CHAPTER 4

MODELLING CHWs' PERFORMANCE ANALYSIS

4.1 Research Design

The analysis of CHWs' performance in malaria control at the village level will involve modelling approach. To test the model, data will be collected by a cross-sectional descriptive study.

4.2 Factors Influencing the CHWs' Performance

This point of the research will focus on selecting the specific factors that can have any influence on the performance of CHWs. There are two kinds: quantitative factors and qualitative factors. They will be included in the model to be built for the performance of the CHWs in malaria control at the village level.

4.2.1 Quantitative factors

The quantitative factors or independent quantitative variables that can influence the performance of a CHW are the followings:

1. Age of the CHW

The age of the CHW may influence the number of patients treated in one year. The young CHW might not be reliable for the patients, as the case of one young woman of 25 who was not allowed by some of the village members to assist the pregnant to deliver in a village of south-east Bénin, although she was selected by a village assembly. This situation is however not generalizable to other regions. The older he/she is, the more experienced he/she might be, and also the more reliable for the potential malaria patients in the community. But on the other hand, the old CHWs are subject to oblivion and are very likely to keep less the instructions in their mind.

2. Number of years of schooling

The level of education, especially the number of years of schooling might play a great role in the understanding of the role of the CHWs in the community. But it is very difficult to find in villages available people with many years of schooling. Unless those old officials who, after retirement, have returned to their home villages for their last days. Those kind of people are more interested in other more "honourable" function such as member of village committees, head of village, mayor etc... However, there are some CHWs who have undergone some years of school education. This might influence positively the number of patients they treat per year.

3. Number of years of experience as CHW

All the CHWs who are currently working in villages have not the same number of years of experience. Because of some few drop-outs, migrations for multiple reasons and deaths all along the implementation of the programme, some CHWs in some villages were replaced by new ones who were trained and supervised by the same health personnel. So that the number of years of experience as CHW varies from five (CHWs on duty since 1990) to one (CHWs on duty since 1994). No CHWs on duty since less than one year will be included in the study. The more years of experience the CHW has in that job, the more reliable he or she might be to the communities beneficiaries. This might have some positive influence on the number of patients treated by him.

4. Annual amount of his/her household income

The CHWs are generally heads of households, and have to take care of the household members. Thus, they need income to respond to the primary needs of the whole household. The five primary needs of human being are the followings: eating, clothing, housing, being educated, and being cared in case of disease. If anyone of these fundamental needs misses, there is no well being in the household. So, the amount of annual income of the household is an important factor for the happiness and the motivation of the head of the household. If enough income is earned for the household to cover its basic needs, there will be no crucial or urgent economic needs in the CHW's household; and the economic burden of the household for the CHW will be less. The less he or she will care about formal or informal rewards. He or she can concentrate on his or her job of CHW; This might have some positive influence on the number of patients treated by him.

5. Number of his/her dependents

The head of household has to cater for all the members of the household. Moreover, the dependents are not only the people inside the household, in the socio-cultural environment of Bénin. The dependents are all the people inside and outside the household whose basic needs must be satisfied by the head of household. The more dependents a CHW has, the more he/she will need to spend. This will have a negative effect on the amount of yearly income of the household. The CHW who has a lot of dependents and a little amount of income will not be as motivated as another who has less burden, and also he will be in need of money all the time. As a result of this demotivation, he or she might perform poorly. So, a big number of dependents might have a negative influence on the number of patients treated by the CHW.

6. Value of informal gift per year

Informal gift are usually given by patients or parents of patients who are happy of the behaviour of the CHWs, or happy of the quality of his or her care. The amount of informal gift a CHW gets per year may be used as an indicator to measure the number of patients he or she has treated successfully. So, the more patients he or she has

treated, the more the amount of informal gift. Thus, the amount of informal gift is supposed to influence the performance of the CHW.

