INTIMATE PARTNER VIOLENCE - A STATISTICAL MEASURE

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Abstract. *One of the most common forms of violence against women is that performed by a husband or an intimate male partner. Although women can be violent in relationships with men, and violence is also found in same-sex partnerships, the overwhelming health burden of partner violence is borne by women at the hands of men. This kind of violence is known as Intimate Partner Violence. In this paper, an attempt has been made to propose a measure for ascertaining the intensity of IPV by using Mahalanobis Distance. Also in this paper, a simulation study has been done to get an idea about the IPV situation. In this paper, we get an idea about IPV situation in India as well as Bolivia. We are trying to make a comparison about the IPV situation in those two countries.*

Keywords: *IPV, Mahalanobis Distance, Simulation, NFHS-3, DHS.*

1. INTRODUCTION

One of the most common forms of violence against women, which is ruthless as well as very much under-reported is that performed by a husband or an intimate male partner. Women can also be violent in relationships with men. Violence is also found in same-sex partnerships. The overwhelming health burden of partner violence is borne by women at the hands of men. This type of violence is known as Intimate Partner Violence (IPV). IPV are of three types, (i) Physical violence (ii) Sexual violence and (iii) Emotional violence.

(a) Physical Violence: In this type of violence, intimate partner intentionally harms their associate physically. They do it in many ways like-beating, pushing, slapping, use of a weapon, etc. This violence has the potential for causing death and permanent disability of the victims.

(b) **Sexual Violence**: In the case of sexual violence, partner uses of physical force on their partner. To engage in a sexual act against associate's will. As a result, there is a lot of cases in which the victim is infected by HIV and many sex-oriented critical problems. Also for this unwanted sexual life women suffer from premature pregnancy, which has a dangerous effect on their health.

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(c) Emotional Violence: In emotional violence, intimate partner is emotionally agonized by their associates. In this case, intimate partners always humiliate their associate. The associate's behaviour with their partners is very shameful. Associates engage in some activities so that their partner feel ashamed and being humiliated in front of others. But it is not only limited to these things. The partner also controlled what the victim can and cannot do. Victims are also isolated from their family and friends. In this case, partners want to have full control over their associates without giving them any choices about anything.

Actually, in the case of IPV, both men and women suffer from unbearable physical and mental pain. But obviously, IPV is more troublesome for women than men. Though nowadays women protest against this, the number of this kind of women is very few. How IPV affects victim's life we describe in the above. But there is another group of suffers, and they are the children. They suffer extremely unjustly. They face many long-term health and mental issues. These types of violence can bring some social problems too.

One of the most influential causes of IPV is child marriage. Godha Deepali et al (2012) apply regression analysis to detect if there is any observed associations present between child marriage and IPV. Female Genital Mutilation or FGM is one of the cruelest types of violence. Salihu HM et al (2012) were used Wald Chi-square tests of independence to compare differences in socio-demographic characteristics between the FGM and non-FGM groups. Palermo Tia et al (2013) has worked on Gender-Based Violence (GBV). GBV is performed by an intimate partner. Actually, gender-based violence (GBV) is widespread globally and has myriad adverse health effects but is vastly underreported. They had performed regressions analysis for examining characteristics associated with reporting to formal sources. Tumwesigye Mbona Nazarius et al (2012) used regression to show that alcohol drinking problem among sexual partners was the main reason for Physical Intimate Partner Violence (PIPV). It is known for women's reports that their partner got drunk sometimes or often and served as the main factor of PIPV. Uthman A Olalekan et al (2009) worked to find out the factors associated with attitudes towards IPV against women in sub Sharahan African countries. Since they thought the rate of IPV is very high there. Researchers used Pearson's chi-squared test for analyzing contingency tables. They performed random-effects estimates models to incorporate between-country heterogeneity. Country heterogeneity was assessed by using the Cochran Q test and the I^2 statistic. (I^2 statistics: The I^2 statistic explains the percentage of disparity across studies that is due to heterogeneity rather than chance (Higgins and Thompson, 2002; Higgins et al., 2003) $I^2 = \frac{100\%(Q-df)}{Q}$. I^2 is an innate and uncomplicated expression of the discrepancy of studies results.)

