

Attributable deaths from smoking in the last 100 years in India

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Tobacco use, and in particular smoking, is the largest cause of preventable death among adults in India, as it is globally. Bidi, an indigenous, leaf-rolled cigarette made from coarse sun-cured tobacco, tied with a coloured string at one end, is the dominant form among all smoked products. More than eight to ten bidis are consumed for every cigarette in India. We present mortality estimates from smoking cigarettes and bidis manufactured over the last 100 years in India. There are currently no estimates of mortality, over a period of time, in India that can be directly attributed to cigarettes/bidis manufactured in the country. The objective of this study is to estimate the number of premature deaths that can be attributable to cigarette and bidi manufactured and consumed over the last 100 years in India. Nearly 4.52 trillion cigarettes and 40.3 trillion bidis have been produced between 1910 and 2010, which are estimated to be responsible for nearly 100 million premature deaths (in which bidis contributed 77 million deaths) in adult men of ≥ 35 years. Some of these deaths will occur up to the middle of this century. These estimates are derived from the most conservative datasets and yet present alarming mortality estimates. This communication calls for greater emphasis on epidemiological research and a review of existing tobacco control measures in India, which together need to inform measures needed for reducing tobacco use and restricting the proliferation of the tobacco industry.

Keywords: Bidis, cigarettes, premature mortality smoking, tobacco.

GLOBALLY, a definitive body of evidence establishes a strong association between smoking and premature death (premature death due to smoking is defined as the difference in the probability of death in a smoker over that of a non-smoker, at a specific age, integrated over all ages)^{1,2}. Between 1950 and 2000, over 70,000 scientific papers have shown that prolonged smoking causes premature death and disability³. In India, three large cohort studies conducted, first in late 1960s and mid-1970s in Srikakulam⁴, second in the late 1970s in Pune⁵, followed by another in mid-1980 in Ernakulam⁶ and in the late-1990s to mid-2000 in Mumbai (Mumbai Cohort Study)⁷ have confirmed the strong association between tobacco use and

premature death. The Mumbai Cohort Study also associates premature death to smoking of bidis in addition to cigarettes.

In 1989, a study estimated that more than 630,000 extra annual deaths were attributable to tobacco use in India. This study concluded that smoking had a higher relative risk for overall mortality than other forms of tobacco use, and was increasing rapidly in younger age groups⁸. The most recent study of mortality associated with smoking in India (2008), estimates that at least 930,000 adult deaths in India could be attributed to smoking, and that this would rise to over one million annually from 2010 (ref. 9). In effect, one in every 10 adult deaths in India is smoking-related.

Despite the clear association between smoking and premature death and the increasing consumption of cigarettes and bidis in India, there is limited research that links smoking-associated mortality with the actual numbers of cigarettes and bidis manufactured and consumed in the country over a period of time. This communication estimates the number of premature deaths in adult male smokers aged ≥ 35 years that can be attributed to cigarettes and bidis manufactured and consumed in the last 100 years in India (1910–2010).

India has a confounding variety of tobacco use, as a result of which it faces diverse epidemics which differ by geographies, populations, gender, age, socio-economic status and educational attainment. The Global Adult Tobacco Survey (GATS) estimated that more than one-third (35% or 274.9 million) of adults in India use tobacco in some form or the other¹⁰. The number of tobacco users in India exceeds the population of Indonesia and Canada combined – by itself this number would be equivalent to the fourth largest country in the world. Nearly 21% adults use only smokeless tobacco (163.7 million), 9% only smoke (68.9 million) and nearly 5% smoke as well as use smokeless tobacco (42.3 million). The prevalence of overall tobacco use among adult males is 48% and that among adult females is 20%. In absolute terms about 111.2 million adults (99.9 million males and 11.3 million females) currently smoke tobacco in some form. In absolute terms, 46.4 million are cigarette smokers (43.1 million males and 3.3 million females) and 73.3 million smoke bidi (66.1 million males and 7.2 million females). In the North East and southern regions of India, cigarette smoking is more prevalent than bidi smoking. There are other forms of smoking that exist in India, but the numbers are small and are not part of this estimation of attributable mortality. GATS data also estimated that nearly 553 billion bidis and nearly 105 billion cigarettes are consumed annually in India (see note 1).

