

Identification of Associated Factors and Prediction for the Level of Intimate Partner Violence against Women in Sri Lanka

H M S D Wijekoon¹ and N Withanage²

¹Department of Statistics & Computer Science, Faculty of Science, University of Kelaniya, SRI LANKA

²Department of Statistics, Faculty of Applied Sciences, University of Sri Jayewardenepura, SRI LANKA

¹Corresponding Author: sitharawijekoon95@gmail.com

ABSTRACT

Intimate partner violence (IPV) can be defined as a serious social problem rapidly increasing in Sri Lanka as same as in other countries in the world. The Sri Lanka Demographic and Health Survey (SLDHS) 2016 revealed that 17% of married women age 15-49 in Sri Lanka have become victims of IPV. The objectives of this study were to determine the factors associated with IPV against women in Sri Lanka and to develop an appropriate regression model and feedforward neural network (FNN) to predict the Violence Index which describes the level of IPV against women in the country. The data records of 2494 ever-married women that have experienced IPV were considered from Sri Lanka Demographic and Health Survey 2016. The Violence Index was estimated using Multiple Correspondence Analysis. Gamma regression analysis revealed that religion, education level of the woman, husband's occupation, woman's married time, the age difference between husband and wife, Empowerment Indicator, enough money for daily household expenses, and household alcohol consumption were significantly associated with IPV against women. The optimum FNN consists of one hidden layer with 3 neurons provided a better prediction on the Violence Index with the minimum mean squared error for the testing set. Based on the prediction accuracy, the FNN was found to be better than the gamma regression model. The findings of this study would support an effort to develop the current policies and implement prevention programs against IPV in Sri Lanka.

Keywords- Feedforward neural network (FNN), Intimate partner violence (IPV), Multiple Correspondence Analysis, Violence Index, Women

in the other countries in the world. Sri Lanka police have reported that during the period from 2005 to 2016, the number of cases of violence against women and children in the country was over 33,000. Altogether literature in the period of 2001 to 2019 revealed that 30%-64% of women in different locations in Sri Lanka have experienced IPV. The highest prevalence rate was reported by women living in the rural areas of the Central Province (64%) (Vadysinghe *et al.*, 2017). Further, Sri Lanka Demographic and Health Survey (SLDHS) 2016 reported that there are 17% of married women age 15-49 in Sri Lanka have experienced any form of intimate partner violence. These statistics indicate that it is essential to give more attention to IPV against women in the country.

Previous studies have identified various factors affecting IPV including victim's characteristics, abuser characteristics, socioeconomic factors, and marriage-related factors. Lack of formal education, young age at marriage, having more children, and low socioeconomic status were known to increase the risk of IPV in many studies (Subramaniam & Sivayogan, 2001; Kohombange, 2012; Guruge *et al.*, 2015). Further, both wife's and husband's age, length of the marriage, wife's regular jealousy and suspicion, marital problems, and lack of knowledge on violence were also identified as the risk factors for IPV (Kargar *et al.*, 2015; Laeheem, 2016). Abuser characteristics including alcohol abuse, mental disorder, unemployment, extra-marital relationship, and history of violence in childhood were also found to be highly associated with IPV (Abramsky *et al.*, 2011; Vadysinghe *et al.*, 2017).

Several studies have documented short-term as well as long-term health issues from IPV including physical injuries, mental disorders, and suicide attempts (Guruge *et al.*, 2015). A study conducted in four districts of Sri Lanka revealed that among female victims of IPV, 48% had been injured by a partner, 23% had a pregnancy that miscarried and 25% reported having suicidal ideation (de Mel *et al.*, 2013). Many studies revealed that most of the women who experienced violence have sought help from family, friends, and neighbors rather than police and health care centers (Jayasuriya *et al.*, 2011; Guruge *et al.*, 2015). However, today the health sector in Sri Lanka effectively responds to IPV. Family Health Bureau (FBH) which is the agency at National

I. INTRODUCTION

Intimate partner violence (IPV) against women is now considered as a global health concern that directly violates the woman's rights. World Health Organization (WHO) reports that almost 30% of all women in the world have experienced any physical and/or sexual violence from their intimate partner. IPV is defined as an act by an intimate partner that causes physical, sexual, or psychological harm, including physical aggression, sexual coercion, psychological abuse, controls, and threats (Hall *et al.*, 2014).

