Abstract

Background: Crime against women is a global phenomenon.

Aims: To estimate and forecast cognizable crime against women in New Delhi, India, from the year 2016 to 2020.

Methods: Reported cognizable crime against women in New Delhi for the period 2009 to 2015 was extracted for statistical analysis, synthesis and modeling. The cognizable crime reported against women are rape, attempt to commit rape, kidnapping and abduction of women, dowry deaths, assault on women with intent to outrage her modesty, insult to modesty of women, cruelty by husband or his relative, importation of girls from foreign countries, abetment of suicide of women, indecent representation of women.

Results: Available data indicated that actual number of registered cases of crime against women ranged from 4251 (2009), to 17 104 (2015). The number of projected cases ranged between 18 991 (95% CI: 13 092–24 889) in 2016 to 28 663 (95% CI: 22 314–35 013) in 2020. Rising trend of crime against women was noticed and rate of crime against women ranged between 204.6 (2016) to 308.8 (2020) per 100 000 women population in New Delhi. Furthermore, it was noticed that after witnessing a substantive increase (116.2%) in reported crime against women in New Delhi in 2013, the subsequent actual and projected rise appears to be incremental in nature with annual percentage point change ranging between 9% to 18%.
Conclusion: Within limitations, it is concluded that the safety of women would be a concern in the near future.

Keywords: crime, women empowerment, gender training, police, time-series.

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Introduction

Gender-based violence is defined as any act that results in, or is likely to result in, physical, sexual, economic or psychological harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life (1). Women across the world (North American region (7–32%); Latin America and Caribbean (14–38%); Europe (13–46%); Africa (6–64%); Asia (6–67%); and Oceania (17–68%) regardless of socio-economic strata are subjected to some form of violence (2).

One in three women has experienced physical/sexual violence at some point in her life. In a WHO multi-country study, 23–56% of women reported experiencing physical or sexual violence from their partner (3). In most countries less than 40% of women who experienced violence sought help of any sort. In addition, studies have revealed that mental health and psychosomatic conditions reported among survivors of violence (especially among refugees) could also be a risk factor for poor reproductive health outcomes (4–8). The prevalence of female genital mutilation/cutting ranged between 1% (Uganda) to 98% (Somalia) including 74% in Ethiopia, 66% in Liberia, 44% in Chad, 26% in Senegal and 15% in Tanzania (9). However, recent evidence suggests a decreasing trend across countries with high rates and a target for elimination of this practice by 2030 (10).
Women can face extreme discrimination due to a historical orthodox discriminatory mindset in society. The lower status of women increases and perpetuates gender-based violence including female feticide, infanticide, gender discrimination (healthcare, nutrition, schooling, higher education, dress code, mobile phones, and movement restriction), early marriage, trafficking, rape, assault, insult to modesty, indecent representation of women, honor killing etc. (11–13). These types of gender-based violence that are directed specifically against women are characterized as ‘crimes against women’.

The constitution of India provides equal rights to its citizens irrespective of cast, colour, creed, religion, socio-economic status and gender. Various policies, legislation, interventions, schemes and welfare measures have been formulated specifically for the protection and safety of vulnerable population including women. Empowered women to live with dignity and contribute as equal partners in an environment free of violence and discrimination is of paramount importance for quality of life as well as economic development of society.

Evaluation of past data can help to predict future rates, patterns, types, locations and/or times of crime. Therefore, a time-series analysis was undertaken to determine and forecast cognizable crime against women in New Delhi, India, for the period 2016–2020 using National Crime Record Bureau (NCRB) statistical data for the period 2009–2015. This information may specifically help policy-makers, administrative and law enforcement agencies in terms of better preparedness for prevention of crime against women.

**Methods**

**Time-series analysis**

A time-series analysis correlates a series of observations collected at regular time intervals (14,15). Typically, a time series comprises four components (variations) and traditionally three approaches (models) for forecasting future values (16). These variations are: 1) trend variation (long-term change in the mean); 2) seasonal variation (patterns that occur in a fixed and known period e.g., quarter of a year, month etc.); 3) cyclic changes (pattern that exists when the data exhibit rise and fall that are not of a fixed or known period); and 4) irregular component (any fluctuations that are observed excluding the above mentioned variations from a time series). The statistical models used for predicting future events include regression based methods, exponential smoothing methods, and autoregressive integrated moving average (ARIMA) models (17).

