# Why is child mortality not declining in Delhi?

Aashish Gupta*

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**Abstract**

Using data from Demographic and Health Surveys conducted in India, this paper documents an increase in post-neonatal and child mortality in Delhi. Between 2005-6 and 2015-16, post-neo-natal mortality increased from 10.5 deaths per 1,000 live births to 13.4 deaths per 1,000 live births, while mortality in the ages 1-4 increased from 6.9 deaths per 1,000 live births to 11 deaths per 1,000 live births. This reverse transition in health is worrying because infant mortality has been falling in most places in the developing world, important because Delhi is the world's second most populous city, as well as the most populous city in a developing country, and perplexing because residents of Delhi are amongst the richest in India. To address why child health is worsening in Delhi, I use vital registration death counts with physician coded causes of death. In places like Delhi, where birth and child death registration is more complete, and where most child deaths may occur in facilities, civil registration death counts are possibly an under-utilized resource. Analysis of civil registration causes of death reveals a rise in the cause of death categories of infectious and parasitic diseases, as well as respiratory conditions. In particular, the rise in pneumonia, other bacterial diseases, and septicemia mortality rates can account for a large portion of the increase in child mortality. These findings are consistent with emerging evidence of increasing exposure to air pollution in the city, and concerns of rising resistance to prescription antibiotics. (244 words)

keywords: child mortality, urbanization, air pollution, epidemiological transition, vital registration, cause of death, Delhi, India

*Email: aashishg@sas.upenn.edu. Ph.D. Student, Demography & Sociology, University of Pennsylvania.
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# 1 Introduction

Documenting and studying reverse transitions in health is important from the perspectives of improving health currently in areas where reverse transitions are occurring, preventing such reverse transitions in other areas, and advancing scientific understanding of population health (Horiuchi, 1999). Along with climate change (Smith et al., 2014) and infectious disease epidemics (Morens et al., 2004), there are significant concerns within the broader health sciences of health consequences of environmental exposures such as air pollution (Landrigan et al., 2017) and antibiotic resistance (Laxminarayan et al., 2013). This paper investigates a reverse transition in child health in the city of Delhi, possibly linked to air pollution and antibiotic resistance. The causes of the reverse transition are not well understood, but more importantly, even the basic fact that child health in Delhi is not improving and worsening has not received attention.

Delhi, one of the great and historical cities of the world, is the second largest urban agglomeration currently, and the largest in a developing country (UN Population Division / DESA, 2018). A substantial literature has investigated health, environmental exposures, and regulation of pollution in urban India and Delhi. Using historical methods and archival materials, Sharan (2014) documents that the concern with pollution is very recent in Delhi, starting around the 1990s. Cropper et al. (1997) use data on air pollution and vital registration deaths in one of the municipal corporations of Delhi to find a higher number of person years lost due to pollution related mortality, particularly because of a higher proportion of deaths in younger periods in the city. Chhabra et al. (2001) measured lung function in three sites (with low, high and medium socioeconomic status) near each of Delhi's 9 permanent air pollution monitoring stations in 1990s, and found better lung function among non-smokers that lived in areas with lower pollution. Greenstone and Hanna (2014) build a dataset of water and air pollution regulations in Indian cities, including Delhi, combined with infant mortality rates from civil registration sources and pollution sources from available monitors

for the years 1986-2007. They find that environmental regulations did lead to a reduction in air pollution, and a modest reduction in Infant mortality as well. Rajarathnam et al. (2011) use the same data for 2002-2004, but for all ages and at daily levels of pollution and mortality, to find that a 10 $\mu g/m^3$ increase in PM 10 is associated with a .15% increase in mortality. Foster and Kumar (2011) report results from air pollution and lung function measurements between 2000-2002 in Delhi, finding that reductions in air pollution were associated with an improvement in lung function, particularly among those residents who spent a substantial amount of time outside the house.

Several sources corroborate a fall in air pollution in Delhi in the early 2000s because of aggressive regulation, and a subsequent increase starting around 2005. For instance, Chatterjee and Ghosal (2015) describe the u-shaped pattern in air pollution trends in Delhi, with pollution dropping sharply from the 1990s, reaching its lowest between 2005-2007, and then rising again continuously till present date (see Appendix Figure A1). Sunita Narain, a prominent activist who has had significant impact on air pollution regulations, provides an insider account of initial victories against air pollution in the 1990s and early 2000s through court-based legislation in Narain (2017), as well as the rise in air pollution subsequently, particularly because of cheaper diesel based private cars. The literature on sources of air pollution in Delhi, based on what are called source apportionment studies, finds that vehicular emissions have the highest contributions to particulate matter in Delhi (Singh et al., 2017), followed by industrial sources, road dust and natural sources, and finally, domestic fuel burning. Evidence on recent regulations, such as those that allowed cars with odd or even-numbered registration numbers on odd or even days has been mixed, with some studies finding marginal reductions, while others finding no effects on air pollution (Chowdhury et al., 2017; Mohan et al., 2017; Greenstone et al., 2018).

The literature on antibiotic resistance, and its link with health is less substantial, especially outside the pharmacology and related sciences. The New Delhi metallo-beta-lactamase (NDM-1), a multidrug resistant bacteria gene was found in a Swedish patient traveling from

Delhi (Yong et al., 2009), and since then has been found in multiple patients from India (Centers for Disease Control and Prevention, 2010), hospitals across India and the world (Kumarasamy et al., 2010), as well as in Delhi's water supplies and sewage systems (Walsh et al., 2011). Several Indian physicians and scientists had flagged the emergence of this resistance, as long as a decade ago before the NDM-1 gene was found in 2008 in the Swedish patient (Mckenna, 2010). Apart from widespread and unnecessary use of antibiotics, India's slower progress on public health measures of pollution control, sanitation, and clean water have been implicated in the emergence of widespread anti-biotic resistance in India (Rolain et al., 2010; Laxminarayan and Chaudhury, 2016). Laxminarayan and Chaudhury (2016) note that no studies of antibiotic resistance and health outcomes are available from India yet, but hypothesizes that it may lead to a rise in sepsis-related mortality among young children.

