
Noodles, rice, big size, fresh	52	RA	01005	16.80	1.49	0.89	0.28	0.36	0.00	0.00	-	0.00	0.00	0.16	0.00	41.00	44.53	12.45	3.68	1.03	0.02	0.16
Rice vermicelli, cooked	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Noodles, wheat, fresh	77	BL	01032	29.38	6.84	1.77	0.52	0.00	-	-	7.33	0.01	0.02	-	0.00	330.44	-	48.54	9.99	1.09		
Rice brown, steamed	76	RA	01056	22.50	2.13	1.06	0.31	1.06	0.22	0.00	0.00	0.09	0.02	0.15	0.00	14.44	99.56	81.32	6.00	0.15	0.03	0.76
Macaroni, cooked, unenrich	80	RA	01045	24.69	4.64	0.74	0.14	1.44	0.45	0.00	0.00	0.02	0.02	0.32	0.00	0.80	35.20	46.40	5.60	0.40	0.08	0.41
Corn, whole kernel, yellow, boiled	80	RA	01024	28.56	2.64	0.96	0.23	4.00	0.23	0.00	6.94	0.07	0.06	0.72	4.00	12.74	-	73.60	8.00	0.96	-	-
Taro, boiled	60	RA	02004	17.28	1.14	0.18	0.04	2.09	0.26	0.00	1.87	0.05	0.03	0.36	2.40	8.00	-	28.80	28.80	0.54	0.11	0.14
Potato, boiled	120	RA	02006	19.56	2.28	0.12	0.03	-	0.86	0.00	-	0.07	0.02	1.56	13.20	3.96	-	52.80	8.40	0.96	0.11	0.23
Sweet potato, yellow flesh, boiled	60	RA	02013	17.64	0.60	0.36	0.08	2.10	-	0.00	49.90	0.05	0.02	0.36	18.60	9.00	144.00	34.80	39.60	0.48	0.12	0.18
Noodles, mungbean, boiled	120	RA	03041	23.16	0.00	0.12	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	4.80	14.40	0.96	-	-
Median values	Energy : 103.2 kcal[2]			22.50	2.13	0.52	0.14	1.06	0.22	0.00	0.94	0.03	0.02	0.35	0.00	12.15	48.75	34.80	8.00	0.91	0.06	0.25

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BL = Blanch

2. Cereal (rice glutinous) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Rice glutinous, polished, steamed	35	RA	01053	18.62	1.59	0.07	0.03	0.10	0.04	0.00	0.0	0.02	0.04	0.82	0.00	4.43	4.51	4.20	1.13	0.37	0.03	0.38
		Energy : 81.48 kcal[2]									0											

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

3. Cereal (bread) group

Food Items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Bread, white, sliced	30	RA	01008	16.66	2.24	1.29	0.40	0.67	1.61	0.83	2.13	0.08	0.00	0.46	0.00	107.03	26.85	24.87	3.74	0.24	0.03	0.18
		Energy : 87.23 kcal[2]																				

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

4. Meat (meat) group

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Pork, tenderloin, boiled	15	RA	06119	0.00	5.01	0.33	0.17	0.00	0.00	10.50	0.00	0.14	0.06	0.05	0.00	4.05	33.00	22.50	0.60	0.17	0.03	0.23
Chicken, meat, raw	15	BO	06008	0.27	3.37	2.42	0.77	0.00	0.00	15.80	0.59	0.01	0.03	0.89	0.00	17.55	36.66	26.72	1.95	0.10	0.01	0.20
Fish, variety	-	-	-	0.00	3.17	0.45	0.16	0.00	0.00	12.60	4.20	0.01	0.01	0.43	0.00	10.05	37.91	28.10	6.96	0.11	0.01	0.06
Pork, liver, boiled	15	RA	06128	0.00	4.40	0.77	0.32	0.00	0.00	36.00	3898.80	0.03	0.46	1.19	0.32	6.90	19.50	36.00	1.65	0.75	0.92	0.56
Pork, organ, variety	-	-	-	0.07	2.78	0.70	0.38	0.00	0.00	37.20	5.31	0.03	0.05	0.71	0.00	15.60	29.86	29.10	2.06	0.45	0.02	0.32
Chicken, liver, boiled	15	RA	06102	0.00	3.96	1.10	0.49	0.00	0.00	87.90	1832.70	0.05	0.32	0.54	0.53	9.90	34.05	43.95	1.05	1.10	0.08	0.21
Chicken, giblets, raw (average)	15	BO	06012	0.04	3.89	0.88	0.38	0.00	0.00	67.02	1015.24	0.04	0.30	1.11	0.35	15.63	39.78	43.12	1.90	1.15	0.06	0.13
Median values	Energy : 22.45 kcal²			0.00	3.89	0.77	0.38	0.00	0.00	36.00	5.31	0.03	0.06	0.71	0.00	10.05	34.05	29.10	1.90	0.45	0.03	0.21

¹ Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

² Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BO = Boiling

Light orange color refers to surrogate in case that no unspecified food item (variety item) in INMUCAL database. (APPENDIX N)

5. Meat (soybean) group

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Soybean curd (tofu), white, soft	90	BO	03011	2.42	5.62	3.25	0.91	2.29	0.62	0.00	-	0.06	0.02	0.40	0.21	20.10	154.65	60.32	25.05	0.98	0.14	0.74
Soybean curd (tofu), yellow, hard	20	BO	03012	0.79	2.43	1.24	0.33	0.38	0.00	0.00	0.00	0.01	0.01	0.15	0.04	193.73	55.68	38.03	24.87	0.51	0.06	0.22
Soybean curd (tofu), white, hard	20	BO	03010	0.66	2.58	1.44	0.33	0.97	0.00	-	-	0.01	0.00	0.04	0.04	14.09	32.11	34.09	10.91	0.38	0.09	0.28
Peanut, boiled	10	RA	03021	1.14	1.44	2.63	0.62	-	0.23	0.00	0.10	0.06	0.01	0.84	0.50	70.04	-	17.80	4.50	0.15	0.05	0.17

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Mungbean, mature seeds, dried, raw	12	BO	03024	2.90	1.08	0.07	0.03	1.22	0.31	0.00	0.28	0.04	0.01	0.12	0.22	0.06	51.79	16.71	4.09	0.33	0.07	0.14
Cowpea, mature seeds, mixed colours, dried, raw	10	RA	03073	6.07	2.42	0.20	0.09	1.10	0.72	0.00	0.25	0.10	0.04	0.30	0.20	0.00	0.80	44.73	6.59	0.85	0.09	0.35
Median values	Energy : 28.87 kcal[2]			1.78	2.42	1.34	0.33	1.10	0.27	0.00	0.18	0.05	0.01	0.23	0.20	17.09	51.79	36.06	8.75	0.45	0.08	0.25

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BO = Boiling

6. Meat (egg) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Egg, hen, whole, boiled	25	RA	08032	0.24	3.25	2.15	-	0.00	0.24	94.99	40.27	0.02	0.08	0.03	0.00	32.48	31.34	41.05	13.42	0.33	0.01	0.24
	Energy : 33.25 kcal[2]																					

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

7. Vegetables group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Kale, chinese, boiled	47	RA	04320	1.47	1.13	0.09	-	-	-	0.00	-	-	-	-	17.41	-	-	-	-	0.24	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Cabbage, raw	47	BO	04009	2.40	0.72	0.08	0.01	0.80	1.46	0.00	3.71	0.02	0.04	0.22	9.40	12.32	116.44	17.57	16.66	0.15	0.02	0.06
Ivygourd, raw	50	BO	04087	1.92	1.73	0.09	0.02	1.27	0.00	0.00	182.85	0.06	0.09	0.40	10.96	8.97	89.92	38.15	31.72	0.66	0.07	0.18
Cabbage, chinese, white, raw	62	BO	04075	0.96	1.11	0.07	0.01	1.36	0.00	0.00	0.74	0.04	0.13	0.71	16.35	18.77	140.96	20.33	36.76	0.27	0.03	0.11
Water mimosa, raw	42	BO	04070	2.27	1.47	0.14	0.06	1.68	0.00	0.00	97.98	0.04	0.12	0.69	8.90	4.70	94.45	21.70	19.12	0.91	0.02	0.12
Water morning glory, thai, white stem, raw	33	BO	04091	1.07	0.49	0.10	0.02	0.95	0.00	0.00	24.12	0.01	0.04	0.22	2.90	24.24	113.34	14.43	8.71	0.50	0.03	0.12
Water morning glory, chinese, raw	50	BO	04090	1.14	1.28	0.14	0.05	1.14	0.00	0.00	99.39	0.01	0.07	0.00	4.28	56.05	124.93	14.73	24.23	1.57	0.05	0.29
Cabbage, chinese, raw	44	ST	04072	1.62	0.81	0.08	0.01	1.05	0.75	0.00	87.09	0.02	0.07	0.29	14.71	43.50	120.66	16.19	56.58	0.58	0.04	0.26
Mustard green stem and leave	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pumpkin, flesh (without skin), boiled	63	RA	04310	8.80	0.61	0.20	-	1.09	-	0.00	-	-	-	-	7.32	4.84	110.10	20.39	7.67	0.25	0.07	0.15
Cauliflower, boiled, drained without salt	50	RA	04006	2.06	0.92	0.23	0.04	1.15	1.04	0.00	0.50	0.02	0.03	0.21	22.15	7.50	71.00	16.00	8.00	0.16	0.01	0.09
Yardlong bean, green, boiled	50	RA	04040	4.05	1.45	0.05	0.01	1.80	0.84	0.00	2.75	0.05	0.06	0.45	9.50	2.00	134.00	18.50	27.50	0.35	0.02	0.15
Mungbean sprout, boiled	42	RA	04036	3.32	0.92	0.04	-	0.55	1.93	0.00	0.42	0.03	0.03	0.21	1.26	6.72	68.46	16.80	2.52	0.17	0.08	0.34
Winged bean, pod, boiled	50	RA	04043	2.95	0.70	0.05	0.01	-	0.00	0.00	5.54	0.10	0.05	0.35	-	1.58	-	18.00	19.50	0.05	-	-
Gourd, wax / winter melon, raw	70	BO	04109	3.10	0.30	0.05	0.01	1.22	0.00	0.00	0.38	0.01	0.01	0.29	21.57	5.00	94.77	12.00	10.01	0.18	0.01	0.07
Eggplant, raw	62	BO	04213	4.67	1.00	0.33	-	2.98	0.00	0.00	7.90	0.07	0.04	0.39	14.99	7.22	184.77	34.11	19.36	0.36	0.05	0.12
Cucumber, raw	116	RA	04030	5.04	0.91	0.12	0.03	1.14	2.35	0.00	2.58	0.05	0.06	0.35	12.57	8.89	193.00	30.30	24.39	0.30	0.05	0.17
Tomato	130	RA	04121	5.69	1.30	0.45	0.05	1.38	-	0.00	44.20	0.10	0.05	0.78	29.34	14.90	244.78	30.13	11.23	0.45	0.13	0.21
Yardlong bean, green, raw	90	RA	04039	5.61	2.30	0.25	0.07	3.38	1.26	0.00	4.34	0.08	0.09	0.83	13.29	17.96	191.23	47.70	31.95	0.68	0.15	0.39
Mungbean sprout, raw	67	RA	04035	4.40	2.95	0.09	0.02	1.68	3.41	0.00	1.18	0.05	0.07	0.74	5.46	10.07	100.07	56.38	15.89	0.39	0.10	0.29
Median values	Energy : 16.64 kcal[2]			2.95	1.00	0.09	0.02	1.22	0.38	0.00	4.34	0.04	0.06	0.35	11.77	8.93	116.44	19.42	19.24	0.35	0.05	0.15

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, BO = Boiling, ST = Steaming, ND = No Data (no information of those food items appeared in the databases)

8. Fruits group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Rambutan	76	RA	05008	13.62	0.74	0.10	0.02	1.24	13.59	-	0.00	0.01	0.06	0.59	34.58	10.44	60.16	13.07	11.40	0.38	0.11	0.10
Guava, common, different varieties	128	RA	05015	13.82	0.70	0.10	0.03	4.70	7.98	-	1.62	0.05	0.07	1.41	221.44	12.04	223.49	17.92	3.88	0.33	0.06	0.11
Watermelon, variety	-	-	-	21.94	1.80	0.23	0.00	1.85	20.48	0.00	65.15	0.08	0.06	0.55	15.47	10.02	293.93	33.30	24.12	0.46	0.14	0.23
Pineapple	108	RA	05058	14.05	0.54	0.06	0.02	1.76	13.86	-	7.83	0.10	0.04	0.32	10.80	2.80	120.43	11.07	8.14	0.29	0.06	0.15
Tangelo / tangerine / mandarin	136	RA	05061	13.26	1.14	0.24	0.03	2.13	14.96	-	15.75	0.07	0.04	0.48	23.57	37.70	228.03	26.75	34.39	0.63	0.10	0.12
Papaya, ripe	100	RA	05042	9.37	0.59	0.08	0.04	1.92	9.20	-	23.19	0.03	0.04	0.32	63.33	21.24	221.77	15.88	12.56	0.40	0.03	0.08
Water rose	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Banana (Nam-wa variety), ripe	40	RA	05003	11.83	0.31	0.06	0.03	0.96	7.39	-	1.31	0.02	0.01	0.39	5.16	1.51	96.33	10.40	2.71	0.21	0.03	0.05
Banana (Horm variety), ripe	44	RA	05004	10.54	0.52	0.05	0.01	0.68	8.43	-	2.28	-	0.02	0.36	11.88	1.82	152.67	20.24	6.31	0.23	0.05	0.05
Banana (Khai variety), ripe	40	RA	05006	10.51	0.54	0.04	0.02	0.78	8.60	-	7.04	0.03	0.03	0.33	3.00	8.63	97.19	8.60	1.90	0.11	0.05	0.07
Mango (Rad variety), unripe	85	RA	05040	15.41	0.43	0.17	0.06	1.86	6.61	-	2.38	0.04	0.04	0.28	18.42	64.65	105.88	11.39	10.21	0.18	0.09	0.07
Mango (Kaew variety), unripe	84	RA	05038	16.08	0.52	0.16	0.05	2.52	7.41	-	15.33	0.05	0.03	0.29	33.04	2.49	105.84	7.56	10.92	0.50	0.05	0.04
Mango (Ok-rong variety), ripe	75	RA	05037	13.77	0.45	0.14	0.04	0.91	9.64	0.00	3.66	0.03	0.05	1.28	6.21	32.74	137.98	11.25	7.29	0.21	0.05	0.05
Median values	Energy : 57.86 kcal[2]		ND	13.70	0.54	0.10	0.03	1.81	8.90	0.00	5.35	0.04	0.04	0.37	16.94	10.23	129.20	12.23	9.18	0.31	0.05	0.08