In the literature of the work on IPV is mainly based on cause and effect analysis. That means on those papers researchers were intended to find out the causes of IPV and the effects of that. Previously researchers found causes like child marriage, alcohol drinking, low educational level, etc. After identifying those causes they illustrated the effects of IPV. The survey questions are treated as IPV indicator. For an example, if the respondents are asked n number of questions then these n questions are treated as IPV indicator.

These questions may not be the same for all countries, but they follow a pattern. These questions are more or less the same type, like (1) "If your partner emotionally hurt, torture or do something to insult you in front of others", (2) "If your partner physically hurt you", (3) "If your partner physically forces you to do some sexual act with him or her or others". The number of questions may be varied for different countries on the basis of their socio-economic structure. The questions have several options or categories as the form of their answers. Those categories are generally "Yes", "No", "Some time" and many more. Some questions may have only two categories i.e. "Yes" and "No". (this type of case is called dichotomous case).

The respondents have to choose any category of all the other categories from each question which describe their situation best. On the basis of those answers, we are able to judge the presence of IPV.

Let us now examine the number of questions regarding IPV which can cover up all types of violence.

First, the questions related to IPV have been framed. These questions have been asked to sampled respondents. On the basis of their answers, we can get an idea about the IPV. In this procedure, the questions have been asked to a group of people. Among all the respondents who choose the category "yes" to any question, they considered as a victim of IPV. Many of those people choose the category "No" i.e. they try to say that IPV does not occur with them. In this way, we can identify the presence of IPV. But during the identication procedure, another problem has been arising. The problem is given below.

Suppose we have five questions and each question has four categories. We decided that if any respondent select category "Yes" for any question then the respondent is a victim of IPV. Now if we asked the same five questions to four different people, then we have faced a problem. We try to give some light on this problem through Table 1. In this table "A", "B","C","D" the respondents and 1, 2, 3, 4 are the questions. In Table 1 we can see that respondent "A" chooses the category "Yes" for the first question. So according to our assumption respondent, "A" is a victim of IPV. Now on proceeding this process, we can see from this table that A give total four "Yes", B gives just one "Yes", C gives three "Yes" and two "No", and D gives three "No" and two "yes". Here the arising of a category "yes" for any question represents the presence of IPV. That means more times the

occurrence of "yes" reflects more intensity of IPV. In all of these cases, the respondents suffer from IPV because every case contains at least one "yes". In this situation the respondent who chooses the category "yes" more then one time, obviously for them IPV is more bothersome on comparison to the others. They are dissimilar on the basis of the intensity of the IPV.

Suppose someone chooses the category "Yes" for just one question and someone choose more than one questions. Here from the mentioned example, the presence of IPV is confirmed but we can not have any idea about the intensity of IPV.

Here we try to measure the intensity of IPV so that we would know the situation in which IPV is severe. We want to measure the intensity of IPV through the mentioned questions. These questions are the quantier of IPV. As they quantify the presence of IPV.

Suppose some respondent faced this type of violence at an earlier period not in the current time. When those questions were asked to the widow women, they admit that IPV occurred with them when their partners alive. Since now their partner passed away so violence does not occur with them. They may consider their recent time and choose the category "No". But this is not right. We should consider the IPV situation in past as well as in current time.

For this reason in our study category "Yes" is broken into four categories. The categories may be "Often during last 12 months", "Some times during last 12 months", "Not in last 12 months", "Yes but currently a widow". These categories treated as nominal and they are mutually exclusive. Actually, we want to find out the intensity of IPV with respect to the questions not over the responses. It means that out of n questions how many times respondents choose the categories except "No". It is not important that which category is chosen by the respondent except "No". So we need a measure which can describe the intensity of IPV properly.

