A Logistic Regression Model to Predict Gender Based Violence in Zambia's Kabwe District

George M. Mukupa, Kalongo Hamusonde, Tiza Mufune, Douglas Kunda

Abstract— **Gender based violence has been associated with high poverty levels, low standards of living and risky sexual behaviors such as multiple and concurrent sexual partnering with low levels of HIV self-risk perception. This study was based on Shamabanse and Makululu compounds in Kabwe district of Zambia's Central Province and Logistic regression was used. It was found that there were high levels of gender based violence cases in these compounds among women who had little or no income at all. This was attributed to the low levels of education which forced these women into early marriages hence being fully reliant on their spouses for support and in return making them vulnerable to different forms of abuse. The study also reviewed that Gender Based Violence increases vulnerability of women to HIV infection by reducing their ability to negotiate for safe sex.**

Index Terms—Logistic Regression, Gender Based Violence.

I. INTRODUCTION

Gender Based Violence (GBV) is violence that results in physical, sexual, psychological or economic harm including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or private life directed against a person on the basis of gender [1]. Majority of countries in the world have a strong interest in preventing and responding to gender-based violence. Regardless of the form that gender-based violence takes, [12]–[15] observes that it is a human rights violation or abuse, a public health challenge, and a barrier to civic, social, political, and economic participation. It is associated with many negative consequences, including adverse physical and mental health outcomes, limited access to education, increased costs relating to medical and legal services, lost household productivity, and reduced income. Gender-based violence undermines not only the safety, dignity, overall health status, and human rights of the millions of individuals who experience it, but also the public health, economic stability, and security of nations [16]–[18].

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Gender-based violence cuts across ethnicity, race, class, religion, education level, and international borders. An estimated one in three women worldwide has been beaten, coerced into sex, or otherwise abused in her lifetime [19]. Intimate partner violence is the most common form of violence experienced by women globally. As noted previously, gender-based violence can also take the form of harmful traditional practices. Children are particularly vulnerable to violence, especially sexual abuse. According to [2], most cases of all sexual assaults worldwide are against girls 15 and younger. In 2002, 150 million girls and 73 million boys under the age of 18 years experienced forced sexual intercourse or other forms of sexual violence. Sexual violence is also often used as a tactic of war during conflicts. In the context of humanitarian crises and emergencies, civilian women and children are often the most vulnerable to exploitation, violence, and abuse because of their gender, age, and status in society. Women with disabilities are two to three times more likely to suffer physical and sexual abuse than women with no disability.

Domestic gender based violence is a problem affecting millions of women globally and this problem manifests in various forms, for instance, in the context of marriage or cohabitation, between siblings and between parents and their children [3]. However, feminist researchers [4], [8], [21]–[30] have pointed out that domestic violence is a gender neutral term and as such fails to clarify who is the victim and who is the perpetrator, masking the fact that in many relationships women are most frequently subjected to violence by men . It is for this reason therefore that the focus of this research is specifically on wife battery in order to emphasize on whom the violence is mainly directed at, thus, the term domestic gender based violence will only be retained for convenience purposes.

Kabwe is the capital of the Zambian Central Province. By 2015, Kabwe's population was estimated at 221,077 of which Makululu and Shamabanse compounds were estimated at 60,000 and 20, 000 respectively. Formerly named Broken Hill, it was founded when the Broken Hill lead and zinc deposits were discovered in 1902. Kabwe also has a claim to being the birthplace of Zambian politics [20]. It is an important transportation, mining centre and is the home of Mulungushi Rock of Authority.

In Kabwe, and in particular Makululu and Shamabanse among other compounds there has been high levels of gender based violence because most men are not in formal employment and this has attributed in increase.

Although our study was confined to Kabwe due to financial limitations, it is vital to acknowledge the fact that violence against women is a world-wide phenomenon and derives its roots from the time society started differentiating roles between women and men. On the basis of the nature of the roles, society started to perceive men's roles as being superior

to those of women and as such the status of men was given a superior position that resulted in power imbalances and consequently abuse [5]. This phenomenon cuts across class, age, race, religious and national classifications [6]. According to [7] and [8], evidence suggesting domestic violence dates way back in history. In Europe, violence towards women was a common aspect of marriage since medieval times. Up until the nineteenth century, [9] and [10] suggest that the laws in many countries that prohibit a man from physically abusing his wife have recently been reinforced with many organizations coming up to combat gender based violence.

