

## CHAPTER IV

### RESULTS

#### Characteristics of the subjects

Two hundred and twelve volunteers participated in this study. The complete data were obtained from only 125 subjects. Eighty seven persons did not complete the study because 15 persons could not reach maximal oxygen consumption, 38 persons failed the cycle ergometer test, 28 persons could not follow the step test protocol, and 6 other persons had high blood pressure or used beta blockers. Table 1 provides the baseline characteristics of the subjects (57 men and 68 women).

Table 1. Characteristics at rest of the subjects (n=125)

Characteristics	Male (n=57)	Female (n=68)	Total (n=125)
Age (year)	34.8 ± 13.3	38.9 ± 12.8	37.0 ± 13.1
Weight (kg)	71.1 ± 10.2	56.0 ± 9.3	62.9 ± 12.3
Height (cm)	171.4 ± 6.9	158.1 ± 4.5	164.2 ± 8.7
Body mass index (kg/m <sup>2</sup> )	24.2 ± 3.2	22.4 ± 3.4	23.0 ± 3.4
Resting heart rate (bpm)	69.9 ± 8.2	72.6 ± 7.0	71.4 ± 7.6
Resting systolic blood pressure (mmHg)	125.6 ± 9.7	115.6 ± 10.8	120.2 ± 11.4
Resting diastolic blood pressure (mmHg)	78.5 ± 7.5	71.2 ± 7.0	74.5 ± 8.1

Values are Mean ± SD

Table 2. Predicted and observed characteristics in response to exercise tests

Characteristics	Male (n=57)	Female (n=68)	Total (n=125)
<b>VO<sub>2</sub>max (ml/kg/min)</b>			
VO <sub>2</sub> max by GXT	39.0 ± 8.4	28.9 ± 5.4	33.5 ± 8.6
Predicted VO <sub>2</sub> max by cycle test	35.4 ± 9.9	29.8 ± 6.7	32.3 ± 8.7
Predicted VO <sub>2</sub> max by step test	39.2 ± 11.2	32.9 ± 8.3	35.8 ± 10.6
<b>HRmax (bpm)</b>			
Age-predicted HRmax	185.2 ± 13.3	181.1 ± 12.8	183.0 ± 13.1
Observed HRmax	189.2 ± 9.6	182.2 ± 12.6	185.4 ± 11.8
<b>HRsubmax (bpm)</b>			
HRsubmax from cycle test	139.3 ± 7.1	141.3 ± 7.4	140.4 ± 7.3
HRsubmax from step test	139.2 ± 13.8	148.2 ± 10.1	144.1 ± 12.7

Values are Mean ± SD

VO<sub>2</sub>max = maximal oxygen uptake

GXT = maximal exercise test

HRmax = maximal heart rate

HRsubmax = submaximal heart rate

#### Heart rate during submaximal exercise tests ( table 2 )

Heart rates during submaximal exercise were recorded to demonstrate the exercise intensity of the two predicted VO<sub>2</sub>max tests. Submaximal heart rates were obtained at the end of the final stage of the YMCA cycle test, and immediately after the 3 minute step test. The present study found the steady stage heart rate in the final stage of YMCA cycle test to be lower than heart rate immediately after 3 minute step test (140.4 ± 7.3 vs 144.1 ± 12.7 bpm, p = 0.002).

Table 3. Age range and number of subjects in each age group

Age range	Male (n = 57)	Female (n = 68)	Total (n = 125)
18 – 20 years	12	11	23
21 – 30 years	14	11	25
31 – 40 years	10	12	22
41 – 50 years	11	21	32
51 – 60 years	10	13	23

Table 4. Lifestyle characteristics of the subjects

Characteristics	Male (n =57)	Female (n =68)	Total (n =125)
<b>Exercise</b>			
No exercise	3 (5.3 %)	6 (8.8 %)	9 (7.2 %)
< 1 hr/wk	7 (12.3 %)	2 (2.9 %)	9 (7.2 %)
1-3 hr/wk	16 (28.1%)	33 (48.5 %)	49 (39.2 %)
3-6 hr/wk	21 (36.8 %)	19 (27.9 %)	40 (32.0 %)
> 6 hr/wk	19 (17.5 %)	8 (11.8 %)	18 (14.4 %)
<b>Smoking</b>			
No smoking	51 (89.5 %)	68 (100 %)	119 (95.2 %)
1-5 rolls/day	2 (3.5 %)	0 (0%)	2 (1.6 %)
6-10 rolls/day	4 (7.0 %)	0 (0%)	4 (3.2 %)
<b>Alcohol</b>			
No drink	27 (47.4 %)	62 (91.2 %)	89 (71.2 %)
< 2 times/wk	10 (17.5 %)	1 (1.5 %)	11 (8.8 %)
3-4 times/wk	10 (17.5 %)	4 (5.9 %)	14 (11.2 %)
5-8 times/wk	7 (12.3 %)	1 (1.5 %)	8 (6.4 %)
> 9 times/wk	3 (5.3 %)	0 (0%)	3 (2.4 %)