**Data source**

Each year the government of India publishes statistical data on crime. The data for the current study were drawn from the National Crime Report Bureau (NCRB) (18). The cognizable crime
as defined under the Indian penal court or local laws and registered by police stations is reflected in the annual report. The cognizable crimes against women are primarily: rape, attempted rape, kidnapping and abduction, dowry deaths, assault with intent to defile her modesty, insult to modesty, cruelty by husband or relative, importation of girls from foreign countries, abetment of suicide, dowry, indecent representation of women, commission of sati, domestic violence and immoral traffic.

Cognizable crime data registered against women in New Delhi for the period 2009–2015 were extracted for statistical analysis, modeling and prediction using SPSS (IBM, Chicago, United States of America) software (version 16) (Table 1). Additional information was derived from the annual report 2015 to determine pattern of cognizable crime committed against women in New Delhi in comparison to India as a whole in order to provide a comprehensive scenario.

Statistical analysis and modelling

The following steps were undertaken during modeling and forecast analysis (15,19):

1. Time-series analysis was applied to determine presence of basic features such as trends, seasonal behaviour or both.

2. Presences of any trend or seasonal components were eliminated either by differencing or by fitting appropriate models to the data. In our data set, only trend was present and was eliminated by using software command (Holt and auto ARIMA).

3. Assessment of stationarity of data series was also checked. The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots were used to determine the stationarity of the data and order of the model (Figure 1).

4. In order to develop a forecasting model for the residuals, several models were chosen that could be representative for the available data. The optimal estimates for the coefficient of the chosen models were obtained at the identification stage. We used 20% of dataset for ‘training’ to find the parameters of the models, i.e., Holt Linear Model (H-L) and ARIMA (20).
5. In order to validate the performance of the models from the previous step, we used the remaining 80% data set for ‘testing’.

6. A statistical tool Lung-Box ‘Q’ statistic was used to determine independence of data series. The test statistics ‘Q’ is represented as:

\[
Q_m = n(n+2) \sum_{k=1}^{m} \left( \frac{r^2(e)}{n-k} \right) - \chi^2_m \]

where:

- \( r^2(e) \) = the residual correlation at lag \( k \).
- \( m \) = the number of times lags includes in the test,
- \( n \) = the number of residuals

7. Forecast accuracy of the models was measured using mean absolute error (MAE), root mean square error (RMSE), mean absolute percentage error (MAPE), and Bayesian Information Criterion (BIC).

8. The best model was selected on the basis of forecast accuracy measures obtained in the previous step and was used to predict future values of cognizable crime against women.

Holt’s linear and ARIMA model were found appropriate for study dataset and the best model was chosen based on the accuracy measures (21–24). Table 2 shows different model accuracy parameters. It was deduced that Holt’s linear model was the best model for forecasting as it had the highest value of R2, suggesting that it explained 85% variability along
with lower values of accuracy measures (RMSE, MAPE, MAE, BIC). Ljung Box test indicated that the model was found statistically correct (P = 0.257 for Holt’s linear model). There were no statistically significant differences between actual and predicted values by model.

**Results**

Available data indicated that actual number of registered cases of crime against women ranged from 4251 (2009) to 17 104 (2015). The number of projected cases ranged between 18 991 (95% CI: 13 092–24 889) in 2016 to 28 663 (95% CI: 22 314–35 013) in 2020. Rising trend of crime against women was noticed and rate of crime against women ranged between 204.6 (2016) to 308.8 (2020) per 100 000 women in New Delhi. Table 3 and Figure 2 depict observed, fitted and forecasted values along with 95% confidence interval.

It was observed that the proportion of women population in New Delhi in comparison to India was 1.5% while crime against women was slightly higher at 5.2% (Table 4). With regard to pattern of crime against women it was noticed that cases registered under section ‘outrage and insult to modesty’ to women was higher in New Delhi (40.4%) in comparison to the country as a whole (27.8%). Furthermore, cruelty by husband and relatives in wedlock was lower in New Delhi (20.5%) in comparison to the country (34.6%) (Figure 3). Similarly, kidnapping and abduction cases registered were also higher in New Delhi (25.0%) in comparison to the country (18.1%). On the contrary, the results also reflect on a positive note, increase female assertive behaviour, gender sensitivity and accountability of system.

