



Swiss Re

Centre for Global Dialogue

Risk Dialogue Series

Health Risk Factors India



In collaboration with



HARVARD T.H. CHAN
SCHOOL OF PUBLIC HEALTH

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Preface

Dear reader

We are very pleased to welcome you to this country edition of the Risk Dialogue Series, Health Risk Factors in India.

Non-communicable chronic diseases (NCDs) are becoming increasingly prevalent in high growth and emerging markets. It is important to better understand these trends, both from a public health perspective and in order to build sustainable life and health insurance pools.

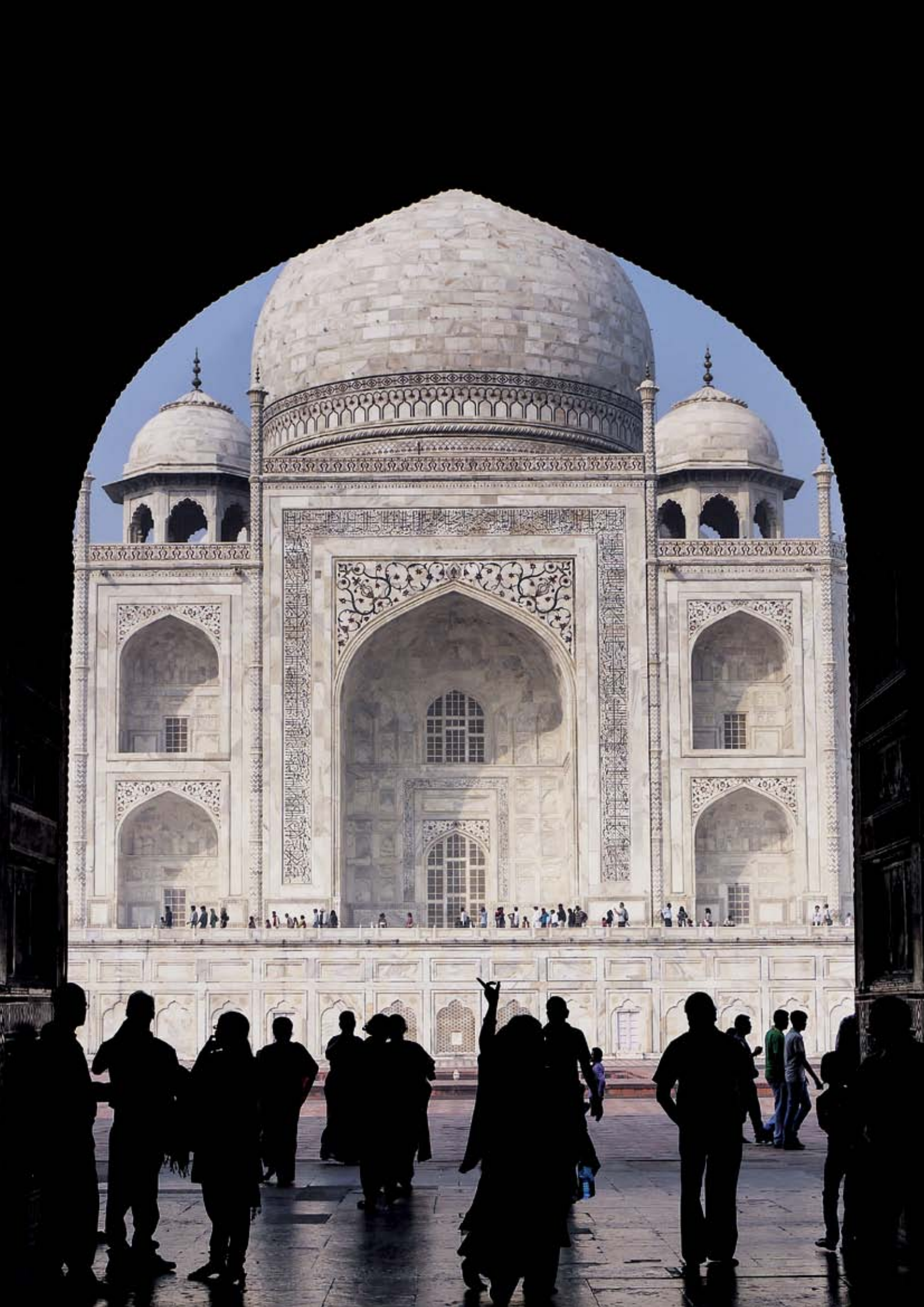
The publication is part of the joint research collaboration by Swiss Re and the Harvard T.H. Chan School of Public Health. The research undertaken by 45 colleagues from both institutions comprises the Systematic Explanatory Analyses of Risk factors affecting Cardiovascular Health (SEARCH) project. The aim of the collaboration is to better understand the relationship between risk factors and health outcomes in the major emerging markets of Brazil, China, India and Mexico. The health profile of these states is changing swiftly and significantly with economic growth. Incidents of NCDs are rising rapidly, providing a major challenge for public and private providers and funders of health care.

India stands at a transition point between the health conditions of developing and developed economies. Hundreds of millions in the vast country still live in rural poverty, coping with undernourishment, poor sanitation, limited health care and outbreaks of infectious disease. However, India has also rapidly urbanised in recent years. Significant segments of the population have shifted their diet to include large amounts of processed food; and have become more sedentary in their jobs and lifestyle. The result is a considerable increase in incidents of NCDs. These twin rural and urban developments are major challenges for the public health authorities. They also highlight the potential positive impact insurance can have in supporting and financing improved health care solutions.

With best regards

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SEARCH – The search for health data and insights from high growth markets

Detloff Rump

India stands on the cusp of rapid shifts in health among high growth markets. Many rural communities continue to suffer outbreaks of infectious disease; while in the cities there are high incidences of non-communicable diseases (NCDs). Particularly notable is that of diabetes; India has more diabetes sufferers than any other country. This SEARCH publication seeks to highlight health data and trends in the country that may make it easier for insurers to price, model and more widely distribute their products.

Life and health insurance and data

Voluntary life and health insurance involves providing coverage to a voluntary risk pool of individuals with a similar risk profile.

Voluntary life and health insurance is the provision of coverage for a voluntary risk pool of individuals who perceive themselves as having a similar risk profile. From an insurance perspective there are three main generic reasons why more data is beneficial:

Having more data helps insurers control insurance risk...

(i) Controlling insurance risk: The life insurance risk landscape is constantly shifting. Pandemics are potentially the most dramatic example of this – a sudden illness that may take many (relatively) young lives. We are currently witnessing a great expansion in chronic diseases, such as cancer and diabetes. These are frequently the product of changing lifestyles. Equally, societal changes can prolong lives. New treatments offer the potential to reduce premature deaths from certain diseases. All of these factors will affect the future claims experience for life and health private insurance pools and influence how insurers price their products.

... extend product coverage

(ii) Extending product coverage: Private, voluntary life and health insurance cannot be all inclusive. Relatively healthy individuals will not willingly accept higher premiums in a pool with high risk individuals. Certain exclusions are inevitable in a private, voluntary insurance system. However, insurance companies, using better data, are able to extend coverage. A notable success in recent years has come with extending coverage to HIV infected individuals in South Africa and similar considerations are currently ongoing in India^{1, 2}.

... and create new products.

(iii) Creating new products: Life coverage has traditionally been distributed through agents, who are required to go through a potentially long underwriting process with their clients. This can be a barrier to retailing, particularly in a digital age in which consumers can purchase most products quickly and easily with a click of a button. Insurers are seeking to use improved data to offer life products that can quickly and easily be offered with minimal underwriting³.

SEARCH – The search for health data and insights from high growth markets

In 2012, high growth markets accounted for 15% of the USD 2621 billion in global life and health premiums.

However, data is often lacking in emerging markets.

Chronic diseases are becoming more prevalent. Diabetes, which was virtually unknown in many high growth markets only thirty years ago, is now quite commonplace.

Some emerging markets are still coping with infectious diseases, while having to deal with the rise in chronic diseases.

Data and emerging markets

On the whole, high growth markets are relatively underinsured. In 2012, they accounted for only 15% of the USD 2621 billion in global life and health premiums⁴. With economic growth, and particularly the growth of the middle class, this figure is expected to grow substantially in the coming years.

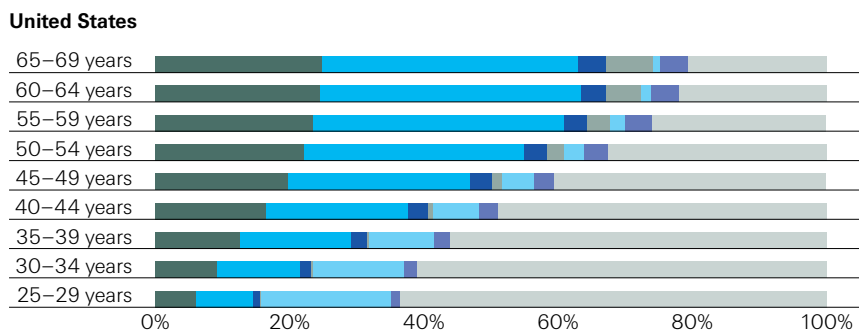
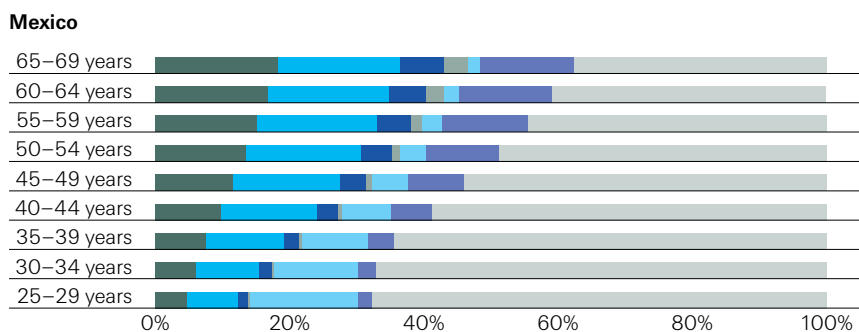
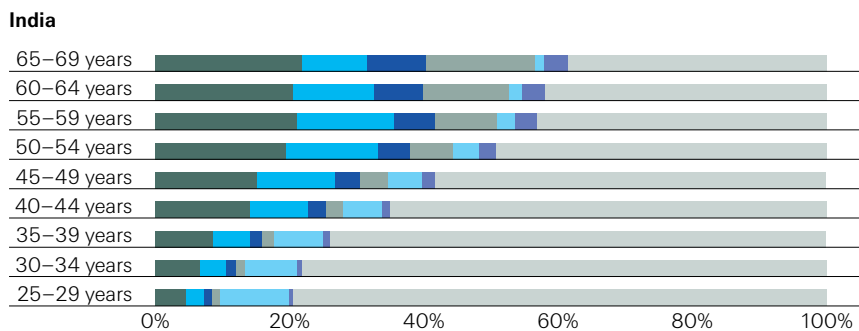
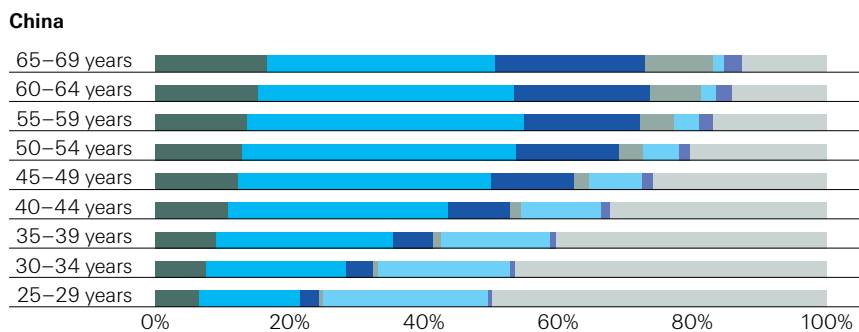
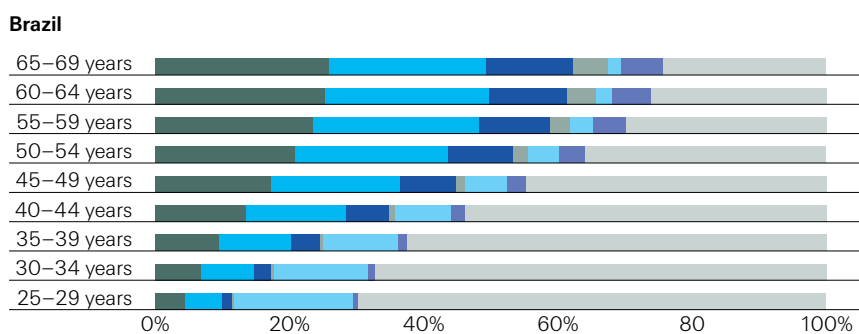
Major insurers are already well placed in the competitive market for new high growth market insurance customers. Frequently, however, standards of data reporting are not what they have experienced in their own developed markets. SEARCH is one attempt to correct and address this relative lack of historic data.

Even where data availability is quite good, the health of many high growth markets is in a state of flux. Through most of human history, the leading cause of death was infectious disease. As communicable diseases are controlled and eliminated, and as populations in many countries have started to age, non-communicable chronic diseases (NCDs) are becoming more prevalent. Diabetes, for example, was virtually unknown in many high growth markets only thirty years ago; due to significant changes in diet, it is now quite commonplace.

