On few issues with percentage and rates

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Maternal Mortality Ratio (MMR) in India was exceptionally high in 1990 with 556 women dying during child birth per hundred thousand live births. Approximately 1.38 lakh women were dying every year on account of complications related to pregnancy and child birth. The global MMR at the time was much lower at 385. There has, however, been an accelerated decline in MMR in India. MMR in the country has declined to 167 (2011-13) against a global MMR of 216 (2015). The number of maternal deaths stands reduced by 68.7%. India's share among global maternal deaths has declined significantly to about 15% as per the Maternal Mortality Estimation Index Agency Group (MMEIG) report. Infant Mortality Rate (IMR) has declined from 58 per 1000 live births in 2005 to 40 per 1000 live births in 2013 and The Neo-Natal Mortality Rate (NMR) has declined from 37 per 1000 live births in 2006 to 28 per 1000 live births in 2013 [1]. India is committed to reduce child deaths by two thirds between 1990 and 2015 as pledged in the Millennium Development Goals (MDG). This implies a reduction of Under Five Mortality Rate (U-5MR) from 125/1000 live births in 1990 to 42/1000 live births by 2015. The Newborn Mortality Rate in India is 28/1000 live births (SRS 2013) which translates into approximately 7.3 lakhs deaths, annually. Newborn deaths contribute to 57% of the Under-5 deaths in the country. After a period of stagnation (from 2003 to 2007), the decline in neo-natal mortality gained pace with a 17% decline been recorded in the last 5 years from (2008 to 2012). More importantly, 6% fall occurred in the each of the last two consecutive years (highest so far)[2]. Pneumonia and diarrhoea are leading childhood killers, responsible for 15% and 12% of child (0-5 years) deaths, respectively [3].

From the above facts it is customary in official statistics to use rates, ratios, proportions and percentages. Rates and percentages are imbibed into the citizens to understand applications. In official reports and publications, applied research papers, books and so on make use of them and interpret based on them. Here is an attempt to know the difficulties in understanding these statistics.

For an example, IMR in India is 40 for 1000 population in 2013 as mentioned above. Here the proportion is 0.04. It means that for a given infant the likelihood of death is 0.04 . It is the risk of death only. But it is interpreted as 40 infants out of 1000 infants! Firstly, the proportion is a relative measure. How is it possible to convert into an absolute measure by just multiplying with 1000 and interpret as the number of deaths? Secondly , the proportion represents the likelihood of happening of infant deaths. If it is multiplied with 1000 , then it amounts to add the 1000's of proportions in sequence. Sequence of proportions can add up to greater than one and tends to infinite also, as the multiplier becomes larger and larger, and this doesn't tell anything about the number of deaths. This only tells about the proportion of death adding up to some positive integer. Thirdly, the likelihood of infant death indicates the risk of death. The risk of death of an infant is independent of other infant. Thus in a group of 1000 infants, the likelihood of death is equal to the product of individual likelihoods. As a result the likelihood of death should be raised to the power of 1000 and hence by reducing the chance of infantile death in a group. Fourthly, suppose the likelihood of infantile death is multiplied by 1000, then it gives a positive integer. Being a responsible person instead of decreasing the chance of deaths in a group, it is interpreted in a wrong manner and says that the number of death in a group! It is also forgotten that the sequence of likelihoods add up to a positive integer. Fifthly, infantile death is 40 out of 1000 , then for what 1000 infants it is true? It is not possible to ensure 40 deaths out of any 1000 or random 1000 or ordered 1000 or the 1000 infants of investigator's choice.

As a result, it is unfair to:

- multiply the proportion with a constant
- add the likelihoods instead of multiplying them.
- interpret the sequence of likelihoods as the number of deaths
- ensure the number of deaths for the investigator's choice of group or general group.

The issue can be even clearer with the following example. A pharmaceutical company representative was arguing to prescribe the vaccine X which had 0.99 chance of preventing the disease. Question is

that can this vaccine be prescribed? Now , let us give this vaccine to a group of 10 people. Representative argument was that 99 members will not get disease out of 100 humans. Here, the chance of prevention is independent from one person to another as individuals are independent. As a result, it should be raised to a power 10 rather than multiplying by the number 10. Thus the chance of prevention of vaccine X will be $(0.99)^{10}$ = 0.904 and for 100 it is 0.366! With this data, can it be prescribed? Based on the former method the doctor may support the vaccine. This thought can be generalized to most of the applications. In mathematics, when we are dealing with just numbers it appears to be ok. But in real life situation, it is customary to interpret properly.

Another problem of percentage is that, overestimation. In small sample problems, it is observed that the interpretation ends up with the percentage. In a study involving 50 infants, let the 20 deaths are due to pneumonia. Then usually the interpretation will be 40% of deaths is due to pneumonia, meaning out of 100 infants 40 deaths occur. Issue here is , suppose 50 new infants are given, is it possible to ensure another 20 deaths among them! Here 40% should be interpreted as the 40% of the portion of 50 infants died. It should not be interpreted as 40 deaths out of 100 infants. Suppose for curiosity sake, for what part of 40% portion of 50 , 20 deaths are occurring? This question is not addressed by the percentage approach.

With these issues , it is safer to interpret with the likelihoods or with the observed frequency directly. One should not support the ease of understanding to the cost of actual fact at the national level.

References:

1. Annual Report of Department of Health & Family Welfare for the year of 2015-16, Chapter 3, 25-50, Ministry of health and family welfare, Govt. of India
2. Annual Report of Department of Health & Family Welfare for the year of 2015-16, Chapter 4, 38, Ministry of health and family welfare, Govt. of India
3. Annual Report of Department of Health & Family Welfare for the year of 2015-16, Chapter 4, 40, Ministry of health and family welfare, Govt. of India