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw, ND = No Data (no information of those food items appeared in the databases)

☐ Light orange color refers to surrogate in case that no unspecified food item (variety item) in INMUCAL database. (APPENDIX N)

276

9. Whole milk (regular) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk, UHT, different flavours	200	RA	09084	9.45	6.41	7.11	2.81	0.00	18.50	14.65	61.77	0.06	0.42	0.18	-	114.77	228.00	176.80	215.33	0.17	0.02	0.68
Drinking yoghurt, pasteurised, different flavours	400	RA	09025	44.78	6.19	6.24	3.89	0.00	61.88	22.67	59.86	0.05	0.37	-	-	145.59		179.86	216.20	0.49	0.04	2.87
Yoghurt, different flavours	200	RA	09029	34.00	7.17	5.60	3.68	1.88	25.47	14.14	40.07	0.07	0.42	0.20	1.32	110.94	406.29	227.20	249.26	0.36	0.15	1.54
Median values				34.00	6.41	6.24	3.68	0.00	25.47	14.65	59.86	0.06	0.42	0.19	1.32	114.77	317.14	179.86	216.20	0.36	0.04	1.54
Energy : 217.82 kcal[2]																						

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].
[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

10. Milk (low fat) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk, low fat, UHT, different flavours	200	RA	09268	10.27	5.94	2.48	1.48	0.00	15.9 0	-	26.0 0	0.04	0.42	-	-	122. 00	-	-	357.33	0.14	-	-
Energy : 87.22 kcal[2]																						

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].
[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

11. Fat (oil, butter) group

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Oil, soybean	5	RA	10004	0.00	0.00	4.90	0.75	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	-	-	0.00	0.00	-	-
Oil, lard	5	RA	10007	0.00	0.00	5.00	1.96	0.00	0.00	4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Coconut milk, UHT, commercial packed	18	RA	10039	1.01	0.37	3.25	3.09	0.00	0.36	0.00	-	-	-	-	-	22.05	-	-	0.90	0.40	-	-
Butter, salted	5	RA	10008	0.00	0.03	4.18	2.69	0.00	0.00	12.43	28.81	0.00	0.00	0.06	0.00	25.16	-	0.60	0.91	0.01	-	-
Butter, unsalted	5	RA	10009	0.02	0.04	4.15	2.95	0.00	-	12.55	30.18	0.00	0.00	-	0.00	0.65	-	-	1.05	0.01	-	-
Median values	Energy : 37.76 kcal[2]			0.00	0.03	4.18	2.69	0.00	0.00	4.75	14.40	0.00	0.00	0.03	0.00	11.35	0.00	0.30	0.90	0.01	0.00	0.01

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

RA = Raw

APPENDIX M

Surrogates and nutrients for unspecified food items (Thai food exchange list)

1. Sweet pepper, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Pepper, sweet, green, raw	100	RA	04158	3.99	0.83	0.29	0.05	1.95	2.94	0.00	12.87	0.10	0.05	0.40	62.93	10.16	143.85	25.47	9.77	0.22	0.07	0.20
Pepper, sweet, red, raw	100	RA	04348	6.55	1.31	0.49	-	1.13	-	0.00	311.13	-	-	-	141.10	7.90	197.90	32.10	6.10	0.05	0.10	0.00
Pepper, sweet, yellow, raw	100	RA	04349	6.04	1.21	0.45	-	1.34	2.55	0.00	6.41	-	-	-	145.70	6.30	173.00	29.30	8.00	0.04	0.09	0.00
Median values	-	-	-	6.04	1.21	0.45	0.05	1.34	2.74	0.00	12.87	0.10	0.05	0.40	141.10	7.90	173.00	29.30	8.00	0.05	0.09	0.00

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

2. Rose apple, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Rose apple / wax jambu / java apple, red color variety (Kam-mam variety)	250	RA	05109	9.50	0.75	0.00	0.00	1.08	8.60	-	27.50	0.35	0.05	2.00	87.50	5.88	103.60	10.00	17.50	0.75	0.05	0.10
Rose apple / wax jambu (Green variety)	250	RA	05009	19.59	1.15	0.09	0.01	2.75	17.30	-	11.04	0.06	0.08	0.79	14.00	164.28	305.83	29.17	12.00	1.57	-	-
Rose apple (Khak-dum variety)	250	RA	05110	13.25	1.50	0.00	0.00	1.73	13.80	-	2.88	1.90	0.08	0.75	60.00	9.40	166.23	45.00	12.50	0.50	0.08	0.15
Rose apple, red color (Tub-tim-chun variety)	250	RA	05164	24.85	1.00	0.33	-	2.75	22.00	0.00	4.58	0.03	0.13	1.00	66.28	15.00	265.00	26.50	2.50	0.25	0.10	0.25

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Rose apple (Toon-klow variety)	250	RA	05202	21.15	1.25	0.25	-	2.68	17.71	0.00	3.06	-	-	-	20.00	12.79	209.33	30.00	5.05	0.54	0.13	0.15
Rose apple / water rose, reddish color (Nak variety)	250	RA	05111	16.13	0.75	0.00	0.00	1.71	13.70	-	2.85	0.03	0.04	0.25	62.50	9.34	165.03	30.00	8.75	1.13	0.05	0.15
Rose apple / malay apple, red color (Ma-meaw variety)	250	RA	05112	19.73	1.25	0.25	-	2.21	17.68	-	52.50	0.44	0.16	1.25	37.50	12.05	430.00	28.33	15.00	2.17	0.09	0.20
Rose apple / water rose, green color (Meuang-peth variety)	250	RA	05115	16.50	1.25	0.00	0.00	2.75	14.40	-	11.04	0.05	0.45	1.50	55.00	9.83	173.45	45.00	5.00	0.75	0.08	0.18
Rose apple / malay apple, red color (Sa-raek variety)	250	RA	05113	19.50	0.00	0.25	-	2.08	16.60	-	3.45	0.03	0.10	0.75	50.00	11.33	199.95	20.00	5.00	1.50	0.08	0.20
Rose apple / water apple, deep-red	250	RA	05114	12.00	1.00	0.00	0.00	1.35	10.80	-	2.25	0.23	0.13	0.50	90.00	7.38	130.10	35.00	5.00	1.00	0.05	0.13
Median values	-	-	-	18.00	1.08	0.04	0.00	2.14	15.50	0.00	4.01	0.06	0.10	0.79	57.50	10.58	186.70	29.58	6.90	0.88	0.08	0.15

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

3. Durian, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Durian (Kob-ta-khum variety)	40	RA	05209	9.42	1.13	1.77	-	0.96	7.23	0.00	13.00	-	-	-	-	8.75	175.67	15.06	1.32	0.14	0.07	0.13
Durian (Kob-pi-kul variety)	40	RA	05210	23.42	2.42	3.50	-	1.96	16.95	0.00	27.24	0.31	0.05	1.62	24.14	27.02	389.41	34.65	4.79	0.41	0.23	0.31
Durian (Kra-dum variety)	40	RA	05211	12.26	1.27	1.83	-	1.19	8.00	0.00	9.01	0.21	0.12	0.40	12.80	7.88	176.47	13.28	1.50	0.32	0.09	0.15
Durian (Kan-yow variety)	40	RA	05117	12.41	1.07	1.18	0.33	0.64	3.50	0.00	3.14	0.18	0.13	0.82	13.87	1.84	272.00	14.27	4.40	0.38	-	0.17
Durian (Kum-pun-jao-krom variety)	40	RA	05212	25.14	1.86	2.68	-	1.73	14.28	0.00	10.04	0.25	0.04	1.41	16.77	11.16	239.63	25.25	3.03	0.17	0.13	0.17
Durian (Chom-poo-sri variety)	40	RA	05213	9.71	1.14	1.52	-	1.57	7.76	0.00	12.29	0.10	0.05	0.51	10.88	9.24	190.98	7.91	1.59	0.18	0.06	0.07
Durian (Cha-nee variety)	40	RA	05088	9.81	1.07	2.10	0.53	1.46	5.63	0.00	4.54	0.14	0.08	0.57	10.29	6.99	178.64	14.68	2.79	0.30	0.08	0.15
Durian (Thong-yoi-chat variety)	40	RA	05214	8.93	1.21	1.47	-	0.37	7.83	0.00	6.66	0.13	0.07	0.52	5.82	10.03	153.35	9.83	2.15	0.18	0.04	0.13
Soursop / prickly custard apple	40	RA	05124	6.04	0.40	0.08	-	-	4.83	0.00	-	0.03	0.04	0.52	9.60	4.99	-	8.40	5.60	0.20	-	-

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Durian (E-loung variety)	40	RA	05215	10.15	1.05	1.30	-	-	-	0.00	-	0.13	0.12	0.84	13.20	-	-	14.80	16.40	0.44	-	-
Durian (Mon-thong variety / golden pillow variety)	40	RA	05012	10.64	0.90	1.34	0.41	1.11	5.90	0.00	1.42	0.11	0.08	0.84	14.60	4.42	155.69	11.90	1.70	0.21	0.06	0.08
Median values	-	-	-	10.15	1.13	1.52	0.41	1.19	7.50	0.00	9.01	0.14	0.07	0.69	13.00	8.32	178.64	14.27	2.79	0.21	0.07	0.14

¹ Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

4. Grape, variety

Food items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Durian (Mon-thong variety / golden pillow variety)	100	RA	05012	14.52	0.51	0.09	0.01	1.18	13.82	-	1.73	0.03	0.04	0.20	5.67	7.60	155.56	20.00	5.75	0.40	0.37	0.06
Grapes, black (Thai variety)	100	RA	05182	11.00	0.50	0.10	-	0.80	12.00	0.00	3.75	-	-	-	2.00	4.00	182.00	15.00	0.00	0.00	-	0.00
Grapes, red, seedless variety	100	RA	05183	16.30	1.00	0.20	-	1.10	15.00	0.00	-	-	-	-	3.00	-	250.00	24.00	7.00	0.27	-	1.64
Grapes, red, small	100	RA	05087	13.31	0.49	0.13	0.01	2.67	11.17	-	2.38	0.03	0.03	0.20	2.11	5.81	174.00	16.75	6.75	0.37	0.07	0.03
Median values	-	-	-	13.92	0.51	0.12	0.01	1.14	12.91	0.00	2.38	0.03	0.03	0.20	2.56	5.81	178.00	18.38	6.25	0.32	0.22	0.04

¹ Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

5. Mango, unripe. variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Mango (Kaew variety), unripe	100	RA	05038	19.15	0.62	0.19	0.06	3.00	8.82	-	18.25	0.06	0.04	0.35	39.33	2.97	126.00	9.00	13.00	0.60	0.06	0.04
Mango (Kaew variety), unripe	100	RA	05038	18.82	0.69	0.13	0.05	3.52	8.77	0.00	7.83	0.07	0.02	0.50	27.50	1.86	143.01	21.50	4.41	0.18	0.09	0.10
Mango (Thong-dum variety), unripe	100	RA	05034	19.91	0.65	0.39	-	-	9.35	-	-	0.02	0.08	0.30	33.50	-	-	6.50	22.00	0.35	-	-
Mango (Ta-wai variety), unripe	100	RA	05197	18.80	0.90	0.10	-	-	-	0.00	-	0.02	0.09	-	40.00	-	-	14.00	11.00	0.80	-	-
Mango (Pim-saen variety), unripe	100	RA	05035	20.66	0.85	0.50	-	1.80	8.86	-	12.33	0.04	0.04	0.60	30.50	-	-	12.00	14.50	0.00	-	-
Mango (Rad variety), unripe	100	RA	05040	18.13	0.50	0.20	0.07	2.19	7.78	-	2.80	0.04	0.05	0.33	21.67	76.06	124.57	13.40	12.02	0.21	0.11	0.08
Median values	-	-	-	18.98	0.67	0.20	0.06	2.59	8.82	0.00	10.08	0.04	0.04	0.35	32.00	2.97	126.00	12.70	12.51	0.28	0.09	0.08

