# ON AN IMPROVED WEIGHTED AND STANDARDIZED FATALITY INDEX USED FOR ESTIMATION OF CASUALITIES AMONG JE CASES

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**ABSTRACT**

Japanese Encephalitis (JE) a dreadful disease of viral origin has attacked South East Asian Regions especially the BBIN (Bangladesh Bhutan, India & Nepal) Countries. In India JE has been occurring in the endemic form since long back particularly in northern states. Eastern parts of Uttar Pradesh (UP) particularly Gorakhpur division is the worst hit division of UP in India. JE started in year 1973 in an epidemic from in Gorakhpur division and other districts of U.P. Since then U.P. has been facing the outbreak of JE; however in the recent years every case is reported from the endemic areas .In this paper we have proposed a new measure of case fatality rate for JE which takes in to account the age and sex distribution of the population under consideration.

**Keywords:** *Case Fatality Rate (CFR), Weighted and Standardized Fatality Rate (WSFR), Age and Sex Specific Fatality Rate (ASFR), Crude Case Fatality Rates (CFR)*

## 1. INTRODUCTION

Generally the vital statistics are available in the form of frequencies of the vital events. e.g., $n_1$ persons die, $n_2$ persons are born, $n_3$ persons get married during a given time's' in any community or region or country. In order that these figures are of some utility to a statistician, from statistical analysis point of view, these are generally transformed by rates or ratios .Rate of a vital event is defined as the ratio of the total number of occurrences of the event to the total number of persons exposed to the risk of occurrence of that event. If this rate is calculated to know importance as a killer of a given disease it is called case fatality rate (CFR) .CFR is very important measure to assess and evaluate the skills, measures taken and the infrastructure for management of the disease provided age sex, occupation, etc, are taken into account in its computation, this may be regarded as the most refined specific death rate. Due to the fact that there is only symptomatic treatment of JE is available, every district in UP is reporting its crude or simple CFR for the assessment of fatality of disease and efficiency in management of the disease but age sex, occupation, etc, are not taken into account in its computation.

Comparing the efforts or management skills at any place instead of using simple CFR, which does not take into account age and sex distribution among the affected cases we propose a weighted and standardized fatality rate (WSFR) as a measure of fatality which gives due weightage to these factors and hence is more suitable and logical. If age and sex distribution is same, simple CFR is coming out to be the same as weighted WSFR but if age and sex composition is different weighted WSFR is changed, and therefore for comparison or evaluation purpose instead of simple or crude CFR, weighted WSER is recommended to be reported.

As a numerical illustration, this new weighted and standardized fatality rate has been calculated.

## 2. AGE AND SEX SPECIFIC FATALITY RATE DUE TO JE (ASFR):

Let ${}_nD_x$ = Number of deaths due to JE in the age-group (x, x+n)

i.e., number of deaths due to JE among the persons with age x or more but less than x+n, in a given region during a given period, t (say).

${}_nP_x$ = Total number of JE cases of the age-group x to (x+n)

Then the age-specific fatality rate for the age-group x to x+n, usually denoted by

$$C_x = {}_nD_x / {}_nP_x \times 100 \quad (1)$$

To be more specific, the age and sex specific fatality rate (ASFR) for males is given by

$${}^mC_x = {}_n{}^mD_x / {}_n{}^mP_x \times 100 \quad (2)$$

Where ${}_n{}^m P_x$ is the number of males affected by JE cases in the age-group x to x+n and ${}_n{}^m D_x$ is the number of deaths amongst this population.
Similarly, the age-S.F.R for females is given by the formula

$$ {}^f C_x = {}_n{}^f D_x / {}_n{}^f P_x \times 100 \quad (3)$$

Formula (2) and (3) give the fatality rates specific to both age and sex.