The displacement of infectious disease with NCDs has evolved over many decades in developed markets. The pace of change is far more rapid in many high growth markets; to the point that some high growth markets are still coping with serious infectious diseases while having to deal with the rise in chronic diseases. This sudden shift towards chronic disease also means that insurers must face the challenge of anticipating future disease trends.

Figure 1:
Causes of death in 2010 in insurance relevant age intervals in selected countries (% total mortality by age band)

- Heart disease
- Cancer
- Stroke
- COPD
- Transport injuries
- Diabetes
- Other



In the younger age bands, transport injuries are the leading cause of death; but then quickly declines in the older age bands. The key differences observed in the country profiles compared to the USA are: Brazil has a higher stroke death rate (13% vs 4%; age band 50-69); India has a high death rate due to communicable diseases (30% communicable diseases, 10% injuries; 60% NCDs; across all age groups) and shows a high lung disease or COPD (chronic obstructive pulmonary diseases) death rate (16% vs 7%; age band 50-69); China has a heart disease mortality which is lower than in the USA (15% vs 24%; age band 50-69) while death due to stroke is significantly higher in China (19% vs 4%; age band 50-69); Mexico stands out with a high diabetes death rate (14% vs 4%; age band 50-69).

Source: Global Burden of Disease 2010

SEARCH – The search for health data and insights from high growth markets

The ultimate effects of these changes on human longevity have to be seen through the perspective of infrastructure development and public health.

India still suffers from premature deaths as a result of infectious diseases, complications around child birth and undernourishment.

The pace with which NCDs are developing, the ability to treat NCDs, and the sheer scale of NCDs in India are major concerns.

The growth in NCDs is concentrated in the rapidly expanding urban centres; the change in diet is one of the chief drivers.

The ultimate effects of these changes on human longevity have to be seen through the perspective of infrastructure development and public health. Again, there are wide variations within high growth markets, from the relatively sophisticated to those with considerable scope for improvement. This is another factor insurers must anticipate in their modelling.

SEARCH and India

As can be seen from the comparative statistics in Figure 1, India has the lowest level of deaths recorded as a result of NCDs among the SEARCH countries. In one sense, India lags in incidence of NCDs compared to other major high growth markets. The country still suffers from premature deaths as a result of infectious diseases, complications around child birth and undernourishment. Over half of the population work in labour-intensive agriculture, and approximately 40% of the population, according to the World Bank, earn less than USD 1.25 per day.

What is more concerning from the Indian perspective is the pace with which NCDs are developing, the ability to treat NCDs, and the sheer scale of NCDs in currently the second most populous nation on the planet. NCDs currently account for 53% of the total deaths and 44% of disability adjusted life years (DALYs) lost. Projections indicate a further increase to 67% of total deaths by 2030⁵. The number one cause of death among those in middle age is now cardiovascular disease (CVD). Projections suggest there will be dramatic increases in these deaths. Indeed, the notion that India may eventually reach an inflexion point where CVD deaths start to fall again – the pattern of developed nations – is off any sensible forecasting radar⁶.

The growth in NCDs is concentrated in the rapidly expanding urban centres. One of the chief drivers is the change in diet. As with other emerging markets, urban India is taking rapidly to processed foods low in fresh fruit and vegetables, high in sugars, fats and animal produce. This switch in primarily urban diet has been combined with a notable increase in sedentary behaviour. The result has been an explosion of incidence of diseases such as hypertension and diabetes. There are over 60 million type 2 diabetes sufferers in India, the largest of any country⁷. Some are calling India the 'global capital of diabetes'. The number is likely to grow considerably.

The Indian health care system

Only around 25% of the population is estimated to have access to health care services in India.

Of all the countries in the SEARCH study, health care is least developed in India. Only around 25% of the population is estimated to have access to health care services at a level that might typically be found in developed states. India spends just 1.4% of its GDP on health care, well below that of comparable high growth markets, and a considerable way behind that of developed markets. India has approximately 0.7 physicians per 1000 population, placing it slightly below equivalent statistics for lower middle income countries. Those individuals with access to good health care are likely to be urban dwellers and are likely to come from the more affluent social strata⁸.

India has subscribed to the ambitious UN target of reducing NCDs by 25% by 2025.

The authorities have subscribed to the ambitious UN target of reducing NCDs by 25% by 2025. A national monitoring framework is in construction, which will lead to a country-wide action plan. There are many opportunities in this, and potential for success at many levels, particularly given that NCDs are currently largely an urban phenomenon⁵. However, the sheer size of India will always make extensive public health measures a challenge; particularly NCDs in a less developed rural context, the number of which is projected to grow.

The Indian health insurance sector is a mix of mandatory social health insurance (SHI), voluntary private health insurance and community-based health insurance (CBHI). However, demand far outstrips supply.

The Indian health insurance sector is a mix of mandatory social health insurance (SHI), voluntary private health insurance and community-based health insurance (CBHI). However, demand far outstrips supply. The result is queues, waits and scheduling at inconvenient times. The considerable underfunding of the public health services – although there is some variation by geography – requires substantial numbers to parallel private health services. In urban areas, around 70% of households rely on the private sector as their primary health provider⁹.

India and health insurance

In 1972, the insurance industry was nationalised; 107 private insurance companies were consolidated into four public sector insurers and the General Insurance Corporation (GIC) was created as the single national insurer.

According to the Insurance Regulatory Development Authority (IRDA), 16.7% of the Indian population was covered under some form of health insurance in 2012.

As the middle class expands, demand for health insurance looks set to increase considerably.

One of the major challenges for public officials and insurers alike is the affordability of healthcare in a country where poverty remains endemic.

Caring for the sick has long been a part of the Indian ethos. It is a common practice for villagers to take a 'piruvu' (a collection) to support a household with a sick patient. Health insurance, as we know it today, was first introduced in 1912 when the first Insurance Act was passed. The current version of the Insurance Act was introduced in 1938. There was little change until 1972 when the insurance industry was nationalised; 107 private insurance companies were consolidated into four public sector insurers and the General Insurance Corporation (GIC) was created as the single national insurer. Private and foreign insurers were allowed to enter the market with the enactment of the Insurance Regulatory and Development Act (IRDA) in 1999.

According to the Insurance Regulatory Development Authority (IRDA), 16.7% of the Indian population was covered under some form of health insurance in 2012, of which government schemes accounted for 12.1%. Group insurance provided by employers constituted 2.8%, and only 1.9% of the population (23.6 million) bought health insurance on a voluntary basis. Growth in health insurance has been impressive in the recent past, averaging 28.4% per annum between 2001 and 2012. Nonetheless, it is from a very low basis, just 0.17% of India's GDP¹⁰. As a result, some 75–80% of health care spending is currently directly out of pocket⁸. This heavy out of pocket expenditure is estimated to push millions into poverty every year, as health bills force individuals into debt or lead to cuts in expenditure elsewhere.

The potential to expand insurance coverage is therefore massive. The insurance market has historically been relatively protected, with limited access to foreign investors to challenge the giant state insurance providers. As the middle class expands, demand for health insurance looks set to increase considerably, with one estimate targeting fourfold growth between 2013 and 2020 to USD 11 billion¹⁰. Given relatively recent liberalisation, the four nationally owned general insurers command 60% of the market share.

One of the major challenges for public officials and insurers alike is the affordability of healthcare in a country where poverty remains endemic. One ground breaking scheme, launched in the Southern province of Tamil Nadu, involved the government covering the insurance premiums of millions of low income citizens¹¹. Impressive reductions in key health ratios have already been recorded. It highlights the potential success that can be achieved in public-private collaborations; and in a country which does not always provide an easy operating environment for private insurers, this could be an even greater bonus.

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Chronic diseases in India: Burden and implications

K. Srinath Reddy, Sailesh Mohan

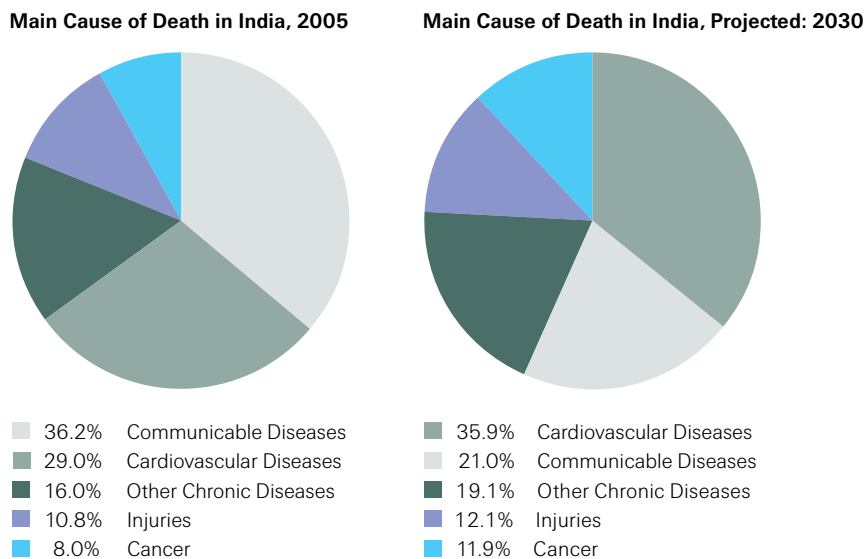
India currently faces the dual burden of communicable diseases and chronic non-communicable diseases (NCDs) such as cardiovascular disease (CVD), diabetes, cancer and chronic obstructive pulmonary disease (COPD). Success in controlling communicable diseases to some extent, as well as increased longevity and changes in people’s lifestyles driven by health transitions and economic progress, are contributing to the increase in NCDs. Increasing burden of NCDs has had not only obvious health implications, but also economic and developmental consequences. In this paper, we outline the major reasons for the increase in NCDs, the current and future risk factor and disease burdens, the responses so far and suggest key public health actions that can contribute to addressing and controlling NCDs effectively.

Why are NCDs increasing in India?

Deaths from non-communicable diseases (NCDs) have risen due to changes in demography, epidemiology and nutrition.

Substantial progress in societal development, health, nutrition and life expectancy occurred during the latter half of the 20th century. Consequently, deaths from communicable diseases have decreased, while those from NCDs have risen. This has been attributed to changes in demography (eg population ageing), epidemiology (eg the shift from communicable to non-communicable diseases) and nutrition (eg high caloric consumption and low physical activity levels). As a result, NCDs currently account for 53% of the total deaths and 44% of disability adjusted life years (DALYs) lost. Projections indicate a further increase to 67% of total deaths by 2030. CVD is the major contributor to this burden, attributable to 52% of NCD associated deaths and 29% of total deaths (Figure 1) ^{1,2}

Figure 1: Causes of death in India

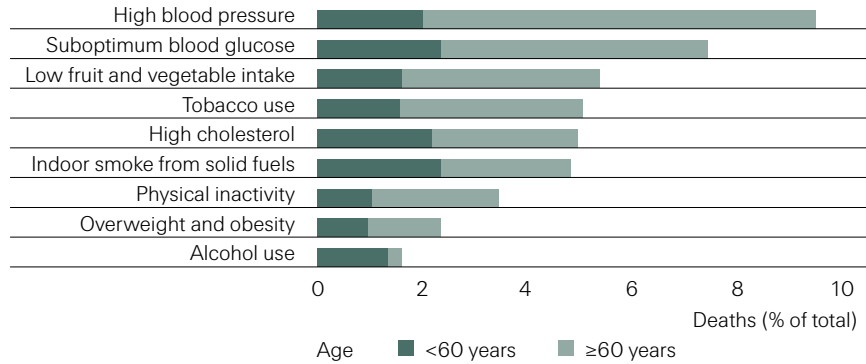


Source: Adapted from Patel V et al (2011)¹ and Mohan S et al (2011)²

What are the major risk factors?

Chief NCD risk factors are shown in Figure 2 and their contribution to the disease burden summarised below.

Figure 2: Deaths (%) from leading risks in India



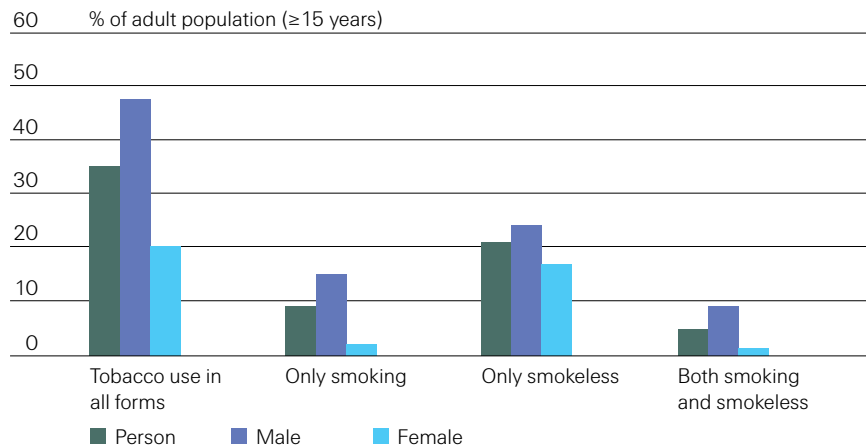
Source: Adapted from Patel V et al (2011)¹

Tobacco use

There are 275 million tobacco users in India. By 2030, nearly 1.5 million deaths will occur annually due to tobacco use.