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

6. Mango, ripe. variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Mango (Kaew variety), ripe	80	RA	05039	17.92	0.48	0.08	0.02	1.28	10.16	0.00	117.87	0.04	0.05	0.88	22.40	39.62	-	8.00	27.20	0.28	-	-
Mango (Kiew-sa-weya variety), ripe	80	RA	05195	14.56	0.40	0.64	-	-	-	0.00	-	0.02	0.04	-	20.00	-	-	-	-	-	-	-
Mango (Tub-ped variety), ripe	80	RA	05196	17.83	0.86	0.00	-	-	-	0.00	-	0.07	0.06	-	36.00	-	-	17.60	-	-	-	-
Mango (Thong-dum variety), ripe	80	RA	05096	15.94	0.48	0.00	0.00	-	12.02	-	-	0.02	0.04	-	20.00	-	-	12.80	32.80	0.32	-	-
Mango (Nam-dok-mai variety), ripe	80	RA	05033	14.19	0.52	0.18	0.05	0.87	11.73	-	39.52	0.09	0.05	1.44	8.15	2.00	112.63	12.80	3.87	0.16	0.07	0.07
Mango (Pimsen-mun variety), ripe	80	RA	05097	11.68	0.80	0.16	-	-	8.81	-	214.00	0.07	0.04	0.64	10.40	-	-	9.60	20.00	-	-	-
Mango, ripe (Karen fruit)	80	RA	05160	17.92	0.48	0.08	-	0.80	10.16	0.00	5.94	-	-	-	14.40	-	-	-	-	-	-	-
Mango (Nung-klang-wan variety), ripe	80	RA	05036	16.24	0.40	0.12	-	-	12.25	-	-	0.06	0.06	0.64	26.80	-	-	12.00	20.00	0.24	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Median values	-	-	-	16.09	0.48	0.10	0.02	0.87	10.94	0.00	78.69	0.06	0.05	0.76	20.00	20.81	112.63	12.40	20.00	0.26	0.07	0.07

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

6. Apple juice, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Juice, apple, 100% (Tipco brand)	120	RA	14102	15.60	0.00	0.00	0.00	0.00	12.48	0.00	0.00	0.00	0.02	-	1.44	-	186.00	-	0.00	0.54	-	-
Juice, apple, 100% (Malee brand)	120	RA	14018	16.80	0.00	0.00	0.00	-	14.88	0.00	-	-	0.01	-	-	21.60	-	-	-	0.29	-	-
Juice, red apple, 100% (Tesco brand)	120	RA	14098	16.20	0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	-	21.60	18.00	-	-	0.00	0.18	-	-
Median values	-	-	-	16.20	0.00	0.00	0.00	0.00	14.88	0.00	0.00	0.00	0.01	0.00	11.52	19.80	186.00	0.00	0.00	0.29	0.00	0.00

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

7. Milk powder, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk powder, vanilla flavour, with 2.5% of fibre	30	RA	09247	16.67	5.00	5.83	2.08	0.38	13.33	4.17	133.33	0.10	0.21	2.50	15.00	66.67	-	133.33	233.33	1.88	-	2.50

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
and mixed berries formula (Carnation 3 Plus brand)																						
Milk powder, vanilla flavour (Alacta 100 3 Plus brand)	30	RA	09246	18.00	5.25	5.25	3.00	0.75	15.00	15.00	180.00	0.09	0.26	1.50	20.25	56.25	210.00	120.00	210.00	2.25	0.09	1.13
Milk powder (Anchor brand)	30	RA	09054	10.77	8.16	8.55	-	-	-	-	216.00	-	-	-	-	-	-	-	-	-	-	-
Milk powder (Alacta nf brand)	30	RA	09055	11.43	8.28	8.04	-	-	-	-	134.34	0.23	0.30	2.91	22.38	78.36	268.65	208.20	268.65	3.03	0.09	2.24
Milk powder (Mission brand)	30	RA	09080	11.28	7.89	8.58	-	-	-	-	247.50	0.08	0.64	0.19	2.23	89.55	366.00	230.64	284.82	0.07	0.00	0.90
Milk powder, vanilla flavour (Similac Gain Plus brand)	30	RA	09226	15.87	5.05	7.21	2.16	0.72	12.98	3.25	115.38	0.32	0.25	3.61	-	79.33	288.46	144.23	230.77	2.70	0.14	1.62
Milk powder, vanilla flavour (Alacta 100 1 Plus brand)	30	RA	09229	18.00	5.25	5.25	3.38	0.75	12.75	15.00	150.00	0.09	0.26	1.20	13.50	63.75	232.50	150.00	150.00	1.69	0.12	1.69
Milk powder, vanilla flavour (Enfa 3 Smart Plus brand)	30	RA	09228	18.00	5.25	5.25	3.38	0.75	12.00	15.00	90.00	0.11	0.19	1.50	9.00	67.50	240.00	150.00	180.00	1.69	0.03	1.69
ilk powder, vanilla flavour (S-26 PE Gold brand)	30	RA	09227	18.41	4.77	4.77	1.02	0.31	12.95	3.41	136.36	0.15	0.23	1.09	16.36	64.77	259.09	109.09	163.64	2.56	0.11	1.53
Milk powder, vanilla flavour, with 2.5% of fibre and apple with spinach formula (Carnation 1 Plus brand)	30	RA	09230	16.67	5.00	5.83	2.08	0.38	12.50	4.17	133.33	0.10	0.21	2.50	15.00	62.50	-	133.33	166.67	1.88	-	2.50
Milk powder, plain (Dumilk 3 brand)	30	RA	09218	20.00	4.29	4.29	1.79	0.33	14.29	3.57	114.29	0.16	0.18	1.43	8.57	50.00	192.86	114.29	171.43	1.61	0.09	1.07
Milk powder, plain (Dumex Gold Plus 3 brand)	30	RA	09219	19.50	4.50	4.50	1.88	0.35	13.50	7.50	120.00	0.23	0.26	1.50	13.50	52.50	202.50	120.00	180.00	1.69	0.09	1.13
Milk powder, plain (Lactogen 3 Gro brand)	30	RA	09217	18.00	4.29	5.14	1.29	0.39	14.57	3.86	137.14	0.26	0.29	1.71	12.86	47.14	137.14	102.86	137.14	1.93	-	1.29
Milk powder, plain (Alacta 100 1 Plus brand)	30	RA	09221	18.00	6.00	3.75	2.25	0.75	9.00	15.00	150.00	0.07	0.26	1.20	13.50	71.25	270.00	180.00	180.00	1.69	0.15	1.69
Milk powder, plain (Enfa 3 Smart Plus brand)	30	RA	09220	18.00	6.00	3.75	2.25	0.75	9.00	18.75	120.00	0.11	0.19	1.50	9.00	78.75	270.00	150.00	180.00	1.69	0.03	1.13
Milk powder, plain (Enfagrow A plus 3 brand)	30	RA	09214	17.25	6.00	3.75	2.25	0.75	9.00	18.75	120.00	0.17	0.26	1.50	11.25	78.75	270.00	150.00	240.00	2.81	0.06	1.69
Milk powder, plain (Hi-Q 1 Plus Super Gold brand)	30	RA	09215	19.50	4.50	4.50	1.88	1.50	12.00	7.50	120.00	0.23	0.26	1.50	15.75	52.50	202.50	120.00	180.00	1.69	0.09	1.13
Milk powder, plain (Hi-Q 1 Plus Prebioproteq brand)	30	RA	09216	19.77	4.09	4.09	2.05	0.31	15.00	6.82	109.09	0.20	0.23	1.36	12.27	47.73	197.73	109.09	163.64	1.53	0.08	1.02
Milk powder, vanilla and plain flavour (Bear brand)	30	RA	09225	16.67	5.00	5.83	2.08	0.83	10.83	8.33	133.33	0.13	0.21	1.67	15.00	62.50	-	-	200.00	2.50	-	3.13

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Brand 1 Plus brand)																						
Milk powder, vanilla and plain flavour (S-26 Progress Gold brand)	30	RA	09223	18.57	4.29	5.00	1.07	0.33	11.43	3.57	114.29	0.11	0.18	1.14	17.14	78.57	342.86	114.29	142.86	2.14	0.06	0.86
Milk powder, vanilla and plain flavour, with 5 nucleotides and lutein (S-26 Progress brand)	30	RA	09224	19.77	4.09	4.77	1.02	0.00	10.23	3.41	81.82	0.10	0.23	1.36	16.36	64.77	245.45	109.09	136.36	1.53	0.14	1.53
Milk powder, plain, with fish oil, 5 nucleotides and choline (Snowmate brand)	30	RA	09222	18.87	4.72	4.25	1.42	1.89	13.21	9.43	113.21	0.14	0.24	1.51	14.15	47.17	160.38	150.94	226.42	2.12	0.11	1.13
Milk powder, honey flavour (Dumilk 3 brand)	30	RA	09232	20.00	4.29	4.29	1.79	0.33	15.71	3.57	114.29	0.16	0.30	1.43	8.57	50.00	192.86	114.29	171.43	1.61	0.09	1.07
Milk powder, honey flavour, with 2.5% of fibre and apple with spinach formula (Carnation 1 Plus brand)	30	RA	09233	16.67	5.00	5.83	2.08	0.38	12.50	4.17	133.33	0.10	0.21	2.50	15.00	62.50	-	133.33	166.67	1.88	-	2.50
Milk powder, sweetened vanilla flavour (Dumilk 3 brand)	30	RA	09231	20.00	4.29	4.29	1.79	0.33	15.71	3.57	114.29	0.16	0.18	1.43	8.57	50.00	192.86	114.29	171.43	1.61	0.09	1.07
Milk powder, with iron (Nan Pro 3 brand)	30	RA	09234	17.34	4.35	6.36	-	-	-	-	113.40	0.12	0.21	0.90	21.00	53.10	147.00	86.40	133.20	1.68	0.09	1.32
Milk powder, follow-on formula (Similac Gain brand)	30	RA	09206	14.97	5.10	7.14	-	0.79	-	-	156.13	0.25	0.32	2.53	21.48	71.70	251.10	130.80	226.80	2.35	0.13	1.11
Milk powder, follow-on formula (Dupro 2 brand)	30	RA	09208	18.63	4.35	5.85	-	0.80	-	-	132.30	0.10	0.31	0.86	22.50	51.90	165.30	90.00	135.00	1.44	0.07	0.96
Milk powder, follow-on formula (Dupro brand)	30	RA	09207	17.70	4.50	6.06	-	0.42	-	-	188.10	0.20	0.21	1.50	23.10	44.40	159.30	90.30	140.10	2.61	0.08	1.35
Milk powder, follow-on formula (Dumex Gold Plus 2 brand)	30	RA	09210	17.82	4.50	6.06	-	1.65	-	-	136.50	0.11	0.27	0.93	23.40	44.70	160.20	87.60	140.40	1.47	0.06	0.99
Milk powder, follow-on formula (Nan 2 brand)	30	RA	09068	16.95	4.80	6.30	-	-	-	-	129.00	0.09	0.18	1.08	11.70	66.00	216.00	132.00	171.00	2.58	0.14	1.08
Milk powder, follow-on formula (Promi brand)	30	RA	09062	16.50	6.00	5.40	-	-	-	-	142.80	0.18	0.25	1.26	13.80	101.40	275.10	194.40	237.90	1.65	0.12	0.90
Milk powder, follow-on formula (Mamil brand)	30	RA	09075	15.81	6.00	5.70	-	-	-	-	135.00	0.09	0.30	1.50	15.00	72.90	267.30	143.10	214.50	2.40	0.16	1.02
Milk powder, follow-on formula (Meiji fu brand)	30	RA	09064	17.04	5.55	5.40	-	-	-	-	117.00	0.12	0.30	1.80	15.00	60.00	210.00	117.00	210.00	2.55		0.75
Milk powder, follow-on formula (Lactogen 2 brand)	30	RA	09057	16.60	4.28	6.56	-	-	-	-	120.09	0.13	0.26	1.14	21.60	54.60	154.80	85.80	132.00	1.56	0.08	1.26
Milk powder, follow-on formula (Lactogen gold)	30	RA	09056	15.48	6.48	5.70	-	-	-	-	126.00	0.08	0.20	1.05	11.10	81.00	243.00	180.00	231.00	1.50	0.08	0.96

2 brand)