Tab. 1: Responses

Question	*A*	*B*	*C*	*D*
1	Y	Y	Y	Y
2	Y	N	Y	Y
3	Y	N	Y	N
4	Y	N	N	N
5	N	N	N	N

2. PROPOSED MEASURE OF IPV

In this study, we have proposed a measure based on the Mahalanobis distance (1936) which can measure the intensity or the amount of the IPV of a region or a community. It is necessary to measure the intensity of IPV of a community with

comparison with a hypothetical situation. Here hypothetical situation means no women suffer from IPV in that region. It means that all women choose the category "No" for all questions related to IPV. We try to compare the intensity of IPV of a community with respect to a hypothetical situation by a difference not ratio nor absolute concept. In our study, we assume that a woman will be asked n questions related to IPV. Each question has k mutually exclusive categories of answer or responses. These categories are nominal.

Let, X_i = The number of occurrence of the ith category or response out of n questions of a single respondent at real life situation, where $\forall i = 1(1)k = 1, 2, 3,\ldots,$ (k-1), k.

$\mathbf{X} = (\mathbf{X}_1, \mathbf{X}_2, \ldots, \mathbf{X}_k)/\sim$ Multinomial $(n, p_1, p_2, \ldots, p_k)$.

$\sum_{i=1}^{k} p_i = 1$, where p_i be the probability of occurrence category "i".

Y_i = The number of occurrence of the ith category out of n questions of a single victim at hypothetical situation.

Here, $Y_1 = n$, $Y_i = 0$; $\forall i = 2(1)k = 2, 3, 4, \ldots, $ (k-1), k.

Here, Y_1 denotes the number of occurrence of the first category out of n questions of a single victim at a hypothetical situation. So Y is treated as fixed. Here Y_1 becomes n i.e. the total number of questions. Since the option "No" is in the first position so Y_1 becomes n if any respondent chooses a first category (i.e. they admit that IPV has not occurred with them). If the category "No" is second or third or any other position then Y_1 becomes Y_2 or Y_3 or whatever the position of "No" is.

Then Y_2 or Y_3 be the hypothetical situation and it becomes n.

Our proposed measure is

$$\mathbf{D} = (\mu_1 - \mu_2)^t \, \Sigma^{-1} (\mu_1 - \mu_2) \tag{1}$$

where, $\mu_1 = E(\mathbf{X}) = (np_1, np_2, \ldots, np_{k-1})/$ = Mean of the respondent group at real life situation.

$\mu_2 = E(\mathbf{Y}) = (n, 0, \ldots, 0)/$ = Mean of the respondent group at hypothetical situation. and $\Sigma^{(k-1)\times(k-1)}$ = Variance and covariance matrix of $\mathbf{X}^{(k-1)}$

$$\begin{bmatrix} np_1(1-p_1) & \cdots & -np_1 p_{k-1} \\ \cdots & \ddots & \vdots \\ -np_{k-1}p_1 & \cdots & np_{k-1}(1-p_{k-1}) \end{bmatrix}$$

Here Σ is a variance covariance matrix. So it could never be singular. We have

here k categories. With out loss of generality we can express one category as the function of others categories. So it takes order up to (k-1). We have used the maximum likelihood estimator (mle) of μ_1, and Σ. The mle of p_i is given below:

$\hat{p}_i = \frac{\bar{x}_i}{n}$, where $\quad \bar{x}_i = \frac{1}{N}\sum_{i=1}^{k} x_i$, where N is the total number of respondents.

So, $\hat{\mu}_1 = \left(n\hat{p}_1, n\hat{p}_2, \ldots, n\hat{p}_{k-1}\right)$, $\hat{\mu}_2 = \left(n, 0, \ldots, 0\right)$

and $\hat{\Sigma} = \begin{bmatrix} n\hat{p}_1\left(1-\hat{p}_1\right) & \cdots & -n\hat{p}_1\hat{p}_{k-1} \\ \cdots & \ddots & \vdots \\ -n\hat{p}_{k-1}\hat{p}_1 & \cdots & n\hat{p}_{k-1}\left(1-n\hat{p}_{k-1}\right) \end{bmatrix}$

$$\hat{D} = \left(\hat{\mu}_1 - \hat{\mu}_2\right)^t \hat{\Sigma}^{-1}\left(\hat{\mu}_1 - \hat{\mu}_2\right). \tag{2}$$