In India, tobacco is widely used in many forms (eg bidis, cigarettes and electronic cigarettes). The country is the second largest producer and the third largest global consumer of tobacco. There are about 275 million tobacco users (Figure 3). Tobacco use is a leading preventable cause of premature, NCD-associated death and disability. Its use is increasing among India’s youth, women and the poor. Almost a million deaths per year are attributed to tobacco use, with most of these deaths occurring among the poor and the economically productive group aged 30–69. By 2030, nearly 1.5 million deaths will occur annually from tobacco use. However, it not only entails health implications, but also significant economic costs. The conservative cost of treating three major tobacco-related NCDs (cancer, heart disease and COPD) in 2002–2003 was estimated to be INR 308.3 billion (USD1=INR 60), which far exceeds the revenue added by tobacco taxes to the public exchequer^{3,4}.

Figure 3: High tobacco use in India



Source: Adapted from Global Adult Tobacco Survey⁴

Diet, physical activity and alcohol use

Oil and fat intake among the Indian population has increased substantially since the early 1990s.

Even though discernible changes in the per capita calorie consumption over the past few decades in India have not been reported, there have been noteworthy increases in edible oil and fat consumption, both in rural as well as urban areas. Oil intake had increased from 18 grams per person daily in 1990–1992 to 27 grams per person daily in 2003–2005, while fat intake increased from 41 grams to 52 grams per person daily during the same period. Aggregate consumption data also indicate an increasing trend in edible oil consumption, which has grown from 9.7 million tonnes in 2000–2001 to 14.3 million tonnes in 2007–2008, with a high proportion of unhealthy oils high in saturated and trans-fats that are linked to NCDs, particularly CVD².

Inadequate fruit and vegetable consumption, the lack of physical activity and the adoption of sedentary lifestyles are among the factors that are contributing to the rise of NCDs.

Conversely, fruits and vegetable consumption, which provides protection against NCDs, is inadequate, particularly among the poor. Similarly, physical activity, another protective factor is at less than recommended levels, with 29% of the population being insufficiently active. Rapid and extensive urbanisation, increased mechanisation of work and adoption of sedentary lifestyles are attributable to reduced activity levels².

Salt consumption is also very high in India.

Dietary salt consumption, a key determinant of hypertension and associated CVD, is also very high, with the average intake ranging between 9–12 grams/day, far exceeding the World Health Organization (WHO) recommended intake of ≤ 5 grams/day².

Alcohol consumption is on the rise and is highest among the poor and less educated.

Alcohol consumption, which results in not only adverse health outcomes, but also social implications, is increasing. It accounts for a significant proportion of neuropsychiatric disorders, fatal road traffic accidents and suicides. Use of alcohol is higher among the poor and less educated, but disconcertingly is also increasing among youth.

Cardiovascular disease

About 2.7 million people die of CVD annually in India. Roughly 30 million people suffer from coronary heart disease.

Currently, about 2.7 million people die of CVD annually. This figure is projected to increase by 1.5 million by 2030. Estimates suggest that currently there are about 30 million coronary heart disease (CHD) patients, with 14 million residing in rural and 16 million in urban areas. The prevalence of CHD in those aged ≥ 20 years ranges from 6.6%–12.7% in urban areas and 2.1%–4.3% in rural areas. During the past few decades, CHD prevalence has increased almost fourfold in rural areas and sixfold in urban areas as a result of varied health transitions. Paralytic stroke prevalence is 334–424 per 1 000 000 population in urban areas and 244–262 per 1 000 000 population in rural areas. Notably, about 10–12% of all stroke deaths in India occur in those below age 40, highlighting the huge impact on families, households and the nation's economy as it affects workforce productivity^{2,5}.

Diabetes mellitus

According to the International Diabetes Federation, there are about 65 million people with diabetes in India.

Type-2 diabetes mellitus has been rising rapidly. Until recently, India was often referred to as the 'diabetes capital' of the world. The most recent estimates from the International Diabetes Federation (IDF) suggest that there are about 65 million people with diabetes. This figure is projected to increase to 109 million by 2035⁶. Moreover, diabetes is an important risk factor for CVD; in persons with diabetes, CVD is the major cause of death and disability. Diabetes currently accounts for almost a million deaths annually.

Hypertension

Hypertension is the leading risk factor for CVD and accounts for nearly 10% of all deaths in India.

Hypertension is the leading risk factor for CVD and accounts for nearly 10% of all deaths in India. Currently 20–40% of adults in urban areas and 12–17% of adults in rural areas suffer from it. The number of people with hypertension in India is projected to nearly double from 118 million in 2000 to 213 million by 2025. Moreover, nearly 40% adults have pre-hypertension, a precursor condition with high likelihood of converting into hypertension if left unaddressed^{1,5}.

Chronic diseases in India: Burden and implications

Chronic obstructive pulmonary disease (COPD) is more common among men but on the rise among women.

Chronic obstructive pulmonary disease

Chronic obstructive pulmonary disease (COPD) is more common among men and has been attributed to the use of tobacco. The prevalence of the disease is also increasing among women due to indoor air pollution resulting from the use of solid fuels for cooking. The number of COPD patients is estimated to increase from 13 million in 1996 to 22 million by 2016, with many likely to require hospitalisation. This will lead to financial repercussions for both patients and the resource constrained healthcare system².

About 800 000 new cases of cancer and 550 000 deaths occur in India each year.

Cancer

Each year about 800 000 new cases of cancer and 550 000 deaths occur in India. The most common cancers in men are those of the oral cavity, oesophagus and lung, while women suffer primarily from cervical, breast and ovarian cancers. Early diagnosis and treatment are often delayed, with more than 75% of cancer patients first surfacing and seeking care when they are already in the advanced stages of the disease². This vastly decreases the likelihood of positive treatment outcomes. Tobacco use is one of the leading risk factors, while alcohol use contributes to a substantial proportion of head, neck and stomach cancers.

There is a huge gap between detection and adequate treatment of NCDs. The use of proven, inexpensive evidence-based secondary prevention therapies is also very low.

Inadequate management and secondary prevention

Notwithstanding the availability of proven and effective prevention and treatment strategies for major NCDs like hypertension and diabetes, their management vis-a-vis detection and control rates are abysmally low. There is a huge gap between detection and adequate treatment: less than half of those who have hypertension or diabetes are actually detected, less than half of those detected receive appropriate treatment and less than half of those receiving treatment have their blood pressure or blood sugar treated to recommended targets ("The rule of halves"). In addition to poor control rates, of considerable concern is the fact that once hypertension-related CVD occurs, the use of proven, inexpensive evidence-based secondary prevention therapies is also very low in primary and secondary care, leading to a large and escalating burden of avoidable and premature mortality². A recent global study indicated that up to 80% of individuals were not on proven and effective life-saving drug treatment after a stroke or heart attack. This results in avoidable complications, increased healthcare costs, poor quality of life, premature disability and death⁷.

Most people suffering from NCDs incur out-of-pocket expenses for their healthcare costs.

Economic impact of NCDs

NCDs and risk factors entail huge costs not only to individuals, but also to the national economy. Most people suffering from NCDs incur out-of-pocket expenses for their healthcare costs. Medicines account for up to 45% of this expenditure. In 2004, the annual income loss among working adults due to NCDs was INR 251 billion (USD 4bn).

The annual total cost of diabetes care in India was estimated to be USD 32 billion.

In 2010, the annual median direct cost per diabetic patient was reported to be USD 525, and the annual total cost of diabetes care in India was estimated to be USD 32 billion. During 2005–2015, the projected income loss due to CVD and diabetes alone is likely to exceed USD 237 billion. To obtain NCD care, individuals and families often resort to distress financing and pay vast amounts, which impoverish and ultimately drive people into poverty. Furthermore, families suffering from NCDs suffer income losses not only due to disease, but also due to care giving and premature death^{8, 9, 10}.

Special features of NCDs in India

CVD, diabetes and associated deaths in India occur at younger ages. The poor suffer increased exposure to risks such as tobacco use and hypertension; they are also more likely to suffer from CVD and diabetes.

In comparison to developed countries, NCDs, particularly CVD, diabetes and associated deaths in India occur at younger ages with related adverse health, economic and societal consequences. This is mainly attributable to the higher risk factor burden at younger ages, earlier disease onset (at least 10 years younger), premature mortality, and higher fatality rates of CVD-related complications. Indians also have a higher predisposition to develop CVD and diabetes at lower thresholds of overweight and obesity^{1, 2, 11}. Reports also indicate the reversal of the social gradient, whereby the poor suffer increased exposure to risks such as tobacco use, hypertension and acquiring diseases such as CVD and diabetes, a situation similar to that observed in developed countries that already have undergone health transitions¹². Compared to other countries, India suffers a very high loss in potential productive years of life because of premature CVD deaths in those aged 35–64: 9.2 million years were lost in 2000 and 17.9 million years are expected to be lost in 2030¹³. These factors are further compounded by the poor lacking access to expensive medical care once disease occurs, leading to widening disparities in care and social inequity.

Current efforts to address NCDs

The focus is still largely on providing acute care and not on providing chronic care.

The health system has not yet fully re-oriented to effectively address the rising burden of NCDs, as the focus is still largely on providing acute care and not on providing chronic care. Thus, there are considerable inadequacies in service delivery both at the primary and secondary care levels. Heterogeneity of providers and wide variations in the quality, availability and accessibility of care have led to disparities, with the rich having access to the most expensive, evidence-based care and the poor lacking access to basic primary care. Efficient referral systems within the public sector as well as between the public and private sectors are also weak. Required emphasis on early diagnosis and evidence-based management approaches are also limited in both the public and private sectors. Furthermore, in the absence of financial risk protection, most people with NCDs pay out of pocket to cover their healthcare costs.

The government has initiated a national programme to address NCDs in addition to existing programmes that address cancer, tobacco, mental health and healthcare of the elderly.

The government has initiated a national programme to address NCDs in addition to existing programmes that addresses cancer, tobacco, mental health and healthcare of the elderly. The National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) has hypertension and diabetes as two of the focus areas. It is being implemented in 100 districts and expected to cover the rest of the country within the 12th 5 year plan period. The NPCDCS aims at: a) assessment of risk factors, early diagnosis and appropriate disease management for high risk groups; and b) health promotion for the general population. Debates are ongoing on implementing universal health coverage strategies, health sector strengthening and reforms that can likely contribute to reducing NCDs¹⁴.

India has also taken steps to discourage the use of tobacco.

India is a signatory to the WHO Framework Convention on Tobacco Control (FCTC) and is implementing the Cigarettes and Other Tobacco Products Act, 2003 (COTPA), which requires smoking bans in public and work places, advertisement bans, prohibits sales to and by minors, and regulates the contents of tobacco products and graphical health warnings on tobacco product packages.

Chronic diseases in India: Burden and implications

Many countries have now agreed to a goal of 25% reduction in NCDs by 2025 and to establish a global monitoring framework to measure progress.

The way forward to address NCDs

Following the landmark United Nations High Level Meeting on NCDs in 2011, which concluded that NCD prevention and control is a high priority issue, many countries have now agreed to a goal of 25% reduction in NCDs by 2025 and to establish a global monitoring framework to measure progress toward this goal¹⁵. The Ministry of Health and Family Welfare in India is in the final stages of establishing a national monitoring framework that is in alignment with the global framework and developing an action plan to prevent and control NCDs¹⁶. The aforementioned global goal and the framework are anticipated to provide an impetus to prioritise NCD control efforts in India to improve population health. A cohesive national action plan that incorporates effective public health interventions to minimise risk factor exposure in the whole population and to reduce the risk of disease related events in individuals at high risk is necessary. Despite many challenges that are likely to be encountered, there are also opportunities to initiate actions required for attaining the WHO-UN goal of 25% reduction in NCD-related mortality. This combination of the population approach and the high risk clinical approach is synergistically complementary, cost-effective, and sustainable; and provides the strategic basis for early, medium and long term impact on NCDs in India in alignment with the aforementioned WHO-UN mandate.

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Urbanisation in China and India: Impact on cardiovascular risk factors

Nancy Long Sieber

China and India, the world's largest nations, are undergoing unprecedented change as their economies expand and more of their populations move into cities. While these developments can potentially promote increased wealth, a more varied diet and better access to health care, they also bring risk. The lifestyle changes that occur as people become urbanised, including increasing consumption of high calorie processed foods, exposure to higher levels of ambient air pollution, and fewer opportunities for physical activity, can translate into a greater risk of obesity, diabetes and cardiovascular disease. This paper will examine how urbanisation occurs in these two countries, and how this process affects the risk of cardiovascular health now and in the future.

As China and India grow, and become industrialised, their populations are moving from rural areas into cities.