In order to estimate the number of premature deaths attributable to cigarette and bidi manufactured and consumed over the last 100 years in India, we first estimated the total numbers of bidis and cigarettes manufactured over the last 100 years (see note 2). For cigarettes, we

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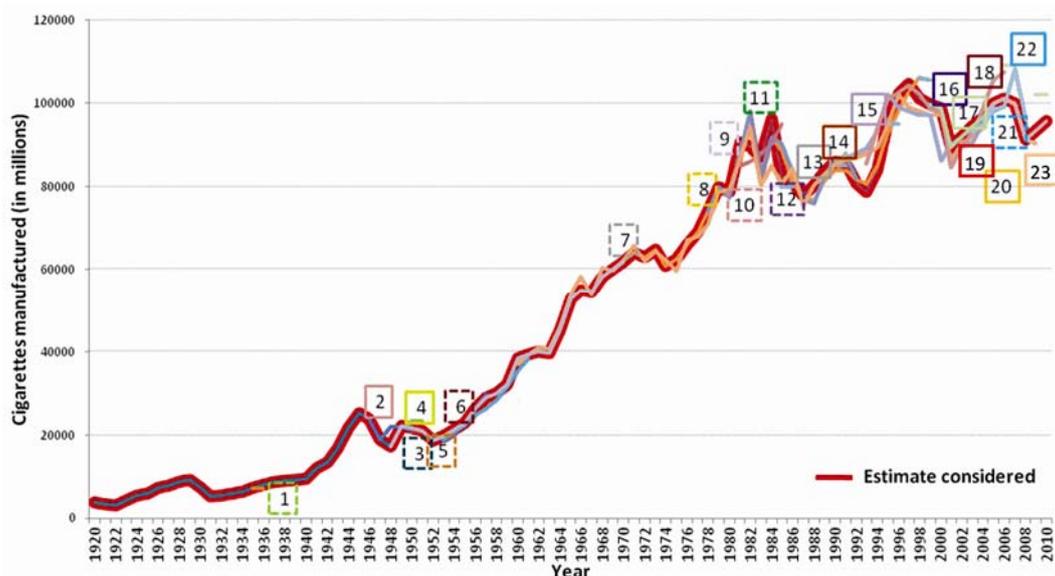


Figure 1. Cigarettes manufactured in India (1920–2010), estimated from various sources.

Data source

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used data from 1920 onwards, as reliable data from 1910 to 1920 were not available. We then used relative risk for mortality derived from the Mumbai Cohort Study.

We collected figures for total cigarettes manufactured in India from multiple sources. These included industry reports, trade and academic journals, paid internet databases, repositories and reports prepared by market research firms from 1920. Of the 23 data sources reviewed, only seven were selected as they covered longer time-frames and provided most conservative estimates of cigarette manufactured (Figure 1). There are no consistent

government records for bidis produced at the national level. To derive total bidis produced, we used total bidi tobacco produced in India using data from the Ministry of Agriculture, Government of India, and divided it by the average tobacco contained in each bidi (0.2 g)^{11–13}. We compared these estimates with 14 other sources (Figure 2). There is negligible export of bidi tobacco; it therefore does not significantly impact the total numbers of bidis derived and is therefore discounted. Bidi export is variable and has ranged from 2% to 7% total production between 1974 and 2010 according to data from the Tobacco Board