The paper finds that the patterns of child mortality rates in Delhi, in particular that of post-neonatal and child mortality, are consistent with the trends in air pollution exposure in Delhi. These rates have also been rising in the period when antibiotic resistance has emerged as a significant concern. As a first step towards documenting this finding, this paper investigates the extent of the increase using data from the Demographic and Health Surveys. As a next step, it compiles 11 years of cause of death data for the ages 0-1 and 1-4 years, from 2006 to 2016, from Medically Certified causes of Death reports, published periodically by the Registrar General of India for all the states of India. Using this compiled dataset, we document the causes of death which contribute to the rise in child mortality. Since child deaths in Delhi are likely to occur in hospitals, and since physician coded death certificates may be better than verbal autopsy based methods which are currently used to estimate causes of death in India(Jha et al., 2005), the MCCD may be an underutilized resource. This paper seeks to understand the utility of sources such as the MCCD in less resource-constrained and urban parts of India as well. Apart from having arguably better information on causes of death, the MCCD is also more timely, has a larger number of death

categories, more transparent, and can aid public health efforts to improve population health more than currently used verbal autopsy methods. The causes from which mortality rates are rising in disease are consistent with the causes of mortality associated with air pollution and antibiotic resistance.

The next section describes the data and the methods used in this paper proposal. Thereafter, I proceed to document an increase in mortality rates in Delhi, compare sources such as the Sample Registration System (SRS) and the Medically Certified Causes of Death (MCCD) reports, and examine cause specific mortality rates for children. I end with a discussion on the implications of these findings and further analyses plans.

# 2 Data and methods

We use three data sources in this paper: birth histories to measure child mortality rates from the Demographic and Health Surveys in India; child mortality rates as estimated by the Sample Registration System over much of this period for the city of Delhi; and finally, child mortality rates from registered deaths, as made available in the Medically Certified Causes of Deaths reports. As of now, the methods consist of calculating death rates per 1,000 or 100,000 live births, for all cause and cause-specific mortality. In future analyses, we intend to calculate age-specific probabilities of death, and age-specific death rates based on population exposures. The data sources and the methods are described in detail below.

## 2.1 Demographic and Health Surveys

The DHS conducts periodic surveys in a large number of countries, and measures child mortality through birth histories, collected from women in the reproductive ages. Because of the special status of Delhi as the National Capital Territory, DHS survey in India have been representative for the city of Delhi throughout. We use data from all available waves of the DHS in India: 1992-93, 1998-99, 2005-06, and 2015-16. India's DHS surveys are also

called National Family Health Surveys.

## 2.2 Sample Registration System

India's SRS monitors vital events continuously in over 8,000 randomly selected enumeration blocks, and is representative at the national and the state level (of India, 2017). The SRS has been used to estimate fertility and mortality levels in India since 1970 (Bhat and Preston, 1984), but has generated infant mortality estimates in Delhi from 1990, and child mortality estimates from 2008. Underlying unit-level SRS data are not usually made available to researchers, but causes of death in the SRS have been estimated in the Million Deaths Study (Jha et al., 2005).

## 2.3 Medically certified causes of death

Deaths that occur in medical facilities in India are assigned causes of death by physicians, coded according to ICD-10 guidelines, and reported to the Registrar General of India (Registrar General of India, 2017). While in most Indian states reporting of deaths in facilities was made mandatory only in 2014, in the city of Delhi, all medical facilities have had to necessarily report causes of deaths since 2003 (Government of NCT of Delhi, 2016). MCCD reports, particularly from urban areas, have been used by researchers in the past to study the epidemiological transition in India (Yadav and Arokiasamy, 2014), malaria burden (Kumar et al., 2007), socioeconomic gradients (Ghosh and Kulkarni, 2004), fire-related mortality (Sanghavi et al., 2009) and have been the subject of qualitative investigation as well (Gupta et al., 2016).

There are several reasons to justify this examination and use of the MCCD and civil registration data. First, researchers continue to use this data source (for instance see Greenstone and Hanna 2014 and Sanghavi et al. 2009). Second, using and examining the MCCD data can have benefits from a health surveillance point of view in the future, and is pertinent in a

context where health may be worsening. Third, since the MCCD has physician coded causes of death, it has higher quality cause of death analysis than verbal autopsy methods currently in use. Finally, a careful analysis will contribute to a better understanding of the limitations of the data source, and provide guidelines for improvement. Thus, for the analysis in this paper, we digitized and cleaned the records for ages 0-1 and 1-4 for the city of Delhi for the years 2006-2016. This dataset is intended to be public-use. These reports come printed, and are available for more recent years as PDFs (see Appendix Figure A2 for an example of a page in these reports). We will also make an attempt to access the underlying unit-level data from civil registration authorities.

Apart from completeness, there is also a concern that some of deaths in the MCCD may be of residents not from Delhi. Delhi's medical facilities are superior to other areas in the country and offer more services, although medical facilities in areas outside Delhi have seen an expansion. Residents in urban areas outside Delhi which are close to Delhi may as likely to go to Delhi's health facilities as Delhi's residents are likely to go to facilities outside Delhi. Importantly, for the analysis of trends, our assumption is that the relative contribution of deaths from outside of Delhi is not increasing in the MCCD data. Also, deaths in Delhi from those who are outside Delhi may consist of causes that are more amenable to the much better health facilities in Delhi, such as cases of childhood cancers and birth defects, which are not the focus of this investigation.

## 2.4 Outcomes

In this version of the paper, we study the outcomes of neonatal, post-neonatal, infant, child (in the ages 1-4 years) and under 5 deaths per 1,000 live births in a year. The advantage of using live births as a denominator is that they are available for all years and can be applied to all sources. Live birth estimates are calculated by multiplying SRS estimated annual birth rates with the projected population of Delhi.

Cause-specific death rates per 1,000 live births are also estimated, but only for the 0-4

age group. We plot these rates for available years - starting from the early 1990s to 2015 for the DHS and SRS, and from 2006 to 2016 for the MCCD. The MCCD data do not identify neonatal deaths and post-neonatal deaths, although some causes can easily be identified as neonatal. In future analyses, we intend to use life table death rates, for the ages 0-1 and 1-4, for both all-cause and cause-specific mortality.

# 3 Results

The results section is organized as follows: first, we examine trends in child mortality in Delhi using DHS data. Next, we compare Delhi to other areas in urban India, and to overall India trends as well. We then compare the three sources - DHS, SRS, MCCD - to understand the extent of under-reporting in the MCCD, as well as the direction of trends. Finally, we analyze cause-specific death rates per 1,000 live births from the MCCD, documenting the causes that have shown an increase in the years for which data is available.