Over the last decade, the IPV against women has shown a significant increase in Sri Lanka as same as

Level has implemented the programs on prevention of domestic violence and established domestic violence care centers of hospitals that provide emotional and medical support.

Although there are many studies related to IPV in Sri Lanka, most of them have been conducted in a few provinces and rural areas in the country. Only a limited number of studies have investigated the overall prevalence of IPV in Sri Lanka (Guruge *et al.*, 2015). Furthermore, studies have not estimated an index to measure the level of IPV suffered by a woman in Sri Lanka. Therefore, this study was aimed to identify the factors associated with IPV against women in Sri Lanka using the database of SLDHS 2016 and to develop an appropriate regression model and feedforward neural network (FNN) to predict the Violence Index which describes the level of IPV against women in the country. By identifying the associated factors of IPV, it is possible to control those to prevent the issues in the future. Hence, this research study intends to create awareness of IPV and encourage to development of the appropriate strategies to prevent IPV in the country.

II. METHODOLOGY

Study participants

The SLDHS 2016 was conducted among the sample of 28,720 housing units in the country by the Department of Census and Statistics in Sri Lanka and within each household total of 18,302 eligible women were interviewed. Out of the total, data records of 2494 ever-married women age 15-49 that was found to be victims of IPV were considered for this study.

Study variables

As the outcome variable, the composite indicator called 'Violence Index' which indicates the level of IPV against a woman in Sri Lanka was developed using the different types of IPV. Based on the previous studies and available information, nineteen explanatory variables that may affect IPV were selected. It consists of the demographic characteristics of the woman including age, residence, religion, ethnicity, education level, and occupation status. The husband's education level and his occupation status were considered as the husband's characteristics. The variables regarding characteristics of the relationship and household were considered as the age difference between husband and wife, woman's married times, woman's married age, duration of the marriage, the number of children, woman having a mobile phone, woman having a bank account, wife's earning compared to husband, Empowerment Indicator, enough money for daily household expenses and household alcohol consumption. This Empowerment Indicator represents the number of household decisions in which women make either alone or jointly with their partners.

Multiple Correspondence Analysis

Multiple Correspondence Analysis (MCA) is a data reduction approach that can be applied for categorical variables (nominal or ordinal) instead of quantitative variables. It revealed the patterns of associations with the set of categorical variables by applying standard correspondence analysis to the indicator matrix (Canuel *et al.*, 2014; Greenacre, 2017). When constructing the composite indicator from ordinal categorical variables using the MCA, two properties must be satisfied: 1) First Axis Ordering Consistency (FAOC-I) for indicator I which implies the ordinal consistency between the categories and corresponding weight scores on the first axis given by the MCA; 2) Global First Axis Ordering Consistency (FAOC-G), which means that all categories (indicators) satisfy the property of FAOC-I with the same direction (Asselin & Anh, 2008).

Artificial Neural Network

Artificial neural network (ANN) is an advanced computing system that has been created to solve problems by following the same process in the human brain. ANN has been developed and widely used in the task of pattern recognition such as face recognition, speech recognition, and image classification. ANN is called the FNN when the information moves through single or multiple hidden layers with the number of neurons in the forward direction. In FNN, the backpropagation algorithm is used as a method to model a given operation by updating weights of inputs to provide an expected output. During the network training process, the number of hidden layers, the number of neurons in each layer, different transfer functions, and also other parameters can be adjusted to meet the optimum neural network.

Statistical analysis

In this study, the Violence Index was estimated using MCA and the theory of Composite Indicator. Since the estimated Index was highly skewed, the association between the Violence Index and each explanatory variable with more than two categories was measured using Kruskal –Wallis test, and each with only two categories was measured using Mann-Whitney U test. The significant variables identified with the above tests were used as the predictors in regression analysis. Gamma regression analysis was carried out to identify the associated factors of IPV against women. R software (version 4.0.3) was used for analysis. The FNN model was trained to predict the Violence Index using MATLAB 2019 version. Three error measurements called mean squared error (MSE), root mean squared error (RMSE), and mean absolute error (MAE) were used to measure the performance of each model and its ability on prediction.