Despite many efforts in eliminating GBV at international, regional and national level, the problem has continued to escalate at a high rate. Many perpetrators of GBV have continued to evade justice owing to the fact that few cases are taken to court. Of the many cases of domestic violence reported to the Victim Support Unit, very few of them are prosecuted. The ones who are mostly affected are women and girls which make it very difficult for them to participate in productive activities at family, school community and national levels. Gender based violence is evident in Zambia particularly against women and girls. Newspapers regularly report of incidences of violence where even babies are assaulted sexually. The latest report [1], reported that about 53 percent of women interviewed reported experiencing some form of battering and a quarter of them having experienced physical abuse several times in a year. Women currently or previously married were more likely to have been physically abused than women who never married.

II. LOGISTIC REGRESSION MODEL

Logistic regression has a wide range of applications in statistics, social sciences, medical and biomedical research mainly to formulate models sorting the factors that might determine whether or not an outcome happens. The distinguishing feature of logistic regression model is that the outcome variable is binary or dichotomous [31]–[34]. In other words, this regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. With a categorical dependent variable, discriminant function analysis is usually employed if all of the predictors are continuous and nicely distributed; logit analysis is usually employed if all of the predictors are categorical; and logistic regression is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not nicely distributed (logistic regression makes no assumptions about the distributions of the predictor variables). Logistic regression has been especially popular with medical research in which the dependent variable is whether or not a patient has a disease. It is for the same reason that this model has been used in this research because the dependent variable is dichotomous that is; one is either a victim of gender based violence or not. We formulate our model as follows:

$$\ln\left[\frac{\pi(x_i)}{1-\pi(x_i)}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \quad + \beta_k x_k \qquad (1)$$

Where

- $\pi(x_i)$= the probability of ever experiencing gender based violence.
- $1-\pi(x_i)$ = the probability of not experiencing gender based violence.
- X_i= the independent variables.
- β= the parameter estimates.

Having analyzed the prepared data in SPSS 16 and STATA 9.2, coefficients and their associated standard errors were calculated in addition to the covariance and 95 percent Confidence Interval around the estimated probabilities of considered outcome for each case. MATLAB 7.4.0 was then used to calculate cut-off probabilities.

III. RESULTS AND DISCUSSION

We present our results by accessing whether there is a relationship between one's average monthly income, highest level of education, age, sex and Gender Based Violence.

A. Average Income and Gender Based Violence

The average income was recorded for each respondent. The highest count was 27 respondents with no income at all and represented 45 percent of the data. They were seconded by mostly maids who earn an average salary of at least K100. Only 3 respondents were above the salary of K1000 and these were government workers i.e. 2 police women and 1 nurse (see Table I).

Table I: Frequency distribution of the respondents by average income

Average Income	Frequency	Percentage
None	27	45
K50-K100	4	6.7
K100-K500	21	35
K500-K1000	5	8.3
K1000+	3	5.0
Total	60	100

In terms of the GBV experiences of the respondents in the study, (Table II) shows that 19 (40.4 percent) with no income and another 19 (40.4 percent) with an income of K100-K500 experienced GBV. In a total of 60, 47 (78 percent) experienced GBV whilst 13 (22 percent) did not.

Table II: Chi-square Contingency Table

Average Income	**Experienced GBV**		**Total**
	Yes	**No**	

None	**19**	**8**	**27**
K50-k100	**3**	**1**	**4**
K100-k500	**19**	**2**	**21**
K500-k1000	**3**	**2**	**5**
K1000+	**3**	**0**	**3**
Total	**47**	**13**	**60**

From (Table III), the chi-square value of 0.032, suggest that, at 5% level of significance, Gender Based Violence is dependent on the victim's average income.

Table III: Chi-Square Test

	Value	df	Asymp.Sig (2-sided)
Pearson Chi-Square	4.68	4	0.032

B. Highest Level of Education and Gender Based Violence

(Table IV) shows the highest levels of education of the respondents. The results show that 25 had not attained a level of education past junior secondary, 20 had been to senior secondary, 11 to primary and only 4 respondents had attained college education. None of them had been to university.