## 3.1 Increase in post-neonatal and child mortality

Figure 1 shows that while the decline in neonatal mortality continued after the mid 2000s in Delhi, declines in the 1990s of post-neonatal mortality and child mortality were reversed. Thus overall under-5 mortality declined only by 4.5 deaths per 1,000 live births in Delhi, from 46.7 deaths per 1,000 at the time of NFHS-3 to 42.2 deaths per 1,000 during NFHS-4, while post-neonatal mortality has increased from 10.5 deaths per 1,000 live births to 13.4 deaths per 1,000. Mortality in the ages 1-4 years increased even more, from 6.9 deaths per 1,000 live births to 11 deaths per 1,000.

Delhi has the second highest per capita income in India, equivalent to 330,000 INR per person, or more than 18,500 USD in PPP terms (USD 4930 using current conversion rates). To put this in context, under-5 mortality rates in Delhi, at 42.2 deaths per 1,000 can be compared to China's under-5 mortality rates, which at a per capita incomes of about 16,000

PPP USD per person, has under-5 mortality rates of 9.95 deaths per 1,000. Or with Brazil, Argentina, and Thailand, which at slightly lower per capita incomes have much lower under-5 mortality rates. Comparisons from the World Development Indicators (World Bank, 2018) reveals that countries which have under-5 mortality rates of similar to Delhi have much lower per capita incomes.

Figure 2 provides further evidence that mortality rates for children in Delhi are not stagnating because they can't decline further. While infant mortality rates in Delhi have kept pace with other urban areas in India, under-5 mortality rates in Delhi are worse than both urban Indian rates. Figure 3 breaks down these rates into neonatal, post-neonatal and child mortality rates. It finds that Delhi's post-neonatal and child mortality rates are even worse than all India rates, an alarming finding given Delhi's relative affluence. This finding of a high rate of infant mortality in Delhi given its relative affluence is corrobarated by analysis of state-wise sample registration system data as well (Sharma and Gupta, 2016).

## 3.2 Comparison of sources

Figure 4 asks the question, do we see these reverse transitions in Delhi in other sources too? For infant mortality, it finds that while the SRS estimated infant mortality rates have been below the DHS rates, there was an increase in SRS infant mortality estimates in the early 2000s. Thereafter, the SRS shows a continuous decline in IMR, which is not seen in the DHS estimates. For infant mortality, MCCD reports rates that are below the DHS and the SRS, but then infant mortality according to the MCCD increases and reaches closer to the DHS. Note that this increase in MCCD infant mortality could be both due to an increase in the number of hospital deaths, or in actual increase in infant mortality.

For child mortality, while the MCCD closely matches the DHS and shows a slight increase (as does the DHS, but the scales make it harder to see it), the SRS reports lower and declining rates. This may imply that for the 1-4 age period in particular, the MCCD may be a good source to analyse causes of deaths. The final graph shows a broad consistency

between MCCD and DHS under 5 mortality rates, even though the MCCD estimates rates lower than that of the DHS. The SRS mortality rates, which are declining in this period, is inconsistent with evidence from DHS and MCCD.

### 3.3 Causes of increase

Table 1 shows under-5 mortality rates per 100,000 live births for twenty broad categories of deaths for the years 2006-2016. Figure 5 plots the mortality rates from the top-6 cause of death categories. Perinatal conditions and other causes are the top causes of death, but there are no broad patterns in perinatal conditions or other deaths. In the year 2013, it seems that some causes of death that were classified as others were classified as perinatal. From the graphs, it seems that nervous and digestive diseases are on declining as well. However, there are increases in infectious and respiratory diseases, consistent with a rise in air pollution and antibiotic resistance.

Table 2 shows the cause-specific under-5 mortality rates for 15 diseases. These 15 causes of death together account for 66.5% of the deaths on average, with a range of 57-75%. Figure 6 displays results for 5 causes - three of which have been rising in this period. Septicemia and other bacterial diseases have increased, as has Pneumonias, while Tuberculosis and lower respiratory diseases rates have not declined (in fact there is an increase for both after 2012 - see Table 2).

Unclassified bacterial diseases and septicemia increased from 244 and 218 deaths per 100,000 live births in 2006 to 450 and 429 deaths per 100,000 live births in 2016 respectively. This corresponds to an increase of about 2 deaths per 1,000 for each. Pneumonia increased from 79 deaths per 100,000 live births in 2006 to 183 deaths per 100,000 in 2016, an increase of about 1 death per 1,000 live birth. Together, these diseases contribute to an increase of about 5.21 deaths per 1,000 live births. Recall that post-neonatal mortality had increased from 10.5 deaths per 1,000 to 13.4 deaths per 1,000, in Delhi according to the DHS surveys in a roughly corresponding period, and child mortality had increased fom 6.9 deaths per

1,000 live births to 11 deaths per 1,000. This is a total increase of 7 deaths per 1,000 in the 1-59 month period. Thus, just these three diseases can account for about 74.4% of the increase in mortality in Delhi.

# 4 Further work

Going further, this paper would benefit from further analysis from both sources of data: the DHS and the MCCD. From the DHS, to the extent its possible, we will try to examine the causes of this increase. Small area estimation methods, which use Bayesian methods, have recently been adapted for use with DHS data with geocodes (Mercer et al., 2015). We will use these methods to estimate the seasonal patterns of child mortality in Delhi, as well as patterns in districts over Delhi. Similarly, we will estimate child mortality by year from existing sources, to estimate the trend within the five year intervals in the DHS. We will also explore if these methods can be combined with satellite air pollution measures. Additionally, we will examine the extent to which migration may be contributing to higher child mortality, calculate child mortality rates by socioeconomic status, and compare Delhi with other urban areas based on observed levels of socioeconomic status and child mortality. It is possible to do most of these analyses for all available DHS surveys, since except for small area estimation, geo-codes are not required.

For the MCCD data, we will make an attempt to access individual death records for the possible years, as well as reports before the year 2006. From already available and digitised data, it is possible to examine rates by sex, and for the ages 0-1 and 1-4. We intend to do this in further analysis. Currently, the exposures in the data are births in the year, however, it is also possible to calculate death rates, ${}_nm_x^{cause}$, using annual SRS estimates of the age-distribution of the overall population of Delhi and census projections of Delhi's population. We also intend to explore additional methods to evaluate the completeness of the MCCD data.