### Predicted and observed maximal oxygen consumption

Figure 2 shows a scatter plot between predicted  $VO_2$ max by YMCA cycle ergometer test and measured  $VO_2$ max by treadmill maximal exercise test (GXT). A High correlation was found between YMCA cycle test and GXT ( $r = 0.85$ ,  $p < 0.001$ ,  $SEE = 4.57$  ml/kg/min). Figure 3 shows a scatter plot between predicted  $VO_2$ max by 3 minute step test and measured  $VO_2$ max by GXT. Three minute step test had a moderate to high correlation with GXT ( $r = 0.73$ ,  $p < 0.001$ ,  $SEE = 5.82$  ml/kg/min). From this study, it was found that the  $VO_2$ max from GXT had a higher correlation with the YMCA cycle test than the 3 minute step test in Thais. The YMCA cycle test underestimated  $VO_2$ max by  $4.55 \pm 16.6\%$  and 3 min step test overestimated  $VO_2$ max by  $4.73 \pm 24.4\%$ .

**Table 5.** Intraclass correlation coefficients between submaximal and maximal exercise tests.

Exercise tests	Intraclass Correlation Coefficient ( r )		
	Men (n =57)	Women (n =68)	Total (n =125)
Cycle test and GXT	0.86 *	0.84 *	0.85 *
Step test and GXT	0.72 *	0.63 *	0.73 *

\* Significant at  $p < 0.001$

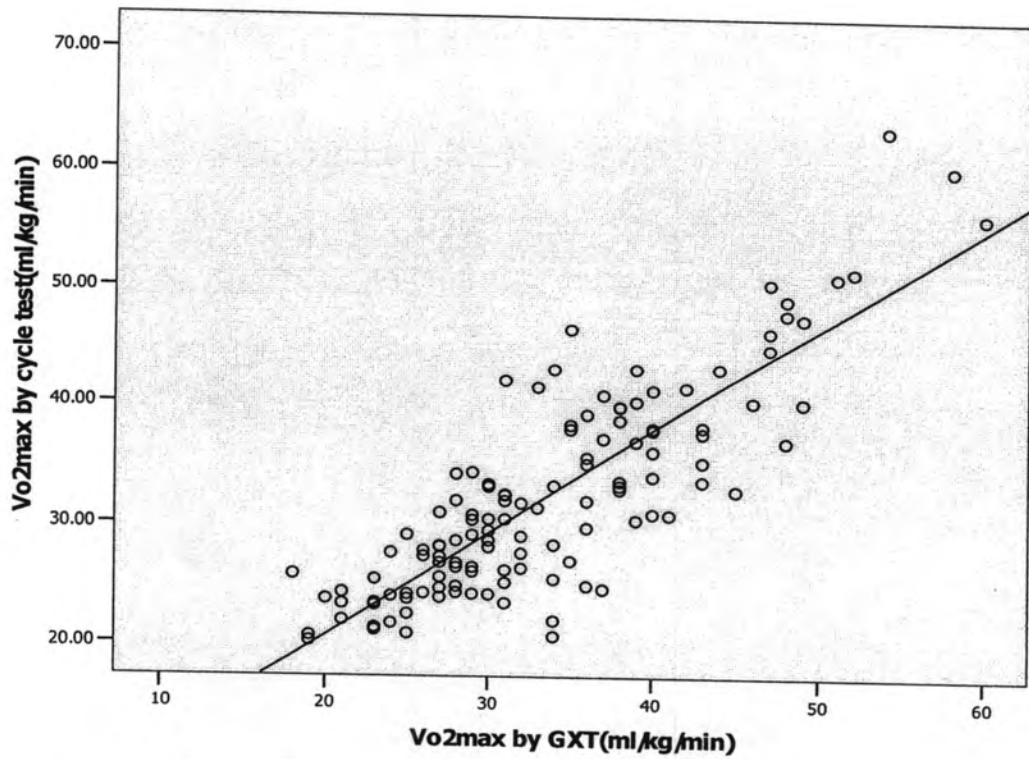


Figure 2 Scatter plot of relationship between measured  $VO_2$ max by GXT and estimated  $VO_2$ max by YMCA cycle test ( $r=0.85$ ,  $p<0.001$ ),  $Y = 6.478 + (0.836X)$ .