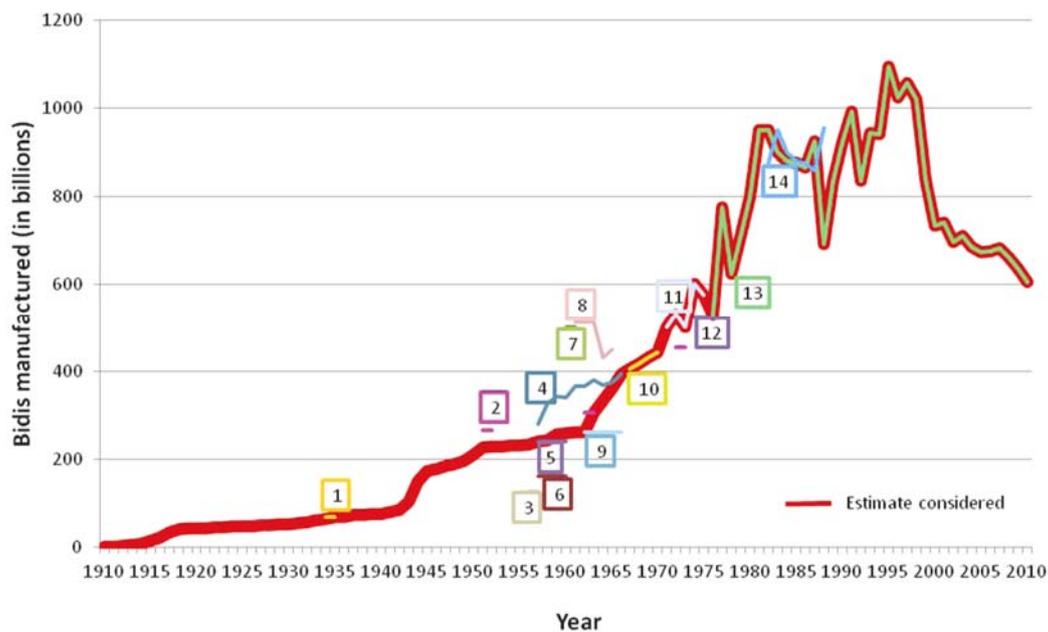


Figure 2. Estimated bidis manufactured in India (1910–2010).

Data source

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of India¹⁴; the overall estimate of bidis manufactured is therefore reduced by 7% to account for tobacco used for this purpose. The total estimated cigarettes and bidis manufactured is shown in Figure 3.

We used relative risk of smoking-associated mortality already published and available in the Mumbai Cohort Study. In brief, this cohort study described 148,173 persons aged ≥ 35 years recruited during 1991–97 and followed-up on an average for 5.5 years. The study had a high response rate ($\sim 95\%$) and concluded that bidi smoking is no less hazardous than cigarette smoking, and smokeless tobacco use may also result in significantly increased mortality. This was the first study from India to report the excess all-cause and cause-specific mortality from smoking and oral tobacco use. The attributable risk

fraction (A) for medical causes of death among cigarette smokers ($R/(R-1)$, where R is the relative risk) is 54.5% (99% CI 50% to 60%) and is obtained from a case-control study of deaths from smoking in India⁷.

During the follow-up period of the Mumbai Cohort Study, a total of around 9,500 male deaths were observed of which $\sim 1,300$ were cigarette smokers and $\sim 2,700$ were bidi smokers. The prevalence of exclusive cigarette smoking (no other concurrent tobacco use) in the Mumbai Cohort Study was around 8% among men and less than 0.05% among women. This study also provides the average number of cigarettes and bidis smoked in a lifetime by an individual, till death. The estimate of total smokers of cigarettes and bidis manufactured for every year in the last 100 years was derived using this average.

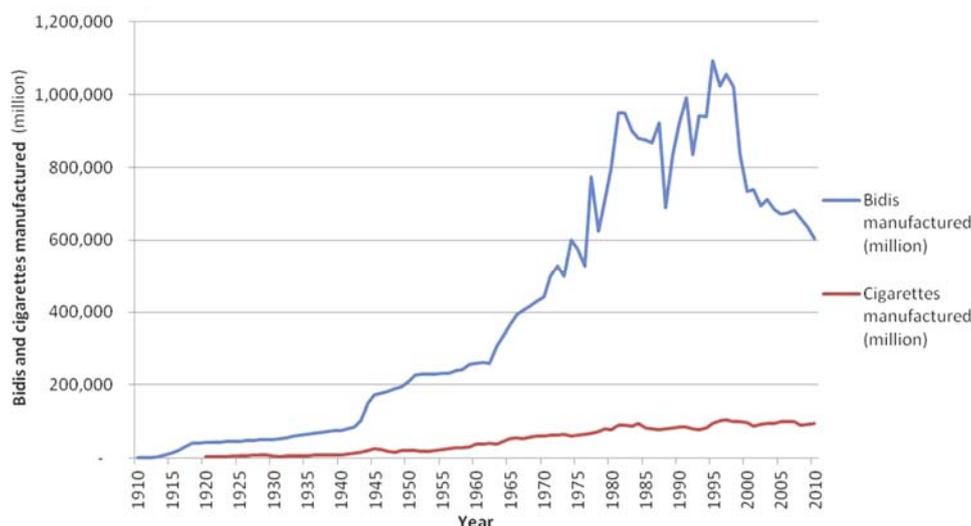


Figure 3. Total bidis and cigarettes manufactured in India (1910–2010).