7. Number of supervision per year

The regular supervision of the CHWs by the health personnel of the commune health centre has two effects: i) the strengthening of the competence of the CHWs, and ii) the legitimation of the actions of the CHW to the villagers. The more the CHW is supervised by the personnel of the health centre, the more reliable he will be to the communities beneficiaries. This might have some positive influence on the number of patients treated by him.

8. Number of retraining

The CHWs have been retrained several times since the beginning of the programme in 1990 in order to strengthen their competence and improve the quality of their care. The more a CHW has been retrained, the better will be the quality of his care. This would be appreciated by the commu-nities beneficiaries, and might lead to more confidence and more reliabi-lity to the CHW. More patients might go to him or her for health seeking.

9. Number of hours of daily availability

The CHWs are not assigned in offices to be opened and closed timely for their task in villages, but they have to devote some time daily for their health activities. They can go to their usual activities, but have to let the villagers know where they would be, so that they can be reached in case of needs. If patients in needs cannot find a CHW on time to solve their simple health problems, this will be quickly known in the villages; and the next patients will go for health seeking elsewhere. The more the number of hours he/she is available a day, the more patients he/she will treat within a year.

10. Amount of formal rewards per year

CHWs were selected by villagers and agreed to work for their communities without claiming any compensation in kind nor in cash for the time they would devote for their people. But when the programme started, it was seen by some of the CHWs and also some villagers as time (thus resource) consuming. That is why in some villages, villagers themselves decided to "give something" formally (yearly or each semester) in cash or in kind to CHWs, to compensate for the time the latter spend for their CHW tasks. Some CHWs are helped in their farms. The value of formal rewards he or she gets per year is supposed to motivate him or her, and have a positive influence on the performance of the CHW. The more the CHW gets this formal rewards per year, the more he or she will be motivated and the more patients he or she will likely have to treat.

4.2.2 Qualitative factors

The qualitative factors or independent qualitative variables that can influence the performance of a CHW are the followings:

11. Sex

The female are likely to be less available than the male, because of their daily household work. Moreover, as they are specialized in maternal care (ante-natal care, post-natal care, risky pregnancies detection, delivery) they are mostly used as traditional birth attendants (TBAs). Thus they are supposed to treat less malaria patients than males. Also, in some villages, the men are not likely to allow their wives CHWs to deal with men, even if the latter are sick. And the female patients may not have willingness to consult CHWs male because of the common and natural reluctance of women to expose their problems, even health problems or others, to men in villages in Bénin.

12. Marital status

The criteria of selection of candidates to be CHWs were set by villagers themselves; and they are not necessarily the same from one village to another. In some villages of the central region of Bénin, the single were systematically eliminated, because the villagers were afraid that they might leave the village and follow their future sweethearts, if it comes to happen that the latter are not originated from the same village. In others, they were accepted but warned not to take advantage of their position to woo the married women. In other villages, they were easily accepted, without any notices. In all cases, the women might be reluctant to go to the CHWs single for health seeking, and also the men may not allow their wives to go for health seeking. So, this might have negative influence on the number of patients treated by the CHW per year. It would be interesting to learn who are the patients of the CHWs single.

13. Employment

CHWS were warned at the beginning of the programme that it was not an employment for them. They ought to have their own employment to respond to their needs and their household's before becoming CHWs. The CHW with no employment has no resources for his or her needs; and he or she might wait for informal gifts from patients or formal rewards from the community. And in the case that none of these is provided to him or her, he or she might not to be motivated, thus less available for the job and finally treat less patients.

14. Competence

If a CHW is competent, the quality of his or her care will be good and well appreciated by the villagers. The more competent the CHW is, the more the number of patients treated. This will be judged by the personnel of the health centre in charge of training, retraining and supervision of CHWs.

15. Attitude of villagers

If the attitude of the villagers is not positive, the CHW might be demotivated to continue the "job". The moral support of the community which can be expressed by their positive attitude towards the CHW includes the acknowledgment of the contribution of the latter to some extent to the good health status of the community served. A positive attitude of the community might encourage him or her to perform better. Also, a positive attitude of the community might encourage people to go to the CHW for health seeking; this might increase the number of patients treated.