Introduction

As the world's two largest nations grow and become industrialised, their populations are moving from rural areas into cities. Cities offer economic opportunities and better access to education, two factors that improve both the health and wealth of citizens. However, urbanisation also brings perils. Fast and processed foods are more available in cities. Work is less likely to involve physical activity, and the streets are less friendly to pedestrians and cyclists. The urban environment is also more likely to be polluted, with air pollution being a particular concern. A challenge for India and China is to manage the process of urbanisation to maximise the economic benefits, while minimising the cardiovascular and other health risks that come with it.

China is urbanising more rapidly than India, even though their populations are similar in size.

China is urbanising more rapidly than India, with 52% of its people living in cities, compared with 32% of Indians, according to 2012 World Bank statistics¹. It is notable that India lags in urbanisation, despite being home to a population similar in size to China's, but with a landmass that is just one-third as large. The relative lack of arable land in China is one factor promoting urbanisation in China, but cultural and political factors are also key.

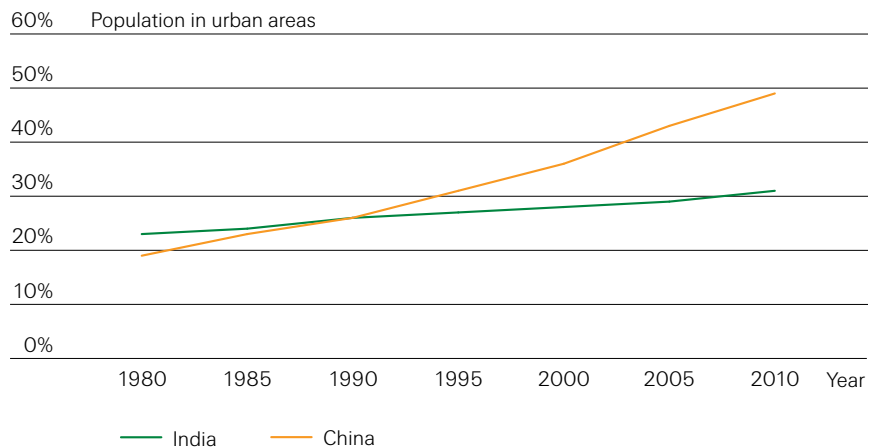
Figure 1:
Population, density, landmass and life expectancy in China and India



Sources: China: National Bureau of Statistics; India: United Nations World Population Prospects

Urbanisation in China and India: Impact on cardiovascular risk factors

Figure 2:
Urbanisation in India and China, 1980–2010



Source: The World Bank – World Development Indicators 2012

India and China are approaching the challenge of urbanisation in different ways.

India and China face similar challenges of growing populations that are drawn to the economic opportunities provided by the cities. However, each country approaches these challenges in different ways, leading to different impacts on the health of urban dwellers.

Urbanisation in China

China exerts control over where people live by assigning a home district to each citizen. Those who move lose government benefits and status.

With its centralised government, China is able to exert control over where its people live. This is achieved by the use of the household registration system known as hukou. These rules, which were established in 1958, assign a home district to each citizen. The hukou system determines who is eligible for full citizenship in any particular place, including access to education, welfare, food subsidies and healthcare. These rules were initially used to maintain stability and control during the rapid industrialisation of China's "Great Leap Forward"². It also ensures cheap labour, as the many migrants who do move to cities lose their expensive government benefits and are willing to work in low-paying jobs. The hukou rules often cause families to split up, with one or both parents working in the city, while the children remain at home under the care of grandparents. Alternatively, families may reside on the edges of the cities or crowded into small apartments. Due to the differences in the income and status of a legitimate city dweller versus an unauthorised migrant, the hukou system has been compared with apartheid or a caste system³. Migrants, often known as the "floating population" make up as much as 20% of the population of many cities. The migrant population is often left out of official census numbers. When these data are used to calculate GDP, China's cities appear to be far more prosperous than they actually are⁴.

China is actively encouraging urbanisation and plans to have 60% of its population living in cities by 2020.

China's future development plans encourage urbanisation, but in a controlled manner. In March 2014, the State Council of China released their "National New-type Urbanization Plan for 2014–2020". Central to this plan is the goal of having 60% of its population living in cities by 2020. The hukou rules are now being used to encourage people to move to certain cities, particularly smaller factory towns in the middle of the country, while discouraging movement to the more cosmopolitan and wealthier eastern cities, such as Shanghai and Beijing. For example, a rural migrant working in Shanghai might be offered hukou in an inland industrial city, creating an incentive for them to live and work in this less desirable place. Beijing has pledged to gradually loosen its hukou rules in coming years to accommodate young migrants who generally spend more freely than their elders, thereby boosting the city's economy^{5,6}.

Urbanisation in India

Mahatma Gandhi did not necessarily oppose urbanisation in India, but he felt it was important that villages maintain their self-sufficiency and autonomy.

Only about one-third of the population lives in cities. Even city dwellers and Indian living abroad retain a close connection to their ancestral villages.

Unlike China, urbanisation in India is far less regulated. This has led to a rise in the number of urban slums.

Figure 3:
A “notified” slum – recognised by the government

At the dawn of the modern era, Mahatma Gandhi encouraged Indians to keep the ideal of village life central to their development plans, stating, “The future of India lies in its villages”⁷. Gandhi did not necessarily oppose urbanisation, but he felt it was important that villages maintain their self-sufficiency and autonomy, a philosophy that he termed *swadeshi*. He emphasised the importance of small communities continuing to function as independent entities, not just adjuncts to the growing cities.

Gandhi’s ideal continues to shape India. With only about a third of its population living in cities, the village remains an important touchstone in the lives of most Indians. In fact, city dwellers and even Indians living abroad often retain a close connection to their ancestral villages. Unlike China, where agricultural lands are owned by the state, and rights to farm the land are distributed more or less equally among all farmers, India has a wealthy class of landowners, whose extended families have lived for generations in their villages. These connections tend to keep people close to their home villages, where they contribute to its cultural and economic life. However, there are fewer opportunities for landless rural workers, and they are far more likely to become migrants. Some reports estimate that migrants make up as many as one-third of India’s population. However, many of these migrants remain in the rural workforce, following harvests and returning home periodically. Others move to the cities in search of better opportunities⁸.

Compared to China, urbanisation in India is far less regulated, with migrants freely settling in large cities. This has led to the expansion of urban slums, which are estimated to number 49 000, and to house some 65 million people⁹. Some slums, known as “notified” slums, are set aside by the cities as housing for migrants. While they may lack running water, they often have electricity and can provide minimal housing for labourers and even office workers. They are also home to many cottage businesses, such as leather work and sewing. Other “non-notified” slums, which house about half of India’s slum dwellers, are makeshift structures under bridges or along sidewalks¹⁰. The lack of even the most basic facilities makes it difficult for people residing in these slums to find work in the formal sector.



Notes: Notice satellite dishes on several of the units, indicating electrical service and disposable income.

Source: author

Figure 4:
Tents crowd many Delhi sidewalks



Source: author

Rural poverty rates are on the decline, while urban poverty is on the rise.

While incomes are generally lower in the countryside, rural poverty rates are declining; meanwhile, urban poverty is growing. This change is largely the result of poor farm workers leaving the countryside and becoming poor urbanites. For most migrants, the hope of a better life in the city fails to materialise. A recent report by UNICEF shows that across India, poor children in the cities fare no better than poor children in rural areas. About 48% of poor urban children are malnourished, as are 47% of poor rural children. Poor urban mothers are slightly more likely to be anaemic (59%) than their rural counterparts (57%). Cultural traditions, such as child marriage occur at equal rates among the poor in the city and the countryside, at 48%⁸.

The impact of urbanisation on cardiovascular risk is unclear. In low and middle income countries (LMICs), greater wealth tends to be associated with higher risk of obesity and diabetes. Air pollution in cities in developing countries is notably bad.

How does city living affect cardiovascular risk?

The impact of urbanisation on cardiovascular risk is unclear. People who live in cities tend to be better educated and wealthier than people in rural areas, two factors that are associated with better health in general. In addition, city dwellers have access to a more varied diet, including fresh fruits and vegetables. They also have better access to running water, transportation and health care. However, in low and middle income countries (LMICs), greater wealth tends to be associated with higher risk of obesity and diabetes. In addition, air pollution in cities in developing countries is notably bad.

It is difficult to assess the health impact of urban life by comparing the life expectancy of city dwellers to that of people who live in rural districts.

It is tempting to assess the health impact of urban life by comparing the life expectancy of city dwellers to that of people who live in rural districts. However, such a comparison is confounded by the large numbers of migrants in both India and China. A person who migrates to the city as a young adult has had very different dietary and other exposures, relative to a person who lived their whole life in the city or in a village. For countries undergoing such rapid change, these numbers do not tell the complete story.

Table 1:
Data showing a longer life expectancy in the cities may not tell the whole story

Life expectancy	Urban	Rural
China (2005)	75	69.2
India (1998–02)	67.9	61.2

Sources: China Human Development Report 2005¹¹; ABRIDGED LIFE TABLES: 2003–07 to 2006–10 of India¹²

It is more meaningful to assess the impact of urbanisation on health by considering differences in known risk factors between cities and the countryside.

A more meaningful way to assess the impact of urbanisation on health is to consider differences in known risk factors between cities and the countryside. This gives us an idea of the exposures that occur in both places, and also provides targets for improving health in either locale.

We consider these variables individually.

Diet

Most migrants who move to the city experience dramatic changes in diet due to the higher cost of food in cities.

For most migrants, moving to the city leads to dramatic changes in diet. In India, basic foods, such as fruits, vegetable and milk cost about 1.5 times more in the cities than in the countryside. Furthermore, the cost of these foods more than doubled between 2007–08 and 2011–12, putting stress on food budgets of rural to urban migrants who can no longer supplement their diet with home grown foods¹³. In addition, small living spaces with inadequate kitchens make it difficult to prepare food from scratch.

Fast food companies have entered the urban food market in India with dishes that are often high in calories and sodium.

Given these constraints, it is inevitable that homemade dishes will increasingly be supplanted by the abundant array of street food available at every turn in the city. Fast food companies have aggressively entered the urban food market as well. Chain restaurants account for an estimated USD 2.5 billion in revenue in 2013, and are expected to earn USD 8 billion by 2020¹⁴. Some western chains have even co-opted Indian street food specialties, like the aloo tikki, a deep fried potato patty. Dubbed the McAloo tikki, McDonalds offers their version of this food – a sandwich made with a deep fried potato patty, served with a side order of french fried potatoes, which when accompanied by a medium soft drink, adds up to about 1000 calories and more than 1200 mg of sodium, according to the McDonald’s website.

The risk of obesity among urban factory workers is far higher than that of people living and working in the countryside.

It is not surprising, therefore, that the risk of obesity among urban factory workers is far higher than that of people living and working in the countryside, with migrant factory workers falling in between the two groups¹⁵.

Table 2:
Obesity odds ratio in among urban, migrant and rural workers in India

	Male	Female
Urban	3.83 (2.95–4.98)	4.89(3.56–6.72)
Migrant	3.12 (2.44–3.98)	3.86 (2.88–5.19)
Rural	1	1

Notes: Risk of obesity, (BMI >25 kg/m²), in urban dwellers and migrants relative to rural dwellers. The migrants were paired with a non-migrant (rural) sibling, 2005–2007.

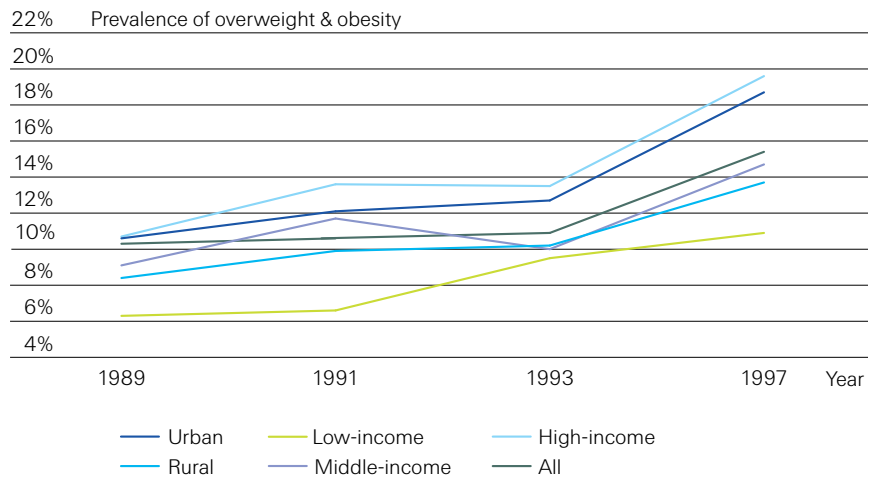
Source: Ebrahim S et al (2010)¹⁵

Urbanisation in China and India: Impact on cardiovascular risk factors

City dwellers in China are more prone to obesity, particularly people with disposable income.

Figure 5: Prevalence of overweight and obesity in China

Similar trends are seen in China, which accounts for nearly half of the global revenue of Yum Foods, owner of Taco Bell, KFC and Pizza Hut¹⁶. City dwellers in China are more prone to obesity, particularly people with disposable income (Figure 5)¹⁷.



Source: Wang et al (2006)¹⁷

India and China have gained notoriety for their levels of air pollution.