The average number of cigarettes and bidis consumed by an individual during his lifetime in the Mumbai Cohort Study was 108,131 and 204,068 respectively. Dividing total cigarettes and bidis manufactured between 1910 and 2010 by the average numbers of cigarettes or bidis consumed in a lifetime by an individual provides the estimate of the number of lifetime smokers of cigarettes and bidis (*B*). In the last 100 years, we estimate that there were at least 41.8 million lifetime cigarette smokers (41,810,399) and 190 million lifetime bidi smokers (190,261,400). The number of deaths in males ≥ 35 years attributable to smoking was derived by multiplying the attributable risk fraction of deaths from cigarettes or bidis consumed by the number of lifetime smokers of cigarettes or bidis (that is, *A* multiplied with *B*).

Nearly 4.52 trillion cigarettes and 40.3 trillion bidis (Figure 3) have been produced between 1910 and 2010, which are estimated to be responsible for nearly 100 million (99,768,948 (84,010,930 to 103,418,471)) premature deaths in adult men of ≥ 35 years (Figure 4). Conservatively, bidis are responsible for 76,982,280 premature deaths (63,105,730 to 88,332,231) whereas cigarettes are responsible for 22,786,668 premature deaths (20,905,200 to 25,086,240).

Some of these deaths occurred in the 20th century. There is considerable lead time between consumption (of bidis or cigarettes) and the mortality resulting from it, and this could be between three to four decades of life. Thus the estimated mortality from consumption of tobacco that took place four decades or more previously has been fully realized. For consumption in the last four decades, the mortality may be only partially realized with some of the mortality occurring in the near future. For current consumption, the full realization of mortality according to the estimates is expected to occur by the mid-21st century.

In India, tobacco use, especially the use of bidis and cigarettes begins in early adolescence and early adult life and then continues. Global studies have shown that future mortality in middle or old age occurs about 30–50 years hence^{15–17}. The burden of lung cancer is a reliable indicator of the adverse health outcomes of the smoking epidemic¹⁸. In India, lung cancer grew rapidly between 1950 and 1959, and doubled between 1954 and 1957; hence this is potentially the period when manifestation of the negative impact of smoking was noticed in India^{19–21}. Early studies incriminated bidi smoking with higher risk of cancer²¹, and the Mumbai Cohort Study further established that smoking bidis is no less hazardous than cigarettes²².

Bidi is the major agent of completely preventable, premature death among adult men in India. Bidis rapidly grew from 0.55 trillion annually in the mid-1970s to nearly a trillion every year by the end of the decade. In the mid-1990s, bidi manufacturing peaked and it is estimated that more than one trillion bidis were consistently produced annually. There was a decline in bidi (tobacco) production by 1998 and in subsequent years. In 2010, around 605 billion bidis were produced, which is considerably less than 1 to 1.2 trillion bidis estimated recently²³. Although bidi production (and consumption) may be declining, the full effects of the high number of bidis smoked from 1980 to 2010 will be felt from 2015 till at least 2050. The public health consequence of dual use (that is users who are both chewers and smokers of tobacco products) is also not fully understood.

Cigarette consumption has been growing consistently in this decade, as cigarettes become more affordable for the poor and existing bidi smokers²⁴. Cigarettes will resurge in the coming decades as smokers are expected to graduate from bidis to cigarettes, and more new smokers are likely to take to smoking cigarettes than bidis²⁵.