16. Support of the hierarchy

The hierarchy here means the health personnel of the commune health centre including the assistant-nurse, the nurse, the midwife and even the medical officer of the district hospital. The support of the hierarchy is the acknowledgement by the latter of the importance of the tasks carried out by the CHW at the village level. The direct effect of this is the legitimation of the CHWs to the community. This will yield more confidence to the CHW. He or she will be more motivated and might perform better. Also, the more reliable he or she will be to the community served. Consequently, he or she might have more patients to treat.

17. Any healing service before

In some villages, the communities preferred to choose as CHW traditional practitioners or traditional birth attendants or retired health personnel back to their home villages. All those types of CHWs with healing service experiences before being selected as CHWs are more reliable to the communities who choose them instead of others. Whether the healing service experience is from traditional medicine or modern medicine does not matter. So, any healing service before being chosen as CHW might strengthen the reliability of the CHW; so might very likely be the quality of the care provided. This might make more patients go to him or her for health care seeking.

4.2.3 Measurement of the variables

1. Quantitative variables measurement

Table 4.1 displays, for the dependent variable and for each of the independent quantitative variables, the unit of measurement (number, years), the mean of measurement (interview, counting...), the type of data (primary or secondary) and the source (where to find) the data.

Table 4.1: Measurement of the Quantitative Variables

Variable	Factors	Unit	Measurement	Type of data	Sources of data
Y	# patients treated	number	counting	secondary data	HC record
x1	age	years	interview	primary data	CHWs
x2	# years schooling	years	interview	primary data	CHWs
x3	# years experience	years	interview	primary data	CHWs
x4	amount HH income/Y	Franc CFA	interview	primary data	CHWs
x5	# dependents	number	interview	primary data	CHWs
x6	amount informal gift/year	Franc CFA	interview	primary data	CHWs
x7	# supervision/year	number	counting	secondary data	HC+CHW record
x8	# retraining	number	counting	secondary data	
x9	# hours available/D	number	interview	primary data	CHWs
x10	amount formal rewards	Franc CFA	interview	primary data	CHWs

2. Qualitative variables measurement

Table 4.2 displays, for each of the independent qualitative variable, the unit of measurement, the instrument of measurement, the type of data and the source the data (where to find). All the qualitative data are primary ones and will be obtained by interview of the CHWs and the personnel of the health centre.

Table 4.2: Measurement of the Qualitative Variables

Var	Factors	Unit	Measurement	Nature of data	Sources of data
x11	sex	male, female	interview	primary data	CHWs
x12	marital status	sing,mar,div,wid	interview	primary data	CHWs
x13	employment	yes , no	interview	primary data	CHWs
x14	competence	poor, good	interview	primary data	HC personnel
x15	attitude of villagers	positive, otherw	interview	primary data	CHWs
x16	support from hierarc	poor, good	interview	primary data	CHWs
x17	healing service before	yes, no	interview	primary data	CHWs

4.3 Multiple Regression Analysis of the Identified Factors

Regression analysis helps to determine the relationship between variables. The objective of this method of analysis here is to predict or estimate the value of the number of malaria patients treated by a CHW, the dependent variable Y, corresponding to a given value of his or her characteristics such as age, sex, number of years of schooling, number of years of experience, etc... which are the independent variables X_i.

The following are the necessary assumptions (Daniel and Terrel 1995, 553) underlying the multiple regression model when inference is an objective of the analysis.

i. The independent variables (X_i) may be either random or nonrandom (fixed) variables. Because of their role in explaining the variability in the dependent variable Y, they are sometimes referred to as explanatory variables. They are also sometimes referred to as predictor variables, because of their role in predicting Y.

ii. The independent variables, the X_i, are measured without error.

iii. For each combination of the X_i values, there is a normally distributed subpopulation of Y values.

iv. The variances of the subpopulations of Y values are all equal.

v. The Y values are statistically independent. This means that the value of Y observed for one value of X does not depend on the value

observed for another value of X.

vi. The error terms (e_i) are normally and independently distributed, with mean 0 and variance σ^2.