III. RESULTS AND DISCUSSION

Characteristics of study participants

As in Table 3, more than three-quarters (77.5%) of women lived in rural areas. Almost half (50.7%) of women were Sinhalese and less than half (47.6%) of the women were Buddhists. Majority (85%) of women had completed lower secondary education while only fifty-two (2.1%) women had no formal education. Almost two-thirds (68.5%) of women were housewives. Over three-quarters (78.7%) of women's husbands had completed lower secondary education and only sixty-one (2.4%) had no education. Nearly one in ten (10.6%) husbands employed in the government sector and eighty-four (3.4%) husbands being unemployed. More than half (57.7%) of the women had one to five years of age difference in their marriage. Majority (96.4%) of women had married only one time and over three-quarters (78.5%) of women had married after age 18. Almost one-quarter (24.7%) of women having a marital duration of more than 20 years. Nearly, two-thirds (63.8%) of women had 1-2 alive children. More than two-thirds

(67.8%) of women had their own mobile phone and more than three-quarters (77.5%) of women had their own bank account. Only one hundred forty-seven (5.9%) women earned money more than their husbands. More than two-thirds (71.3%) of women made household decisions either alone or jointly with their partners. One-fifth (21.9%) of the households had not enough money for daily expenses. More than half (54.2%) of the women reported that any member of the house consumes alcohol.

Estimation of Violence Index

In SLDHS 2016, women were asked to report their experienced status of different types of IPV. Table 1 presents the percentage of women that have experienced IPV according to those different types and frequencies. There are almost three-quarters (75.8%) of women had suffered from the type of violent which is "Belittled/Seriously offended". Further, 44.3% of women had experienced the violence called "Slapped/Beaten/Thumped". The minority (3.1%) of women had suffered from the Violence called "Burned" by their intimate partners.

Table 1: Percentage of women who suffered from intimate partner violence according to types and frequency of violence

Type of violence	Experienced (%)				Not Experienced (%)
	Daily	Weekly	Monthly	Less often	
Slapped/Beaten/Thumped	2.1	4.6	19.2	18.4	55.7
Pushed/Shoved	1.8	4.1	10.6	14.0	69.5
Tried to Strangulate	1.1	2.1	3.8	5.1	87.9
Dragged/Pulled	0.9	2.4	4.7	8.0	84.0
Beat with an object	0.7	2.0	3.4	7.9	86.0
Burned	0.1	0.6	0.5	1.9	96.9
Prevented leaving home	0.5	1.9	5.3	9.5	82.8
Forced to have sex	1.9	3.2	2.9	6.6	85.4
Belittled/Seriously offended	7.9	6.3	22.3	39.3	24.2

MCA was performed based on the nine types of IPV as included in Table 1 and its 45 modalities. Then preliminary MCA demonstrated that 12.9% of the total variance of the indicators were alone explained by the first axis while the second axis explained only 9%. The results of weights on the first axis showed that all variables met the property of FAOC-I, except the variable which was the violence type of "Belittled/Seriously offended". After restructuring the variable so as to meet the property, the final MCA based on the nine variables and 42 modalities led to an increase in the explanatory power of the first axis, which rose to 13.2%. All variables satisfied the FAOC-I as well as FAOC-G with the final MCA. Since the Index had both

negative and positive values, it was rescaled as positive by adding the absolute value of the minimum Composite Index (-0.374) to each.

Table 2: Descriptive statistics for the Violence Index

Statistics	Value
Mean	0.377
Standard Deviation	0.020
Median	0.057
Minimum	0.03
Maximum	10.53

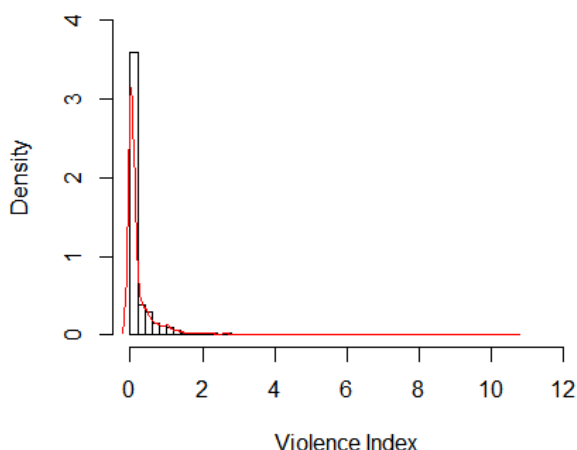


Figure 1: Distribution of the Violence Index

As in Table 2, the highest value of the Violence Index was 10.53 which represented the highest level of IPV against a woman and the lowest value was 0.03 which represented the lowest level of IPV against a woman. Further, the estimated Violence Index was positively skewed with a very long right tail (Figure 1). There can be seen different countries which have developed multiple indicators on violence against

women using their National Surveys (United Nations, 2007). MCA has commonly used for the construction of Composite Indicator when having categorical ordinal indicators (Kohn, 2012; Ezzrari & Verme, 2013).