Air pollution

India and China seem to be locked in competition for the world's worst air quality. In 2013, China was embarrassed by off-the-charts levels of particulate air pollution, which were measured at the US embassy in Beijing, and widely reported in the media¹⁸. This year the attention turned to India, whose cities were reported by the WHO to have the highest level of especially dangerous PM_{2.5} particles. The WHO air quality guidelines recommend annual mean levels of PM_{2.5} be less than 10 µg/m³. High levels are associated with an increased risk of heart attack and stroke¹⁹.

In 2010, air pollution is thought to have contributed to 1.2 million deaths in China, and 620 000 deaths in India.

According to the WHO report, ambient air pollution was estimated to contribute to 3.7 million deaths worldwide in 2012, 88% of which occurred in low and middle income countries. In 2010, air pollution is thought to have contributed to 1.2 million deaths in China, and 620 000 deaths in India, reflecting the larger urban population of China. However, Indian cities are more polluted than cities in China. Delhi has the world's highest levels of PM_{2.5} at 153 µg/m³. The next three highest cities are also in India, and they range from 134–149 µg/m³. The most polluted city in China is number 36 on this list, the city of Lanzhou with 71 µg/m³ of PM_{2.5}²⁰.

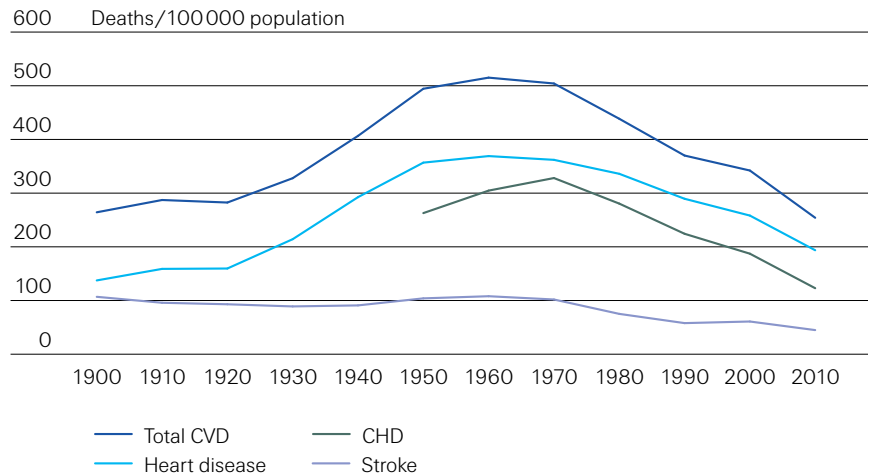
Cardiovascular health suffers in China and India due to the rise in the number of less physically demanding jobs, air pollution and traffic problems that make it difficult to walk or bike.

Physical activity

Many factors combine to reduce the level of physical activity in China and India. Most rural migrants leave farming jobs, which provide aerobic exercise, to take jobs in factories or in construction sites, which, while physically demanding, do not generally improve cardiovascular health. Air pollution and traffic problems in both countries make it difficult for people to walk or bike. China's bicycle fleet decreased by 35%, from 670 million to 435 million, between 1995 and 2005²¹. However, there are some signs of a resurgence in the popularity of cycling, particularly with newly engineered bicycle paths in some cities²². In India, streets are often obstructed by vendors or make-shift housing that impede walking and cycling, making exercise difficult.

Urbanisation in India and China resembles that of the United States and Europe in the early 20th century.

Figure 6:
Death rates for cardiovascular diseases in the US, 1900–2010



Notes: This data is not age-adjusted.
Source: National Heart, Lung and Blood Institute Factbook, 2012²³

Heart disease declined in the US in large part due to lower rates of cigarette smoking, improved diets and leisure time physical activity.

While some of the decline in heart disease mortality is due to medical control of cardiovascular risk factors, as well as better treatments for heart attacks and strokes, much has come from lifestyle changes – particularly among wealthier and better educated people – such as lower rates of cigarette smoking, improved diets and leisure time physical activity²⁴. So while the wealthy city dwellers were the first to experience this increase in cardiovascular risk, they have also been the first to make the changes necessary to reduce their risk, and to reap the benefits of these changes. In the US, smoking and obesity, the two largest behavioural risk factors, are now far more common among the poor than the wealthy.

In China, heart disease incidence is higher among city dwellers than rural residents. In India, cardiovascular risk factors are also higher in the urban and migrant population than in the rural population.

These trends are beginning to play out in China, where the age-adjusted standardised coronary heart disease incidence among city dwellers is 73–81 per 100000 higher than among the rural population²⁵. In India, cardiovascular risk factors, including hypertension, diabetes, and glucose intolerance are higher in the urban and migrant population than in the rural population¹⁵.

India and China can make the transition to becoming wealthier, more urbanised societies without experiencing a surge in heart disease mortality by emphasising walkable streets, clean air and healthy diets.

The hope is that India and China will make the transition to becoming wealthier, more urbanised societies without experiencing the surge in heart disease mortality that occurred in the US and Europe in the mid-20th century. One key to making this transition is to focus on the physical environment of the city, emphasising walkable streets and clean air. Food policy should make it easier for city dwellers to afford the abundance of fruits and vegetables available in the cities, while discouraging the spread of fast food and snacks. Since cardiovascular risk is likely to trickle down to the poor, policies should be in place to enable migrants to experience the benefits that cities offer, including education and economic opportunities.

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Will lessons learned from the West during the epidemic of cardiovascular disease translate into better cardiovascular disease outcomes in developing countries?

Brian Ivanovic

Declines in cardiovascular disease (CVD) mortality have been a primary driver of improved mortality in Western developed countries. At the same time, developing countries such as India are seeing a shift in key causes of death from communicable diseases to non-communicable chronic disease (NCD). As a result, the risk of CVD as a major cause of death is increasing, which if not aggressively managed now will have negative implications on future rates of mortality improvement. The question for developed countries is whether they can shorten and reduce the severity and societal cost of this CVD epidemic by implementing strong primary prevention measures now. Within this context the present situation in India is considered.

Overall mortality in the United States has declined by more than 50% in the last 60 years due to tremendous public health and research efforts aimed at understanding the origins of CVD and the implementation of primary and secondary prevention measures in reducing CVD.

Overall mortality in the United States has declined by more than 50% in the last 60 years¹. An analysis of underlying cause of death data confirms that this decline has been significantly driven by major ongoing declines in cardiovascular disease death rates. The burden of cardiovascular disease (CVD) and the subsequent reversal in CVD related death rates is certainly a testament to the tremendous public health and research efforts aimed at understanding the origins of CVD and the implementation of primary and secondary prevention measures in reducing CVD risk factor burden and downstream morbidity and mortality. While it is impressive to see the progress that has been made, the reality is that the problem took decades to recognise and successfully counter.

By the mid-1950s, the prevalence of smoking was high in the US. The population had become increasingly inactive and diets were high in saturated fats.

By the mid-1950s, the prevalence of smoking in the US was over 50%. The population continued to industrialise and migration from rural areas to cities meant the proportion of the work population in jobs requiring a high degree of physical exertion was on a steep decline. Diets were high in saturated fats. This risk factor environment and a growing life expectancy due to reductions in infectious and accidental causes of death meant that the population was increasingly at risk for incident cardiovascular disease. During this period, research on the harmful effects of smoking, lack of physical activity and other CVD risk factors were being conducted and our understanding of the relationship between CVD risk factors and CVD prevalence and mortality was increasing. However, societal trends that had taken decades to form were not going to change overnight. It was not until the mid-1970s that improved management of cardiovascular disease risk factors, declines in smoking and improved treatments of those with CVD reversed the steady rise in CVD death rates, an improving trend that has continued in death statistics to the present².

As recently as 2010, the economic costs of CVD are estimated to be over USD 440 billion in the United States.

While the progress made over the past 40 years is commendable, as recently as 2010, the economic costs of CVD are estimated to be over USD 440 billion in the United States, representing 17% of total health care expenditures³. Both in human and economic terms, developing countries cannot afford to let CVD become as major a public health issue as it has in Western countries. Without effective interventions, their populations are at risk of seeing CVD incidence and mortality increase from current levels as individuals transition from rural lifestyles and diets to urban, more sedentary lifestyles and diets that contribute to cardiovascular disease risk⁴.

CVD deaths in India have been estimated at over 680 per 100 000 for men and over 420 per 100 000 in women, rates that are twice those observed in the United States.

Unfortunately, there is evidence that certain segments of the population in India are heading down a similar pathway to what was experienced in the West. In both economically advanced states in India and in urban populations, the number one cause of death in middle age is now CVD⁵. Asian Indians have twice the risk of coronary artery disease and three times the risk of diabetes compared to European populations⁶. CVD deaths in India have been estimated at over 680 per 100 000 for men and over 420 per 100 000 in women, rates that are twice those observed in the United States⁷. The annual number of deaths due to CVD in India is projected to rise to 4 million by the year 2030⁸. For India and for other countries undergoing rapid epidemiologic transitions, the cycle from recognition of health risk factors, improved better risk factor control and finally more optimal management of those with CVD needs to be shortened to reduce the burden and economic costs of CVD compared

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to the historic experience in Western countries. Given the greater understanding of the risk factors and pathophysiology of CVD that governments and public health agencies can benefit from, what are countries such as India doing to curtail this public health threat and what more can they do?

Control of risk factors

The prevalence of daily smoking in India is 18% in males and 3% in females.

Across all ages the prevalence of daily smoking in India is 18% in males and 3% in females, placing India below the OECD average prevalence of 26% in males and 18% in females⁹. Specific to younger age groups, trends may be less favourable. National health surveys suggest a doubling of smoking rates in the 15–24 year old age group between 1999 and 2006 and a majority of heart disease at younger ages in India is attributed to tobacco^{10, 11}.

Mean serum cholesterol has been on the rise since the 1980s. The average activity levels of the population in India are on the decline.

Trends in the prevalence of hypertension have been flat (urban populations) to modestly increasing (rural populations) with recent prevalence estimates running in the 30% range for urban populations and in the 20% range for rural groups¹². Mean serum cholesterol has been on the rise since the 1980s with more recent estimates in the mid 195mg/dl range in urban populations¹³. Like many other countries, the average activity levels of the population in India are on the decline, but the rate of decline is slower in India, primarily due to generally higher activity levels of those in India who remain impoverished or work in rural areas¹⁴. Urban/rural differentials also exist in the prevalence of diabetes, with generally higher prevalence in urban areas. Urban populations in India over the past 20 years have seen average BMI's increase; smoking and systolic BP decreased and lipid profiles and diabetes prevalence remained stable¹⁵. Increasing education was noted to be a factor that generally attenuated these trends, confirming the importance of increasing literacy rates in the population to help reverse unfavourable risk factor trends associated with CVD.

South Asian populations may have early life exposures and other non-conventional risk factors that increase the risk for development of coronary artery disease.

Trends in CVD risk factors will influence future trends in the prevalence of CVD in India and are amenable to cost effective primary prevention efforts. Additionally, South Asian populations may have early life exposures and other nonconventional risk factors that increase the risk for development of coronary artery disease¹⁶. Good evidence exists for taking action to reduce the population burden of these risk factors to reduce CVD incidence, although much of the historic evidence is predominantly weighted towards Western populations. Fortunately the body of cardiovascular research in India is growing exponentially, which will provide a strong foundation for implementing public health solutions that are more tailored to its own population. The concept of primordial strategies that attempt to address not only risk factor management, but the societal environment that influences the risk of CVD – including factors such as literacy, adequate healthcare financing, health insurance availability and legislation to foster public health – is a key component in attempting to reduce the prevalence of CVD in developing countries such as India. With that background, what is the current state of primary prevention efforts in India, particularly in urban populations where the burden of sedentary life style and other CVD risk factors might be greater?

Healthcare delivery in India

Differences exist between what medical care is available in urban centres compared to more rural regions in India.

Similar to other countries, differences exist between what medical care is available in urban centres versus more rural regions in India; however, the differences appear to be much greater. Those seeking care can choose between public or private health care. Physicians working in the public sector are required to have a six year degree that is equivalent to a Western medical degree. In the private sector, the range of training is wider and not always equivalent. Degrees may be in traditional medicine, such as Ayurveda, or course work in western medicine could be over shorter timespans. Use of private sector providers is more prevalent both in rural and urban settings; however, the proportion of visits to providers with Western equivalent medical degrees for rural residents is far less compared to urban residents¹⁷. Perhaps one-fourth of the population has access to western medicine and that access is mainly for urban populations¹⁸.

The prevalence of treatment for CVD and diabetes is also influenced by socioeconomic status.

More effective pharmacologic management of hypertension and other CVD risk factors might be facilitated by combining pharmacologic preparations.

There is room for improvement in a number of areas related to CVD prevention, including health care financing and insurance availability, tobacco control and promotion of physical activity.

Due to traffic congestion and a greater reliance on public transport over ambulances, the time to obtain medical care for acute coronary syndromes in India is nearly twice that of developed countries.

Physician utilisation of secondary prevention of CVD needs to be improved.

It is essential to make the investment required to deliver better CVD primary prevention now as the downstream health and economic impacts that could result from not aggressively addressing current issues will be significant and costly for India.