The performance of CHWs is measured by the number of patients treated by each CHW. The performance of a CHW is assumed to be a function of the set of both quantitative and qualitative factors identified in section 4.4 as shown by the function below:

Y = f (x1; x2: x3; ..... x17)

where:
Y is the Performance (dependent variable);

the independent quantitative variables are:
x1 represents the age of the CHW
x2 represents the number of years of schooling
x3 represents the number of years of experience as CHW
x4 represents the annual amount of his/her household income
x5 represents the number of his/her dependents
x6 represents the value of informal gift he/she gets per year
x7 represents the number of supervision he/she receives per year
x8 represents the number of retraining since the beginning of the programme
x9 represents the number of hours he/she is available a day
x10 represents the amount of formal rewards he/she gets per year;

the independent qualitative variables are:
x11 represents his/her sex
x12 represents his/her marital status
x13 represents his/her occupation
x14 represents his/her competence
x15 represents the attitude of villagers
x16 represents his/her support from the hierarchy
x17 represents any healing service before becoming CHW.

In order to incorporate the qualitative independent variables in the regression model, they must be quantified in some manner. This may be accomplished through the use of what is known as dummy variables. The dummy variable is a variable that assumes only a finite number of values (such as 0 or 1) for the purpose of identifying the different categories of a qualitative variable. According to Daniel (1995, 568), the term "dummy" is used to indicate the fact that the numerical values (such as 0 and 1) assumed by the variable have no quantitative meaning but are used merely to identify different categories of the qualitative variable under consideration. Table 4.3 shows the dummy variables of the qualitative factors that might influence the performance of the CHWs in malaria control at the village level in Bénin.

Table 4.3: Dummy Variables for the Measurement of Qualitative Factors

Var.	Qualitative factors	Number of categories	Dummy variables
x11	sex	2 (male, female)	x11= {1 for male {0 for female
x12	marital status	4 (single, married, divorced, widowed)	x12a = {1 for single {0 otherwise x12b = {1 for married {0 otherwise x12c = {1 for divorced {0 otherwise if x12a = x12b = x12c = 0, then marital status = widowed
x13	employment	2 (yes, no)	x13 = {1 for yes {0 for no
x14	competence	2 (poor, good)	x14 = {1 for good {0 for poor
x15	attitude of villagers	2(positive, otherwise)	x15 = {1 for positive {0 for otherwise
x16	support from the hierarchy	2 (poor, good)	x16 = {1 for good {0 for poor
x17	healing service before being CHW	2 (yes, no)	x17 = {1 for yes {0 for no

4.4 The Multiple Regression Model

For the sample multiple regression equation of each CHW's performance, we will consider all the quantitative variables. Also, all the qualitative variables will be included. But the selection of the quantitative and qualitative variables which will be included in the final multiple regression model will be done in this thesis with hypothetical data in chapter 6 while evaluating this model. Different combinations of independent variables will be regressed with the dependent variable; and the final model will be the combination which yields the maximum coefficient of multiple determination[2] .

The inclusion of the qualitative variables in the regression equation according to Daniel (1995, 460, 466) may contribute significantly to the reduction of the error sum of squares and thereby, provides more precise estimates of the parameters of interest. Moreover, the dummy variables approach also yields more precise inference regarding other parameters, since more degrees of freedom would be available for the calculation of the error mean square. Thus,

2 See subsection 4.4.1

the multiple linear regression model is as follows:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \beta_{10} x_{10} + \beta_{11} x_{11} + \beta_{12} x_{12a} + \beta_{13} x_{12b} + \beta_{14} x_{12c} + \beta_{15} x_{13} + \beta_{16} x_{14} + \beta_{17} x_{15} + \beta_{18} x_{16} + \beta_{19} x_{17} + e_i .$$

where y_i is a typical value from one of the subpopulations of the Y values (CHWs' performance), the β_i are called the regression coefficient, x1, x2, x3... are respectively particular values of the independent variables X1, X2, X3..., and e_i is a random variable with mean 0 and variance σ^2, the common variance of the subpopulations of Y values.