Through Mahalanobis distance, we want to measure the mean distance of all categories for all questions in a region with respect to the hypothetical situation of that region. So we are able to get a clear picture about the intensity or the strength of IPV. From the Mahalanobis distance measure through the number of occurrences of different categories out of all questions we have our desired intensity of IPV. The proposed measure has been used as the measure of the intensity of IPV. As the value of this measure for a region increases, we can say that IPV also increases in that region. If the value is zero, then there is no case of IPV i.e. same as a hypothetical situation. But $\hat{D} \geq 0$, so from a single value of $\hat{D}$ we can not get any exact conclusion. But if we are going to compare two or more communities, then for which the value of $\hat{D}$ is more, the IPV situation for that community is worse than the others.

3. SIMULATION STUDY

It is difficult to find any standard theoretical distribution of the above proposed measure **D**. So we have studied the simulated distribution of the above measure.

At first we generate the values of p_i from Uniform Distribution (0,1) for $i = 1(1)(k\ 1)$, s.t. $\sum_{i=1}^{k-1} P_i \leq 1$ for given k. We get p_k from $p_k = 1 - \sum_{i=1}^{k-1} P_i$. After getting p_is we get the value of **D** for given n from equation 2. We have repeated this process 400000 times and get the simulated values of **D**.

We get the frequency diagram (Fig.1) of **D** for different choices of *n* and *k*. We noticed that if p_1 is increased then the value of **D** is decreased. That means the intensity of IPV is less if much more response chooses the first category i.e "No"

category. That is quite expected. After finding the values of **D** by changing n as well as *k* we have computed the mean of **D** for each case. From the Table 2, we can say that if we increase the categories number with increasing of the number of questions, then mean of **D** is increasing. One should choose *n* and *k* as a manner that the picture of IPV of a region or a community can be reflected properly. Before starting a study, *n* and *k* should be chosen optimally. This simulation study shows that one should choose *n* and *k* properly.

But we cannot increase the values of n and k innitely. Because n represents the number of questions and *k* represent the number of categories of those questions. So obviously both of them cannot be a large number. We can compare the IPV situation of two communities of the survey be conducted on these two communities on the same questions and the same responses.
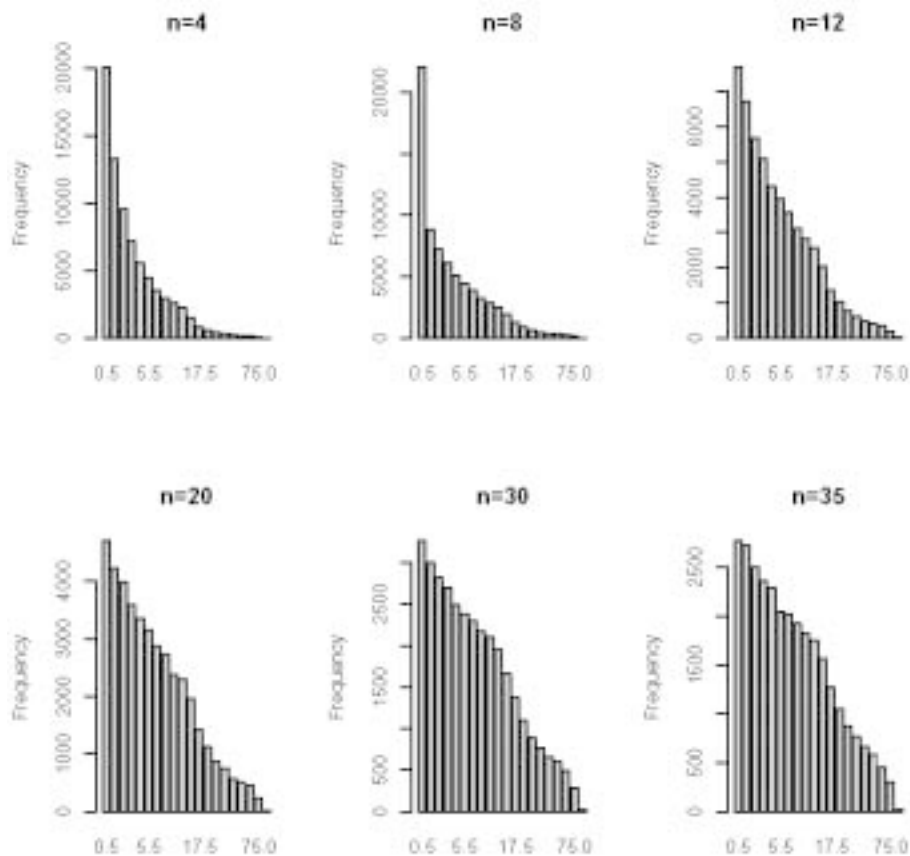