The prevalence of treatment for CVD and diabetes is also influenced by socioeconomic status, with evidence of more treatment episodes and more private care management in higher socioeconomic status (SES) groups¹⁹. In hypertensive groups, the number achieving optimal control appears to be low (approximately 25% or less)²⁰. Studies of urban and rural populations in India suggest that the lack of education, social class and occupation is associated with treatment interruption of CVD risk factors such as hypertension and diabetes^{21, 22}.

More effective pharmacologic management of hypertension and other CVD risk factors might be facilitated by combining pharmacologic preparations. Research on “poly-pill” type medications has been conducted on populations in India and the tolerability of a multiple compound formulation was found to be similar to single drug tolerability rates, a relevant finding due to the frequent association of hypertension to other cardiovascular risk factors²³.

Current assessments

In assessing the situation in India against a number of other countries, Gupta et al⁵ felt that there was room for improvement in a number of areas related to CVD prevention, including health care financing and insurance availability, tobacco control and promotion of physical activity. Some feel that the health care infrastructure in India has lagged behind the rapid growth and urbanisation of the population. India has approximately 0.7 physicians per 1000 population, placing it slightly below equivalent statistics for lower middle income countries and at a 50% level against global averages²⁴. Staffing of nurses is similarly below the lower middle income country average and global staffing levels. Approximately 75% to 80% of health spending is out of pocket and the GDP allocated to healthcare is approximately 1.4%, substantially less than China (2.3%) and European countries (~7%)²⁵. Fifteen percent of healthcare spending is allocated to preventive care services²⁶. Less than half of the community health centres that would be optimal for a population in a country of its size are operating and only 11% of the population have some form of health insurance²⁷.

As in any country, it is far more cost effective to reduce CVD incidence than to treat emerged disease. There are additional challenges in caring for the population who go on to develop CVD in India. Due to traffic congestion and a greater reliance on public transport over ambulances, the time to obtain medical care for acute coronary syndromes in India is nearly twice that of developed countries²⁸. There is also a shortage of specialists in cardiology to provide acute coronary care. Approximately 75% of patients who had a diagnosis of myocardial infarction (MI) were from lower middle class or less economically advantaged backgrounds²⁹. With the current insurance coverage situation in India, this makes finding sufficient money to pay for acute and downstream secondary prevention difficult. According to the Healthcare in India report, limited health care insurance coverage has resulted in millions falling below the poverty line each year because of indebtedness due to healthcare needs³⁰.

Physician utilisation of secondary prevention of CVD needs to be improved. Studies in urban primary care settings and in primary, secondary and tertiary care centres find that there is underutilisation of anti-platelet therapy and treatment of underlying risk factors for CVD^{31, 32}. Studies using standardised patients describing cardiovascular conditions, such as assessment of unstable angina, also find low rates of adherence to generally accepted clinical and diagnostic assessment protocols³³.

The current situation suggests an urgent need for improvement; however, the large size of India’s population and distribution of health care resources makes progress on the primary prevention front challenging to deliver to the majority of the population. In spite of those challenges, it is essential to make the investment required to deliver better CVD primary prevention now as the downstream health and economic impacts that could result from not aggressively addressing current issues will be significant and costly for India, and slow the rate of development that the country could otherwise make.

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The nutrition transition in India: Trends in dietary intake and associations with cardiometabolic outcomes

Shilpa Bupathiraju

India is facing an epidemic of diet-related non-communicable disease. Currently, India has the largest absolute number of persons with diabetes at approximately 61.3 million people. With rapid globalisation, urbanisation, and advances in agriculture and food production systems, India has witnessed a rapid nutrition transition in the past several decades. This transition is characterised by a shift away from the traditional Indian diet that was abundant in minimally processed foods, fruits and vegetables, to a diet that is rich in highly refined and processed grains, potatoes, salt, sugar-sweetened beverages, animal fats and products, and hydrogenated oils. When such changes are coupled with declining levels of physical activity in an increasingly urbanised environment, there has been a rapid escalation in the incidence of hypertension, obesity, insulin resistance, type 2 diabetes and cardiovascular disease. Future research that is translational in nature is urgently needed to understand the effectiveness of a multi-pronged approach in preventing and controlling the rapid epidemic of cardiometabolic diseases such as type 2 diabetes and cardiovascular disease. Such research requires multi-disciplinary and multi-level coordination and will need to include all the relevant stakeholders, ie community, local governments, farmers, food establishments, worksites, policy makers and clinicians in order to be truly effective.

India has been undergoing a rapid transition on economic, demographic, epidemiologic and nutritional fronts. The direct impact of this transition has been on the incidence of cardiometabolic outcomes, especially type 2 diabetes and cardiovascular disease.

Recent data from the Indian Migration Study have shown that migration into urban areas is associated with increases in hypertension, obesity and type 2 diabetes.

Surveys have shown a decline in cereal intake among rural, urban slum and urban middle income groups despite reductions in the cost of cereals.

Introduction

Research on diet and nutrition in the Indian subcontinent has primarily focused on the problem of undernutrition, specifically in children and women of child-bearing age. However, in recent years, India has been undergoing a rapid transition on economic, demographic, epidemiologic, and nutritional fronts. The direct impact of this transition has been on the incidence of cardiometabolic outcomes, especially type 2 diabetes and cardiovascular disease. The most recent National Family and Health Survey (NFHS-3; 2005–2006) data indicate that the prevalence of overweight or obesity among ever married women has increased from 11% in NFHS-2 (1998–1999) to 15%. The simultaneous occurrence of undernutrition and malnutrition implies that adults in India are suffering from the dual burden of malnutrition¹.

Nutrition transition is occurring at a much faster pace in low and middle-income countries like India than in the West. Reasons for this include a shift in occupation structures from labour-intensive occupations to more sedentary and less strenuous work, a rapid introduction of the mass media, and migration from rural to urban areas. In fact, recent data from the Indian Migration Study have shown that migration into urban areas is associated with increases in hypertension, obesity and type 2 diabetes. Not surprisingly, among this group, migration also resulted in an increase in physical inactivity². Misra et al³ have described the nutrition transition in India as occurring in 3 stages. The first stage is characterised by a transition from traditional staple foods to items more prevalent in the Western diet, such as increased consumption of bread, cakes and cookies. In the second stage, the effects of globalisation are much more marked and there is easy access to a variety of processed and fast foods. In the final stage, some individuals, especially those of the higher income group, realise the adverse effects of their dietary habits and transition to a healthier diet and lifestyle. In this report, we briefly review trends in major food sources and their associations with cardiometabolic outcomes.

Cereals

National trend data from the National Nutrition Monitoring Bureau (NNMB) surveys have shown a decline in cereal intake between 1975–80 and 1995–96 among rural, urban slum and urban middle income groups despite reductions in the cost of cereals. Still, cereals remain the main staple of the Indian diet and provide the bulk of calories⁴. When examining trends by income group, data from the National Sample Survey Organization (NSSO) indicate that although cereal consumption decreased in middle and high-income groups, consumption increased in the lowest income group.

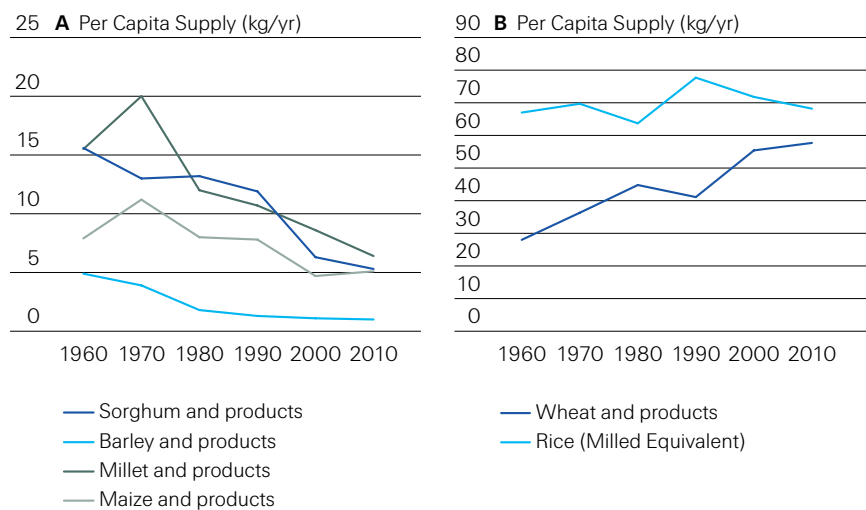
The nutrition transition in India: Trends in dietary intake and associations with cardiometabolic outcomes

The increased consumption of polished rice in India, which has a high glycaemic index, has been associated with higher rates of type 2 diabetes.

The declines in overall cereal intake are masked by increases in refined grains and a reduction in the consumption of traditional coarse-grains.

Per capita supply data from the Food and Agriculture Organization (FAO), which broadly reflect consumption patterns, indicate that the supply of coarse cereals like barley, sorghum, millet, and maize has declined drastically over the past four decades, while consumption of wheat and milled rice has increased (Figure 1A and 1B)⁵. Such changes are characterised by reductions in overall fibre intake, increases in overall energy-density, and increases in two important measures of carbohydrate quality (glycaemic index and glycaemic load) of the Indian diet. Highly polished white rice, whose use is prevalent among South Indians, has a high glycaemic index value of approximately 75–80. The high consumption of white rice, coupled with its high glycaemic index, results in a high glycaemic load in the Indian diet. We have previously shown that high glycaemic index and glycaemic load diets are associated with a 19% and 13% higher risk, respectively of type 2 diabetes⁶.

Figures 1A and 1B:
Trends in per capita supply (kilograms/year) of traditional coarse grains (A) and refined grains (B)



Source: Food and Agricultural Organization⁵

High intakes of dietary fibre were associated with a 69% lower odds ratio of type 2 diabetes.

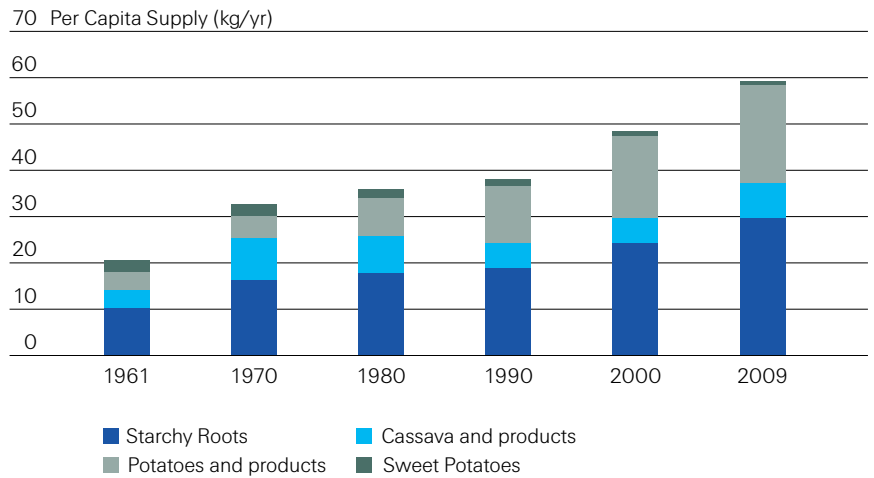
Such shifts in cereal consumption have important public health implications in South Asians who have fewer beta cells and are, therefore, more likely to be predisposed to type 2 diabetes in response to a high demand for insulin⁷. For example, in an urban sample of adults in Chennai, India, refined grain intake was associated with a nearly 5-fold higher odds (odds ratio [OR]: 5.31, 95% confidence interval [CI]: 2.98–9.45) of newly diagnosed type 2 diabetes. Similarly, a high glycaemic index and high glycaemic load were associated with a 2.5 fold (95% CI: 1.42–4.43) and 4.25 fold (95% CI: 2.33–7.77) higher odds of newly diagnosed type 2 diabetes. On the other hand, high intakes of dietary fibre were associated with a 69% lower odds ratio (95% CI: 38%–85%) of type 2 diabetes⁸ emphasising the importance of switching back to traditional Indian diets that are rich in coarse grains and dietary fibre. In fact, randomised cross-over studies have conclusively shown that simple dietary changes, such as substituting brown rice for white rice, can have profound and immediate beneficial effects on glucose and insulin responses⁹.

Since 1961, the consumption of potatoes and its products has dramatically increased while consumption of sweet potatoes has decreased. Studies have shown that a daily serving of potatoes was associated with a higher risk of type 2 diabetes.

Starchy roots and tubers

Aggregate FAO data indicates that the per capita supply of starchy roots has increased since 1961. However, when examining individual roots and tubers, consumption of potatoes and its products has dramatically increased while consumption of sweet potatoes has decreased (Figure 2)⁵. These changes indicate not only an increase in the energy density of the Indian diet, but a greater susceptibility to development of chronic disease. In India, consumption of potato is gradually shifting from the fresh market to processed products in the form of chips and French fries, which have a high glycaemic index and glycaemic load. Recently, McCain Foods, the world’s largest manufacturer of French fries and assorted potato snacks, has made a foray into the untapped Indian market. It is estimated that out of the total snacks, potato based products like French fries, wedges, and other Indian snacks claim a 30% share in the fast food industry¹⁰ with the fastest growth seen in the sale of frozen French fries. Studies in the US have shown that a daily serving of potatoes is associated with an 18% higher risk for type 2 diabetes. Every 2 servings/week of French fries was associated with a 16% higher risk of type 2 diabetes. More importantly, substituting one serving of whole grains for one serving of potatoes was associated with a 30% higher risk for type 2 diabetes¹¹. While the potato is classified as a vegetable, many agencies including the World Health Organization (WHO) recommend that individuals meet their recommended intake for vegetables by excluding potatoes. The effects of sweet potatoes on chronic disease are far less well understood. Although they have a lower glycaemic index and are good sources of fibre and other micronutrients, a recent systematic review concluded that there is insufficient evidence about the use of sweet potatoes for type 2 diabetes¹².