4.4.1 Evaluating the multiple regression equation

1. Coefficient of multiple determination

The Coefficient of multiple determination (R^2) explains what proportion of the total variability in Y (number of malaria patients treated in one year), the dependent variable, can be explained by the independent variables X_i. The coefficient of multiple determination is defined as follows:

$$R^2_{Y.12...17} = \frac{\sum(\hat{Y}_i - \bar{Y})^2}{\sum(Y_i - \bar{Y})^2} = 1 - \frac{\sum(Y_i - \hat{Y}_i)^2}{\sum(Y_i - \bar{Y})^2}$$

The numerator of the middle term is the explained sum of squares due to regression (SSR). The denominator is the total sum of squares (SST). The subscript (Y.12...17) on R^2 indicates that Y is the dependent variable and X1 X2 ... X17 are the independent variables. Thus, we may write the equation of multiple determination this way:

$$R^2_{Y.12...17} = \frac{SSR}{SST}$$

But as the coefficient of multiple determination R^2 is a positively biased estimator of the population coefficient of multiple determination, it can be adjusted for bias by computing a measure of adjusted R^2 that is written:

$$\bar{R}^2_{Y.12...17} = 1 - \frac{\dfrac{\sum(Y_i - \hat{Y}_i)^2}{(n - k - 1)}}{\dfrac{\sum(Y_i - \bar{Y})^2}{(n - 1)}}$$

Since the correction factor (n-1)/(n-k-1) approaches 1 as the size of the sample increases, the difference between $R^2_{Y.12...17}$ and adjusted $R^2_{Y.12...17}$ is negligible for large samples.

2. **Correlation analysis**

The correlation analysis measures the strength of the relationship between the variables. It will be will be generated to detect independent variables which are correlated with other independent variables, and also the degree of the correlation. This will lead to a rational choice of only relevant independent variables for the final model.

3. **Testing the regression hypothesis**

To determine whether the overall regression is significant, we may test the hypothesis that follows:

The null hypothesis is Ho: $\beta_1 = \beta_2 = \beta_3 = \ldots = \beta_k = 0$ and the alternative is Ha: not all $\beta_i = 0$. In words, the null hypothesis states that all the independent variables (the set of quantitative and qualitative factors) are of no value in explaining the variation in the different numbers of malaria patients treated at the village level by the CHWs (Y values).

4.4.2 One-way Analysis of variance model

Analysis of Variance (ANOVA) is most often used to analyze data derived from designed experiments. Also, ANOVA can be used to analyze data from surveys, as in the present study. The multiple regression model above has both continuous and dummy independent variables. As the sample of CHWs can be controlled, we may consider all the continuous independent variables that we keep constant; we can then include the dummy variables, one after another, and test whether there is any difference in the number of patients treated per year (Y value), between the two groups of the values of the dummy variable, e.g. the sex of the CHW (X11 = 1 for male or 0 for female). The mean of number of patients treated can be calculated for each category of sex; and we can test whether or not there is any difference between the two means.

1. **Testing hypothesis**

To determine whether there is any significant difference between the two means μ_1 and μ_0, we may perform a hypothesis test that follows nine steps:

i) Description of data

The research situation and the data generated by the research are examined. μ_1 is the mean of number of patients treated by CHWs male and μ_0 is the mean of number of patients treated by CHWs female.

ii) Statement of necessary assumptions

We presume that the multiple regression model and its underlying assumptions as presented in section 4.2.4 are applicable.

iii) Statement of null and alternative hypotheses

The null hypothesis is Ho: $\mu_1 = \mu_0$, the alternative is Ha: $\mu_1 \neq \mu_0$. In words, the null hypothesis states that there is no difference between the two means; that assumes that the population variances are equal.

iv) Identification of the test statistic

The appropriate test statistic about the equality of two populations variances is variance ratio or F test, which is computed as a part of an analysis of variance. The general ANOVA table is shown below (MRS = mean square due to regression and MSE mean square of error).