Food Items	Weight (g/mL)¹	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk powder, follow-on formula (Snow F-plus brand)	30	RA	09066	16.95	5.22	5.91	-	-	-	-	153.00	0.12	0.33	1.62	20.10	69.00	225.00	120.00	153.00	2.43	0.11	1.11
Milk powder, follow-on formula (Snowmate brand)	30	RA	09209	17.64	4.71	5.70	-	-	-	-	135.00	0.12	0.30	1.50	30.00	54.00	210.00	117.00	180.00	2.55	0.09	1.20
Milk powder, follow-on formula (Bear brand)	30	RA	09200	17.19	4.35	6.66	-	-	-	-	126.00	0.13	0.20	1.15	23.61	48.00	154.80	87.90	135.30	1.57	0.08	1.26
Milk powder, follow-on formula (Alacta 100 brand)	30	RA	09212	16.80	4.77	5.73	-	0.78	-	-	123.00	0.11	0.27	1.08	27.30	60.00	210.00	99.00	162.00	1.62	0.10	1.50
Milk powder, follow-on formula (Enfa 2 Smart Plus brand)	30	RA	09211	18.60	4.68	4.68	-	0.72	-	-	159.00	0.14	0.32	1.89	15.90	56.10	213.00	120.00	153.00	2.28	0.08	1.20
Milk powder, follow-on formula (Enfapro brand)	30	RA	09047	17.16	5.82	5.52	-	-	-	-	132.30	0.13	0.32	1.68	16.80	75.00	294.00	156.00	195.00	2.52	0.08	1.26
Milk powder, follow-on formula (Enfalac A plus 2 brand)	30	RA	09203	18.30	4.74	4.62	-	-	-	-	120.00	0.10	0.30	1.56	30.30	59.10	216.00	126.00	153.00	2.40	0.09	1.32
Milk powder, follow-on formula (S-26 Promil Gold brand)	30	RA	09202	17.40	4.50	6.60	-	0.66	-	-	127.20	0.11	0.30	0.86	18.30	72.30	194.10	110.10	164.10	2.58	0.11	0.90
Milk powder, follow-on formula (Hi-Q Super Gol brand)	30	RA	09204	17.70	4.50	6.00	-	1.65	-	-	158.40	0.11	0.27	0.93	32.10	45.00	160.20	124.50	193.50	2.49	0.06	1.71
Milk powder, follow-on formula (Hi-Q Prebioproteq brand)	30	RA	09205	17.76	4.50	6.00	-	1.65	-	-	136.80	0.11	0.27	0.93	14.40	44.70	160.20	104.70	140.40	1.59	0.06	0.99
Milk powder, follow-on formula, honey (Bear brand brand)	30	RA	09052	15.30	6.66	5.70	-	-	-	-	126.00	0.09	0.18	1.05	11.40	84.30	255.00	180.00	231.00	1.80	0.08	1.02
Milk powder, follow-on formula, with 5 nucleotides and lutein (S-26 Promil brand)	30	RA	09201	17.70	4.80	6.00	-	-	-	-	160.80	0.21	0.32	0.86	19.20	64.20	214.20	139.20	246.30	2.58	0.09	1.08
Milk powder, follow-on formula, with enzymatic hydrolysed whey protein concentrate (Hi-Q H.A.2 brand)	30	RA	09213	18.63	3.24	6.09	-	1.62	-	-	121.20	0.10	0.24	0.93	19.20	51.30	158.70	87.00	129.00	2.16	0.09	1.08
Milk powder, follow-on formula, with iron (Nan Pro 2 brand)	30	RA	09199	17.43	4.35	6.39	-	-	-	-	126.00	0.12	0.23	1.14	21.60	40.80	148.20	87.00	133.50	1.58	0.09	1.20

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk powder, infant formula (Gain brand)	30	RA	09072	12.51	5.79	8.04	-	-	-	-	136.20	0.15	0.24	1.65	14.40	66.00	264.00	150.00	237.30	2.49	0.14	1.14
Milk powder, infant formula (Similac brand)	30	RA	09071	15.85	3.20	8.47	-	0.91	-	-	129.10	0.18	0.33	1.62	22.77	40.50	189.00	64.80	120.00	2.73	0.12	1.14
Milk powder, infant formula (Dumex Gold Plus 1 brand)	30	RA	09193	17.61	3.15	7.80	-	1.77	-	-	126.30	0.11	0.26	1.00	16.50	39.00	130.20	54.00	91.50	1.32	0.09	0.84
Milk powder, infant formula (Dulac brand)	30	RA	09196	17.70	3.24	7.59	-	0.45	-	-	148.80	0.16	0.23	1.20	26.10	38.70	129.90	57.30	96.90	2.28	0.09	0.99
Milk powder, infant formula (Nan 1 brand)	30	RA	09067	17.37	3.42	7.74	-	-	-	-	138.00	0.09	0.21	1.14	12.30	36.00	150.00	49.50	99.00	1.80	0.09	1.14
Milk powder, infant formula (Mamex brand)	30	RA	09074	16.95	3.60	8.10	-	-	-	-	135.00	0.09	0.15	1.50	13.50	34.50	126.00	77.40	116.40	1.80	0.10	0.81
Milk powder, infant formula (Meiji fmt brand)	30	RA	09063	17.16	3.75	7.65	-	-	-	-	153.00	0.12	0.24	1.80	13.50	42.00	147.00	69.00	120.00	1.80	0.10	0.84
Milk powder, infant formula (lactogen gold 1 brand)	30	RA	09010	15.99	4.08	8.43	-	-	-	-	140.40	0.09	0.21	0.75	12.60	39.30	159.00	48.00	96.00	1.80	0.09	1.05
Milk powder, infant formula (Snow P-7I brand)	30	RA	09065	16.17	3.96	8.25	-	-	-	-	144.00	0.12	0.27	1.56	19.20	42.00	138.00	63.00	111.00	2.07	0.11	0.93
Milk powder, infant formula (Enfa 1 Smart Plus brand)	30	RA	09197	15.90	3.30	9.00	-	0.84	-	-	141.00	0.13	0.38	1.89	20.40	40.80	189.00	72.00	141.00	2.67	0.12	1.74
Milk powder, infant formula (Enfalac a.r. brand)	30	RA	09044	16.77	3.81	7.77	-	-	-	-	135.00	0.12	0.14	1.50	18.00	52.50	187.50	97.50	123.00	1.68	0.01	1.50
Milk powder, infant formula (Enfalac A plus 1 brand)	30	RA	09190	17.10	3.21	8.10	-	0.92	-	-	129.00	0.13	0.25	0.99	27.60	42.90	180.00	78.00	123.00	1.53	0.10	1.23
Milk powder, infant formula (Enfalac brand)	30	RA	09045	16.29	3.60	8.67	-	-	-	-	141.75	0.12	0.29	1.89	17.10	34.50	173.10	69.30	105.30	2.82	0.10	0.93
Milk powder, infant formula (S-26 SMA Gold brand)	30	RA	09188	16.20	3.00	8.40	-	0.69	-	-	153.60	0.23	0.26	1.16	21.00	37.20	151.20	55.80	97.80	1.86	0.10	1.41
Milk powder, infant formula (S-26 brand)	30	RA	09008	16.80	3.60	8.40	-	-	-	-	186.84	0.17	0.26	1.18	13.80	35.40	132.00	77.91	104.70	3.00	0.11	0.87
Milk powder, infant formula (Hi-Q Super Gold brand)	30	RA	09194	17.19	3.15	7.86	-	1.77	-	-	127.50	0.01	0.26	1.00	22.50	40.50	132.00	55.50	93.00	1.32	0.09	0.84
Milk powder, infant formula (Hi-Q Prebioproteq brand)	30	RA	09195	17.70	3.15	7.71	-	1.77	-	-	126.30	0.12	0.20	1.08	19.50	39.00	130.20	54.00	91.50	1.35	0.09	0.87
Milk powder, infant formula (Enfamil brand)	30	RA	09048	16.32	3.51	8.67	-	-	-	-	140.40	0.12	0.28	1.89	17.70	45.00	195.00	99.00	129.00	0.78	0.10	1.05
Milk powder, infant formula, with 5 nucleotides and lutein (S-26 SMA brand)	30	RA	09189	17.10	3.60	8.40	-	-	-	-	177.30	0.24	0.35	1.18	21.30	37.80	165.30	78.60	108.60	1.89	0.13	1.41
Milk powder, infant formula, with iron (Nan Pro 1)	30	RA	09191	17.35	2.88	8.31	-	-	-	-	118.80	0.13	0.18	0.90	16.80	31.80	126.00	43.80	109.20	1.23	0.10	1.29

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk powder, infant formula, with iron (Bebe brand)	30	RA	09198	17.35	2.88	8.31	-	-	-	-	118.80	0.13	0.18	0.90	16.80	31.80	126.00	43.80	79.20	1.23	0.10	1.29
Milk powder, infant formula, with iron (Lactogen 1 brand)	30	RA	09192	17.43	3.15	7.80	-	-	-	-	115.20	0.13	0.24	0.90	17.10	32.40	138.60	44.40	79.80	1.11	0.09	1.53
Milk powder, infant formula, with iron (Enfamil brand)	30	RA	09049	16.32	3.51	8.67	-	-	-	-	140.40	0.12	0.28	1.89	17.70	45.00	195.00	99.00	129.00	2.82	0.10	1.05
Milk powder, plain (Dumilk 4 brand)	30	RA	09237	20.71	4.29	3.57	1.43	0.33	14.29	3.57	114.29	0.16	0.18	1.43	8.57	50.00	192.86	114.29	171.43	1.61	0.09	1.07
Milk powder, plain (Dumex Gold Plus 4 brand)	30	RA	09238	19.50	5.25	3.75	1.50	0.35	12.75	3.75	120.00	0.23	0.26	2.25	13.50	60.00	240.00	150.00	210.00	1.69	0.12	1.13
Milk powder, plain (Alacta 100 3 Plus brand)	30	RA	09239	18.00	6.00	3.75	2.25	0.75	9.00	15.00	180.00	0.11	0.26	1.50	20.25	67.50	247.50	150.00	240.00	2.25	0.09	1.13
Milk powder, plain (Enfagrow A plus 4 brand)	30	RA	09240	17.25	6.00	3.75	2.25	0.75	10.50	18.75	150.00	0.17	0.26	1.50	11.25	82.50	255.00	150.00	240.00	2.81	0.09	1.69
Milk powder, plain (Enfakid 4 brand)	30	RA	09241	18.00	6.00	3.75	2.25	0.75	9.00	15.00	180.00	0.11	0.26	1.50	20.25	67.50	247.50	150.00	240.00	2.25	0.09	1.13
Milk powder, plain (Hi-Q 3 Plus Super Gold brand)	30	RA	09242	19.50	5.25	3.75	1.50	1.50	12.00	3.75	120.00	0.23	0.26	2.25	15.75	60.00	240.00	150.00	210.00	1.69	0.12	1.13
Milk powder, plain (Hi-Q 3 Plus Prebioproteq brand)	30	RA	09243	18.75	5.25	3.75	1.50	0.35	15.00	3.75	120.00	0.23	0.26	2.25	13.50	52.50	232.50	150.00	210.00	1.69	0.12	1.13
Milk powder, vanilla and plain flavour (Bear Brand 3 Plus brand)	30	RA	09245	15.83	5.83	5.83	2.08	0.83	10.83	8.33	133.33	0.13	0.28	1.67	15.00	66.67	-	-	233.33	2.50	-	3.13
Milk powder, plain, with fish oil, 5 nucleotides and choline (Snowmate Kids brand)	30	RA	09244	19.81	4.25	4.25	1.42	0.65	14.15	7.08	113.21	0.17	0.24	1.70	16.98	49.53	162.74	113.21	226.42	2.12	0.11	1.27
Milk powder, honey flavour (Dumilk 4 brand)	30	RA	09248	20.71	4.29	3.57	1.43	0.33	15.71	3.57	114.29	0.16	0.18	1.43	8.57	50.00	192.86	114.29	171.43	1.61	0.09	1.07
Milk powder, honey flavour, with 2.5% of fibre and mixed berries formula (Carnation 3 Plus brand)	30	RA	09249	16.67	5.00	5.83	2.08	0.38	13.33	4.17	133.33	0.10	0.21	2.50	15.00	66.67	-	133.33	233.33	1.88	-	2.50
Goat milk, powder, plain (DG-3 Advance brand)	30	RA	09187	16.55	5.17	6.21	4.14	0.00	10.34	20.69	124.14	0.23	0.35	3.10	18.62	51.72	330.00	206.90	248.28	2.33	-	0.93
Median values	-	-	-	17.35	4.50	5.85	2.06	0.75	12.75	5.49	133.33	0.12	0.26	1.50	16.36	52.50	194.55	114.29	165.38	1.87	0.09	1.13

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

8. Milk powder, non fat, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Milk powder, non fat	30	RA	09107	11.79	7.38	0.00	0.00	0.00	10.11	0.00	294.90	0.19	0.39	1.02	11.10	101.70	283.20	206.40	194.10	1.98	0.01	1.23
Milk powder, non fat, high calcium (Anlene brand)	30	RA	09082	14.40	11.58	0.27	0.18	0.00	-	10.96	300.00	0.06	0.63	-	3.90	130.50	492.00	390.00	480.00	0.60	-	1.68
Median values	-	-	-	13.10	9.48	0.14	0.09	0.00	10.11	5.48	297.45	0.12	0.51	1.02	7.50	116.10	387.60	298.20	337.05	1.29	0.01	1.46

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

9. Salad dressing, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Salad dressing, cream	15	RA	10017	4.15	0.18	6.75	1.16	0.12	3.19	2.88	11.40	0.01	0.01	-	0.00	82.01	-	-	3.17	0.08	-	-
Salad dressing, japanese sesame flavour	15	RA	10050	4.53	0.36	2.26	-	0.29	1.92	-	4.05	0.01	0.00	-	0.00	132.30	-	-	2.33	0.15	-	-
Salad dressing, japanese sauce flavour	15	RA	10051	1.85	0.42	2.30	-	0.25	2.37	-	4.05	0.01	0.00	-	0.00	229.15	-	-	2.25	0.12	-	-
Salad dressing, thousand island	15	RA	10013	2.57	0.18	5.61	-	-	2.66	3.60	-	0.00	0.00	-	0.00	110.40	-	-	1.65	0.11	-	-
Median values	-	-	-	3.36	0.27	3.95	1.16	0.25	2.51	3.24	4.05	0.01	0.00	0.00	0.00	121.35	0.00	0.00	2.29	0.11	0.00	0.00

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list [10].