Association between the Violence Index and explanatory variables

According to Table 3, the results of the Kruskal-Wallis H test and Mann-Whitney U test revealed that woman’s age, ethnicity, occupation status, and wife’s earnings compared to husband were not significantly associated with Violence Index and the rest of all variables included in the table were associated with the Violence Index at a 5% level of significance.

Associated factors of IPV

Since the Violence Index was positively skewed, the gamma regression analysis which deals with skewed data was carried out as the most appropriate regression analysis for determining the significant factors of IPV (Rahayu *et al.*, 2020; Williford *et al.*, 2020). The Gamma Regression (GR) model was fitted using 80% of the data and tested the model validity using remained 20% of the data. The “best” variables fit to the final model were selected using the Stepwise Forward Selection method.

Table 3: Association between the Violence Index and 19 explanatory variables

Variables	Frequencies (%)	Kruskal-Wallis H Test	Mann-Whitney U Test	P
1. Woman’s age		5.799		.122
[15-24]	174 (7.0)			
(24-34)	827 (33.2)			
(34-44)	1019 (40.9)			
>44	474 (19.0)			
2. Residence		12.260		.020
Urban	426 (17.1)			
Rural	1932 (77.5)			
Estate	136 (5.5)			
3. Religion		10.019		.040
Buddhism	1188 (47.6)			
Hindu	780 (31.3)			
Islam	255 (10.2)			
Catholic	208 (8.3)			
Other	63 (2.5)			
4. Ethnicity		7.968		.930
Sinhala	1264 (50.7)			
Sri Lanka Tamil	909 (36.4)			
Indian Tamil	70 (2.8)			
Muslim	245 (9.8)			
Other	6 (0.2)			
5. Education level		115.758		.000

	No school	52 (2.1)		
	Primary	322 (12.9)		
	Lower secondary	1593 (63.9)		
	Upper secondary	437 (17.5)		
	Graduate & above	90 (3.6)		
6.	Occupation status		661488.0	.547
	Employed	7 86 (31.5)		
	Housewife	1708 (68.5)		
7.	Husband's education level		120.616	.000
	No school	61 (2.4)		
	Primary	471 (18.9)		
	Lower secondary	1561 (62.6)		
	Upper secondary	328 (13.2)		
	Graduate & above	73 (2.9)		
8.	Husband's occupation status		19.287	.000
	Government Employee	265 (10.6)		
	Private sector Employee	1283 (51.4)		
	Own work	862 (34.6)		
	Unemployed	84 (3.4)		
9.	Age difference Between husband and wife		9.602	.048
	0	212 (8.5)		
	[1-5]	1439 (57.7)		
	(5-10]	652 (26.1)		
	(10-15]	160 (6.4)		
	>15	31 (1.2)		
10.	Woman's married times		76417.0	.000
	Once	2404 (96.4)		
	More than once	90 (3.6)		
11.	Woman's married age		454401.5	.000
	Under 18	536 (21.5)		
	Over 18	1958 (78.5)		
12.	Duration of marriage (years)		27.366	.000
	[0-5]	318 (12.8)		
	(5-10]	510 (20.4)		
	(10-15]	528 (21.2)		
	(15-20]	521 (20.9)		
	>20	617 (24.7)		
13.	Number of alive children		17.566	.001
	None	620 (24.9)		
	[1-2]	1591 (63.8)		
	(2-4]	226 (9.1)		
	>4	57 (2.3)		
14.	Having a mobile phone		586966.0	.000
	Yes	1692 (67.8)		
	No	802 (32.2)		

15. Having a bank account		501075.5	.005
Yes	1933 (77.5)		
No	561 (22.5)		
16. Wife's earning compared to husband		3.728	.292
More than him	147 (5.9)		
Less than him	524 (21)		
Same	73 (2.9)		
No employment/Don't know	1750 (70.2)		
17. Empowerment Indicator		26.653	.000
0	188 (7.5)		
1	187 (7.5)		
2	342 (13.7)		
3	1777 (71.3)		
18. Enough money for daily household expenses		20.209	.000
Yes	1163 (46.6)		
No	545 (21.9)		
Don't know	786 (31.5)		
19. Household alcohol consumption		659584.5	.000
No	1143 (45.8)		
Yes	1351 (54.2)		