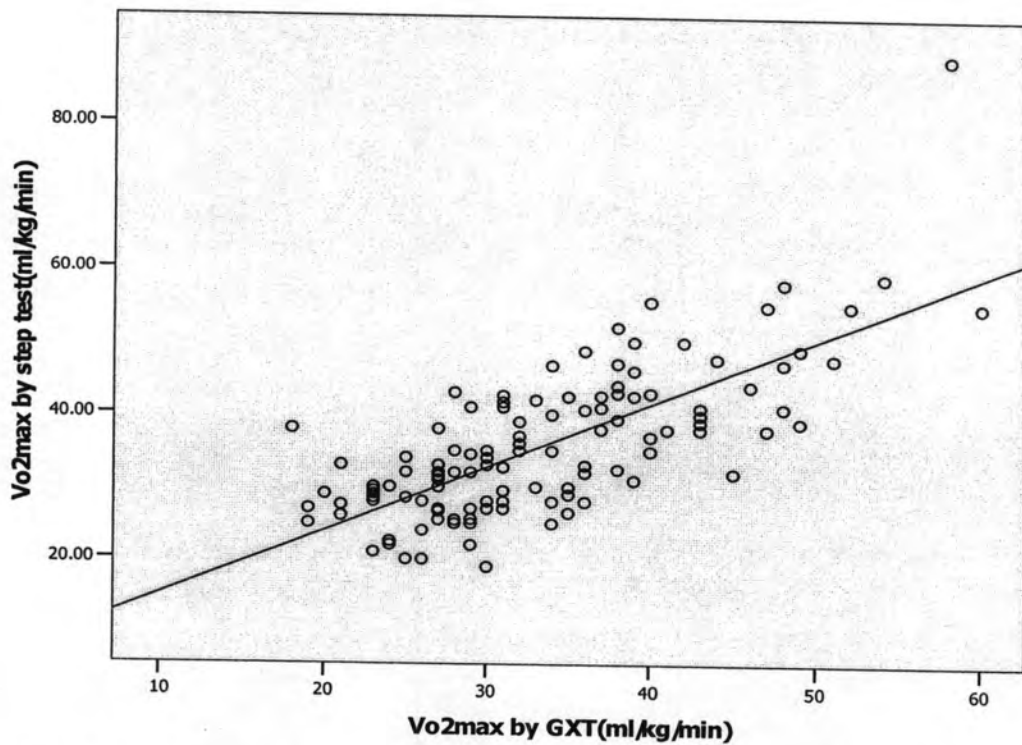


Figure 3 Scatter plot of relationship between measured  $VO_2$ max by GXT and estimated  $VO_2$ max by 3 minute step test ( $r=0.73$ ,  $p<0.001$ ),  $Y = 11.27 + (0.621X)$ .

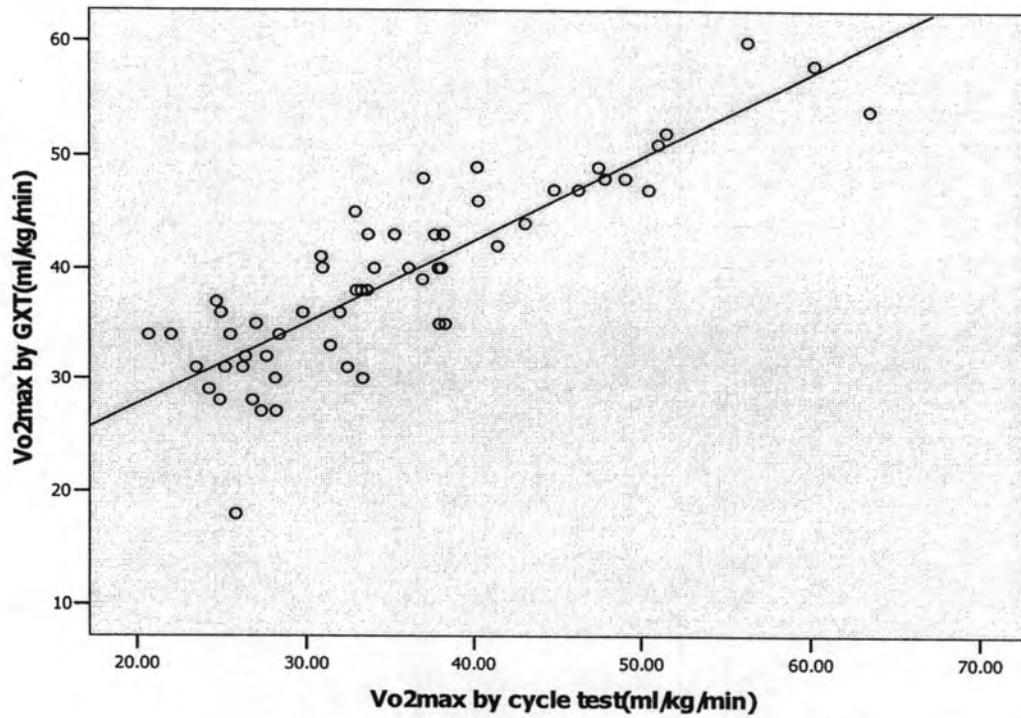


Figure 4 Scatter plot of relationship between measured  $VO_2\max$  by GXT and predicted  $VO_2\max$  by YMCA cycle ergometer test in men ( $r=0.86$ ,  $p<0.001$ ).