RA = Raw

APPENDIX N

Surrogates and nutrients for unspecified food items (Food based dietary guideline)

1. Fish, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, catfish, truncated estuarine, raw	15	BO	07008	0.00	3.03	0.31	0.11	-	0.00	12.47	5.35	0.03	0.00	0.21	-	-	-	27.22	15.88	0.68	-	-
Fish, sea catfish, raw	15	BO	07009	0.00	3.56	0.18	0.06	-	0.00	11.71	-	0.01	0.02	0.28	-	8.68	-	33.39	6.83	0.28	-	-
Fish, bluespot gray mullet, boiled	15	RA	07281	0.00	3.86	0.33	0.15	0.00	-	10.30	1.56	0.05	0.01	0.70	-	13.21	35.45	-	5.81	0.08	0.29	0.22
Fish, spotted featherback, raw	15	BO	07013	0.00	2.76	0.25	0.07	0.00	0.00	12.13	-	0.01	0.01	1.34	-	-	-	27.09	7.09	0.19	-	-
Fish, armed spiny eel, raw	15	BO	07266	0.13	3.73	0.63	-	0.00	-	-	-	0.04	0.04	0.37	0.16	-	-	7.93	-	-	-	-
Fish, marlin, raw	15	BO	07067	0.00	3.79	0.52	-	0.00	0.00	-	0.83	0.02	0.01	0.73	0.16	-	-	30.78	1.46	0.13	-	-
Fish, giant seaperch, boiled	15	RA	07121	0.00	3.56	0.69	0.25	0.00	0.00	15.30	2.66	0.01	0.01	0.38	0.00	10.05	31.05	26.85	7.20	0.06	0.02	0.00
Fish, malabar red snapper, boiled	15	RA	07123	0.02	3.56	0.14	-	0.00	0.00	14.85	2.44	0.00	0.03	0.48	0.00	17.10	29.25	26.70	8.25	0.06	0.00	0.18
Fish, threadfins, raw	15	BO	07172	0.00	3.03	0.49	0.17	0.00	0.00	14.09	1.63	0.02	0.01	0.57	0.16	4.70	36.61	31.91	5.18	0.08	-	-
Fish, grouper, raw	15	BO	07070	0.07	3.05	0.09	0.02	0.00	0.00	8.75	-	0.00	0.01	0.19	-	26.73	32.09	23.65	8.76	0.06	0.00	0.03
Fish, surgeonfish / tang, raw	15	BO	07071	0.00	3.41	0.09	0.01	-	0.00	-	9.41	0.01	0.01	0.70	-	-	-	31.18	8.30	0.09	-	-
Fish, iridescent mystus, raw	15	BO	07186	0.07	2.95	0.37	0.15	-	0.00	-	-	0.00	0.01	0.26	-	-	-	16.05	5.90	0.13	-	-
Fish, asian redtail catfish, raw	15	RE	07219	0.55	2.58	1.34	-	0.00	-	-	-	-	-	-	-	9.50	-	-	-	-	-	-
Fish, white pomfret / silver pomfret, raw	15	RE	07072	0.00	2.91	1.02	0.42	0.00	0.00	12.60	4.20	0.00	0.01	0.30	0.00	24.83	31.33	28.08	2.05	0.08	0.01	0.05
Fish, black pomfret, steamed	15	RA	07130	0.19	3.47	1.04	0.35	0.00	0.00	14.10	-	0.04	0.02	0.24	0.00	15.75	32.10	31.20	8.70	0.11	0.02	0.05
Fish, anchovy, raw	15	RE	07238	0.00	5.75	0.27	-	0.00	-	-	-	-	-	-	-	672.58	-	-	-	-	-	-	-
Fish, barred queenfish, raw	15	BO	07045	0.00	3.18	0.44	-	-	0.00	-	-	0.00	0.01	0.58	-	-	-	31.75	12.31	0.00	-	-
Fish, striped snakehead fish, boiled	15	RA	07104	0.29	2.81	1.29	0.40	0.00	0.00	18.15	-	0.00	0.03	0.48	0.00	5.40	39.75	22.20	4.50	0.03	0.02	0.03
Fish, great snakehead / giant snakehead, raw	15	BO	07244	0.00	2.70	0.51	0.19	0.00	0.00	23.02	-	0.01	0.01	0.31	-	7.57	48.98	29.05	3.71	0.15	0.02	0.06
Fish, rasbora, raw	15	BO	07193	0.11	2.80	1.40	0.64	-	0.00	22.82	-	-	-	-	-	57.93	-	-	186.44	-	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, salmon, chinook, raw	15	BO	07198	0.00	3.50	1.83	0.54	0.00	0.00	8.78	23.87	0.01	0.02	1.48	0.70	8.25	69.15	50.72	4.56	0.04	0.01	0.08
Fish, salmon, atlantic farmed, raw	15	BO	07200	0.00	3.58	2.36	0.54	0.00	0.00	9.65	-	0.04	0.03	1.52	0.68	10.35	63.71	42.12	1.58	0.06	0.01	0.06
Fish, herring wolf, raw	15	ST	07076	0.15	4.35	0.40	-	-	0.00	9.80	5.54	0.01	0.01	0.58	0.19	14.27	58.79	55.59	10.86	0.17	0.19	-
Fish, batrachian walking catfish, raw	15	BO	07018	0.35	3.28	0.41	0.21	0.00	0.00	15.39	-	0.04	0.02	0.27	-	17.50	58.64	46.41	2.86	0.15	0.01	0.16
Fish, gunther's walking catfish, boiled	15	RA	07109	0.00	2.73	2.33	0.71	0.00	0.00	14.55	-	0.02	-	-	0.00	6.75	53.10	23.10	3.30	0.11	0.00	0.08
Fish, orante threadfin bream, raw	15	BO	07047	0.00	3.06	0.19	0.06	0.00	0.00	9.23	5.18	0.00	0.00	0.00	0.00	11.83	37.91	11.34	7.29	0.11	0.00	-
Fish, common silver barb, boiled	15	RA	07163	0.11	2.91	1.61	0.53	0.00	0.00	13.35	-	0.00	0.02	0.35	0.00	9.60	28.20	26.85	5.55	0.09	0.02	0.03
Fish, purple-spotted bigeye, raw	15	BO	07297	0.00	3.16	0.08	-	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish, nile tilapia, red, steamed	15	RA	07298	0.16	3.40	1.29	0.50	0.00	-	10.44	-	0.00	0.00	0.40	0.00	-	45.29	-	-	0.10	-	0.13
Fish, short bodied mackerel, boiled	15	RA	07143	0.07	3.47	0.84	0.33	0.00	0.00	14.10	0.44	0.01	0.02	0.77	0.00	15.15	32.40	40.05	13.95	0.17	0.02	0.11
Fish, black ear catfish, raw	15	BO	07246	0.00	3.03	0.31	0.11	0.00	0.00	12.47	5.35	0.03	0.00	0.21	-	-	-	27.22	15.88	0.68	-	-
Fish, rainbow trout, raw	15	BO	07202	0.00	3.50	1.08	0.24	0.00	0.00	10.35	14.74	0.02	0.02	0.98	0.51	8.95	66.16	39.66	4.39	0.05	0.01	0.08
Fish, smallscale mud carp, raw	15	BO	07247	0.00	2.73	0.72	0.32	0.00	0.00	13.08	-	0.00	0.01	0.51	-	14.72	33.03	28.12	5.23	0.10	0.02	0.02
Fish, nile tilapia, boiled	15	RA	07158	0.01	3.19	0.63	0.19	0.00	0.00	12.30	-	0.01	0.03	0.35	0.00	11.10	51.60	25.95	28.50	0.15	0.00	0.03
Fish, whisker sheatfish, raw	15	BO	07046	0.06	2.95	0.36	0.13	0.00	0.00	-	-	0.00	0.01	0.26	-	-	-	16.05	5.81	0.12	-	-
Fish, carp, common, raw	15	BO	07049	0.00	3.67	0.74	0.15	0.00	0.00	30.03	7.56	0.01	0.01	0.49	-	9.62	-	35.72	10.77	0.26	-	-
Fish, mekong giant catfish, raw	15	BO	07192	0.25	2.56	2.90	-	0.00	0.00	8.95	-	0.00	0.03	0.14	0.35	11.23	47.74	23.52	4.21	0.25	0.00	0.02
Fish, sleepy goby / marbled sleeper, raw	15	BO	07029	0.00	2.90	0.05	0.02	0.00	0.00	9.27	8.82	0.00	0.01	0.49	0.31	8.65	55.62	15.60	12.98	0.05	-	-
Fish, false trevally, raw	15	ST	07077	0.00	4.13	0.19	-	-	0.00	10.86	-	0.01	0.01	1.38	-	-	-	43.45	3.41	0.11	-	-
Fish, lizard, raw	15	BO	07030	0.00	3.56	0.22	0.10	0.00	0.00	-	-	0.01	0.01	0.44	0.55	-	-	39.48	7.75	0.11	-	-
Fermented fish, red color (Pla-pang-dang)	15	ST	07239	2.27	0.82	0.59	0.32	-	-	-	-	-	-	-	-	102.67	-	-	-	-	-	-
Fish, common ponyfish, raw	15	ST	07171	0.00	4.30	0.92	0.32	0.00	0.00	-	-	0.03	0.01	0.64	-	-	-	37.28	8.95	0.43	0.00	0.02
Fish, seven-striped barb / julian's golden carp, raw	15	BO	07248	0.00	2.73	0.72	0.32	0.00	0.00	13.08	-	0.00	0.01	0.51	-	14.72	33.03	28.12	5.23	0.10	0.02	0.02
Fish, giant gourami, steamed	15	RA	07187	0.00	3.13	1.59	-	-	-	13.90	8.50	0.00	-	-	0.00	9.95	-	-	-	0.11	-	-
Fish, indian mackerel, raw	15	BO	07310	0.00	3.57	0.57	-	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish, freshwater sole / river sole, raw	15	ST	07032	0.00	3.66	0.40	0.09	-	0.00	-	3.20	0.01	0.03	0.70	-	-	-	34.93	6.18	0.26	-	-
Fish, mimrow, raw	15	BO	07033	0.00	3.03	0.42	0.16	-	-	-	2.77	0.00	0.01	0.00	-	-	-	-	17.71	0.33	-	-

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Fish, grey feather back, raw	15	BO	07034	0.11	2.99	0.08	0.03	0.00	0.00	-	12.92	0.00	0.00	0.55	0.79	2.84	36.38	17.33	10.40	0.05	-	-
Fish, snake skin gourami, raw	15	BO	07036	0.00	2.79	0.13	0.05	0.00	0.00	11.34	3.73	0.16	0.03	0.32	0.49	1.62	41.15	28.67	11.34	0.37	-	-
Fish, spinefoot, raw	15	BO	07316	0.00	2.74	0.02	-	0.00	-	-	-	-	-	-	-	-	-	22.84	6.64	-	-	-
Fish, striped catfish, boiled	15	RA	07152	0.14	2.91	1.62	0.67	0.00	0.00	10.20	-	0.00	0.03	0.11	0.00	8.85	36.75	22.35	3.45	0.11	0.00	0.02
Fish, black-banded trevally, steamed	15	RA	07133	0.04	3.19	1.29	0.57	0.00	0.00	13.80	-	0.01	0.02	1.01	0.00	51.60	39.60	25.95	9.30	0.12	0.02	0.11
Fish, brown spotted trevally, raw	15	BO	07317	0.00	3.63	0.11	-	0.00	-	-	-	-	-	-	-	-	-	46.01	6.80	-	-	-
Fish, indian anchovy / common anchovy, whole, raw	15	BO	07021	0.02	3.32	0.06	0.02	0.00	0.00	-	3.69	0.00	0.01	0.11	0.00	14.05	-	38.93	40.22	0.31	-	-
Fish, java tilapia, raw	15	BO	07039	0.00	3.05	0.45	0.14	-	0.00	14.58	4.21	0.00	0.02	0.50	-	8.68	-	27.86	8.75	0.06	-	-
Fish, common climbing perch, raw	15	BO	07040	0.00	2.79	1.15	0.35	0.00	0.00	-	0.16	0.00	0.03	0.42	-	9.72	-	26.08	10.37	0.41	-	-
Fish, spiny eel, raw	15	BO	07185	0.00	3.32	0.15	0.05	-	0.00	22.32	16.61	0.01	0.16	0.04	-	10.70	46.68	28.23	6.09	0.31	0.00	0.15
Fish, hardtail scad, raw	15	BO	07043	0.00	3.58	0.05	0.02	0.00	0.00	-	4.05	0.01	0.03	0.52	0.00	10.04	37.10	25.11	8.26	0.34	-	-
Fish, eel swamp, boiled	15	RA	07113	0.15	3.09	0.09	0.01	0.00	0.00	17.40	-	0.00	0.15	0.32	0.00	9.60	37.20	20.85	3.45	0.24	0.02	0.11
Fish, skipjack tuna, raw	15	BO	07048	0.00	4.24	0.34	0.11	-	0.00	7.66	1.62	0.00	0.02	0.29	0.32	6.03	-	35.64	1.30	0.65	-	-
Median values	-	-	-	0.00	3.17	0.45	0.16	0.00	0.00	12.60	4.20	0.01	0.01	0.43	0.00	10.05	37.91	28.10	6.96	0.11	0.01	0.06

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

RA = Raw, BO = Boiling, ST = Steaming, RE = Ready to eat

2. Pork, organs, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Pork, stomach, raw	15	BO	06050	0.00	3.14	0.70	0.32	-	0.00	37.20	28.72	0.02	0.02	0.90	0.41	11.52	21.50	39.46	2.06	0.45	0.03	0.28
Pork, spare ribs, boiled	15	RA	06113	0.14	3.87	2.82	1.19	0.00	0.00	9.75	0.00	0.06	0.05	0.05	0.00	10.95	19.50	22.50	0.90	0.20	0.02	0.23
Pork, kidney, boiled	15	RA	06108	0.80	2.09	0.48	0.16	0.00	0.00	56.15	5.31	0.02	0.11	0.77	0.00	21.30	16.04	29.10	2.55	0.63	0.08	0.47
Pork, lung, raw	15	BO	06056	0.07	2.36	0.66	0.41	0.00	0.00	38.99	3.62	0.02	0.04	0.64	1.90	26.55	52.57	22.77	10.87	8.21	0.01	0.35