## 3. STANDARIZED FATALITY RATES

Using (1) the crude case fatality rates (CFR) in terms of age-specific death rates for two regions A and B are given respectively by( a and b are used as prefixes and suffixes with rates notations to denote places A and B respectively).

$$ C^a = D^a / P^a \times 1000 = \sum_x C_x{}^a P_x{}^a / \sum_x P_x{}^a \quad (4)$$

$$ C^b = D^b / P^b \times 1000 = \sum_x C_x{}^b P_x{}^b / \sum_x P_x{}^b \quad (5)$$

Expressions (4) and (5) may be calculated separately for males and females making it more specific with respect to sex with age. We also observe that the expression in (4) and (5) are nothing but the weighted arithmetic means of the age-specific F.R., the weights being the corresponding populations in the age-groups. We observe that even if age-specific F.R.'s are same, i.e., $C_x{}^a = C_x{}^b$ For all x, $C^a \neq C^b$,
since in general , $P_x{}^a / \sum_x P_x{}^a \neq P_x{}^b / \sum_x P_x{}^b$
i.e., since the age-distributions of the populations in the two regions A and B are not identical. Therefore while comparing two places we observe that even if age and sex specific fatality rate are same we may get different values of CFR if populations under consideration have different age and sex distribution and that could be misleading. This drawback is removed if the same set of weights is used in (4) and (5) for computing the weighted average of the age-specific F.R.'s. This is what is done in standardized death rates (STDR) or adjusted death rates, used with a prefix to identify the basis of adjustment as, for example, age-adjusted death rates and so on. In case of CFR this drawback may be removed if these ASFR are applied on some other bigger population called standard population which is usually taken to be that population of which places to be compared are a part. These **Standardized Fatality Rate (STFR) with respect to age and sex denoted** as ${}^s C_m$ and ${}^s C_f$ for males and females respectively are given as follows

$$ {}^s C_m = \sum \frac{{}^x P_s \cdot {}^x C_m}{P_s} \quad (6)$$

$$ {}^s C_f = \sum \frac{{}^x P_s^f \cdot {}^x C_f}{P_s^f} \quad (7)$$

## 4. PROPOSED WEIGHTED STANDARDIZED FATALITY RATE (WSFR):

Considering the effect of age and sex distribution on CFR we propose the following single new measure of fatality named_Weighted Standardized Fatality Rate (WSFR) $C_w$ as a convex combination of ASFR for males and females given in (6) and (7) **:**

$$ C_w = \alpha {}^s C_m + \beta {}^s C_f \quad (8)$$

Where $\alpha + \beta = 1$ For all practical purposes constants $\alpha$ and $\beta$ may be taken as proportion of males and females in JE cases in the standard population. if the proportion of male and females and age distribution is same in places to be compared and standard population then this value will coincide with simple case fatality rate (CFR) otherwise it will give the different values .Moreover it will also highlight the sensitivity and gender discrimination in case management of JE cases and help in identifying the need of sensitization of people to take proper care of their girl child (as children are most susceptible victims) suffering from JE. This is a very important social aspect because JE is attacking mainly lower and rural class of the population who are usually biased towards a particular gender and due to negligence in health care to females CFR becomes very high which is not due to system failure or lack of expertise but due to social and economic factors. Therefore in any case it is better to use this measure of fatality instead of simple fatality rate which ignores age and sex distribution completely to assess the disease management system at any place for comparison purpose as well as recommendation and priorities of places for taking the preventive measures.

## 5. NUMERICAL ILLUSTRATION:

To demonstrate the calculations of measures discussed above we take the population of JE cases in Gorakhpur division and some other districts (Gorakhpur, Maharajganj, Kusinagar, Deoria, Basti, Siddhartha Nagar and Sant Kabir Nagar in U.P.) and obtain the following results shown in the following tables for the year 2005 when a huge number of JE cases and deaths occurred:

*Table 1. Showing Different Types of Fatality Rates in JE Prone Districts of UP (2005)*

| Districts | CFR C | CFR (male) $C_m$ | CFR (Female) $C_f$ | STFR (Male) ${}^sC_m$ | STFR (Female) ${}^sC_f$ | WSFR $C_w$ |
|---|---|---|---|---|---|---|
| **Gorakhpur** | 18.71 | 18.69 | 18.75 | 18.96 | 18.66 | 18.85 |
| **Mahrajganj** | 21.53 | 19.74 | 24.47 | 16.88 | 24.16 | 19.65 |
| **Kushinagar** | 14.46 | 14.14 | 14.95 | 14.03 | 14.97 | 14.39 |
| **Deaoria** | 18.55 | 19.23 | 17.58 | 19.66 | 18.62 | 19.27 |
| **Basti** | 20.54 | 18.42 | 23.94 | 15.24 | 19.59 | 16.89 |
| **Siddharthnagar** | 14.21 | 15.63 | 10.91 | 16.66 | 10.81 | 14.44 |
| **Sant Kabir Nagar** | 15.38 | 14.29 | 17.07 | 14.71 | 27.60 | 19.61 |

It is clear from Table 1 that trend of all types of fatality rates is same. CFR shows that Basti observes highest rate of fatality whereas according to weighted and standardized fatality rate (WSFR) it is Mahrajganj closely followed by S.K. Nagar, Deoria and Gorakhpur. According to CFR Siddharthnagar is observing minimum but as per WSFR it is Kushinagar and Siddharthnagar is a little higher than farmar.STFR for females is highest in S.K. Nagar which is observing third lowest CFR, this is a serious concern and the matter needs to be investigated that why female fatality rate is so high in this district.

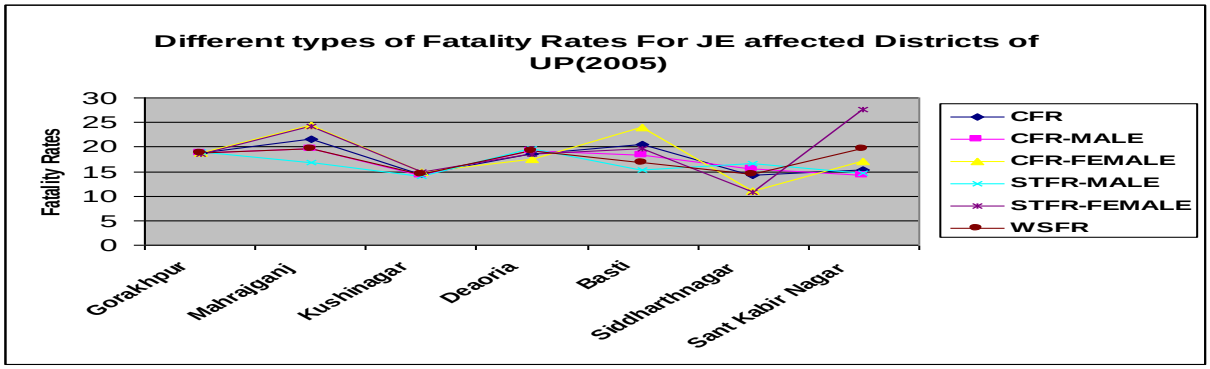


*Figure 1. Different types of fatality rates for JE affected Districts of U.P. (2005)*

It is clear from fig 1 that trend of all types of fatality rates is same. CFR shows that Basti observes highest rate of fatality whereas according to weighted and standardized fatality rate (WSFR) it is Mahrajganj closely followed by S.K. Nagar, Deoria and Gorakhpur. According to CFR Siddharthnagar is observing minimum but as per WSFR it is Kushinagar and Siddharthnagar is a little higher than farmar.STFR for females is highest in S.K. Nagar which is observing third lowest CFR, this is a serious concern and the matter needs to be investigated that why female fatality rate is so high in this district .