Finally, there is also a role for qualitative checks on the available datasets, as well as interviewing pediatricians in Delhi to explore why the death rates are increasing. Similarly, we will pursue additional evidence on anti-biotic resistance, anti-biotic use, pollution, and causes of death in Delhi that will shed light on the questions that this paper proposal asks.

# 5 Discussion

Why might children's health in a comparatively rich and urban part of a fast growing developing country, and that too, the country's capital city, with no lack of health facilities or shortage of doctors be worsening? Research on the health transition has been concerned with the relative roles of increase in wealth, nutrition, health care, disease environment, and socio-cultural factors in explaining health improvements or declines. Preliminary questions explored in this paper point to the role of a worsening disease environment. This reverse transition in health is similar to earlier reverse transitions in cities such as London during the Industrial revolution (Hanlon, 2015). Pollution levels in Delhi today are similar to levels in London in that period (Fouquet, 2011), child mortality in London was higher (Hill, 1990), but London's population in 1901 was about 6.5 million. A much greater population in Delhi, closed to 17 million in 2011 within the state's boundaries, is exposed to this worsening in the disease environment. In 1901, antibiotics didn't exist in London, or elsewhere. Recent research has emphasized that some antibiotics may not be working in Delhi, while some children may be exposed to diseases that cannot be cured by most antibiotics (Gandra et al., 2016).

Admittedly, this study is limited by available data on the questions it seeks to answer. However, given declines in population health, as well as the potential to learn about improving methods to monitor population health, the questions in the study deserve further research.

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Figure 1: Trends in child mortality rates in Delhi

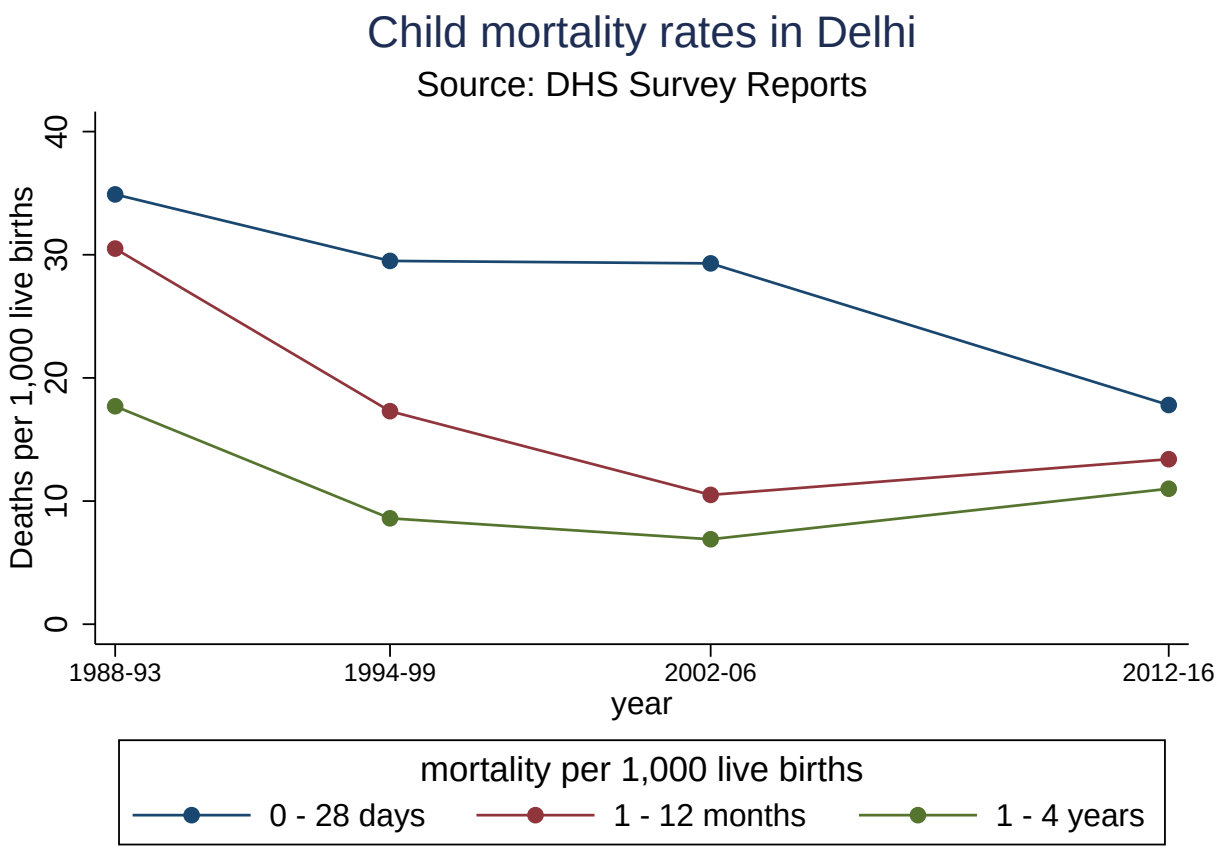
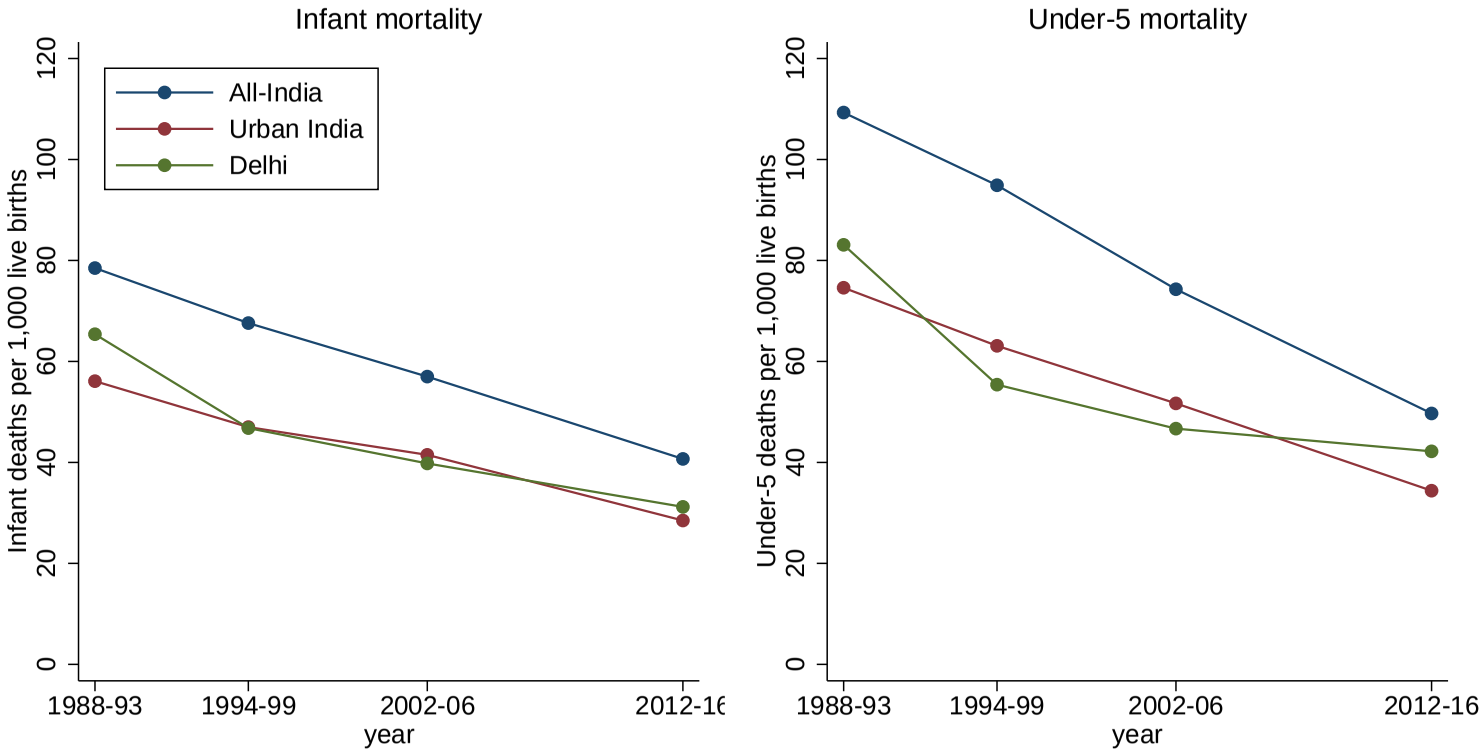
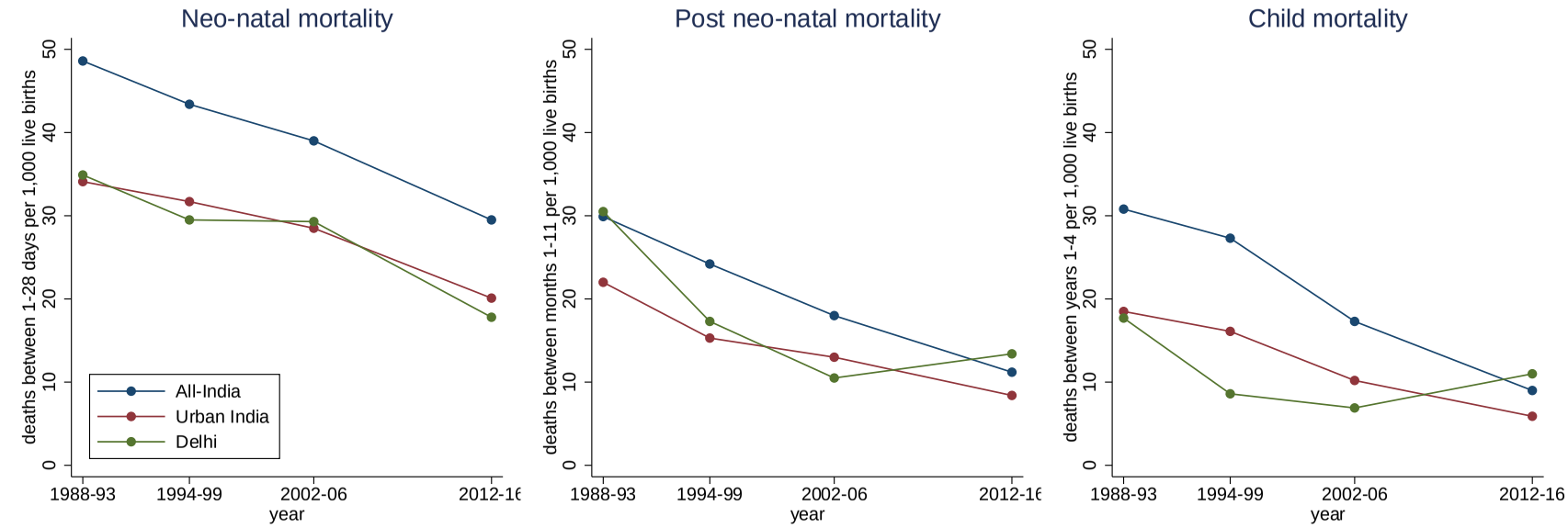