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Pork, spleen, raw	15	BO	06057	0.00	2.78	0.43	-	-	0.00	57.77	41.04	0.04	0.07	0.76	0.00	15.60	63.02	35.54	2.24	1.19	0.02	0.40
Pork, tongue, raw	15	BO	06061	0.24	2.83	2.12	0.74	-	0.00	15.89	8.65	0.01	0.04	0.71	0.00	17.31	38.23	27.26	3.45	0.41	0.01	0.47
Pork, brain, raw	15	BO	06164	0.00	1.77	1.59	0.36	0.00	0.00	378.64	0.00	0.03	0.05	0.74	2.33	20.70	44.51	48.65	1.73	0.28	0.04	0.22
Pork, heart, boiled	15	RA	06112	0.20	4.22	1.19	0.47	0.00	0.00	21.00	0.15	0.05	0.18	0.11	0.00	12.15	16.50	36.00	1.50	1.05	0.14	0.29
Pork, small intestine, raw	15	BO	06060	0.00	2.17	0.40	0.20	0.00	0.00	24.15	37.09	0.03	0.06	0.50	2.42	10.22	-	25.88	1.55	0.41	-	-
Median values	-	-	-	0.07	2.78	0.70	0.38	0.00	0.00	37.20	5.31	0.03	0.05	0.71	0.00	15.60	29.86	29.10	2.06	0.45	0.02	0.32

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

RA = Raw, BO – Boiling

3. Watermelon, variety

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
Watermelon, red flesh variety	275	RA	05010	23.13	2.22	0.19	0.00	0.95	22.41	-	127.29	0.08	0.06	0.55	18.72	11.64	293.13	30.85	28.63	0.55	0.14	0.19
Watermelon, yellow flesh variety	275	RA	05201	20.75	1.38	0.28	-	2.76	18.55	0.00	3.01	-	-	-	12.22	8.40	294.73	35.75	19.62	0.37	0.14	0.28
Median values	-	-	-	21.94	1.80	0.23	0.00	1.85	20.48	0.00	65.15	0.08	0.06	0.55	15.47	10.02	293.93	33.30	24.12	0.46	0.14	0.23

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food based dietary guidelines [12].

RA = Raw

APPENDIX O

Development of protein free starch group

1. Screening food items for development

In this study, protein free starch group refers to the criteria of Notification of the Ministry of Public Health (No. 182) B.E. 2541 (1998) Re : Nutrition Labelling [44] that any products that contain protein < 1% could be determined as zero. In case of foods which are not prescribed quantity of reference serving size, or consumption behavior not like the prescribed quantity of serving size of foods, shall be exempted from displaying of the quantity of serving size and servings per package and the expression "Nutrition value per 100 g.", or "Nutrition value per 100 ml.", shall be used instead of "Nutrition value per serving. Moreover, foods which be claimed as "good source, contains, provides" shall not contain protein less than 5 grams per 100 grams of food or 2.5 grams per 100 kilocalories [44] (Table *64* and Table *65*).

Therefore, various food items were examined for criterion mentioned above from Thai food composition tables 2015 [72] (section "Cereals and their products", "Starchy roots, tubers and their products"). There are twelve food items included by this criterion as showed in Table *66*.

2. Selection and household unit weight determination

In order to make food items in Table *66* from Thai food composition tables 2015 [72] become compatible with other food groups which were resulted from INMUCAL database, selection and portion size determination of these foods have been relied on the information of INMUCAL database [79].

According to food items in Table *66*, the researcher selected eight foods commonly consumed by in Thailand. Selected foods include "Corn flour (100%)", "Sweet potato, purple-red flesh, raw", "Sweet potato, yellow flesh, steamed", "Arrowroot flour", "Tapioca, flour", "Mungbean, flour", "Noodles, Mungbean sheets, dried (Shanghai-style noodles)", "Mungbean noodles, soaked 15 min, blached 3 min"

Sweet potato (purple and yellow) and Mungbean noodles have been determined their weight of 1 ladle as 60 grams, according to Thai food based dietary

guidelines [12]. Because other food items have not been determined by previous studies, their portion size was determined by weight measurement using commonly used household units (Table 63).

In case of "Mungbean sheets", INMUCAL database contains only "Mungbean sheets (Guay-teaw-sienghai), dried" (ID 03085). However, the researcher found abnormal nutrient profile when assigned it with method: Boiling from database. It returns energy 309.14 kilocalories and carbohydrate 76.92 grams from 100 grams of food. Therefore, the researcher tried weight measurement in laboratory. The researcher found that boiled Mungbean sheets 1 ladle weigh about 55 grams, and also found that Mungbean sheets had weight change from 40.86 grams to 186.52 grams after boiling. In the same way, boiled Mungbean sheets 55 grams should be expected to be 12.05 grams when dried. Therefore, the nutrient information of "Mungbean sheets (Guay-teaw-sienghai), dried" weigh 12.05 grams from INMUCAL database has been used.

Table 63 Household unit, weight, and carbohydrate content of foods in protein free starch group

Foods	Household unit	Weight per household unit (g)	Carbohydrate per household unit (g)
1. Sweet potato, purple-red flesh, raw	ladle	60*	19.73
2. Sweet potato, yellow flesh, steamed	ladle	60*	18.90
3. Mungbean noodles, soaked 15 min, blached 3 min	ladle	60*	11.58
4. Noodles, Mungbean sheets, boiled (Shanghai-style noodles)	ladle	55 ± 0.34**	10.91
5. Corn flour (100%)	ladle	28.36 ± 0.56**	24.11
6. Tapioca, flour	ladle	24.86 ± 0.67**	21.68
7. Mungbean, flour	ladle	29.91 ± 0.43**	20.85
8. Arrowroot flour	ladle	40.50 ± 1.04**	37.6

* Referred from The Development of Thai Food based Dietary Guidelines: Quantification of Food for Daily Compumption

** The average value from weight measurement (3 times)

3. Portion size determination

   After determining weight per household unit, the researcher determine portion size based on the number of household unit that can make carbohydrate contents of these food become 18 grams per serving. Finally, weight of portion size was rounded to the nearest integer (adjustment B) (Table *67*). Energy and nutrients of protein free starch group used in the developed application are summarized in Table *68*.

Table 64 The criteria of rounding of decimals in nutrition data display box on nutrition labelling

Energy and Nutrients	Unit	Analysis Results	Display of Quantity of Nutrient*	Calculated results as percentage of Recommended Daily Intake**	Display as Percentage of Recommended Daily Nutrition Intake**	Very small quantity that is insignificant to be regarded as zero
Energy, Energy from fat	kilocalories	< 5 ≤ 50 > 50	Display as 0 value Display in 5/step; up and down Display in 10/step; up and down			< 5 kilocalories
Total Fat, Saturated Fat	gram	< 0.5 < 5 ≥ 5	Display as 0 value Display in 0.5/step; up and down Display in 1/step; up and down			< 0.5 gram
Cholesterol	milligram	< 2 2-5 > 5	Display as 0 value Display value "less than 5" Display in 5/step; up and down			< 2 milligrams
Protein, Total Carbohydrate, Dietary Fiber, Sugar	gram	< 0.5 ≤ 1 > 1	Display as 0 value Display value "less than 1" Display in 1/step; up and down			< 1 gram (only for sugar < 0.5 gram)
Sodium	milligram	< 5 5-140 > 140	Display as 0 value Display in 5/step; up and down Display in 10/step; up and down	All levels of obtained results	Rounding to the nearest full integer.	< 5 milligrams
Vitamins, Minerals (Except Sodium)			(Not to be displayed)	< 2 ≤ 10 > 20-50 > 50		< 2% of recommended daily intake

* Display per serving size on labels, if there isn't any prescribed quantity of reference serving size of food or any consumption behavior not similar to the prescribed quantity of reference serving size, shall be displayed per 100 g. or 100 mL.

** Recommended Daily Intakes mean nutrients which are recommended daily intakes for Thai ages of 6 years and up (Thai Recommended Daily Intakes – Thai RDI)

Table 65 Conditions of Nutrition Claim per Quantity of Serving Size

Energy/Nutrient	Claims	Conditions	
		Per 100 g. of food (solid)	Per 100 mL of food (liquid)
Protein	Good source, contains, provides	Shall not less than 5 g. per 100 g. of food Or Shall not less than 2.5 g. per 100 kilocalories.	Shall not less than 2.5 g. per 100 mL or per 100 kilocalories.
	High, rich, rich in, excellent source of	Shall not less than 10 g. per 100 g. of food Or Shall not less than 5 g. per 100 kilocalories.	Shall not less than 5 g. per 100 mL or per 100 kilocalories
	Increased, more than, added, enriched, fortified	1. Protein increasing from 25% and up, compared to other same food or similar food products and, 2. The quantity of increased protein not less than 5 g. per 100 g. of food or not less than 2.5 g. per 100 kilocalories.	1. Protein increasing from 25% and up, compared to other same food or similar food products and, 2. The quantity of increased protein not less than 2.5 g. per 100 g. of food or per 100 kilocalories.

Table 66 Energy and nutrients of foods which contain protein less than 1 gram per 100 gram of edible portion in "Cereals and their products" and "Starchy roots, tubers and their products" from Thai food composition tables 2015 [72]

Food items	Weight (g)	Energy (kcal)†	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
1.Corn flour (100%)	100	360.0	89.13	0.29	0.15	ND	0.4	ND	ND	ND	0.0	0.0	0.07	ND	4.0	4.0	17.0	12.0	0.25	0.0	0.04
2.Sweet potato, purple-red flesh, raw	100	76.0	17.6	0.9	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	49.0	ND	1.7	ND	ND
3.Sweet potato, yellow flesh, steamed	100	122.0	27.3	0.9	0.1	ND	4.2	9.42	ND	28.0	0.12	0.03	0.68	13.0	105.0	308.0	62.0	27.0	0.53	ND	0.3
4.Cassava, raw	100	137.0	33.0	0.8	0.2	ND	ND	ND	ND	ND	0.79	0.24	ND	60.0	ND	ND	10.0	33.0	0.6	ND	ND

Food items	Weight (g)	Energy (kcal)†	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
5.Cassava, boiled	100	119.0	27.74	0.4	0.2	ND	2.3	ND	ND	ND	ND	ND	ND	ND	2.0	340.0	ND	12.0	0.49	ND	0.53
6.Arrowroot flour	100	370.0	91.8	0.1	0.0	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14.0	0.6	ND	ND
7.Tapioca, flour	100	353.0	87.42	0.11	0.09	ND	1.2	ND	ND	ND	0.06	0.02	0.1	ND	ND	ND	35.0	84.0	0.9	ND	ND
8.Noodles, Mungbean sheets, dried (Shanghai-style noodles)	100	360.0	88.7	0.2	0.1	ND	1.8	0.0	ND	ND	ND	ND	ND	ND	7.0	ND	ND	14.0	0.6	ND	ND
9. Mungbean, flour	100	357.0	88.61	0.17	0.05	ND	0.9	0.0	ND	ND	0.0	0.0	0.05	ND	4.0	1.0	16.0	11.0	0.25	ND	0.06
10.Mungbean noodles, soaked 15 min, blached 3 min	100	83.0	20.15	0.07	0.0	ND	1.3	0.0	ND	ND	ND	ND	ND	ND	2.0	1.0	10.0	1.0	0.14	ND	0.03
11.Mungbean, noodles, dried	100	355.0	85.76	0.14	0.2	ND	4.9	1.94	ND	0.0	0.0	ND	ND	ND	7.0	ND	ND	14.0	0.7	ND	ND
12.Sago flour	100	242.0	85.3	0.03	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

"-" = Databases did not provide the nutrients content in those food items.