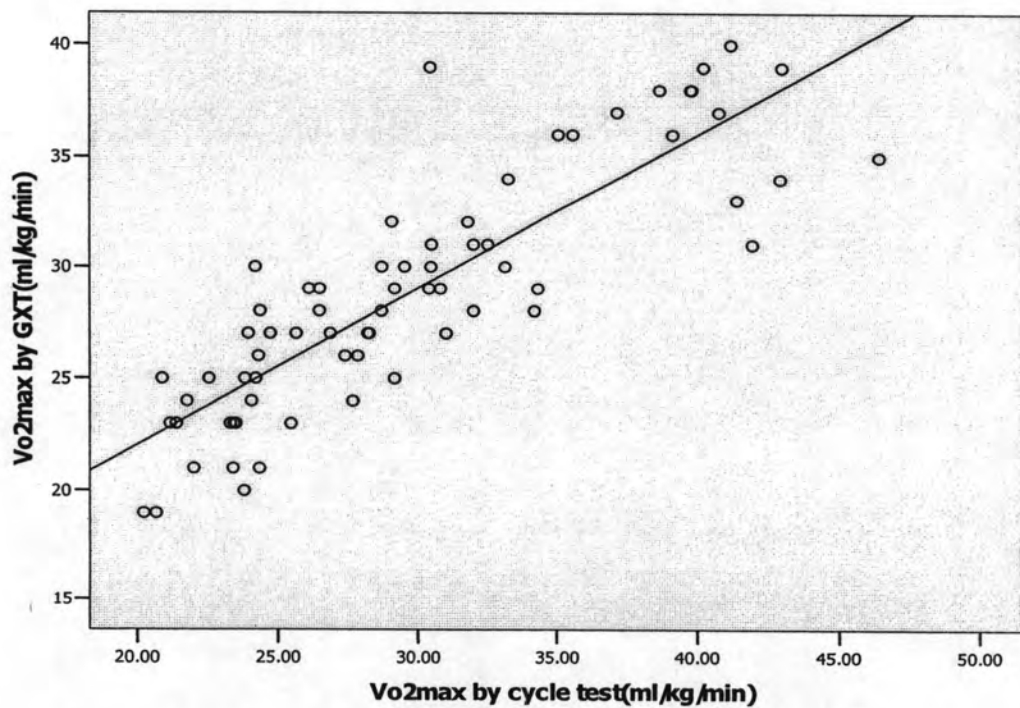


Figure 5 Scatter plot of relationship between measured  $VO_2\max$  by GXT and predicted  $VO_2\max$  by YMCA cycle ergometer test in women ( $r=0.84$ ,  $p<0.001$ ).

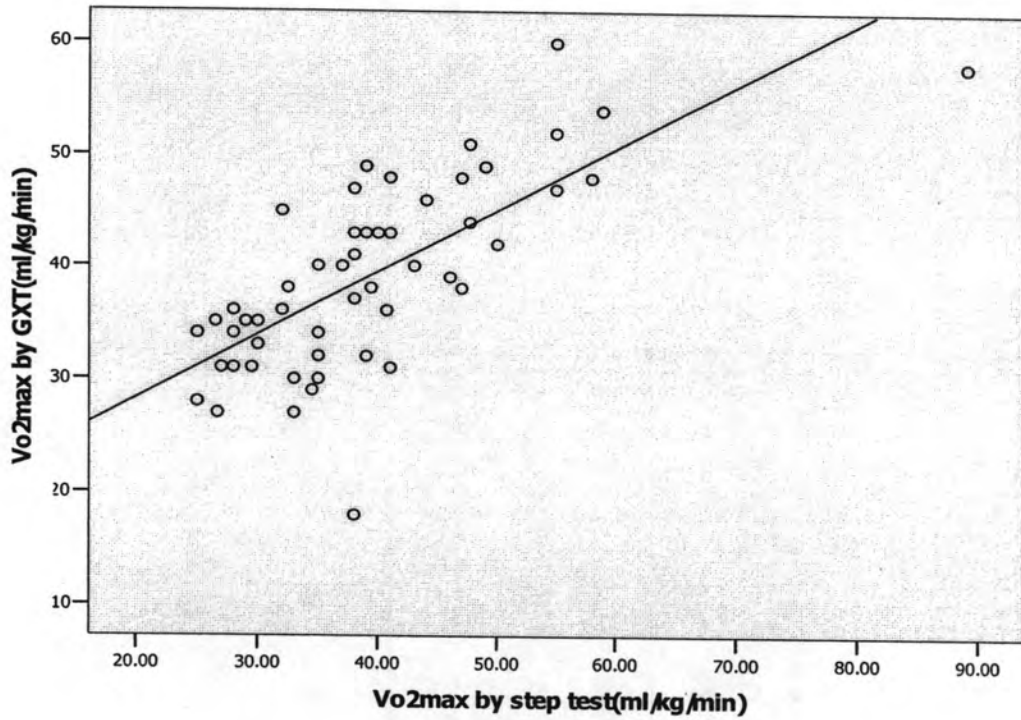


Figure 6 Scatter plot of relationship between measured  $VO_2$ max by GXT and predicted  $VO_2$ max by 3 minute step test in men ( $r=0.72$ ,  $p<0.001$ ).