Table IV: Frequency distribution of the respondents by highest level of education

Highest Level of Education	**Frequency**	**Percentage**
Primary	11	18.3
Junior Secondary	25	41.7
Senior Secondary	20	33.3
College	4	6.7
Total	**60**	**100**

(Table V) shows that those with a junior secondary level of education had the most count of 25. Out of these 25, 18 experienced gender based violence while 7 were not victims of gender based violence. The least count was of those who had attained college education with only 4 victims.

Table V: Chi-square Contingency Table

Level of education	Experienced GBV		Total
	Yes	No	
Primary	9	2	11
Junior Secondary	18	7	25
Senior Secondary	16	4	20
College	4	0	4
Total	47	13	60

A chi square test was done to test the hypothesis whether there was any relationship between one's highest level of education and them been a victim of gender based violence. The results are shown in (Table VI).

Table VI: Chi-Square Test

	Value	df	Asymp.Sig (2-sided)
Pearson Chi-Square	1.81	3	0.024

The chi-square value of 0.024 suggests that, at 0.05 level of significance, Gender Based Violence can be influenced by the victim's level of education.

C. Age and Gender Based Violence

From the 60 respondents, those in the age group of 31-40 had the highest frequency of 20 and the age groups 51-60 and 61-70 shared the same level of frequency with 4 respondents each. The figures are shown in (Table VII).

Table VII: Frequency distribution of respondents by age

Age Group	**Frequency**	**Percentage**
10-20	9	15
21-30	11	18.3
31-40	20	33.3
41-50	12	20
51-60	4	6.7
61-70	4	6.7
Total	**60**	**100**

The contingency (Table VIII) allows us to perform a Chi-square test of independence.

Table VIII: Chi-square Contingency Table

Age (in years)	**Experienced GBV?**		**TOTAL**
	YES	**NO**	

10-20	7	2	9
21-30	9	2	11
31-40	15	5	20
41-50	10	2	12
51-60	3	1	4
61-70	3	1	4
Total	**47**	**13**	**60**

We realize that the chi-square value of 0.036 from (Table IX) suggest a very strong association between age and Gender Based Violence.

Table IX: Chi-square Test

	Value	df	Asymp.Sig (2-sided)
Pearson Chi-Square	0.44	5	0.036

D. Sex and Gender Based Violence

Most traditional and customary practices regard women as inferior to men and hence both their Gender and Sex roles perpetuate the stereotype view of women [11]. A woman or wife is told to make her marriage a success by preserving her marriage and keeping her marriage problems secret which may lead to failure to report or withdraw gender based cases once reported to the police station.

The results from this study indicate that only 2 men and 45 women had experienced GBV (see Table XI). There could have been other men who had been victimized but due to the society's perception of men being superior to women; it is always a shame to come out in public as a man that you have been victimized by a woman.

Women on the other hand are not as physical as men, hence in most physical confrontations, a woman would fall prey thus the high numbers of GBV cases among women. Unequal gender norms within society can compromise the quality of life women have to access to, as well as facilitate acts of violence. It is believed in certain societies that it is acceptable for a husband to beat his wife under certain circumstances. Throughout the world, boys and men are largely the perpetrators of violence, and girls and women are the victims. In view of this, most respondents under this investigation were women (see Table X).

Table X: Frequency distribution of respondents by Sex

Sex	Frequency	Percentage
Male	2	3.3
Female	58	96.7
Total	**60**	**100**

Table XI: Chi-square Contingency Table

Sex	Experienced GBV?		Total
	Yes	No	
Male	2	0	**2**
Female	45	13	**58**
Total	**47**	**13**	**60**

Based on (Table XII), we have sufficient evidence at 5% level of significance to conclude that gender based violence is dependent on sex.