Figure 2: Comparison of infant and under-5 mortality rates in Delhi with Urban India and All-India



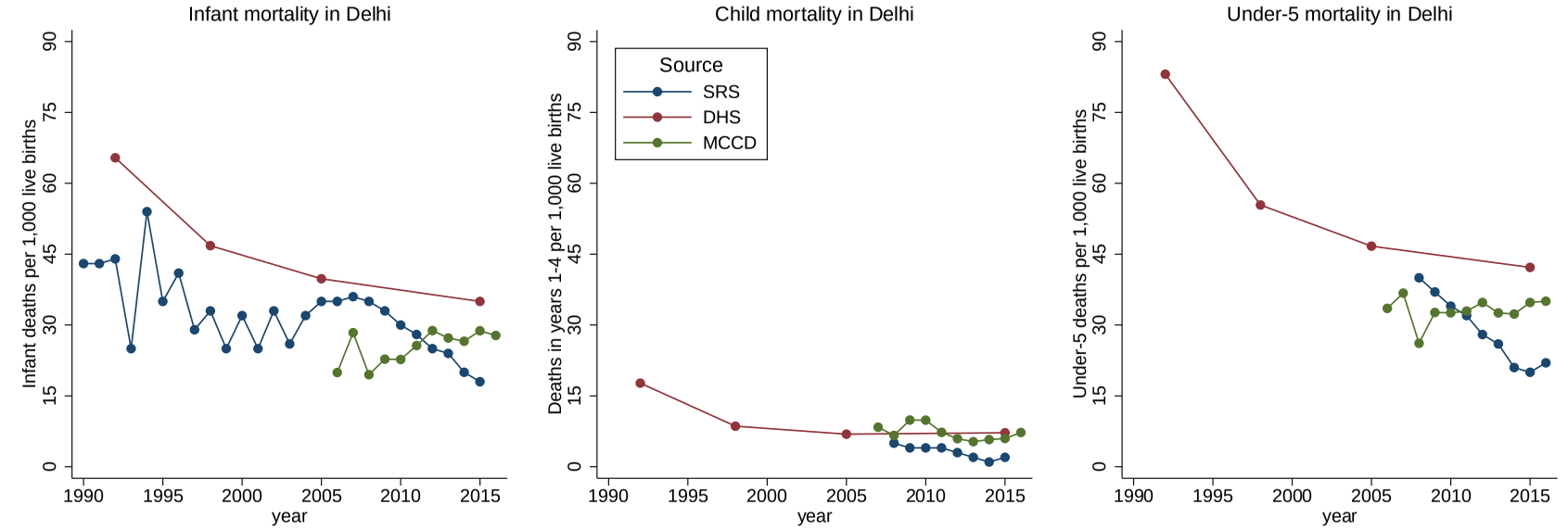

Source: DHS surveys

Figure 3: Comparison of neo-natal, post-neo-natal and child mortality rates in Delhi with Urban India and All-India




Source: DHS surveys

Figure 4: Comparison of infant, child and under-5 mortality rates in Delhi across sources




Note: DHS estimates are for 4 years before survey year

Figure 5: Trends in top-6 broad categories of causes of death

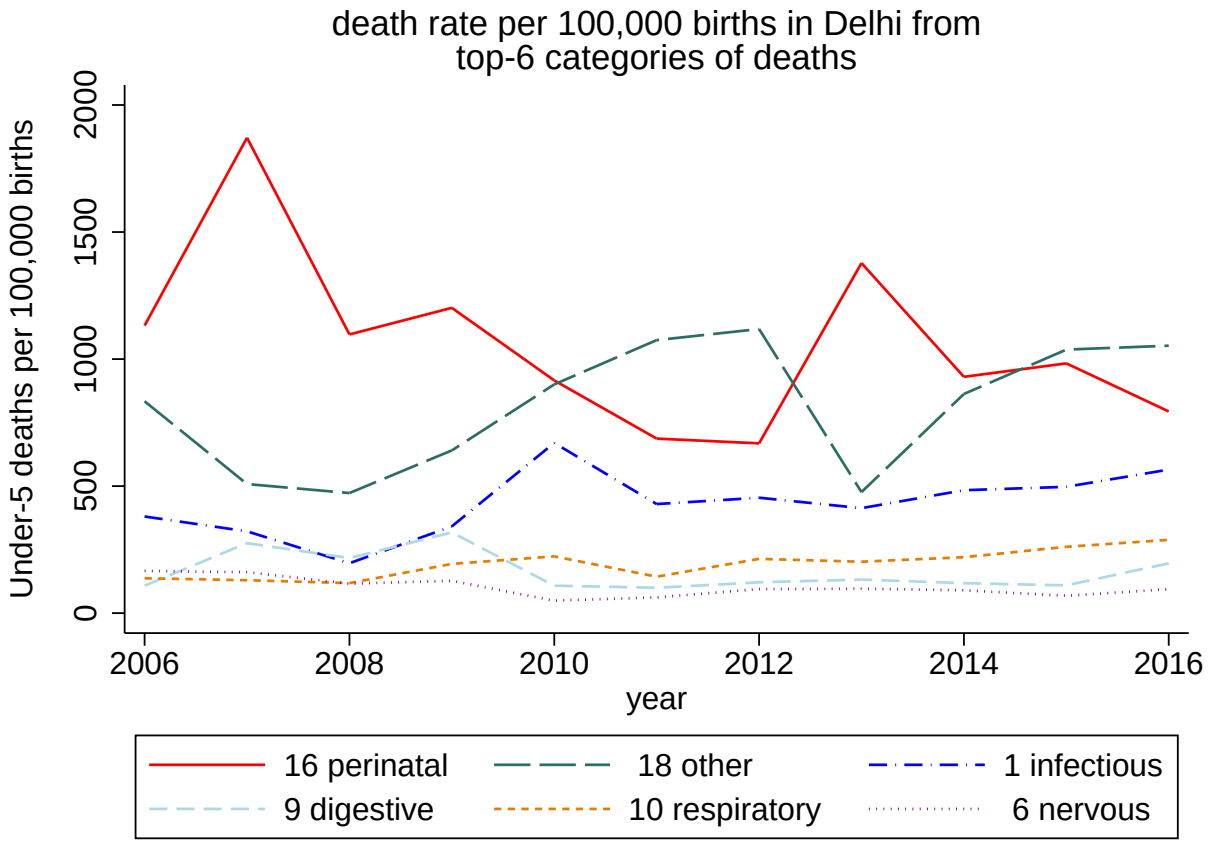


Figure 6: Rise in bacterial diseases, septicemia, and lower respiratory conditions in Delhi