Table 67 Portion size of foods in the protein free starch group

Food items	Serving size	Weight (g)	Carbohydrate (g)	Adjustment A		Adjustment B		Adjustment C	
				Weight (g)	Carbohydrate (g)	Weight (g)	Carbohydrate (g)	Weight (g)	Carbohydrate (g)
1. Sweet potato, purple-red flesh, raw	1 ladle	54.7	18.0	55.0	18.1	55.0	18.1	55.0	18.1
2. Sweet potato, yellow flesh, steamed	1 ladle	57.1	18.0	58.0	18.3	60.0	18.9	60.0	18.9
3. Mungbean noodles, soaked 15 min, blached 3 min	2 ladles	93.3	18.0	95.0	18.3	100.0	19.3	100.0	19.3
4. Noodles, Mungbean sheets,	2 ladles	90.78	18.0	91.0	18.0	90.0	17.85	90.0	17.85

Food items	Serving size	Weight (g)	Carbohydrate (g)	Adjustment A		Adjustment B		Adjustment C	
				Weight (g)	Carbohydrate (g)	Weight (g)	Carbohydrate (g)	Weight (g)	Carbohydrate (g)
boiled (Shanghai-style noodles)									
4. Noodles, Mungbean sheets, dried (Shanghai-style noodles)	2 ladles	19.9	18.0	20.0	18.1	20.0	18.1	25.0	22.6
5. Corn flour (100%)	1 ladle	21.2	18.0	22.0	18.7	20.0	17.0	25.0	21.3
6. Tapioca, flour	1 ladle	20.6	18.0	21.0	18.3	20.0	17.4	25.0	21.8
7. Mungbean, flour	1 ladle	25.8	18.0	26.0	18.1	25.0	17.4	25.0	17.4
8. Arrowroot flour	1/2 ladle	19.4	18.0	20.0	18.6	20.0	18.6	25.0	23.2
Median values	-	-	18.0	-	18.3	-	18.1	-	19.3

Table 68 Energy and nutrient contents of protein free starch group used in TFEL-based NDPro application

| Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Energy (kcal) (INMU)	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
1. Sweet potato, purple-red flesh, steamed	55	RA	02037	76.33	18.09	0.87	0.06	-	2.24	7.01	-	2.36	-	-	-	6.68	12.42	198.05	-	10.68	0.51	-	0.14
2. Sweet potato, yellow flesh, steamed	60	RA	02044	78.30	18.90	0.54	0.06	-	2.52	5.65	-	16.93	0.07	0.02	0.41	7.86	63.00	184.80	37.20	16.20	0.32	-	0.18
3. Noodles, mungbean, boiled	100	RA	03041	78.1	19.3	0.0	0.1	0.0	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	4	12	0.8	-	-
4. Mungbean sheets (Guay-teaw-sienghai), boiled[3]	90	-	-	72.74	18.1	0.04	0.02	-	0.36	0.0	-	-	-	-	-	0.0	1.4	-	-	2.8	0.12	-	-
5. Mungbean sheets (Guay-	20	RA	03085																				

Food items	Weight (g/mL)[1]	Method	INMUCAL ID	Energy (kcal) (INMU)	Carbohydrate (g)	Protein (g)	Fat (g)	SFA (g)	Dietary fiber (g)	Sugar (g)	Cholesterol (mg)	Vitamin A (mcg RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Sodium (mg)	Potassium (mg)	Phosphorus (mg)	Calcium (mg)	Iron (mg)	Copper (mg)	Zinc (mg)
teaw-sienghai), dried[3]																							
6. Flour, corn	20	RA	01026	70.92	17	0.1	0.28	0.05	0.0	0.12	0.0	0.0	0.01	0.0	0.04	0.48	2.2	4.8	31	3	0.28	-	-
7. Flour, cassava	20	RA	02009	70.18	17.44	0.06	0.02	0.01	0.0	0.0	0.0	0.0	0.01	0.0	0.02	0.0	0.0	-	7	16.8	0.18	-	-
8. Flour, mungbean	25	RA	03026	70.72	17.43	0.2	0.03	0.01	-	0.0	0.0	-	0	0.0	0.03	0.0	0.0	-	2.75	8	0.25	-	-
9. Starch, arrowroot	20	RA	02031	74.36	18.57	0.02	0.0	0.0	0.24	0.0	0.0	0.0	0.02	0.0	-	0.0	0.42	-	-	3.4	0.21	-	-
Median value	Energy : 73.11 kcal[2]			73.55	18.10	0.08	0.05	0.01	0.30	0.0	0.0	0.0	0.01	0.0	0.03	0.0	0.91	184.80	7.0	9.34	0.27	0.0	0.16

RA = Raw; " - " = Databases did not provide the nutrients content in those food items.

[1] Weight of each food item was set up based on the recommended weight per portion size defined in the original Thai food exchange list

[2] Energy was calculated by multiplying medians of carbohydrate (both digestible and non-digestible), protein, and fat by 4, 4, and 9 kcal/g, respectively.

[3] weight received from converting boiled Mungbean sheet 55 grams to 12.05 gram dried Mungbean sheet (according to weight measurement method).
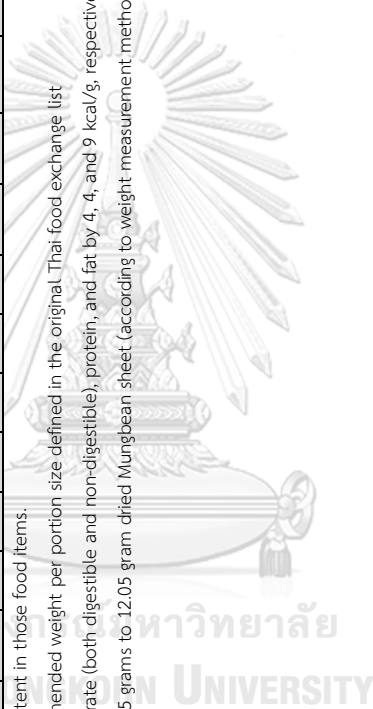
APPENDIX P

Nutritional dianosis terminology and medical conditions in application

Nutritional diagnosis terminology (64 items)

Energy balance (5 items)

1. Hypermetabolism (Increased energy needs)
2. Increased energy expenditure
3. Hypometabolism (Decreased energy needs)
4. Inadequate energy intake
5. Excessive energy intake

Oral or Nutrition support intake (5 items)

1. Inadequate oral food / beverage intake
2. Excessive oral food / beverage intake
3. Inadequate intake from enteral/parenteral nutrition infusion
4. Excessive intake from enteral/parenteral nutrition
5. Inappropriate infusion of enteral/parenteral nutrition

Fluid intake (2 items)

1. Inadequate fluid intake
2. Excessive fluid intake

Bioactive substance (3 items)

1. Inadequate bioactive substance intake
2. Excessive bioactive substance intake
3. Excessive alcohol intake

Nutrients (non-specify) (5 items)

1. Increased nutrient needs (specify)
2. Evident protein-energy malnutrition
3. Inadequate protein-energy intake
4. Decreased nutrient needs (specify)
5. Imbalance of nutrients

Nutrients (carbohydrate and fibers) (6 items)

1. Inadequate carbohydrate intake
2. Excessive carbohydrate intake
3. Inappropriate intake of types of carbohydrate (specify)
4. Inconsistent carbohydrate intake
5. Inadequate fiber intake
6. Excessive fiber intake

Nutrients (protein) (3 items)

1. Inadequate protein intake
2. Excessive protein intake
3. Inappropriate intake of amino acids (specify)

Nutrients (fat and cholesterol) (3 items)

1. Inadequate fat intake
2. Excessive fat intake
3. Inappropriate intake of food fats (specify)

Nutrients (vitamin) (2 items)

1. Inadequate vitamin intake (specify)
2. Excessive vitamin intake (specify)

Nutrients (mineral) (2 items)

1. Inadequate mineral intake
2. Excessive mineral intake

Functional (4 items)

1. Swallowing difficulty
2. Chewing (masticatory) difficulty
3. Breastfeeding difficulty
4. Altered GI function

Biochemical (3 items)

1. Impaired nutrient utilization
2. Altered nutrition-related laboratory values (specify)
3. Food-medication interaction

Weight (6 items)

1. Underweight
2. Kwashiorkor
3. Marasmus
4. Involuntary weight loss
5. Overweight/obesity
6. Involuntary weight gain

Knowledge and beliefs (7 items)

1. Food, nutrition, and nutrition-related knowledge deficit
2. Harmful beliefs/attitudes about food or nutrition-related topics (use with caution)
3. Not ready for diet/lifestyle change
4. Self-monitoring deficit
5. Disordered eating pattern
6. Limited adherence to nutrition-related recommendations
7. Undesirable food choices

Physical activity and functions (6 items)

1. Physical inactivity
2. Excessive exercise
3. Inability or lack of desire to manage self-care
4. Impaired ability to prepare foods/meals
5. Poor nutrition quality of life
6. Self-feeding difficulty

Safety (2 items)

1. Intake of unsafe food
2. Limited access to food

Medical related conditions (149 items)

Weight management (5 items)

1. Bariatric surgery history (Gastric banding)
2. Bariatric surgery history (Gastric bypass)
3. Bariatric surgery history (Vertical banded gastroplasty)
4. Bariatric surgery history (Biliopancreatic diversion with duodenal switch)
5. Bariatric surgery history (Laparoscopic sleeve gastrectomy)

Bone related disorders (5 items)

1. Osteopenia
2. Primary osteoporosis
3. Secondary osteoporosis
4. Estrogen-androgen deficient osteoporosis
5. Age-related primary osteoporosis

Dental disorders (6 items)

1. Dental caries
2. Fluorosis
3. Early childhood caries (ECC)
4. Tooth loss
5. Dentures dependence
6. Periodontal disease

Gastrointestinal tract disorders (2 items)

1. Gastroesophageal reflux disease
2. Esophagitis

Diabetes Mellitus (4 items)

1. Prediabetes
2. Type 1 diabetes
3. Type 2 diabetes
4. Gestational diabetes mellitus

Eating Disorders (12 items)

1. Anorexia nervosa (AN)
2. Bulimia nervosa (BN)
3. Binge eating disorder (BED)
4. Other specified feeding and eating disorder (Atypical anorexia)
5. Other specified feeding and eating disorder (Bulimia nervosa of low frequency and/or limited duration)
6. Other specified feeding and eating disorder (Binge eating disorder of low frequency and/or limited duration)
7. Other specified feeding and eating disorder (Purging disorder)
8. Other specified feeding and eating disorder (Night eating syndrome)
9. Unspecified feeding or eating disorder
10. Avoidant/Restrictive food intake disorder
11. Pica
12. Rumination disorder

Endocrine disorders (6 items)

1. Hypothyroidism
2. Hyperthyroidism
3. Polycystic ovary syndrome
4. Cushing's syndrome
5. Addison's disease
6. Adrenal fatigue

Cancer (1 items)

1. Cancer (specify)

Hepatobiliary and pancreatic disorders (19 items)

1. Viral hepatitis A
2. Viral hepatitis B
3. Viral hepatitis C
4. Viral hepatitis D
5. Viral hepatitis E
6. Nonalcoholic fatty liver disease (NAFLD)
7. Alcoholic liver disease (hepatic steatosis)
8. Alcoholic liver disease (alcoholic hepatitis)
9. Alcoholic liver disease (cirrhosis)
10. Primary biliary cirrhosis (PBC)
11. Primary sclerosing cholangitis (PSC)
12. Hemochromatosis
13. Wilson's disease
14. Alpha1-antitrypsin deficiency
15. Cholestasis
16. Cholelithiasis
17. Cholecystitis
18. Cholangitis
19. Pancreatitis

Anemia (13 items)

1. Iron deficiency anemia
2. Hemochromatosis
3. Folic acid deficiency anemia
4. Vitamin B12 deficiency anemias
5. Anemia of protein-energy malnutrition
6. Copper deficiency anemia
7. Sideroblastic anemia
8. Hemolytic anemia
9. Anemia of pregnancy
10. Anemia of chronic disease
11. Sickle cell anemia
12. Thalassemia
13. Hypochromic microcytic transient anemia (Sports anemia)

Cardiovascular disease (11 items)

1. Cardiovascular disease
2. Hyperlipidemias
3. Hyperlipidemias (Familial hyperlipidemias)
4. Hyperlipidemias (Polygenic familial hyperlipidemias)
5. Hyperlipidemias (Familial combined hyperlipidemias)
6. Hyperlipidemias (Familial dysbetalipoproteinemia)
7. Atherosclerosis
8. Hypertension
9. Heart failure
10. Heart failure (Cardiac cachexia)
11. Cardiac transplantation history

Pulmonary disease (12 items)

1. Cystic fibrosis
2. Asthma
3. Chronic obstructive pulmonary disease
4. Chronic obstructive pulmonary disease (with pulmonary cachexia)
5. Tuberculosis
6. Lung cancer
7. Obesity hypoventilation syndrome (OHS)
8. Obstructive sleep apnea (OSA)
9. Chylothorax
10. Acute respiratory distress syndrome (ARDS)
11. Pneumonia
12. Bronchopulmonary dysplasia

SIRS/MODS (2 items)

1. Systemic inflammatory response syndrome (SIRS)
2. Multiple Organ Dysfunction syndrome (MODS)

Renal disorders (22 items)

1. Kidney stones (Calcium stones)
2. Kidney stones (Oxalate stones)
3. Kidney stones (Uric acid stones)
4. Kidney stones (Cystine stones)
5. Kidney stones (Melamine and Indinavir stones)
6. Kidney stones (Struvite stones)
7. Acute kidney injury (AKI)
8. Chronic interstitial nephritis
9. Fanconi syndrome
10. Renal tubular acidosis (RTA)
11. Pyelonephritis
12. Nephritic syndrome
13. Chronic kidney disease (stage G1)
14. Chronic kidney disease (stage G2)
15. Chronic kidney disease (stage G3a)
16. Chronic kidney disease (stage G3b)
17. Chronic kidney disease (stage G4)
18. End-stage renal disease (with palliative care)
19. End-stage renal disease (with hemodialysis (HD))
20. End-stage renal disease (with peritoneal dialysis (PD))
21. Kidney transplantation history (4-6 weeks after transplant)
22. Kidney transplantation history (more than 6 weeks after transplant)

HIV and AIDS (2 items)

1. Human immunodeficiency virus disease infection (HIV)
2. Acquired immune deficiency syndrome (AIDS)

Rheumatic disease (10 items)

1. Osteoarthritis (OA)
2. Rheumatoid arthritis (RA)
3. Sjögren's syndrome (SS)
4. Temporomandibular disorders (TMDs)
5. Gout
6. Scleroderma
7. Systemic lupus erythematosus (SLE)
8. Spondylarthritides (Ankylosing spondylitis (AS))
9. Spondylarthritides (Polymyalgia rheumatica (PMR))
10. Spondylarthritides (Polymyositis (PM))

Neurologic disorders (10 items)

1. Dysphagia
2. Stroke
3. Traumatic brain injury (TBI)
4. Spinal cord injury (SCI)
5. Adrenomyeloleukodystrophy (ALD)
6. Amyotrophic lateral sclerosis (ALS)
7. Epilepsy
8. Myasthenia gravis
9. Multiple sclerosis
10 Parkinson's disease (PD)

Psychiatric and cognitive disorders (7 items)

1. Anxiety
2. Bipolar disorder
3. Dementia
4. Depression
5. Chronic fatigue syndrome (CFS)
6. Fibromyalgia syndrome (FMS)
7. Schizophrenia