*Table 2. Showing Maximums and Minimums of Different Types of Fatality Rates in JE Prone Districts of UP (2005)*

| | CFR C | CFR (male) $C_m$ | CFR (Female) $C_f$ | STFR (Male) ${}^sC_m$ | STFR (Female) ${}^sC_f$ | WSFR $C_w$ |
|---|---|---|---|---|---|---|
| **First Minimum** | 14.21 (S.N.) | 14.14 (K.N.) | 10.91 (S.N.) | 14.03 (K.N.) | 10.81 (SN) | 14.39 (KN) |
| **Second Minimum** | 14.46 (K.N.) | 14.29 (SKN) | 14.95 (K.N.) | 14.71 (SKN) | 14.97 (KN) | 14.44 (SN) |
| **First Maximum** | 21.52 (M.G.) | 19.74 (M.G.) | 24.47 (M.G.) | 19.66 (D) | 27.60 (SKN) | 19.65 (MG) |
| **Second Maximum** | 20.54 (B) | 19.23 (D) | 23.94 (B) | 18.96 (G) | 24.16 (MG) | 19.61 (SKN) |

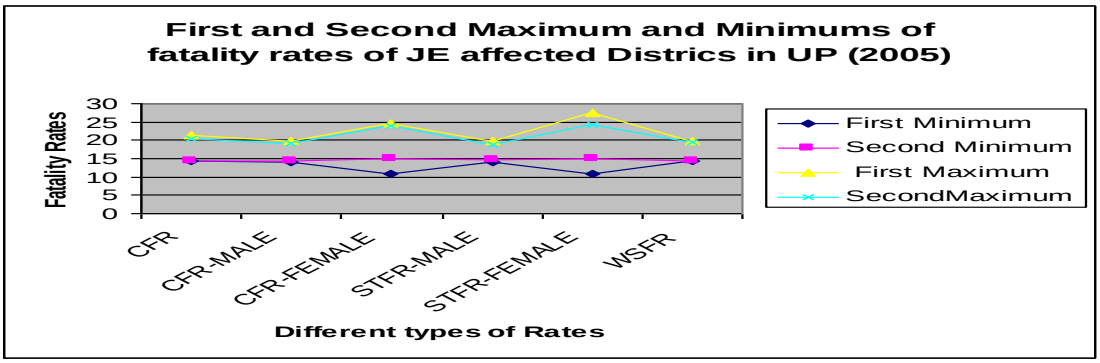


*Figure 2. First and Second Maximum and Minimum of fatality rates of JE affected Districts in UP (2005)*

Figure 2 shows that CFR is showing least difference between minimum and maximum fatality rates whereas STFR-females is showing the highest difference between minimum and maximum fatality rates of both first and second orders.

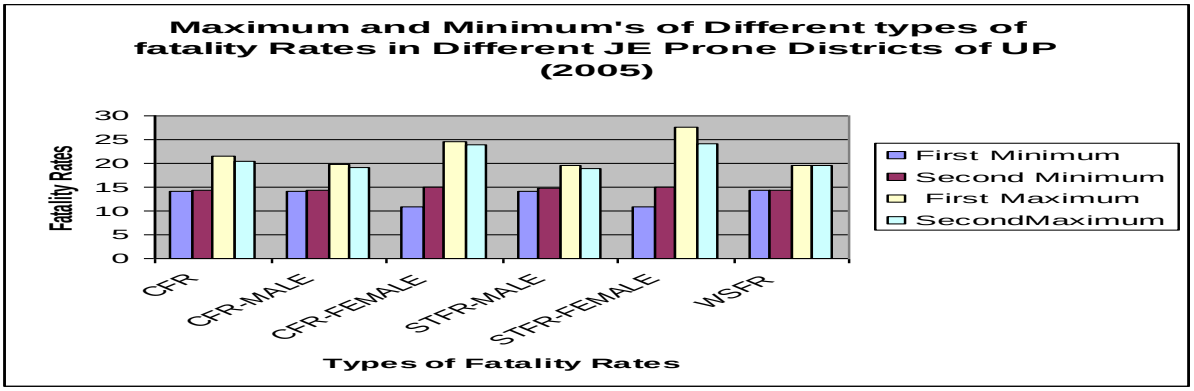


*Figure 3. Maximum and minimum's of different types of fatality rates in different JE prone Districts of UP (2005)*

Above figure 3 shows that first and second minimum are very close to each other for CFR, CFR-Male, and STFR-male whereas the difference between the two is higher for CFR-Female and STFR-female. In general CFR is underestimating for female fatality and overestimating male fatality. WSFR is smoothing out the age and sex fluctuations and giving more reliable figures. All types of fatality rates are higher for females than males and this must be investigated in the light of social and economical behavior of people regarding different attitudes for female and not caring for them properly making fatality rates to rise irrespective of skill, expertise and infrastructure provided by the government.