Figure 2: Trends in per capita supply (kilograms/year) of total and individual starchy roots



Source: Food and Agricultural Organization⁵

Consumption of sugar in India is growing at a more rapid pace than the global average.

Sugars

According to a recent report on India’s Sugar Policy and the World Sugar Economy, the per capita consumption of sugar in India in 2012 was 20.2kg, which is lower than the global average of 24.8kg. Yet, consumption of sugar in India is growing at a more rapid pace than the global average. In fact, in the last five decades, the production of sugar among Indians has risen from less than 3% to more than 20% of sugar produced globally¹³. Food balance sheet data from the FAO demonstrate dramatic increases in per capita supply of raw sugar (Figure 3)⁵. Most of the sugar available in the open market is consumed in the form of sweets, baked goods, candies, ice cream and soft drinks.

The nutrition transition in India: Trends in dietary intake and associations with cardiometabolic outcomes

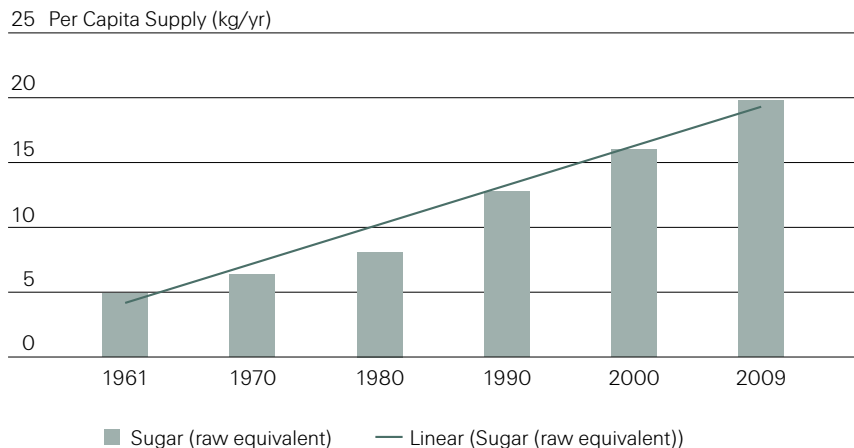
The consumption of soft drinks may rise given the efforts of multinationals to tap the market in India.

Urban residents consume more sugar than their rural counterparts. The Global Burden of Diseases Study found that consumption of sugar-sweetened beverages is linked to 133000 deaths from diabetes, 44000 deaths from cardiovascular diseases, and 6000 deaths from cancer.

Although carbonated beverage consumption has been historically low in India compared to the West, this is set to change as soft drinks companies are now targeting low and middle-income countries as the US market is saturated. For example, Coca-Cola plans to invest USD 5 billion in India by 2020 with the majority of this money being spent on increasing capacity in bottling units, expanding distribution and brand building. Limited availability of clean drinking water in most areas and the increasing presence of refrigerators in small grocery stores have promoted the increased consumption among the new Indian middle-class who are now seeking to define themselves as part of a global consumer class.

Urban-rural differences in sugar intake highlight the effects of globalisation with urban participants reporting up to 35% higher sugar intake than their rural counterparts¹⁴. Interestingly, India does not use any high fructose corn syrup and sucrose is the primary sugar that is used in most carbonated beverages. Most recent data from the Global Burden of Diseases Study indicate that sugar-sweetened beverages consumption is linked to 133 000 deaths from diabetes, 44 000 deaths from cardiovascular diseases, and 6000 deaths from cancer. Most importantly, nearly 78% of these deaths are from low and middle-income countries rather than high-income countries. Sales of sugar-sweetened beverages in India have increased by 13% every year since 1998, exceeding 11 litres per capita per year. It is estimated that if sugar-sweetened beverage consumption continued to increase linearly in accordance with secular trends, a 20% sugar-sweetened beverage excise tax would be expected to prevent nearly 11.2 million new cases of overweight and obesity (representing a 3% decline), and 400 000 cases of type 2 diabetes (representing a 1.6% decline) over the decade 2014–2023.

Figure 3: Trends in per capita supply (kg/year) of raw sugar equivalent



Source: Food and Agricultural Organization⁵

National aggregate statistics suggest a high consumption of unhealthful oils in India.

Fats and oils

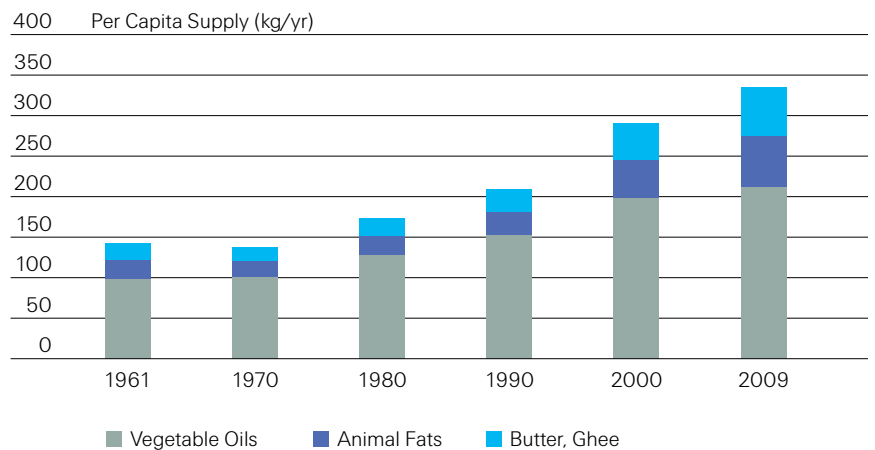
Although precise data on consumption of oils and fats at the individual and household level are missing, national aggregate statistics show high consumption of unhealthful oils. NSSO survey data showed that there has been an increase in the per capita consumption of edible oil; between 1993–94 and 2004–2005, there has been a rise in oil consumption both in rural and urban areas¹⁵. Time trends in the per capita supply fats and oils between 1961 and 2009 have shown that the supply of vegetable oils has nearly doubled while those of animal fats have increased threefold. Among animal fats, per capita supply of clarified butter or ghee, which contains over 60% of saturated fatty acids, has seen about a fourfold increase (Figure 4)⁵. While exact household and individual level data on oil consumption are unavailable, national aggregate data indicate that the share of raw oil, refined oil and vanaspati oil in the total edible oil market is estimated at 35 percent, 55 percent,

and 10 percent respectively¹⁶. Vanaspati oil or ghee is fully or partially hydrogenated vegetable cooking oil that has a longer shelf life and is often used in food establishments and households as a cheaper alternative to clarified butter or ghee. Palm oil, rich in saturated fats, is the primary oil used for production of vanaspati.

The Food Safety and Standards Authority of India has issued a proposal to limit trans fat content of hydrogenated vegetable oil.

The Food Safety and Standards Authority of India has issued a proposal to limit trans fat content of hydrogenated vegetable oil to a maximum of 10%, which will be further reduced to 5% in 3 years¹⁷. However, there are no specifications for trans fats in other edible oils and fats. A recent analysis of trans fatty acid content in edible oils and fats in India revealed that, except in sunflower oil, the average trans fatty acid content in both mustard and soybean oil was above the prescribed limit (2%) of Denmark. The average trans fatty acid content in branded and unbranded butter was 15.1% and 18.9% respectively, which exceeded the prescribed Denmark limit by 3.5-fold to over 10-fold in branded and unbranded samples¹⁸. These data imply that trans fat intake is steadily increasing in the Indian diet given that the consumption of edible oil and animal fat is increasing. This represents a significant public health concern as there is no safe upper limit for trans fat intake. At the same time, no regulations exist for trans fats in packaged foods. However, the Government of India now requires manufacturers to list trans fat on the nutrition label if it exceeds 0.2 grams per serving. Still, India's lax food labelling laws have allowed manufacturers to define their own serving sizes. Therefore, many foods which have considerable amounts of trans fats (such as potato chips) are now labelled trans fat free by presenting nutrition labels for unreasonably small serving sizes.

Figure 4: Trends in per capita supply (kilocalories/day) of edible oils



Source: Food and Agricultural Organization⁵

Dietary salt

The overall prevalence of hypertension in India was reported as 29.8%, indicating that over 370 million Indian adults suffer from elevated blood pressure.

Based on a recent meta-analysis of population-based studies, the overall prevalence of hypertension in India was reported as 29.8%, indicating that over 370 million Indian adults suffer from elevated blood pressure. Estimates were higher in urban compared to rural areas (33.8% vs 27.6%), indicating the effects of rapid urbanisation on the country's changing cardiovascular risk profile¹⁹. High salt intake is an established risk factor for cardiovascular disease. The average salt consumption in India is estimated to be between 9–12 grams/day with higher intakes seen in urban compared to rural areas^{20, 21}. This level of consumption is far above the joint WHO and FAO recommended consumption of less than 5 grams/day²². Such high levels of consumption can partly be attributed to consumption of foods such as pickles (fruits and vegetables with spices that are preserved in salt and oil), papadams (crisp, thin seasoned discs with salt, spices and oil usually served as an accompaniment), namkeens (a salty Indian snack) and chutneys.

The intake of processed and ready to eat foods high in sodium tends to rise with income.

As income levels continue to increase, consumption of processed and ready to eat foods, which are typically high in sodium, has gone up. The efficacy of reducing salt consumption in lowering blood pressure has been well established, although the long-term effects on incidence of cardiovascular disease are less well understood. Using a Markov prediction model, Basu et al²³ estimated that if current consumption levels of salt remain unaltered in India, there would be approximately 8.3 million myocardial infarctions, 830 000 strokes, and 2 million deaths per year among Indian adults aged 40–69 years over the next three decades. However, a 25% reduction in salt intake (representing reduction of 0.1 g/year over the next 3 decades) would result in an annual reduction of 350 000 myocardial infarctions (4.6%), 48 000 strokes (6.5%), and 81 000 deaths (4.9%) among this group.

Although India is one of the largest producers of fruits and vegetables, consumption remains much below WHO recommended levels.

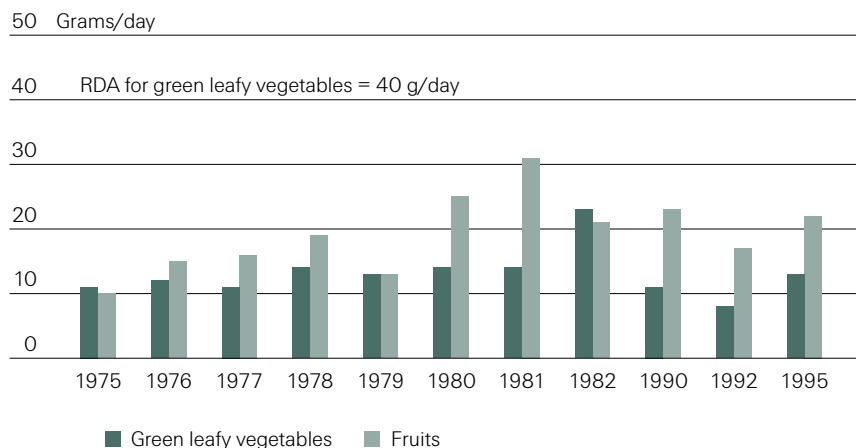
Fruits and vegetables

Although India is one of the largest producers of fruits and vegetables, consumption remains much below the WHO recommendation of 400 g/day²². For example, in a study of urban adults in Chennai, overall consumption of fruits and vegetables was 265 g/day⁴. In another study of urban residents in Jaipur, nearly 70.3% of adults consumed <3 helpings of fruits and vegetables per day¹³. Despite a high prevalence of predominantly plant-based diets, consumption of fruits and vegetables remains low among Indians. Analysis of the INTERHEART data indicate that only 26.5% of South Asians consumed fruits and vegetables on a daily basis compared to 45.2% of control arm patients from the remaining 47 non-South Asian countries²⁴. National data from the National Nutrition Monitoring Bureau reveal that intakes of green leafy vegetables continue to be much below the recommended daily allowance (only one-third) of 40 g/day. Similarly, intake of fruits is extremely low (Figure 5)²⁵. Low fruit and vegetable intake has been recognised by the WHO as one of the major risk factors for cardiovascular disease. In a case-control study conducted in New Delhi and Bangalore, persons consuming a median of 3.5 servings/week had a 67% lower risk (95% CI: 36%–83%) of ischemic heart disease compared to those consuming 0.5 servings/week²⁶.