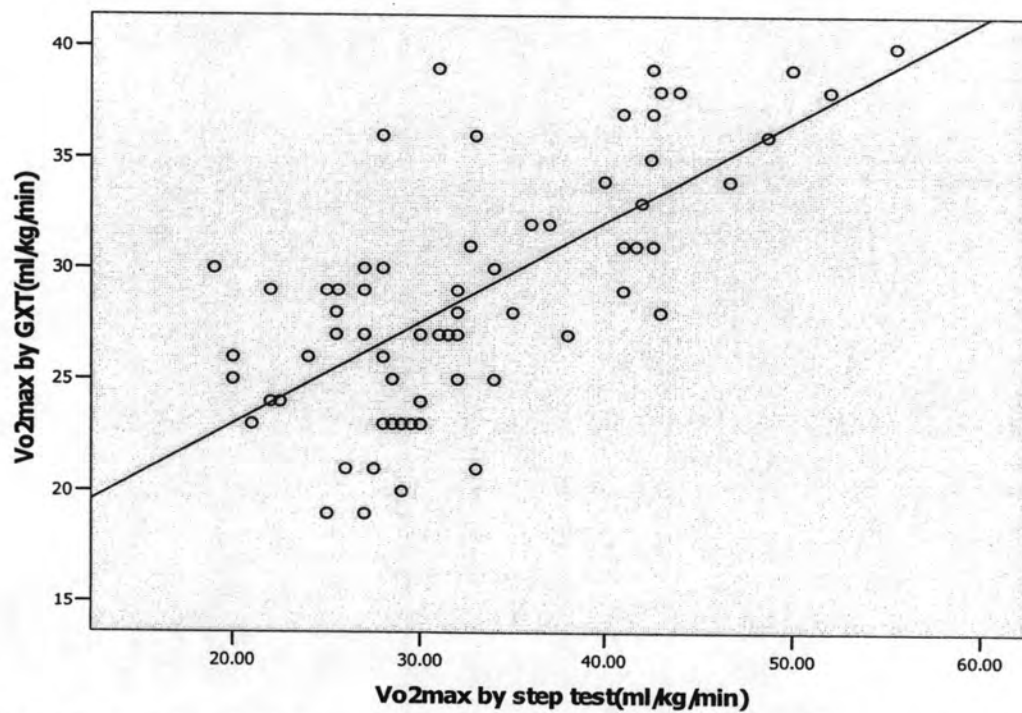


Figure 7 Scatter plot of relationship between measured  $VO_2$ max by GXT and predicted  $VO_2$ max by 3 minute step test in women ( $r=0.63$ ,  $p<0.001$ ).

Figures 4-7 show the correlations between predicted  $VO_2\text{max}$  by the two submaximal exercise tests and measured  $VO_2\text{max}$  by treadmill maximal exercise test (GXT). It was found that the correlations between estimated  $VO_2\text{max}$  by both submaximal exercise tests in men were 0.86 for cycle test and 0.72 for step test, while the correlations in women were 0.84 for cycle test and 0.63 for step test.

**Table 6.** Intraclass correlation coefficients between maximal and two submaximal exercise tests classified by age groups.

Age and Mode	r	p - value
<b>18-20 years (n = 23)</b>		
Step test and GXT	0.71	<0.001
Cycle test and GXT	0.97	<0.001
<b>21-30 years (n = 25)</b>		
Step test and GXT	0.38	0.027
Cycle test and GXT	0.64	<0.001
<b>31-40 years (n = 22)</b>		
Step test and GXT	0.37	0.042
Cycle test and GXT	0.65	<0.001
<b>41-50 years (n = 32)</b>		
Step test and GXT	0.62	<0.001
Cycle test and GXT	0.72	<0.001
<b>51-60 years (n = 23)</b>		
Step test and GXT	0.44	0.017
Cycle test and GXT	0.71	<0.001

\* Significant at  $p < 0.05$



Table 6 shows intraclass correlation coefficients between measured  $\text{VO}_2\text{max}$  by GXT and predicted  $\text{VO}_2\text{max}$  by two different submaximal exercise tests in 5 age groups of the subjects. Correlations between measured  $\text{VO}_2\text{max}$  by GXT and predicted  $\text{VO}_2\text{max}$  by YMCA cycle ergometer test ( $r=0.97$ ,  $p<0.001$ ) and between measured  $\text{VO}_2\text{max}$  by GXT and estimated  $\text{VO}_2\text{max}$  by 3 minute step test in group age between 18-20 years ( $r=0.71$ ,  $p<0.001$ ) were highest in the youngest group (age 18 – 20 years).