Table 4.4: ANOVA Table for Multiple Regression

Source of variation	SS	d.f.	MS	F
Regression	SSR	k	MSR=SSR/k	MSR/MSE
Error	SSE	n-k-1	MSE=SSE/(n-k-1)	
Total	SST	n-1		

where: SSR = $\sum(\hat{Y}_i - \bar{Y})^2$ (regression sum of squares)
SSE = $\sum(Y_i - \bar{Y})^2$ (error sum of squares)
SST = SSR + SSE (total sum of squares)
k = number of independent variables
n = sample size.

v) Specification of the significance level of the test-statistic

Although any value of α could be chosen between 0 and 1, the most common values are 0.05 and 0.01. These choices of α though arbitrary, are based on tradition (Daniel and Terrel, 1995). In this study, $\alpha = 0.05$.

vi) Statement of the decision rule

The decision rule is a guide that is followed when deciding whether or not to reject the null hypothesis: Reject Ho if the computed value of F is equal or greater than the critical value of F.

vii) Calculation of test statistic from sample data

See table above.

viii). Making the statistical decision

The computed test statistic is evaluated in the light of the decision rule. The statistical decision consists of rejecting or failing to reject the null hypothesis based on the evaluation of the computed test statistic. In all cases, the decision rule is to reject the null hypothe-sis if the computed F is equal or greater than the critical value of F.

ix) Drawing a conclusion

If the null hypothesis is rejected, we conclude that, in the population from which the sample was drawn, the number of patients treated by a CHW is different between male and female. If we fail to reject the null hypothesis (Ho), we conclude that the number of patients treated by a CHW is the same whether the CHW is male or female.

2. **Testing other hypotheses**

Likewise, other hypotheses may be tested to study the specific relationship of some independent variables with the dependent variable, the number of patients treated in one year.

4.5 Binary Choice Model: Linear Probability Model, Logit Model, and Probit Model

Some explanatory variables in the multiple regression model above, the dummy variables (see table 4.3), e.g. the attitude of villagers towards the CHWs, are dichotomous in nature. As well as the performance of a CHW can be explained by the positive or negative attitude of the villagers, the performance of a CHW can also explain the positive or negative attitude of the villagers. To analyze the role of the number of patients treated per year per CHW in explaining such dichotomous variables, we will consider one among them as dependent variable while the number of patients treated is considered as independent variable. This will help to predict the likelihood of the number of patients treated by a CHW for the given value of the considered dummy variable.

Let us consider for example the dummy variable X15 "attitude of the villagers towards the CHW" with the values 1 (if positive) and 0 (if otherwise) as dependent variable and the number of patients treated as the independent one. In this regression model, the purpose is to find a relationship between the "attitude of the villagers towards the CHW", and the probability to have a certain number of malaria patients treated during one year. The choice model, like most models, will be written in a form which is both useful for predictive purposes and easily estimated.

4.5.1 Linear probability model

The regression form of the model in the linear probability model is as follows:

$$X15_i = \alpha + \beta Y_i + \epsilon_i$$

where: $X15_i$, the attitude of villagers towards the CHW
= 1 for positive attitude
0 for otherwise;
Y_i = the number of patients treated by each CHW
ϵ_i = an independently distributed random variable with 0 mean.

The interpretation of the equation above as a linear probability model comes about when the expected value of each dependent variable observation

$$E(X15_i) = \alpha + \beta Y_i .$$

Since $X15_i$ can take only two values 1 and 0, the probability

$P_i = Prob(X15_i=1)$ and $1-P_i = Prob(x15_i=0)$.

Then $E(X15_i) = 1(P_i) + 0(1-P_i) = P_i$.