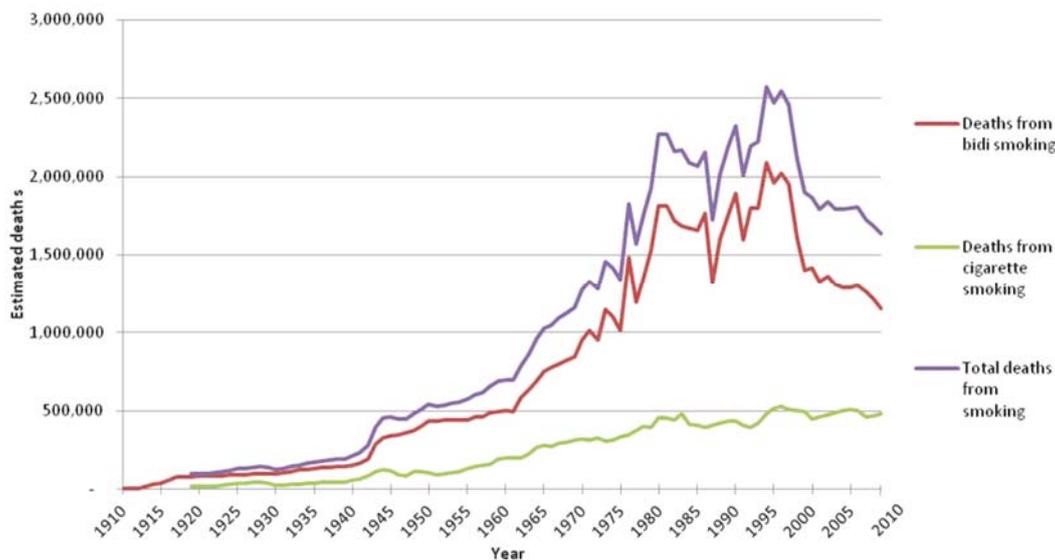


Figure 4. Attributable deaths from smoking of bidis and cigarettes manufactures in the last 100 years in India (1910–2010).

Why then is such a serious public health concern not integral to mainstream public policy? The underlying reason for this is historical. The Government of India has promoted tobacco cultivation and its use since the early 20th century to garner revenue through taxes and provide employment and welfare benefits linking these to rural communities. The economic benefit of promoting tobacco production (and consumption) needs to be weighed against the burden of current and future deaths caused by its use. This study is a step in that direction. Other studies are needed to assess the reasons why tobacco use is still promoted by governments, and the true costs for the society, communities and the government itself.

Our study has some limitations. It estimates mortality only in adult males ≥ 35 . This could be an underestimation since a small fraction of mortality will also occur in younger males, and the very small proportion of female smokers has been excluded. We also assume that (per capita) consumption and the risk fraction for attributable mortality derived from the Mumbai Cohort Study is representative for the entire country and does not change across the entire duration of 100 years. Per capita consumption has changed over time in India. According to the study, per capita consumption of cigarette in India per adult per annum was 80 in 1935, 100 in 1950 and 190 in 1975 (ref. 26). A later review of tobacco use in India by WHO found that this trend had changed – from 190 cigarettes per capita in 1970, 178 in 1980, 102 in 1990, 114 in 1995 and 107 per capita in 2000 (ref. 27). The Tobacco Atlas reports that per capita cigarette consumption in India in 2009 was 99 and in 2011 was 96 (refs 28 and 29). Factoring these changes will further refine the estimation of mortality over time, but is beyond the scope of this communication. Limitation relating to estimation of the cause-specific death rates and cause-specific relative

risks in the Mumbai Cohort Study also applies to the estimations made here.

This study also does not attempt to estimate the indirect effect of smoking on those exposed to its smoke, commonly referred to as second-hand smoke or passive smoking. According to GATS, nearly 29% adults in India are exposed to tobacco smoke in public places. Many more vulnerable groups especially children, are regularly exposed at home as well³⁰. In effect, this study only attempts to estimate death among lifelong smokers who would die prematurely from consuming bidis and cigarettes manufactured over 100 years. It does not estimate the annual mortality from smoking.

More studies using age-wise cohort models are needed to estimate annual mortality and mortality in the future. Research conducted in developed countries has demonstrated that mortality is higher for those who smoke compared to those who have never smoked^{31,32}. In addition, mortality for those who smoked and quit smoking is different from current smokers, and these rates also differ from those who have never smoked³³. The number of cigarettes or bidis smoked per day, the length of time a person has smoked, and the age of initiation also contribute significantly to quitting and therefore have a bearing on mortality. Relationships between smoking and mortality trends in the adult population over time are therefore too complex to be captured, especially in the context of India where population and age-wise data on many of these factors are limited or not available.

Despite these limitations, these conservative estimations of mortality among males ≥ 35 years, from smoking cigarettes and bidis over the last century are probably the only such estimates available and emphasize the striking burden of death from smoking bidis and cigarettes manufactured in the last 100 years in India.

Our calculations are derived from using the most conservative estimates and yet present mortality estimates which are significant and alarming. Results presented here call for an urgent review of tobacco control interventions and efforts, and to also re-examine policies that promote the tobacco industry at the cost of human life in India.

Notes

1. According to GATS, total bidi smokers (73,314,000) × mean number of bidis smoked per day (11.6) × 365 = 552,878,756,000 or 553 billion bidis. Similarly, total cigarette smokers (46,358,000) × mean number of cigarettes smoked per day (6.2) × 365 = 104,908,154,000 or about 105 billion cigarettes.
2. Most studies have correlated production with consumption data. For example Proctor (2001) projects global cigarette consumption and lung cancer mortality (1900–2030) using production data for cigarettes (see ref. 34).

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