Gamma regression (GR) analysis revealed that eight factors that were statistically significant with IPV (p value < 0.05): religion, woman's education level, husband's occupation, married times, the age difference between husband and wife, Empowerment Indicator, enough money for daily household expenses, and household alcohol consumption. The residual deviance was 8174.4 with a degree of freedom of 1972 (p value < 0.0001). The final GR model showed an improvement over the null model and adequately fitted the data. The ANOVA type representation of the fitted GR model is

given below and its parameters estimates are presented in Table 4.

$$\ln(\mu_{ijklmnpq}) = \beta_0 + \lambda_i^{\text{Religion}} + \lambda_j^{\text{Education_Level}} + \lambda_k^{\text{Husband_Occupation}} + \lambda_l^{\text{Age_Difference}} + \lambda_m^{\text{Married_Times}} + \lambda_n^{\text{Empowerment_Indicator}} + \lambda_p^{\text{Enough_Money}} + \lambda_q^{\text{Alcohol_Consumption}}$$

Table 4: Parameter Estimation of Gamma regression model

Coefficient	Estimate	S.E	P	Reference level
Intercept	0.4763	0.5579	.393	
$\lambda_2^{\text{Religion}}$ (Hindu)	0.0553	0.1322	.676	Buddhism
$\lambda_3^{\text{Religion}}$ (Islam)	0.2458	0.2000	.219	
$\lambda_4^{\text{Religion}}$ (Catholic)	0.3483	0.2106	.098	
$\lambda_5^{\text{Religion}}$ (Other)	-0.8307	0.3503	.018	
$\lambda_2^{\text{Education_Level}}$ (Primary)	-0.8800	0.4492	.050	No school
$\lambda_3^{\text{Education_Level}}$ (Lower secondary)	-1.2671	0.4311	.003	
$\lambda_4^{\text{Education_Level}}$ (Upper secondary)	-1.8812	0.4485	.000	
$\lambda_5^{\text{Education_Level}}$ (Graduate & above)	-3.3055	0.5256	.000	
$\lambda_2^{\text{Husband_Occupation}}$ (Private sector employee)	0.0215	0.1928	.911	Government Employee
$\lambda_3^{\text{Husband_Occupation}}$ (own work)	-0.1973	0.1998	.324	
$\lambda_4^{\text{Husband_Occupation}}$ (Unemployed)	0.8322	0.3516	.018	

$\lambda_2^{\text{Age_Difference}}$ ([1-5] years)	-0.2900	0.2012	.252	No age difference (0)
$\lambda_3^{\text{Age_Difference}}$ ((5-10] years)	-0.7261	0.2174	.001	
$\lambda_4^{\text{Age_Difference}}$ ((10-15] years)	-0.3278	0.2864	.252	
$\lambda_5^{\text{Age_Difference}}$ (>15 years)	-0.1680	0.5808	.772	
$\lambda_2^{\text{Married_Times}}$ (More than once)	0.6790	0.304	.026	Once
$\lambda_2^{\text{Empowerment_Indicator}}$ (Empowerment Indicator=1)	-0.4058	0.2865	.157	Empowerment Indicator=0
$\lambda_3^{\text{Empowerment_Indicator}}$ (Empowerment Indicator=2)	-0.8835	0.2553	.000	
$\lambda_4^{\text{Empowerment_Indicator}}$ (Empowerment Indicator=3)	-0.5046	0.2169	.020	
$\lambda_2^{\text{Enough_Money}}$ (No)	0.3878	0.1436	.007	Yes
$\lambda_3^{\text{Enough_Money}}$ (Don't know)	0.2854	0.1334	.032	
$\lambda_2^{\text{Alcohol_Consumption}}$ (Yes)	0.6397	0.1186	.000	No