Fig. 1: Frequency diagram of D

The above graphs shows us when we take the number of trails are four (n=4) and categories are five (k=5) then we have a positively skewed distribution. As we increases the value of n then it will remain a positively skewed distribution. Though the right tail is not as long as the first. This implies that the data will be more cluster if we increase the number of questions. When the number of questions was increased the respondents have more exibility for answering those questions. If we asked those respondents very few questions then sometimes we may not get exactly the true answer. But if we break the same questions in different types or forms then they may easily record their answers. In this way, we have our value of D.

Tab. 2: Table of mean of D for different choices of n and k

| Values of k | Values of n | | | | | |
	4	8	12	20	30	35
2	43.7119	87.4239	182.2713	513.9542	350.9833	492.4414
3	142.0615	284.1231	355.8488	724.6760	969.6808	898.5469
4	157.6500	315.300	472.9501	788.2501	$1.1824e^{+003}$	$1.3794e^{+003}$
5	219.8617	439.7234	659.5851	$1.0993e^{+003}$	$1.6490e^{+003}$	$1.9238e^{+003}$
6	248.4947	496.9894	853.6815	$1.8399e^{+003}$	$2.2732e^{+003}$	$2.7236e^{+003}$
7	443.7530	662.0639	924.6415	$1.3985e^{+003}$	$1.9768e^{+003}$	$2.5455e^{+003}$

4. DATA ANALYSIS

We have studied the intensity of IPV situation through a proposed measure for two regions. We have found the value of $\hat{\mathbf{D}}$ for four states separately for India and Bolivia.

DHS (Demographic and Health surveys) collect the data of IPV on regular basis over worldwide. For our study, we use women dataset from NFHS-3 (National Family Health Survey-3) for India and DHS dataset for Bolivia. NFHS is a part of DHS for India.

4.1 INDIA

For India, we take eight questions (explained in the introduction and proposed a measure of IPV sections) from NFHS-3 data set. (**data source: WWW.DHS program.com**).

Those questions are as follows:
(a) Spouse ever threatened her with harm, (b) Spouse ever pushed shook or throw something, (c) Spouse ever slapped, (d) Spouse ever punched with fist or something harmful, (e) Spouse ever kicked or dragged, (f) Spouse ever tried to strangle or burn, (g) Spouse ever threatened or attacked with a knife or other weapons, (h) Spouse

ever twisted her arm or pull her hair. We take these eight questions because of these questions covered all the three types of violence mentioned before.

In this case, the corresponding values of n, N, k (which are clearly explained in the introduction and proposed measure of IPV sections)are as follows

n = 8, N = 69388 (data size), k= 5

These eight questions andve categories of each question are same for all the states in India as well as India its self. But obviously the number of respondents (which is N) is different. We want to measure the intensity or amount of IPV of a region with respect to no IPV of that region. All of them contains exactly these five categories.

These categories are mentioned below.

0 = No (No violence), 1 = Often during last 12 months, 2 = Some times during last 12 months, 3 = Not in last 12 months, 4 = Yes but currently a widow.