#### Correlation between heart rate of submaximal exercise tests and $\text{VO}_2\text{max}$ by GXT

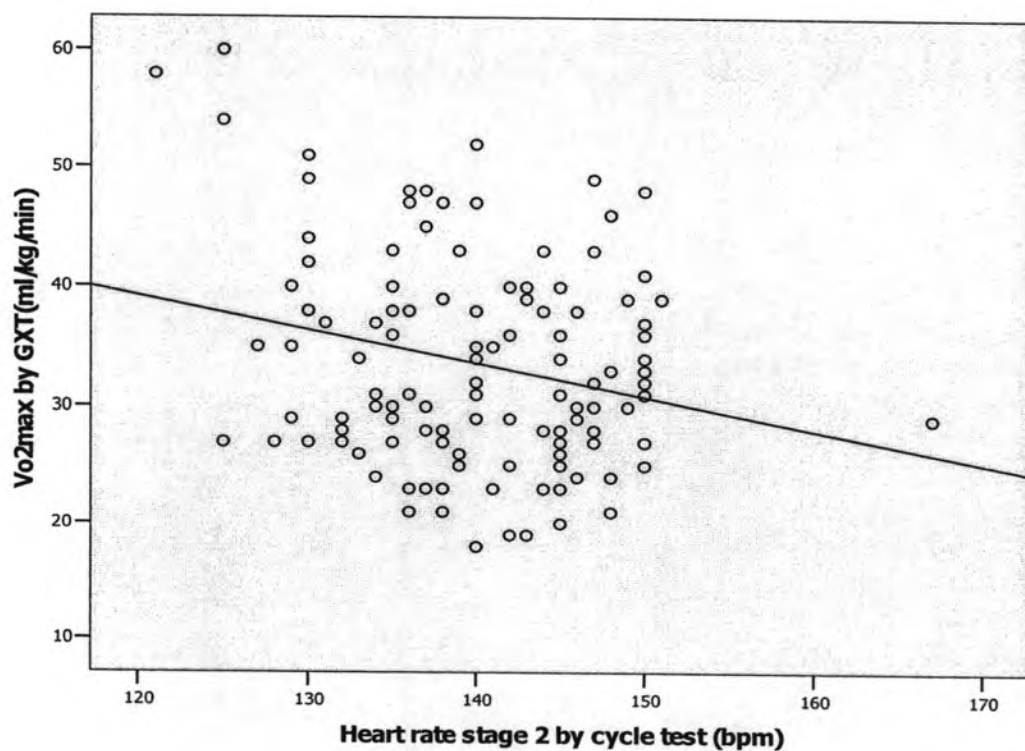


Figure 8. Scatter plot of relationship between steady state heart rate in last stage by cycle test and  $\text{VO}_2\text{max}$  by GXT ( $r= -0.24$ ,  $p = 0.007$ ).

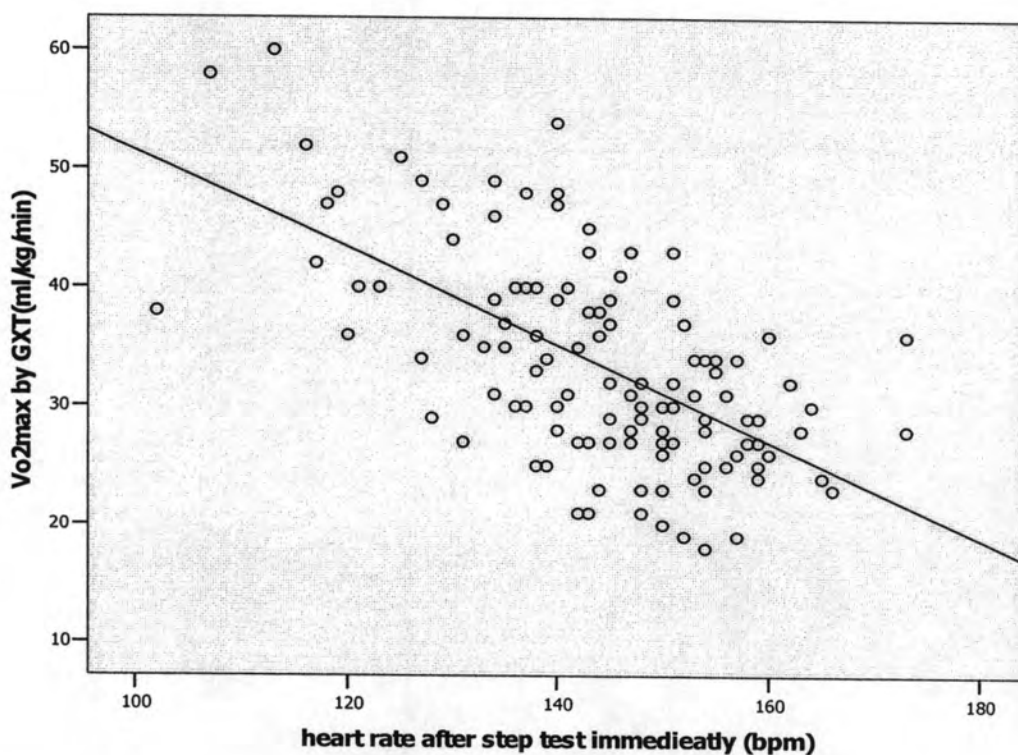


Figure 9. Scatter plot of relationship between heart rate immediately after 3 minute step test and  $VO_2$ max by GXT ( $r = -0.60$ ,  $p < 0.001$ ).