It was found that the mean Violence Index for the group of women that followed any other religion except Buddhism, Hindu, Islam, and Catholic decreased by 0.4357 ($e^{-0.8307}$) compared to the group of Buddhists. The mean Violence Index for the group of women that have been educated up to primary level, lower secondary level, and higher secondary level decreased by 0.4148 ($e^{-0.8800}$), 0.2816 ($e^{-1.2671}$), and 0.1524 ($e^{-1.8812}$) respectively compared to the group of no education. When considering the group of graduates & above, the mean Violence Index for that group decreases by 0.0367 ($e^{-3.3055}$) compared to the group of no education. Previous studies by Kohombange (2012), Kargar Jahromi *et al.* (2015), and Muzrif *et al.* (2018) also confirm that low education is more likely to be a victim of violence. The results show that the group of women whose husbands being unemployed is significantly associated with the mean increase of 2.2984 ($e^{0.8322}$) in the Violence Index compared to the group of women whose husbands were government employers. Similarly, Mohamadian *et al.* (2016) found that the risk of partner violence was 5.1 times higher among Iranian women whose husbands were unemployed compared to women whose husbands had a government job. Han *et al.* (2017) also claimed that unemployment of the spouse was significantly associated with the risk of physical abuse of the women from their spouse. Further, the results indicated that age difference belongs to the range of 5 years to 10 years was significantly associated with the mean decrease of 0.4838 ($e^{-0.7261}$) in the Violence Index compared to the group of no age difference. The mean Violence Index for the group of women that have married more than once also increased by 1.9719 ($e^{0.6790}$) compared to the group of women that married once.

The mean Violence Index for the group of women that have participated in making two out of three decisions and all three decisions either alone or jointly with their partners decreased by 0.4133 ($e^{-0.8835}$) and 0.6037 ($e^{-0.5046}$) respectively compared to the group of

no participation in decision making. This is similar to the study done by Agumasie *et al.* (2013) who revealed that the women whose partners made decisions on household issue alone were more likely to expose domestic violence than women that made decisions jointly with partners. Compared to the group of women that have enough money for daily household expenses, the mean Violence Index for the group of women that have no enough money and that have no idea about the amount of money increased by 1.4737 ($e^{0.3878}$) and 1.3303 ($e^{0.2854}$) respectively. This finding goes along with the studies done by Subramaniam & Sivayogan (2001), Abramsky *et al.* (2011), and Kisaka (2019) who stated that the poor socio-economic environment can lead to an increase in the risk of domestic violence against women. In this study, alcohol consumption by any member in the house instead of only the husband was examined, and then, it was found that household alcohol consumption was significantly associated with the mean increases of 1.8959 ($e^{0.6397}$) in the Violence Index compared to no alcohol consumption. Similarly, Abramsky *et al.* (2011) revealed that there was a strong relationship between problematic alcohol use by both husbands and wives and IPV. In many studies, alcohol consumption by husbands was identified as a major factor that causes a positive impact on partner violence behavior against women (Kurupparachchi *et al.*, 2010; Agumasie *et al.*, 2013; Laeheem, 2016).

Feedforward Neural Network

The training data set used in the GR model was randomly divided into two sets as the training set and validation set that present the overall percentage of 70% and 10% respectively. The training set was used to train the network and the validation set was used to validate that network is generalizing and also to stop training before over-fitting. The same testing dataset used in the GR model was used to measure the network performance. Through the number of experiments, the optimum architecture of the FNN was found as in Figure 2.

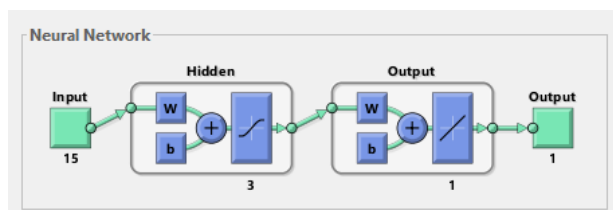


Figure 2: Architecture of optimum FNN

The optimum network was found when having one hidden layer with three neurons. There was one neuron in the output layer which provided the value of the Violence Index. Fifteen inputs used as the predictors in GR analysis were applied to the input layer. After applying the different transfer functions such as tan sigmoid, log sigmoid, and pure linear, the transfer function of the hidden layer was fixed as tan sigmoid, and in the output layer, it was fixed as the pure linear. The FNN was trained by tuning the values of weights and biases of the network to optimize the network performance function which was measured in terms of MSE. The Levenberg Marquardt backpropagation algorithm (trainlm) was found as the best choice of the training function in the maximum epochs of 100. The optimum learning rate was fixed to 0.01 and the optimum combination coefficient was 0.001 with 0.1 as the decreasing factor and 10 as the increasing factor

The best validation performance for the optimum FNN model was 0.7563 and further, it showed that the process of network performance has been improved in the training. As can be seen from Table 5, the values of error performance indicators were considerably small for the FNN model and it illustrated that the FNN model provided a better prediction on the Violence Index.