In this work category "0" denotes no violence. We can use any digit for denoting these categories. These categories are not ordinal, they are nominal. The category "4" implies that violence is happened with a victim (widow) by her partner when he alive. We have considered them as a victim because IPV has occurred with her in her lifetime. If this category is not included in the list of categories then there is a chance that the widows may be excluded from the interview by the interviewers.

$$\hat{\mu}_{In} = \begin{bmatrix} -0.91 \\ 0.08 \\ 0.40 \\ 0.30 \end{bmatrix} \text{and } \hat{\Sigma}_{In} = \begin{bmatrix} 0.78 & -0.08 & -0.34 & -.26 \\ -0.08 & 0.09 & -0.00 & -0.00 \\ -0.34 & -0.00 & 0.36 & -0.01 \\ -0.26 & -0.00 & -0.01 & 0.27 \end{bmatrix}.$$

$$\hat{D}_{In} = \left(\hat{\mu}_{In} - \hat{\mu}_{2} \right) / \hat{\Sigma}^{-1} \left(\hat{\mu}_{In} - \hat{\mu}_{2} \right) = 1.06$$

The value of D for India as well as for some states are shown below through a table.

Tab. 3: The estimated values of Measure D

State	$\hat{D}$
India	1.06
Delhi	0.4752
Haryana	0.8968
Bihar	2.00
West Bengal	1.00

4.2 SITUATION IN ANOTHER COUNTRY

For another choice we consider a South American country "Bolivia". We used Bolivian couple data 2008 from DHS data. (data source: https://dhsprogram.com/Data/) The five questions which were asked to the respondents are:
(a) Partner pushed or pinched respondent,(b) Partner beat or kicked respondent, (c) Partner beat her with an object, (d) Partner tried to strangle or burn her, (e) Partner tried to force sex with her.

And the five categories are:
1. No, 2. Yes often, 3. Yes: a few times, 4. Yes one time, 5. Dont know.
n= 5, k= 5, N= 2714 (data size).

Now after calculating required estimated mean and variance covariance matrix, we get

$$\hat{\mu}_{Bol} = \begin{bmatrix} -0.55 \\ 0.06 \\ 0.30 \\ 0.10 \end{bmatrix} \text{ and } \hat{\Sigma}_{Bol} = \begin{bmatrix} 0.48 & -0.06 & -0.27 & -0.09 \\ -0.06 & 0.07 & -0.00 & -0.00 \\ -0.27 & -0.00 & 0.28 & -0.00 \\ -0.09 & -0.00 & -0.00 & 0.29 \end{bmatrix}.$$

$$\hat{D}_{Bol} = \left(\hat{\mu}_{Bol} - \hat{\mu}_2 \right) / \hat{\Sigma}^{-1} \left(\hat{\mu}_{Bol} - \hat{\mu}_2 \right) = 0.6367 \, .$$

We get the values of $\hat{D}$ for India as well as Bolivia which are 1.06 and 0.6367.

For this result, we can conclude that IPV situation of India is worse than Bolivia as ^D is greater in India then Bolivia. We were also comparing four states of India.

From those values, we can see that the value of $\hat{D}$ for Bihar is more than the other three states. So after comparing the values of $\hat{D}$ we can say IPV situation is in a anxiety stage in Bihar than in Delhi.

After finding these results we can repeat the same procedure for finding the IPV situation in all other states in India. By doing this we can have the IPV situation of all the states separately.

5. CONCLUSION

In this paper, the number of questions is different for the countries (For India it is eight and for Bolivia, it is five). But the number of categories are same which is five. Though the identication numbers are different for those categories. But for both the countries those questions covered all types of Intimate partner violence. For the

comparison purpose, the number of questions is not important. It is important that those questions which we take for identifying IPV should cover the above-mentioned types of violence. That means those questions should represent all types of Intimate Partner Violence. For this reason, though the number of questions is different we can compare between those two countries.

This work can be extended for an finding of all individual states in India and also for other countries.

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