Formally, the linear probability model is often written in the following form, which allows the dependent variable to be interpreted as a probability:

$$P_i = \begin{cases} \alpha + \beta Y_i, & \text{when } 0 < \alpha + \beta Y_i < 1 \\ 1 & \text{when } \alpha + \beta Y_i \geq 1 \\ 0 & \text{when } \alpha + \beta Y_i \leq 1. \end{cases}$$

4.5.2 Probit model

Since the most serious difficulty of the linear probability model arises from the fact that predictions may lie outside the values 0 and 1, the obvious solution to the problem is to transform the original model in such a way that for all Y_i, prediction may lie between 0 and 1. This requirement suggests the use of the cumulative probability function. The resulting probability distribution might be represented as follows:

$$P_i = F(\alpha + \beta Y_i) = F(X15_i)$$

where F = a cumulative probability function.
The linear probability model will then be

$$P_i = \alpha + \beta Y_i .$$

The probit probability model is associated with the cumulative normal probability function. Let us assume that the variable $X15_i$ measuring the attitude of the villagers towards the CHW is a linear

function of the number of patients treated by each CHW (Y_i)

$$X15_i = F^{-1}(P_i) = \alpha + \beta Y_i$$

The probability P_i resulting from the probit model as an estimate of the conditional probability that a CHW treats a certain number of patients Y_i, given the attitude of the villagers ($X15_i$). This is equivalent to the probability that a standard normal dependent variable ($X15_i$) will be less than or equal to $\alpha + \beta Y_i$.

4.5.3 Logit model

Logit analysis presents a unique complement to multiple regression in its ability to utilize a binary dependent variable, e.g. X15, the attitude of the villagers towards the CHW. Logit analysis does not predict just whether an event occurred or not (0 or 1), but instead, it predicts the probability of an event to happen. In this way, the dependent variable can be any value between 0 and 1. This also means that the predicted value must be bounded to fall within the range of 0 and 1.

The logit model, based on the cumulative logistic probability function, is shown by the following equation:

$$P_i = F(X15_i) = \frac{1}{1 + e^{-X15i}} = \frac{1}{1 + e^{-(\alpha + \beta Yi)}}$$

where P_i represents the probability that the attitude of the villagers towards the CHW is positive or otherwise ($X15_i$ = 1 or 0), given the number of malaria patients treated in one year (Y_i). That equation can also be written as follows:

$$\text{logit}(P_i) = \ln\left(\frac{P_i}{1 - P_i}\right) = \alpha + \beta Y_i, \quad \text{which can also be written}$$

$$\frac{P_i}{1 - P_i} = e^{\alpha + \beta Yi}$$

or, equivalently, if we solve for P_i, then the model can be expressed in the form:

$$P_i = \frac{e^{\alpha + \beta Yi}}{1 + e^{\alpha + \beta Yi}}$$

Testing the statistical significance of the slope coefficient

In logit analysis, hypothesis can be tested by using the t-test. Ho: $\beta = 0$; there is no relationship between the attitude of the villagers towards the CHW and the number of patients treated by the latter; the alternative is Ha: $\beta \neq 0$; there is a relationship between

the attitude of the villagers towards the CHW and the number of patients treated.

4.6 Unit of Analysis of Performance

The unit of analysis of performance is the CHW. The performance of each CHW will be analyzed regarding his or her own characteristics (quan-titative and qualitative factors given by himself or herself, by health centre record and health centre personnel), and the number of malaria patients treated at the village level by him or her during the last 12 months.

4.7 Population and Sampling

The target population for the measurement of the CHWs' performance in malaria control at the village level is all the CHWs working in all the formal and informal programmes throughout the country. The study population is the CHWs of the six pilot EPI communes in all the six provinces of Bénin. The number of CHWs in the programme was 130 at the beginning in 1990, and 126 at the end of 1995 because of a couple of drop-outs and also because of some deaths. There will be no sampling, for the number of CHWs is already small. So, all the 126 CHWs of the programme will be surveyed.