Model comparison

As shown in Table 5, the values of all performance indicators were smaller for the FNN than the GR model. It indicated that the FNN provided a better prediction on the Violence Index than the GR model. This agrees with the conclusion of the study by Amusa *et al.* (2020) who have shown that compared to the regression model, different neural network models were more preferable to predict the vulnerability of women to IPV. Another study by Babcock & Cooper (2019) stated the same conclusion for prediction on the history of arrest among men who were perpetrators of IPV.

Table 5: Model Testing Performance between GR model and FNN

Performance Indicator	GR	FNN
MSE	0.9447	0.8483
RMSE	0.9720	0.9210
MAE	0.5306	0.4590

IV. CONCLUSION

This study showed that religion, woman's education level, husband's occupation, woman's married time, the age difference between husband and wife, Empowerment Indicator, enough money for daily household expenses, and household alcohol consumption were the associated factors of IPV against women in Sri Lanka. Further, the FNN model provided a better prediction on the Violence Index which describes the level of IPV against ever-married women age 15-49 in the country. This study recommends the development of the current policies and regulations on IPV and enhancing public awareness of associated factors of IPV by implementing programs at the national level.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support extended by the Department of Census and Statistics of Sri Lanka for providing the data necessary for the study, free of charge.

REFERENCES

- [1] Abramsky, T., Watts, C. H., Garcia-Moreno, C., Devries, K., Kiss, L., Ellsberg, M., ... Heise, L. (2011). What factors are associated with recent intimate partner violence? findings from the WHO Multi-country Study on women's Health and Domestic Violence. *BMC Public Health*, 11. <https://doi.org/10.1186/1471-2458-11-109>
- [2] Agumasie Semahegn, Tefera Belachew, & Misra Abdulahi. (2013). 19. BMC domestic violence_2013 MPH 1st. *Reproductive Health*, 10(63), 1-9. <https://doi.org/10.1186/1742-4755-10-63>
- [3] Amusa, L. B., Bengesai, A. V., & Khan, H. T. A. (2020). Predicting the Vulnerability of Women to Intimate Partner Violence in South Africa: Evidence from Tree-based Machine Learning Techniques. *Journal of Interpersonal Violence*, (September). <https://doi.org/10.1177/0886260520960110>
- [4] Asselin, L. M., & Anh, V. T. (2008). Multidimensional poverty and multiple correspondence analysis. *Quantitative Approaches to Multidimensional Poverty Measurement*, 80-103. <https://doi.org/10.1057/9780230582354>
- [5] Babcock, J. C., & Cooper, J. (2019). Testing the utility of the neural network model to predict history of arrest among intimate partner violent men. *Safety*, 5(1). <https://doi.org/10.3390/safety5010002>
- [6] Canuel, M., Abdous, B., Bélanger, D., & Gosselin, P. (2014). Development of composite indices to measure the adoption of pro-environmental behaviours across Canadian provinces. *PLoS ONE*, 9(7). <https://doi.org/10.1371/journal.pone.0101569>
- [7] de Mel, N., Peiris, P., & Gomez, S. (2013). *Broadening Gender: Why Masculinities Matter:*

Attitudes, practices and gender-based violence in four districts in Sri Lanka. 1–35.

[8] Ezzrari, A., & Verme, P. (2013). A multiple correspondence analysis approach to the measurement of multidimensional poverty in Morocco 2001–2007. *Economic Studies in Inequality, Social Exclusion and Well-Being*, 9(June), 181–209.

https://doi.org/10.1007/978-1-4614-5263-8_7

[9] Greenacre, M. (2017). Correspondence analysis in practice, third edition. In *Correspondence Analysis in Practice, Third Edition*.

<https://doi.org/10.1201/9781315369983>

[10] Guruge, S., Jayasuriya-Illesinghe, V., Gunawardena, N., & Perera, J. (2015). Intimate partner violence in Sri Lanka: a scoping review. *The Ceylon Medical Journal*, 60(4), 133–138.

<https://doi.org/10.4038/cmj.v60i4.8100>

[11] Hall, M., Chappell, L. C., Parnell, B. L., Seed, P. T., & Bewley, S. (2014). Associations between Intimate Partner Violence and Termination of Pregnancy: A Systematic Review and Meta-Analysis. *PLoS Medicine*, 11(1).