**Discussion**

A time-series analysis was undertaken to determine and forecast crime against women in New Delhi, as defined under Indian legislation, for the period 2016–2020. From the given dataset it was noticed that there was a 40% increase in reported cases of crime against women in New Delhi from 2009 to 2012 while the rise was 33% from 2013 to 2015. Furthermore, it was deduced from the study that if the current situation remains unchanged there will be a 25% increase in crime against women.

The results of the study needs to be considered in view of a number of limitations: firstly, the rate of increment of crime against women should be the same with some fluctuation in the future as compared to current levels; secondly, the social makeup should be considered as the present scenario, and finally distribution of crime has a variation with respect to age but the study includes total crime against women irrespective of age.
India, the second most populated country and largest democracy in the world is undergoing an epidemiological, demographical, cultural, social, nutritional and economic transition and witnessing the double burden of disease (communicable and noncommunicable) with widespread ramifications for mortality. In recent years, societal awareness, system of accountability and enforcement of existing legislation have improved in country following the brutal gang rape and death of a victim in Delhi in the year 2012. This was considered to be a water-shed year, which attracted global media attention, discussion, debate, protest and candle-lit marches in the streets of the capital, which resulted in an enhanced political commitment and announcement of additional women safety measures. Following this event, a sudden rise in reporting of crime against women was noticed (116.2%) in New Delhi during 2013. The subsequent actual and projected rise appears to be incremental in nature with an annual percentage point change varying between 9% and 18%. The prevailing high crime rate in Delhi is suggestive of either that such cases were not registered by the police in the past, or women have become more assertive and/or the scope of cognizable crime against women has also broadened under various legislative sections and local laws and/or sensitivity has increased since women personnel have been inducted in police force.

The national capital region constitutes a mix of urban, slum and urbanized rural population of 20 million residing in 11 revenue districts, with an 86% literacy rate along with one of the highest per capita income rates in India, but with a skewed sex ratio (number of females per 1000 males) of 868 compared with 940 for the whole country (2011 Census). The cosmopolitan environment constitutes diverse economic, cultural, dietary, language and religious practices. The porous boundaries of planned and unplanned urban development of the region is expanding and encroaching on neighbouring states. Such increasing urbanization, material aspirations and migration are leading to challenging pressures on space, basic utility services, increased pollution and mushrooming of slum clusters. Meanwhile, there is also increasing access to internet, social media, mobile phones and other tools of technology with concomitant misuse leading to increase impersonation, defamation and public insult of women. Furthermore, the proportion of cases registered as ‘cruelty by husband and relatives’ was 20.5%, which appears to correlate with a slightly higher population-based prevalence of spousal violence (26.8%) experienced by women in New Delhi (25).

In neighbouring Pakistan spousal abuse is also considered to be widespread (26). The World Economic Forum’s Global Gender Gap report revealed that Pakistan is the second lowest performing country globally in terms of gender equality. Tazeen et al. found that almost all forms of spousal abuse (81.8%, psychological; 56.3%, physical and 53.4% of sexual abuse) have been prevalent in urban areas of Karachi (27). In Saudi Arabia, spousal physical violence was reported by 45.5% of women (28). It is pertinent to mention that the South-East Asia Region has one of the highest (37.7%) prevalence rates of partner violence globally in comparison to the Eastern Mediterranean Region (37.0%), African Region (36.6%), the Americas Region (29.8%),
European Region (25.4%) and Western Pacific Region (24.6%) (5).

**Conclusion**

From the current study it is deduced that safety of women would remain a concern and require a multi-pronged preventive strategy. A comprehensive approach (individual, family, community and societal) including efforts to improve women’s access to resources (e.g., credit, training, inheritance and land rights), hostels for working women and access to them (e.g., through anti-discrimination and gender-based violence legislation, gender-aware justice systems, and government mechanisms to improve gender equality) may improve the situation (29). Other measures such as sustained political commitment, increasing system accountability, social consciousness, digital awareness, removing online child pornography, restricting migration, socio-economic improvement, safe transport, gender sensitization training, counseling, surveillance and increased crime control policing may lead to lower crime rates against women in society. On a positive note, some of the recent legislative, policy and developmental measures initiated by the present government of India would transform society, strengthen transparency including financial transactions and as a secondary outcome may possibly bring down crime rates.

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