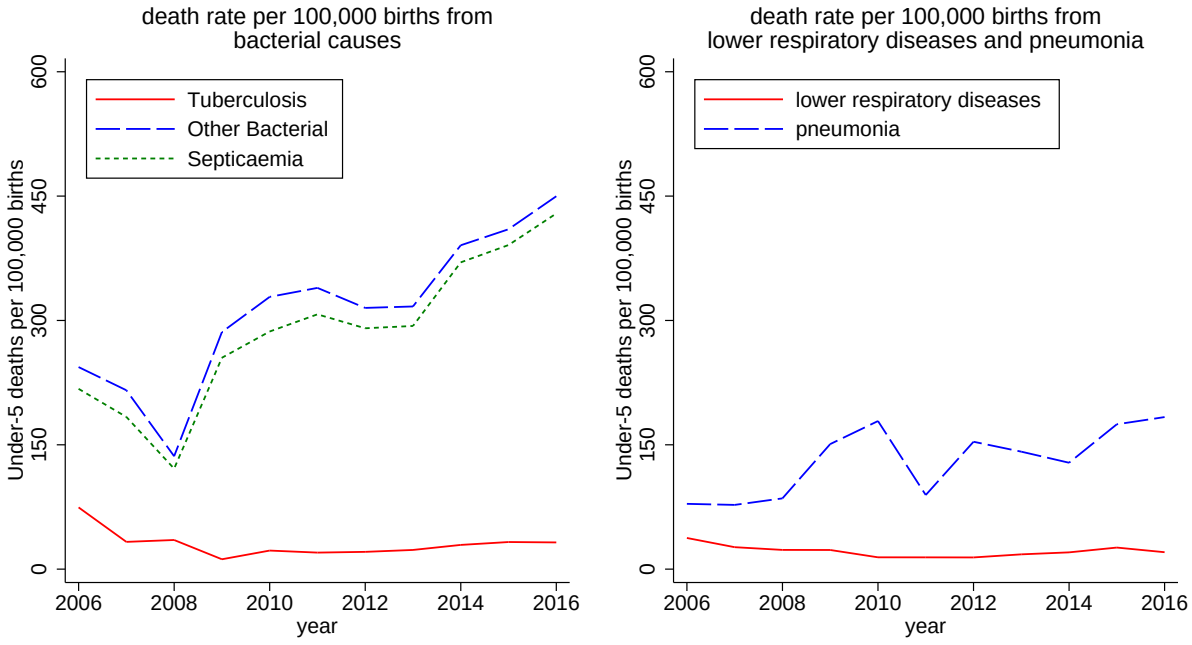


Table 1: Deaths rates among children aged 0-5 per 100,000 births in Delhi by Cause of Death Categories, 2006-2016

| | | year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| class | disease classification | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| I | Infectious / parasitic diseases | 380 | 322 | 196 | 342 | 670 | 429 | 454 | 413 | 484 | 497 | 565 |
| II | Neoplasms | 18 | 20 | 28 | 52 | 138 | 335 | 189 | 70 | 57 | 69 | 47 |
| III | Diseases of blood & blood forming organs | 45 | 26 | 16 | 29 | 15 | 19 | 25 | 21 | 24 | 26 | 20 |
| IV | Endocrine, nutritional, & metabolic diseases | 323 | 185 | 252 | 268 | 8 | 16 | 30 | 26 | 30 | 18 | 25 |
| V | Mental and behavioral disorders | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 4 | 1 | 3 |
| VI | Diseases of the nervous System | 166 | 161 | 116 | 127 | 49 | 62 | 95 | 96 | 90 | 69 | 94 |
| VII | Diseases of the eye and adnexa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| VIII | Diseases of the ear and mastoid process | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| IX | Diseases of the circulatory system | 108 | 276 | 217 | 318 | 108 | 100 | 121 | 132 | 118 | 109 | 196 |
| X | Diseases of the respiratory system | 137 | 130 | 118 | 194 | 223 | 143 | 214 | 202 | 220 | 261 | 289 |
| XI | Diseases of the digestive system | 48 | 38 | 24 | 25 | 41 | 62 | 92 | 52 | 60 | 60 | 43 |
| XII | Diseases of the skin and subcutaneous tissue | 1 | 1 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 1 | 3 |
| XIII | Diseases of the musculoskeletal system | 1 | 4 | 2 | 1 | 2 | 11 | 3 | 1 | 2 | 1 | 4 |
| XIV | Diseases of the genitourinary system | 24 | 21 | 18 | 15 | 62 | 93 | 117 | 27 | 29 | 13 | 17 |
| XV | Pregnancy, childbirth, and the pierperium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| XVI | Conditions originating in the perinatal period | 1132 | 1871 | 1097 | 1202 | 916 | 687 | 668 | 1378 | 930 | 983 | 794 |
| XVII | Congenital Malformations etc | 25 | 26 | 2 | 10 | 25 | 89 | 162 | 172 | 127 | 121 | 114 |
| XVIII | Not elsewhere classified | 834 | 508 | 473 | 641 | 900 | 1075 | 1118 | 476 | 863 | 1037 | 1053 |
| XIX | Injury, poisoning etc | 69 | 69 | 34 | 22 | 163 | 44 | 76 | 64 | 75 | 80 | 77 |
| XX | External causes of morbidity and mortality | 40 | 17 | 20 | 20 | 90 | 127 | 110 | 119 | 117 | 128 | 160 |
| | TOTAL | 3352 | 3676 | 2614 | 3266 | 3413 | 3295 | 3477 | 3257 | 3233 | 3477 | 3505 |

Table 2: Deaths rates among children aged 0-5 per 100,000 births in Delhi by top 15 Causes of Death, 2006-2016

| | year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cause of death | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Tuberculosis | 75 | 33 | 35 | 12 | 22 | 20 | 21 | 23 | 29 | 33 | 32 |
| Unclassified bacterial diseases | 244 | 216 | 136 | 286 | 328 | 339 | 315 | 317 | 391 | 410 | 450 |
| Septicaemia | 218 | 184 | 121 | 255 | 287 | 307 | 291 | 293 | 370 | 391 | 429 |
| Malaria | 1 | 2 | 1 | 2 | 87 | 14 | 21 | 20 | 6 | 4 | 5 |
| Neoplasms | 18 | 20 | 28 | 52 | 138 | 335 | 189 | 70 | 57 | 69 | 47 |
| Anaemias | 45 | 26 | 16 | 29 | 15 | 19 | 25 | 21 | 24 | 26 | 20 |
| Meningitis | 119 | 70 | 61 | 90 | 35 | 37 | 54 | 59 | 52 | 16 | 34 |
| Encephalitis etc | 40 | 74 | 18 | 9 | 6 | 18 | 24 | 20 | 24 | 29 | 34 |
| Lower respiratory diseases | 38 | 27 | 23 | 23 | 14 | 14 | 14 | 18 | 20 | 26 | 20 |
| Pneumonia | 79 | 77 | 85 | 151 | 179 | 89 | 154 | 142 | 128 | 175 | 183 |
| Prematurity | 353 | 429 | 209 | 241 | 117 | 229 | 265 | 209 | 209 | 209 | 148 |
| Birth trauma | 69 | 37 | 46 | 62 | 11 | 9 | 12 | 6 | 4 | 3 | 1 |
| Birth asphyxia | 463 | 555 | 409 | 457 | 252 | 217 | 182 | 344 | 441 | 585 | 471 |
| Other perinatal conditions | 226 | 839 | 408 | 418 | 537 | 232 | 209 | 820 | 276 | 186 | 174 |
| Shock, not elsewhere classified | 116 | 104 | 139 | 217 | 263 | 288 | 205 | 90 | 116 | 91 | 144 |
| Proportion of total deaths (%) | 63 | 73 | 66 | 71 | 67 | 66 | 57 | 75 | 66 | 65 | 63 |