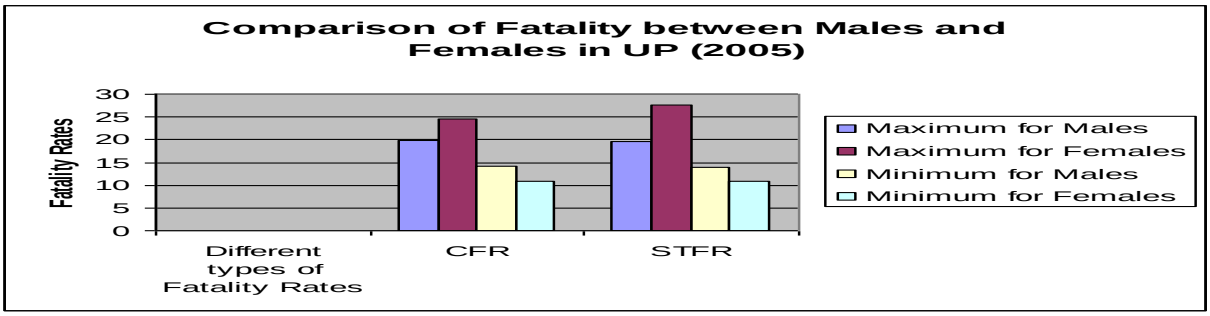


*Figure 4. Comparison of Fatality between Males and Females in UP (2005)*

It is clear from the above diagram 4 that it is the cases of females which are highly mismanaged and are observing quite high fatality rate at all the places irrespective of medical facilities, govt policies and expertise though it is well known that it is males who get more JE attacks. This factor needs immediate attention because unless female fatality comes down, efforts taken by govt can not be evaluated accurately because of the social and economic factors

playing their role. It has been observed that though male fatality has been brought down it is because of female fatality that high CFR is being reported.

## 6. CONCLUSION:

**1.** It is clear from fig 1 that trend of all types of fatality rates is same. CFR shows that Basti observes highest rate of fatality whereas according to weighted and standardized fatality rate (WSFR) it is Mahrajganj closely followed by S.K. Nagar, Deoria and Gorakhpur. According to CFR Siddharthnagar is observing minimum but as per WSFR it is Kushinagar and Siddharthnagar is a little higher than farmar.STFR for females is highest in S.K. Nagar which is observing third lowest CFR, this is a serious concern and the matter needs to be investigated that why female fatality rate is so high in this district .

**2.** Figure 2 shows that CFR is giving least difference between minimum and maximum fatality rates whereas STFR-females is giving the highest difference between minimum and maximum fatality rates of both first and second orders.

**3.** Figure 3 shows that first and second minimum are very close to each other for CFR, CFR-Male, and STFR-male whereas the difference between the two is higher for CFR-Female and STFR-female. In general CFR is underestimating for female fatality and overestimating male fatality. WSFR is smoothing out the age and sex fluctuations and giving more reliable figures. All types of fatality rates are higher for females than males and this must be investigated in the light of social and economical behavior of people regarding different attitudes for female and not caring for them properly making fatality rates to rise irrespective of skill, expertise and infrastructure provided by the government.

**4.** It is clear from the multiple column diagram 4 that it is the JE cases of females which are highly mismanaged and are observing quite high fatality rate at all the places irrespective of medical facilities, govt policies and expertise though it is well known that it is males not females who get more JE attacks. This factor needs immediate attention because unless female fatality comes down, efforts taken by govt can not be evaluated accurately. Social and economic factors play their role and IEC activities are to be taken seriously to sensitize people towards female illness management as there is only symptomatic management of the disease that can avoid death and bring down the fatality rate considerably. It has been observed that though male fatality has been brought down with efforts and policies on vaccination etc it is because of female fatality that high CFR is being reported and is still a major health problem .

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