Figures 8-9 show the correlations between heart rate during submaximal exercise tests and measured  $VO_2$ max by GXT. The low correlations between heart rate were obtained at the end of the final stage of the YMCA cycle test and measured  $VO_2$ max by GXT ( $r = -0.24$ ,  $p = 0.007$ ), while the middle correlations between heart rate immediately after the 3 minute step test and measured  $VO_2$ max by GXT ( $r = -0.60$ ,  $p < 0.001$ ).



### Observed maximal heart rate and predicted maximal heart rate

In this study, predicted maximal heart rate and observed maximal heart rate during GXT were compared by paired t-test. It was found that the subjects ( $n=125$ ) had a higher observed maximal heart rate than predicted maximal heart rate ( $185.4 \pm 11.8$  vs  $183 \pm 13.1$  bpm,  $p = 0.013$ ). The intraclass correlation coefficient showed a positive relationship between the observed and predicted HRmax ( $r = 0.63$ ,  $p < 0.001$ ). The intraclass correlation coefficients ( $r$ ) of the observed and predicted HRmax were  $0.61$  ( $p < 0.001$ ) for men and  $0.62$  ( $p < 0.001$ ) for women. The scatter plot of the relationship between observed maximal heart rate and predicted maximal heart rate is shown in figures 10, 11, 12.

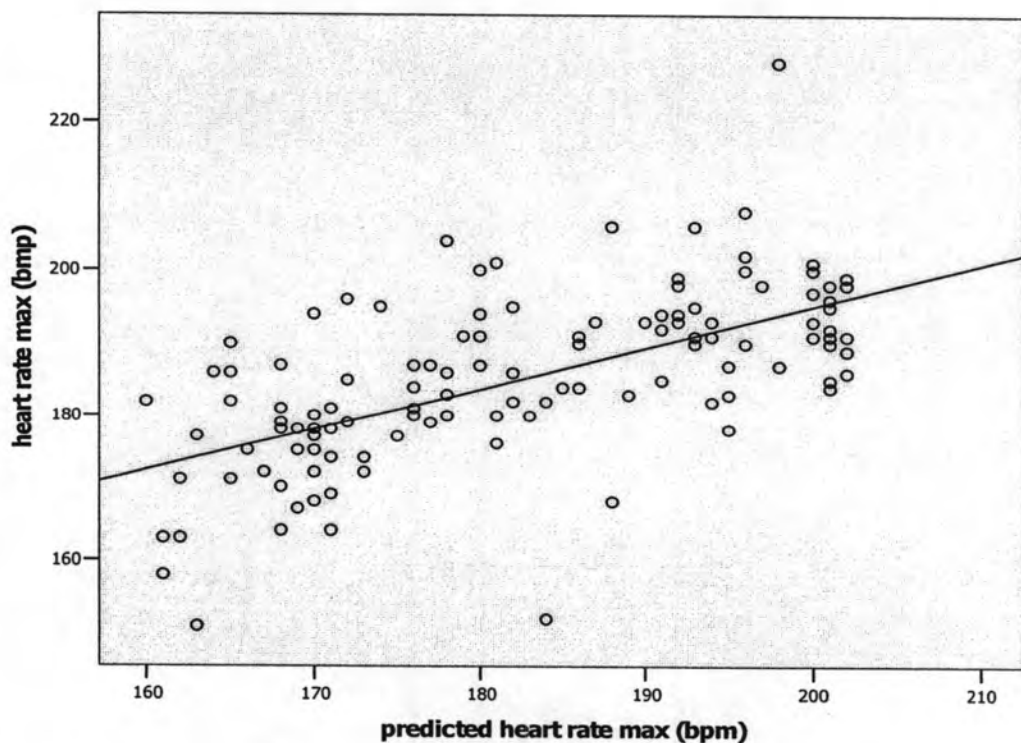


Figure 10 Scatter plot of relationship between maximal heart rate and predicted maximal heart rate ( $r=0.63$ ,  $p<0.001$ ).