<https://doi.org/10.1371/journal.pmed.1001581>

[12] Han Almis, B., Koyuncu Kutuk, E., Gumustas, F., & Celik, M. (2017). Risk Factors for Domestic Violence in Women and Predictors of Development of Mental Disorders in These Women. *Noro Psikiyatri Arsivi*, 67–72.

<https://doi.org/10.5152/npa.2017.19355>

[13] Jayasuriya, V., Wijewardena, K., & Axemo, P. (2011). Intimate partner violence against women in the capital province of Sri Lanka: Prevalence, risk factors, and help seeking. *Violence Against Women*, 17(8), 1086–1102. <https://doi.org/10.1177/1077801211417151>

[14] Kargar Jahromi, M., Jamali, S., Rahmanian Koshkaki, A., & Javadpour, S. (2015). Prevalence and Risk Factors of Domestic Violence Against Women by Their Husbands in Iran. *Global Journal of Health Science*, 8(5), 175–183.

<https://doi.org/10.5539/gjhs.v8n5p175>

[15] Kisaka Ngimbi, J. J. (2019). Psychosocial Factors Associated with Domestic Violence Inflicted on Women by their Husbands at Kenge, Kwango Province, DRC. *Biomedical Journal of Scientific & Technical Research*, 18(2).

<https://doi.org/10.26717/bjstr.2019.18.003130>

[16] Kohn, J. L. (2012). What is health? A multiple correspondence health index. *Eastern Economic Journal*, 38(2), 223–250.

<https://doi.org/10.1057/ej.2011.5>

[17] Kohombange, C. (2012). Intimate partner violence: the silent burden in Sri Lankan women. *Injury Prevention*, 18(Suppl 1), A183.2-A183.

<https://doi.org/10.1136/injuryprev-2012-040590q.18>

[18] Kurupparachchi, K., Wijeratne, L., Weerasinghe, G., Peris, M., & Williams, S. (2010). A study of intimate partner violence among females attending a Teaching Hospital out-patient department. *Sri Lanka Journal of*

Psychiatry, 1(2), 60.

<https://doi.org/10.4038/sljpsyc.v1i2.2577>

[19] Laeheem, K. (2016). Factors affecting domestic violence risk behaviors among Thai Muslim married couples in Satun province. *Kasetsart Journal of Social Sciences*, 37(3), 182–189.

<https://doi.org/10.1016/j.kjss.2016.08.008>

[20] Mohamadian, F., Hashemian, A., Bagheri, M., & Direkvand-Moghadam, A. (2016). Prevalence and risk factors of domestic violence against Iranian women: A cross-sectional study. *Korean Journal of Family Medicine*, 37(4), 253–258.

<https://doi.org/10.4082/kjfm.2016.37.4.253>

[21] Muzrif, M. M., Perera, D., Wijewardena, K., Schei, B., & Swahnberg, K. (2018). Domestic violence: A cross-sectional study among pregnant women in different regions of Sri Lanka. *BMJ Open*, 8(2), 1–8.

<https://doi.org/10.1136/bmjopen-2017-017745>

[22] Rahayu, A., Purhadi, Sutikno, & Prastyo, D. D. (2020). Multivariate gamma regression: Parameter estimation, hypothesis testing, and its application. *Symmetry*, 12(5).

<https://doi.org/10.3390/SYM12050813>

[23] Subramaniam, P., & Sivayogan, S. (2001). The prevalence and pattern of wife beating in the Trincomalee district in eastern Sri Lanka. *Southeast Asian Journal of Tropical Medicine and Public Health*, 32(1), 186–195.

[24] United Nations. (2007). *Indicators to measure violence against women: report of the Expert Group Meeting*. (October).

[25] Vadysinghe, A. N., Rathnayake, R. M. I. S. D., Premaratne, B. G., & Wickramasinghe, W. M. M. H. P. (2017). A preliminary study of domestic violence in a rural community in Central province, Sri Lanka. *Sri Lanka Journal of Forensic Medicine, Science & Law*, 7(1), 13.

<https://doi.org/10.4038/sljfmsl.v7i1.7770>

[26] Williford, E., Haley, V., McNutt, L. A., & Lazariu, V. (2020). Dealing with highly skewed hospital length of stay distributions: The use of Gamma mixture models to study delivery hospitalizations. *PLoS ONE*, 15(4), 1–12. <https://doi.org/10.1371/journal.pone.0231825>