Figure A1: Newspaper clipping showing pollution levels in Delhi (Indian Express, March 15 2015)


Indian Express, March 15, 2015

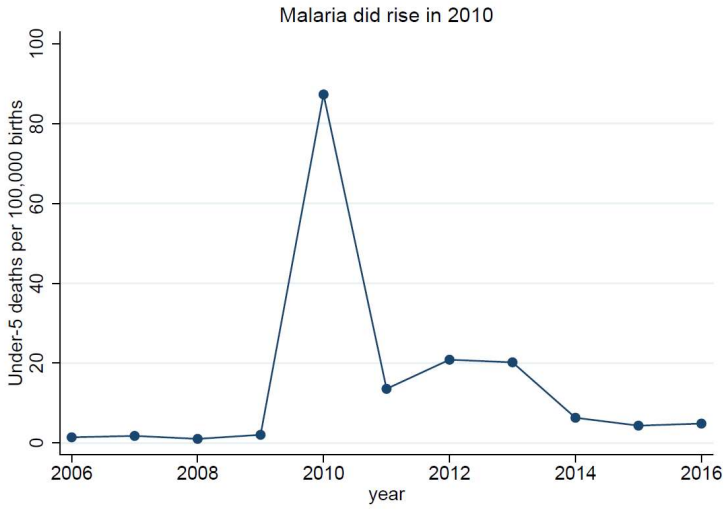
Figure A2: Example of a page of the MCCD report (2016)

**Table -1**

**DEATHS BY CAUSE OF DEATHS, AGE AND SEX FOR MEDICALLY CERTIFIED DEATHS - 2016**

| SL. No. | NAME OF THE DISEASE | SEX | AGE IN YEARS <1 | 1-4 | 5-14 | 15-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65-69 | >=70 | NOT STATED | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| 2 | Tuberculosis of nervous system (A17) | M | 2 | 7 | 18 | 15 | 30 | 25 | 22 | 13 | 6 | 5 | 1 | 144 |
| | | F | 5 | 3 | 9 | 24 | 16 | 8 | 10 | 6 | 3 | 7 | 4 | 95 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Tuberculosis of other organs & miliary Tuberculosis (A18-A19) | M | 4 | 3 | 9 | 25 | 37 | 33 | 36 | 32 | 6 | 20 | 4 | 209 |
| | | F | 2 | 4 | 18 | 39 | 42 | 17 | 12 | 14 | 4 | 17 | 6 | 175 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | |
| **3** | **Other bacterial diseases (A20-A49)** | **M** | **594** | **182** | **260** | **211** | **318** | **507** | **604** | **764** | **360** | **943** | **57** | **4800** |
| | | **F** | **366** | **155** | **200** | **218** | **259** | **281** | **364** | **470** | **217** | **702** | **47** | **3279** |
| | | **O** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** |
| 1 | Plague (A20) | M | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 4 | 1 | 2 | 0 | 9 |
| | | F | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 9 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Leprosy (A30) | M | 1 | 0 | 0 | 0 | 1 | 0 | 3 | 6 | 5 | 4 | 0 | 20 |
| | | F | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Neontorum Tetanus (A33) | M | 2 | 0 | 1 | 0 | 0 | 1 | 2 | 3 | 4 | 0 | 0 | 13 |
| | | F | 5 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 5 | 0 | 15 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Other Tetanus (A34-A35) | M | 0 | 2 | 4 | 3 | 2 | 1 | 2 | 2 | 0 | 2 | 0 | 18 |
| | | F | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Diphtheria (A36) | M | 1 | 13 | 58 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 77 |
| | | F | 0 | 11 | 50 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 62 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Whooping cough (A37) | M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Meningococcal infection (A39) | M | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| | | F | 0 | 2 | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 8 |
| | | O | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Figure A3: Figure showing rise in Malaria deaths in children in Delhi in 2010, and an example of a news article that discussed a rise in Malaria in the year




Publication: The Times Of India Delhi;Date: Aug 18, 2010;Section: Times City;Page: 6;

# Games mess bites traders in Karol Bagh, Paharganj

Ruhi Bhasin | TNN

Photos: Yogesh Kumar

The construction work in Karol Bagh and Paharganj has spelt doom for residents and traders in these areas. Open drains, stagnant water and garbage dumped at every street corner have led to massive mosquito breeding. According to resident welfare association in Karol Bagh, one or two members in each household are suffering from dengue.

Ruin too has aggravated the problem. "The construction work has led to widespread mosquito breeding. The civic agency has left the drainages open and many people are falling sick with dengue. MCD is carrying out fogging but it is not a permanent solution to this problem. We are suffering as MCD has not been able to complete their work on time. And no one seems answerable for this mess," said Arun Verma, vice-president of RWA in Karol Bagh.

Added Murli Mani, president of Ajmal Khan traders association, "It seems unlikely that MCD will be able to meet August 31 deadline. The work will continue till late September."

As a result of the stagnant water, shopkeepers are falling sick. "We are paying with our health here thanks to the Games. I was sick with malaria last week. I made numerous complaints to MCD office to fog the area but no one seems to take notice," said Praveen Kumar.

Added Shiv Kumar, owner of Sareen Mens wear: "We have not only lost out on business but are suffering everyday. At least three staff members working in my shop have fallen ill in the last few weeks."

The deputy commissioner of Karol Bagh zone, D V Verma, said MCD was carrying out fogging in areas where mosquito breeding has been found.

In Paharganj, malba is lying everywhere and construction material is falling from buildings which are being repaired in the main bazaar. Tourists look scared passing by such sites and some of them seemed so overwhelmed by the state of affairs that they have decided to head back to their respective countries.

**DANGER LURKS:** Shopkeepers say many of them have fallen ill due to waterlogging and open drains

Said Hartal from Germany: "I usually spend four months in Delhi before heading to the hills but after looking at the present condition of Paharganj, I have decided to go back to Germany next week. The areas is dirty and there are too many mosquitoes all over the place."

Said Prem Mohania, general secretary of the Main Bazaar: "People are falling sick here and business is down. Shops are functioning without shutters and the guesthouses are getting many cancellations."

MCD officials claimed steps are being taken to deal with mosquito breeding. Said deputy commissioner, Sadar Paharganj zone, Renu Jagdev: "There were complaints of mosquito breeding. To deal with it, we put sand inside ducts where water used to stagnate."