Table XII: Chi-Square Test

	Value	df	Asymp.Sig (2-sided)
Pearson Chi-Square	0.572	1	0.0049

IV. Fitting the Binary Logistic Model

Since we have tested the predictor variables above using the Chi-Square test of independence and we have seen from the results that the variables are all significant, we now turn to our main hypothesis which is fitting a binary logistic regression model using these variables. In doing so, we will start by explaining what a binary logistic regression is, the assumptions it follows and how the interpretation of the results is done.

Logistic regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. With a categorical dependent variable, discriminant function analysis is usually employed if all of the predictors are continuous and nicely distributed; logit analysis is usually employed if all of the predictors are categorical; and logistic regression is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not nicely distributed (logistic regression makes no assumptions about the distributions of the predictor variables).

One of the many basic concepts in this model is the concept of the ODDS RATIO (OR). An odds ratio is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. When a logistic regression is calculated, the regression coefficient for example β_1 is the estimated increase in the log odds of the outcome per unit increase in the value of the exposure. In other words, the exponential function of the regression coefficient e^{β_1} is the odds ratio associated with one-unit increase in the exposure. The odds ratio can also be used to

determine whether a particular exposure is a risk factor for a particular outcome, and to compare the magnitude of various risk factors for that outcome.

The odds ratio (OR) is written as;

$$\text{Odds} = o = \frac{\pi_i}{1-\pi_i} \qquad (2)$$

Where π_i = the probability of Success.

$1-\pi_i$ = the probability of failure.

We realise that if;

- OR=1 Exposure does not affect odds of outcome.
- OR>1 Exposure associated with higher odds of outcome.
- OR<1 Exposure associated with lower odds of outcome.

Regardless of the importance of the odds ratio, our main interest is deriving the probability P_i of an event occurring and this is done as follows;

We defined L = ln (odds of event Y), sometimes called the "log odds" or logit of Y. We can write L in terms of p, Probability, as follows:

$$L = \ln(o) = \ln\left(\frac{p_i}{1-p_i}\right)$$

We can then use the laws of exponents and logs and some algebra to express p (the proportion of successes or risk of the event) in terms of L:

$$\ln(o) = \ln\left(\frac{p_i}{1-p_i}\right)$$

We then exponent both sides,

$$e^L = O = \frac{p_i}{1-p_i}$$

Multiplying both sides by $1-p_i$ we get,

$$p_i = e^L(1-p_i)$$

Making p_i the subject of the formula gives us our end result:

$$p_i = \frac{e^L}{1+e^L}$$

The function can be shown in relation to a multiple logistic regression as follows;

$$p_i = \frac{e^{\beta_0+\beta_1x_1+\beta_2x_2+\ \ +\beta_kx_k}}{1+e^{\beta_0+\beta_1x_1+\beta_2x_2+\ \ +\beta_kx_k}} \qquad (3)$$

This is called the logistic function. Note here that p, the probability of the event, increases from 0 to 1.

To fit our data, we consider age, sex, level of education and average level of income as our four predictor variables or independent variables. The dependent variable is whether one is a victim of gender based violence which is dichotomous. Our model is constructed by an iterative maximum likelihood procedure. The program starts with arbitrary values of the regression coefficients and constructs an initial model for predicting the observed data. It then evaluates errors in such prediction and changes the regression coefficients so as to make the likelihood of the observed data greater under the new model. This procedure is repeated until the model converges, that is, until the differences between the newest model and the previous model are trivial. The software produces many outputs for this regression but only the necessary ones are used.

A probability (p) value is computed from the chi-square distribution with 8 degrees of freedom to test the fit of the logistic model (see Table XIII). If the Hosmer and Lemeshow (H-L) goodness-of-fit test statistic is greater than 0.05, as we want for well-fitting models, we fail to reject the null hypothesis that there is no difference between observed and model-predicted values, implying that the model estimates fit the data at an acceptable level. That is, well-fitted models show non-significance on the H-L goodness-of-fit test. This desirable outcome of non-significance indicates that the model prediction does not significantly differ from the observed.

Table XIII: Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.949	8	.653

The H-L statistic assumes sampling adequacy, with a rule of thumb being enough cases so that 95 percent of cells (typically, 10 deciles groups times 2 outcome categories = 20 cells) have an expected frequency greater than 5. Our H-L statistic has a significance of 0.653 which means that it is not statistically significant and therefore our model is quite a good fit.