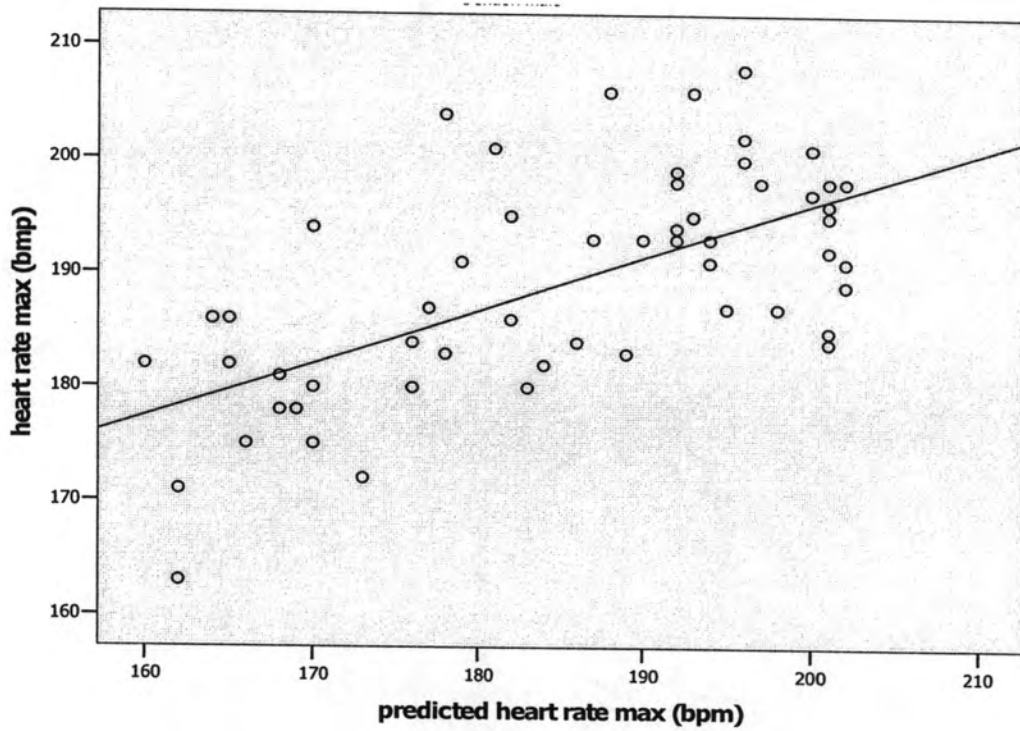


Figure 11 Scatter plot of relationship between maximal heart rate and predicted maximal heart rate in men ( $r=0.64$ ,  $p<0.001$ ).

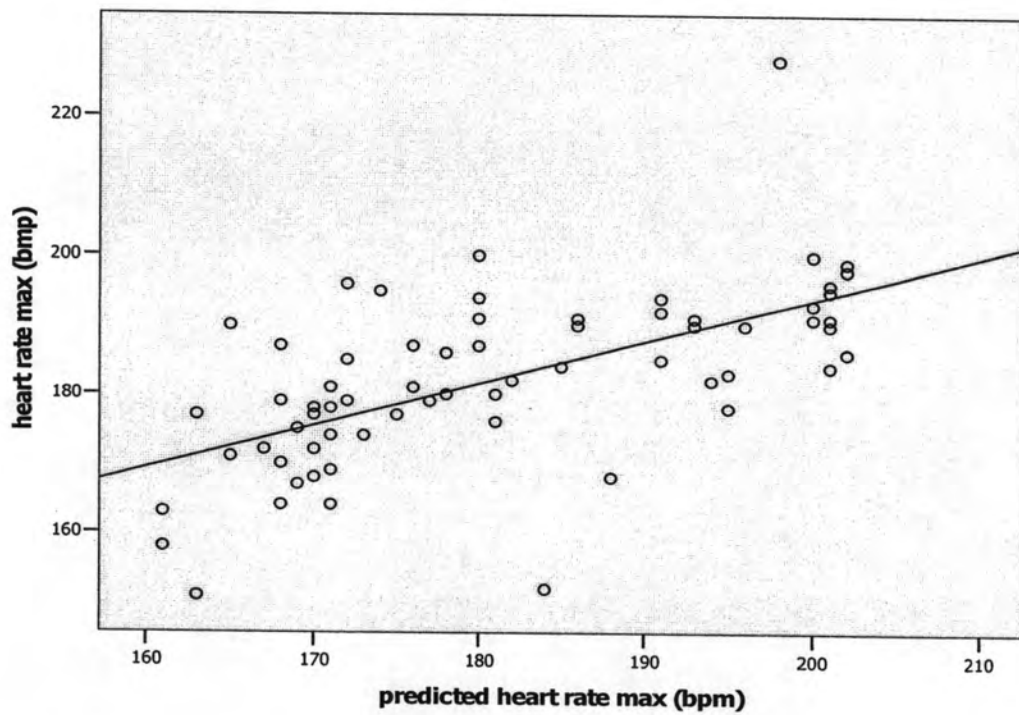


Figure 12 Scatter plot of relationship between maximal heart rate and predicted maximal heart rate in women ( $r=0.62$ ,  $p<0.001$ ).