APPENDIX Q

Coefficient and description in each level of physical activity

Coefficient of physical activity

Activity levels	Thai DRI (2020) [32]	IOM (2005) [56]			
		Normal weight		Over weight	
		Male	Female	Male	Female
Exclude this factor	1.0	1.0	1.0	1.0	1.0
Sedentary / Very low active	1.21	1.0	1.0	1.0	1.0
Low active	1.4	1.11	1.12	1.12	1.16
Active	1.7	1.25	1.27	1.29	1.27
Very active	2.0	1.48	1.45	1.59	1.44

Description of each activity level

Activity levels	Description
Exclude this factor	This is used when the users do not want to include the activity factor in the analysis. For example, when they only want to know the resting energy expenditure or when using an equation that does not require activity factors, such as a Simple equation.
Sedentary / Very low active	Activities with very low physical movement are commonly observed in the following groups: elderly individuals with mental health issues, adolescents with brain disabilities, individuals with abnormalities in spinal cord neurons, and sedentary adults. These groups have Physical Activity Level (PAL) values close to the basal energy expenditure required for survival only (LG Bandini, et al. (1991), LO Schulz, et al. (1992), E Ravussin, et al. (1991) cited by DRI for Thais (2020)).
Low active	These are activities that involve minimal physical exertion, such as talking, reading books, watching television, listening to the radio, using the computer, office work, or working at home with amenities. They are commonly found among the elderly, office workers, and individuals who reside in homes with amenities [FAO/WHO/UNN (2004), DRI for Thais 2020. (2020)].
Active	These activities involve moderate physical exertion and require more energy compared to Low active level. Examples include individuals who work in offices and engage in regular exercise, individuals with daily routines that involve occasional mild physical exertion but also having moderate to intense exercise, such as walking, running, cycling, aerobic dancing, construction workers, individuals in rural areas who engage in long walks to fetch water or search for firewood, and so on [FAO/WHO/UNN (2004), DRI for Thais 2020. (2020)].
Very active	These activities involve high levels of physical exertion in daily life or activities that require prolonged intense physical effort for several hours. Examples include athletes during average training sessions of around 2 hours per day, farmers who engage in manual labor without the usage of machinery but still use tools like machetes, hoes, and axes for several hours each day, and individuals who engage in long-distance hauling of heavy goods on rugged terrain. [FAO/WHO/UNN (2004), DRI for Thais 2020. (2020)].

APPENDIX R

Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. (IOM, 2005) [56]

Life stage groups	Carbohydrate (g/d)	Total Fiber (g/d)	Fat (g/d)	Linoleic Acid (g/d)	α-Linolenic Acid (g/d)	Protein (g/d)
Infants						
0 – 6 mo	60*	ND	31*	4.4*	0.5*	9.1*
7 – 12 mo	95*	ND	30*	4.6*	0.5*	13.5
Children						
1 – 3 y	130	19*	ND	7*	0.7*	13
4 – 8 y	130	25*	ND	10*	0.9*	19
Males						
9 – 13 y	130	31*	ND	12*	1.2*	34
14 – 18 y	130	38*	ND	16*	1.6*	52
19 – 30 y	130	38*	ND	17*	1.6*	56
31 – 50 y	130	38*	ND	17*	1.6*	56
51 – 70 y	130	30*	ND	14*	1.6*	56
>70 y	130	30*	ND	14*	1.6*	56
Females						
9 – 13 y	130	26*	ND	10*	1.0*	34
14 – 18 y	130	26*	ND	11*	1.1*	46
19 – 30 y	130	25*	ND	12*	1.1*	46
31 – 50 y	130	25*	ND	12*	1.1*	46
51 – 70 y	130	21*	ND	11*	1.1*	46
>70 y	130	21*	ND	11*	1.1*	46
Pregnancy						
14 – 18 y	175	28*	ND	13*	1.4*	71
19 – 30 y	175	28*	ND	13*	1.4*	71
31 – 50 y	175	28*	ND	13*	1.4*	71
Lactation						
14 – 18 y	210	29*	ND	13*	1.3*	71
19 – 30 y	210	29*	ND	13*	1.3*	71
31 – 50 y	210	29*	ND	13*	1.3*	71

NOTE: This table presents Recommended Dietary Allowances (RDAs) in bold type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake; ᵃBased on 0.8g protein/kg body weight for reference body weight; SOURCE: Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (2002). This report may be accessed via www.nap.edu. Copyright 2002 by the National Academy of Sciences. All rights reserved.

Life stage group	Calcium (mg/d)	Chromium (mcg/d)	Copper (mcg/d)	Fluoride (mg/d)	Iodine (mcg/d)	Iron (mg/d)	Magnesium (mg/d)	Manganese (mg/d)	Molybdenum (mcg/d)	Phosphorus (mg/d)	Selenium (mcg/d)	Zinc (mg/d)
Infants												
0 – 6 mo	210*	0.2*	200*	0.01*	110*	0.27*	30*	0.003*	2*	100*	15*	2*
7 – 12 mo	270*	5.5*	200*	0.5*	130*	11	75*	0.6*	3*	275*	20*	3
Children												
1 – 3 y	500*	11*	340	0.7*	90	7	80	1.2*	17	460	20	3
4 – 8 y	800*	15*	440	1*	90	10	130	1.5*	22	500	30	5
Males												
9 – 13 y	1,300*	25*	700	2*	120	8	240	1.9*	34	1,250	40	8
14 – 18 y	1,300*	35*	890	3*	150	11	410	2.2*	43	1,250	55	11
19 – 30 y	1,000*	35*	900	4*	150	8	400	2.3*	45	700	55	11
31 – 50 y	1,000*	35*	900	4*	150	8	420	2.3*	45	700	55	11
51 – 70 y	1,200*	30*	900	4*	150	8	420	2.3*	45	700	55	11
>70 y	1,200*	30*	900	4*	150	8	420	2.3*	45	700	55	11
Females												
9 – 13 y	1,300*	21*	700	2*	120	8	240	1.6*	34	1,250	40	8
14 – 18 y	1,300*	24*	890	3*	150	15	360	1.6*	43	1,250	55	9
19 – 30 y	1,000*	25*	900	3*	150	18	310	1.8*	45	700	55	8
31 – 50 y	1,000*	25*	900	3*	150	18	320	1.8*	45	700	55	8
51 – 70 y	1,200*	20*	900	3*	150	8	320	1.8*	45	700	55	8
>70 y	1,200*	20*	900	3*	150	8	320	1.8*	45	700	55	8
Pregnancy												
14 – 18 y	1,300*	29*	1,000	3*	220	27	400	2.0*	50	1,250	60	12
19 – 30 y	1,000*	30*	1,000	3*	220	27	350	2.0*	50	700	60	11
31 – 50 y	1,000*	30*	1,000	3*	220	27	360	2.0*	50	700	60	11
Lactation												
14 – 18 y	1,300*	44*	1,300	3*	290	10	360	2.6*	50	1,250	70	13
19 – 30 y	1,000*	45*	1,300	3*	290	9	310	2.6*	50	700	70	12
31 – 50 y	1,000*	45*	1,300	3*	290	9	320	2.6*	50	700	70	12

NOTE. This table presents Recommended Dietary Allowances (RDAs) in bold type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI lor other life stage and gender groups is believed to cover needs of all individuals in the group. but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake; SOURCES: Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride (1997), Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin 86, Folate, Vitamin 8,2, Pantothenic Acid. Biotin, and Choline (1998); Dietary Reference Intakes for Vitamin C, Vitamin E. Selenium, and Carotenoids (2000); and Dietary Reference Intakes for Vitamin A. Vitamin K, Arsenic, Boron, Chromium. Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc (2001). These reports may be accessed via www.nap.edu; Copyright 2001 by The National Academies of Sciences. All rights reserved.

Life stage groups	Vitamin A (mcg/d)[a]	Vitamin C (mg/d)	Vitamin D (mcg/d)[b,c]	Vitamin E (mg/d)[d]	Vitamin K (mcg/d)	Thiamin (mg/d)	Riboflavin (mg/d)	Niacin (mg/d)[e]	Vitamin B6 (mg/d)	Folate (mcg/d)[f]	Vitamin B12 (mcg/d)	Pantothenic Acid (mg/d)	Biotin (mcg/d)	Choline[g] (mg/d)
Infants														
0 – 6 mo	400*	40*	5*	4*	2.0*	0.2*	0.3*	2*	0.1*	65*	0.4*	1.7*	5*	125*
7 – 12 mo	500*	50*	5*	5*	2.5*	0.3*	0.4*	4*	0.3*	80*	0.5*	1.8*	6*	150*
Children														
1 – 3 y	300	15	5*	6	30*	0.5	0.5	6	0.5	150	0.9	2*	8*	200*
4 – 8 y	400	25	5*	7	55*	0.6	0.6	8	0.6	200	1.2	3*	12*	250
Males														
9 – 13 y	600	45	5*	11	60*	0.9	0.9	12	1.0	300	1.8	4*	20*	375*
14 – 18 y	900	75	5*	15	75*	1.2	1.3	16	1.3	400	2.4	5*	25*	550*
19 – 30 y	900	90	5*	15	120*	1.2	1.3	16	1.3	400	2.4	5*	30*	550*
31 – 50 y	900	90	5*	15	120*	1.2	1.3	16	1.3	400	2.4	5*	30*	550*
51 – 70 y	900	90	10*	15	120*	1.2	1.3	16	1.7	400	2.4[h]	5*	30*	550*
>70 y	900	90	15*	15	120*	1.2	1.3	16	1.7	400	2.4[h]	5*	30*	550*
Females														
9 – 13 y	600	45	5*	11	60*	0.9	0.9	12	1.0	300	1.8	4*	20*	375*
14 – 18 y	700	65	5*	15	75*	1.0	1.0	14	1.2	400[i]	2.4	5*	25*	400*
19 – 30 y	700	75	5*	15	90*	1.1	1.1	14	1.3	400[i]	2.4	5*	30*	425*
31 – 50 y	700	75	5*	15	90*	1.1	1.1	14	1.3	400[i]	2.4	5*	30*	425*
51 – 70 y	700	75	10*	15	90*	1.1	1.1	14	1.5	400	2.4[h]	5*	30*	425*
>70 y	700	75	15*	15	90*	1.1	1.1	14	1.5	400	2.4[h]	5*	30*	425*
Pregnancy														
14 – 18 y	750	80	5*	15	75*	1.4	1.4	18	1.9	600[i]	2.6	6*	30*	450*
19 – 30 y	770	85	5*	15	90*	1.4	1.4	18	1.9	600[i]	2.6	6*	30*	450*
31 – 50 y	770	85	5*	15	90*	1.4	1.4	18	1.9	600[i]	2.6	6*	30*	450*
Lactation														
14 – 18 y	1,200	115	5*	19	75*	1.4	1.6	17	2.0	500	2.8	7*	35*	550*
19 – 30 y	1,300	120	5*	19	90*	1.4	1.6	17	2.0	500	2.8	7*	35*	550*
31 – 50 y	1,300	120	5*	19	90*	1.4	1.6	17	2.0	500	2.8	7*	35*	550*

NOTE: This table (taken from the DRI reports, see www.nap.edu) presents Recommended Dietary Allowances (RDAs) in bold type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

^{a}As retinol activity equivalents (RAEs). 1 RAE=1 μg retinol, 12 μg β-carotene, 24 μg α-carotene, or 24 μg β-cryptoxanthin The RAE for dietary provitamin A carotenoids is two-fold greater than retinol equivalents (RE), whereas the RAE for preformed vitamin A is the same as RE.

^{b}Cholecalciferol. 1 ag cholecalciferol=40 IU vitamin D.`

^{c}In the absence of adequate exposure to sunlight.

^{d}As α-tocopherol. α-Tocopherol includes RRR-α-tocopherol, the only form of α-tocopherol that occurs naturally in foods, and the 2R-stereoisomeric forms of α-tocopherol (RRR-, RSR-, RRS-, and RSS-α-tocopherol) that occur in fortified foods and supplements. It does not include the 2S-stereoisomeric forms of α-tocopherol (SRR-, SSR-, SRS-, and SSS-α-tocopherol), also found in fortified foods and sup-plements.

^{e}As niacin equivalents (NE). 1 mg of niacin =60 mg of tryptophan; 0-6 months= preformed niacin (not NE).

^{f}As dietary folate equivalents (DFE). 1 DFE= 1 μg food folate=0.6 μg of folic acid from fortified food or as a supplement consumed with food=0.5 μg of a supplement taken on an empty stomach.

^{g}Although AIs have been set for choline, there are few data to assess whether a dietary supply of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages. ^{h}Because 10 to 30 percent of older people may malabsorb food-bound B_{12} it is advisable for those older than 50 years to meet their RDA mainly by consuming foods fortified with B_{12} or a supplement containing B_{12}.

^{i}In view of evidence linking folate intake with neural tube defects in the fetus, it is recommended that all women capable of becoming pregnant consume 400 μg from supplements or fortified foods in addition to intake of food folate from a varied diet.

^{j}It is assumed that women will continue consuming 400 μg from supplements or fortified food until their pregnancy is confirmed and they enter prenatal care, which ordinarily occurs after the end of the periconceptional period—the critical time for formation of the neural tube.

VITA

NAME	Thanasak Tantichaiyakul
DATE OF BIRTH	6 June 1993
PLACE OF BIRTH	Chonburi hospital
INSTITUTIONS ATTENDED	Faculty of Allied Health Sciences, Chulalongkorn university
HOME ADDRESS	99/6 Village No.5 Setthakit Road, Ban Suan Sub-district, Muang District, Chonburi, 20000