The variables in (Table XIV) include the coefficients of the independent variables and their odds ratios. (Table XIV) has several important elements. The Wald statistic and associated probabilities provide an index of the significance of each predictor in the equation. The Wald statistic has a chi-square distribution.

The simplest way to assess Wald is to take the significance values and if less than .05 reject the null hypothesis as the variable does make a significant contribution. In this case, we note that all the variables contributed significantly to this model.

Table XIV: Variables in the Equation

	B	Wald	df	Sig.	Exp(B)
Age	-.014	.411	1	.021	.986
Sex	19.285	.000	1	.013	2.374E8
Income	-.06	.992	1	.019	.942
Education	-.026	.004	1	.041	.974
Constant	-8.12	.000	1	.009	.000

The Exp(B) column in (Table XIV) presents the extent to which raising the corresponding measure by one unit influences the odds ratio. We can interpret EXP (B) in terms of the change in odds. If the value exceeds 1 then the odds of an outcome occurring increase; if the figure is less than 1, any increase in the predictor leads to a drop in the odds of the outcome occurring. For example, the EXP (B) value associated with sex is 2.374. Hence when sex is raised by one unit (i.e. from male to female) the odds ratio is 2 times as large and therefore females are 2 times likely to be victim of gender based violence than males.

The 'B' values are the logistic coefficients that can be used to create a predictive equation. It is fitted in the same manner a linear regression model is fitted [35]. Our model, (1) now becomes:

$$\ln\left[\frac{\pi(x_i)}{1-\pi(x_i)}\right] = -8.12 - 0.14Age + 19.285Sex - 0.06Income - 0.026Education \quad (4)$$

In (4), it can be seen that age, income and education are negatively related with being a victim of gender based violence. That is, the higher ones income is, the lesser the chances of been a victim of gender based violence.

Since our above model is based on the log of the odds ratios, we shall now try and predict the probability of one being a victim of gender based violence based on different factors and to do this we will consider the probability formula (3).

Here is an example of the use of the predictive equation for a certain case. Imagine a female (coded as 2), aged 35 with a salary of K100 per month. What is the probability of such a person been a victim of gender based violence?

$$P = \frac{e^{-8.12+(-0.14age)+(19.285sex)-(-0.06income)}}{1+e^{-8.12+(-0.14age)+(19.285sex)+(-0.06income)}}$$

$$P = \frac{e^{-8.12+(-0.14*35)+(19.285*2)+(-0.06*100)}}{1+e^{-8.12+(-0.14*35)+(19.285*2)+(-0.06*100)}}$$

$$P = \frac{e^{19.55}}{1+e^{19.55}}$$

$$= 0.99$$

Therefore, the probability that a female in Makululu compound aged 35 with an average income of K100 will be a victim of gender based violence is 99 percent.

On the other hand, let us consider a male (coded as 1) of the same characteristics as the woman in the above example:

$$P = \frac{e^{-8.12+(-0.14*35)+(19.285*1)+(-0.06*100)}}{1+e^{-8.12+(-0.14*35)+(19.285*1)+(-0.06*100)}}$$

$$= \frac{e^{0.265}}{1+e^{0.265}}$$

$$= 0.57$$

Therefore, a man aged 35 with an income of K100 has a probability of 0.57. Comparing this with the previous result, it can be seen that a woman has a higher probability of being a victim of gender based violence compared to a man. Our findings are consistent with other empirical findings in [36]-[39].

V. Conclusion

Women are more likely to suffer Gender Based Violence than their male counterparts. Gender Based Violence increases vulnerability of women and exposes them to different kinds of adverse events like the risk of HIV infection by sex, body injuries or trauma in such relationships. Low levels of education and income had a huge role to play in these victims. Women who are abused by their partners are less likely to earn a living and less able to care for their children. Also, children who witness violence are significantly more at risk of mental health problems such as anxiety disorders, poor school performance and violent behavior. We strongly recommend women empowerment, sensitizations and severe punishment to perpetrators of GBV as a way to save our future generations. We further wish to consider other towns within Zambia and use alternative methods of modeling GVB cases so as to enable a comparative study in the future.

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