Gupta et al²⁷ found that cardiovascular mortality was higher among Indian states with lower intakes of fruit and vegetables.

Using an ecological study design, Gupta et al²⁷ found that cardiovascular mortality was higher among Indian states with lower intakes of fruit and vegetables (in grammes/consumption units/day). In a population-based cross-sectional study on a representative population of Chennai in Southern India, a higher intake of fruit and vegetables explained nearly half (48%) of the protective effect against CVD risk factors, such as systolic blood pressure, BMI, waist circumference, total cholesterol and LDL-cholesterol. Given that fruit and vegetable intake continues to be below national and international recommendations, despite their abundance, policy efforts should focus on education and behavioural changes to promote fruit and vegetable consumption.

Figure 5:
Mean intake of fruits and green leafy vegetables – a 25 year report of the National Nutrition Monitoring Bureau²⁵



Source: National Nutrition Monitoring Bureau²⁵

Conclusion

Nutrition transitions in India are leading to higher rates of cardiovascular disease and type 2 diabetes.

India is in the midst of a public health crisis. Incidence of cardiovascular disease and type 2 diabetes are escalating as global free trade continues to fuel rapid economic and nutrition transitions, especially in urban settings. While rural India is still in the early stages of the nutrition transition, urban India is in the midst of the second stage of the nutrition transition where Indian diets are more westernised and there is widespread access to highly processed foods. A direct consequence of these transitions is the sudden increases in the prevalence of type 2 diabetes and cardiovascular disease.

The economic impact of cardiovascular disease and type 2 diabetes is estimated at nearly 240 billion international dollars.

The economic impact of these transitions is estimated to cost the country 236.6 billion international dollars for type 2 diabetes and cardiovascular disease alone. While it is now well established that increases in non-communicable diseases are fuelled by modifiable risk factors such as diet and physical activity, there is a paucity of research on the role of diet and lifestyle in the prevention of cardiometabolic outcomes in India.

A number of research studies could be undertaken to better understand the role of diet and lifestyle in India with the goal of reducing cardiometabolic outcomes.

Key research areas include: (i) understanding the feasibility, acceptability and efficacy of simple dietary interventions such as substituting brown rice for white rice on cardiometabolic risk, (ii) mechanistic research to understand the lower age of onset of cardiovascular disease and type 2 diabetes and the lower threshold for various risk factors among South Asians, (iii) the effect of policy changes such as taxation on sugar sweetened beverages and fast foods, as well as changes in food labelling laws on the incidence of type 2 diabetes and cardiovascular disease, (iv) the effect of educational campaigns via local and social media to discourage consumption of sugar-sweetened beverages and refined grains and to promote consumption of healthy foods and increase physical activity, (v) the effect of worksite interventions including provision of healthy food choices in the cafeteria, structured physical activity and behavioural change education on markers of cardiometabolic risk, and (vi) the effect of improvements in the built environment with parks, walkable, and bike-friendly streets and neighbourhoods, periodic celebrations of walk/bike days, and community yoga programmes on body weight and cardiometabolic risk factors. Such research needs to involve all sectors of the community, including local government bodies, the food and beverage industry, food establishments, worksites, local celebrities and leaders, farmers, and agricultural producers. Future research should be translational (from cells to communities) in order to develop a successful multi-pronged approach to prevent the epidemic of type 2 diabetes and cardiovascular disease.

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About the author

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Dr Shilpa Bhupathiraju is a Research Associate in the Department of Nutrition at the Harvard T.H. Chan School of Public Health. Bhupathiraju received her PhD in Nutritional Epidemiology from the Friedman School of Nutrition Science and Policy at Tufts University in 2011. As a Research Fellow at Harvard T.H. Chan School of Public Health, she has been examining the dietary and lifestyle predictors in the prevention and development of cardiovascular disease and type 2 diabetes in the Harvard cohorts. Bhupathiraju received an American Heart Association postdoctoral fellowship grant to examine the association of quantity and variety in fruit and vegetable intake in the prevention of cardiovascular disease in both the Women's Health Initiative and the Harvard cohorts. As a Swiss Re fellow, Bhupathiraju explored the association between fruits and vegetable intake and cardiometabolic risk using data from the India Migration Study. She is especially interested in understanding how the nutrition transition in India is affecting rates of cardiovascular disease and type 2 diabetes in India.



Socioeconomic inequalities in the prevalence of cardiovascular disease and risk factors in India

Daniel J. Corsi, Subu Subramanian

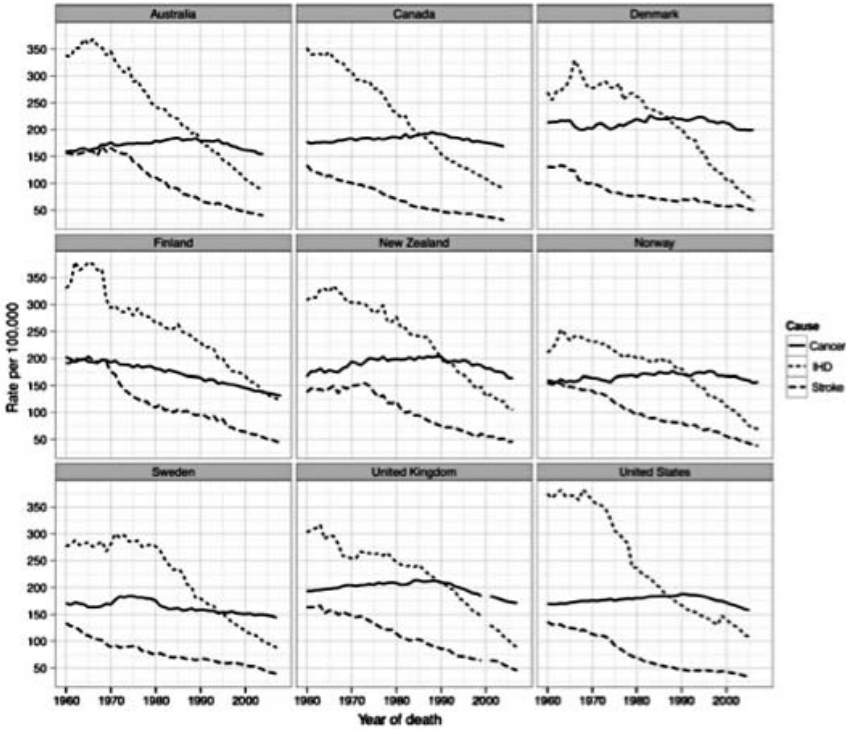
This article reviews the socioeconomic inequalities in the prevalence of cardiovascular disease (CVD) and risk factors in India. Using a variety of data sources, we describe the association between socioeconomic status (SES), risk factors and CVD-related mortality in India. Together, the evidence clearly suggests, with the exception of certain types of tobacco use, that the prevalence of conventional cardiovascular risk factors (CVRF), including elevated blood pressure, cholesterol, diabetes and obesity, are greater among the most socially advantaged groups in Indian society. Further, the proportion of deaths from CVD-related causes was greatest among higher SES groups, although CVD-related mortality rates appear to be higher among the lower SES groups. These findings have implications for resource allocation and prioritisation in India, which should reflect the proportional burden of disease on different population groups.

Introduction

Cardiovascular diseases (CVD), chiefly ischemic heart disease (IHD) and stroke, are among the leading contributors to the burden of morbidity and mortality in India.

The burden of CVD is projected to increase in India over the next two decades, coinciding with reductions in deaths due to communicable diseases, maternal, perinatal and nutritional causes. This is in contrast to the situation in high-income countries, where CVD-related mortality has declined considerably since 1960 (Figure 1). These declines in part have been attributed to rigorous study and investigation into the causes of CVD in populations, with a focus on the contribution of 'conventional' cardiovascular risk factors (CVRF), including tobacco smoking, elevated blood pressure and cholesterol, diabetes and obesity.

Figure 1: Trends in age-standardised mortality from ischemic heart disease (IHD), stroke, and cancer in selected high-income countries, 1960–2010



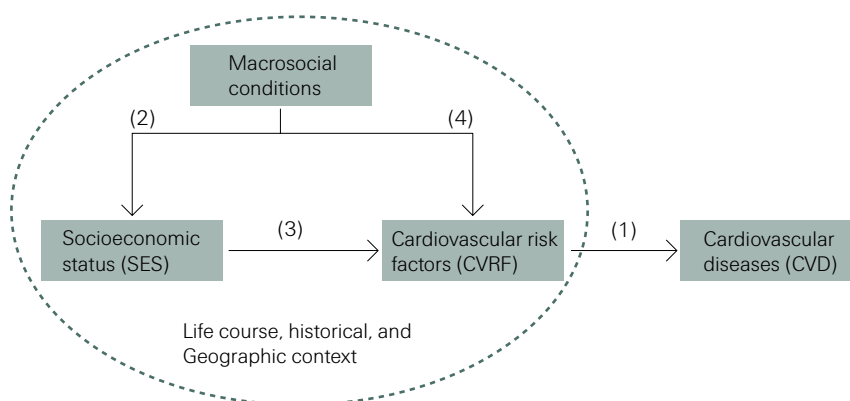
Sources: Harper S, Lynch J, Davey Smith G (2011)⁶⁵; Organisation for Economic Co-operation and Development (2010)⁶⁶

Socioeconomic inequalities in the prevalence of cardiovascular disease and risk factors in India

CVD in India is influenced not only by diet, physical activity and smoking, but also by education, income, occupation and social caste.

In addition to the conventional risk factors, population levels of CVD are also influenced by macrosocial conditions (including culture, media, urbanisation and policy) which have an influence on the overall levels of risk factors such as diet, physical activity, and smoking in populations. Levels of risk factors can also be differentially distributed across the socioeconomic status (SES) of population groups defined by education, income, occupation or social caste; the distributions of these social groupings within the population are also subject to macrosocial conditions. Figure 2 describes a conceptual framework for the relationship between macrosocial conditions, SES, CVRF, and CVD within a population life course, historical and geographic context. Using this conceptual framework, the following paper describes in detail the current socioeconomic inequalities and social gradients in CVD and major CVRF which have emerged in the Indian context.

Figure 2: Conceptual framework for the relationship between macrosocial conditions, socioeconomic status, cardiovascular risk factors, and cardiovascular disease with a life course, historical, and geographic contextual perspective⁶⁵



Notes: Levels of population CVD are directly influenced by the prevalence of major CVRF(1). Levels of CVRF are also dependent on macrosocial conditions (2) that influence population level trends in smoking, diet, physical activity etc. CVRF may be differentially distributed across social groups (3) and the distribution of social groupings within populations according to income, education, and occupation may change or be influenced by macrosocial conditions (4). These associations are embedded in a life course, historical, and geographic contextual framework, suggesting a dynamic relationship between the dependencies and that their relationships with CVD may change over time and place.

Source: Adapted from Harper et al (2011)⁶⁵

Tobacco use

A national survey conducted in 2010, reported that there were 111 million smokers over the age of 15 in India.

In India, men consume tobacco in the form of bidis (small cigarettes hand-rolled in Tendu leaves) or standard manufactured cigarettes^{2,3}. Both forms carry a significant increase in risk of mortality and are responsible for nearly one million adult deaths per year⁴. The Global Adult Tobacco Survey (GATS-India), a national survey conducted in 2010, reported that there were 111 million smokers over the age of 15 in India, 100 million of whom were men⁵. Among men, the prevalence of exclusive bidi smoking and cigarette smoking was found to be 16.5% and 9.4% respectively. The social distribution of smoking in India appears to resemble that of other countries (ie higher among lower socioeconomic status (SES) groups)^{6,7}; although the relationship is complicated by the numerous forms of tobacco use (including chewing and other smokeless forms), each popular within different socioeconomic and demographic groups^{8,9}. Making use of the GATS dataset, we report the social patterning of bidi and cigarette smoking in Indian men along the SES dimensions of education and household wealth¹⁰.

The literature suggests that the CVD risks of smoking can be measured in terms of 'pack-years' – where one 'pack-year' was equal to 20 cigarettes/bidis smoked per day for one year.

One survey found that levels of tobacco consumption increased among those with higher status occupations and among those with higher levels of income and education.

The GATS India survey produced data on tobacco use (smoking and smokeless) and tobacco control indicators. It covered household residents aged 15 years and older in all 29 states and two Union Territories.

For the survey, current smoking was defined as the regular consumption of at least 1 cigarette and/or bidi per week.

The literature suggests that the CVD risks of smoking bidis and cigarettes could be measured in terms of 'pack-years' (ie a measure of cumulative tobacco exposure¹¹), where one 'pack-year' was equal to 20 cigarettes/bidis smoked per day for one year¹². In addition, a graded increase in the risk of mortality has been established for both bidi and cigarette smoking in India⁴.

In a survey from rural Andhra Pradesh (South India), it was possible to estimate the number of cigarettes/bidis smoked daily and pack-years by different groups. Overall, men consumed an average of 7 (95% confidence interval [CI]: 6.9–7.9) cigarettes/bidis per day and had 7.7 (95% CI: 7.1–8.4) pack years of exposure, compared to 4 (95% CI: 2.6–5.0) bidis consumed per day among women and 2 (0.7–3.4) pack-years of exposure¹³. Findings from this survey also indicated that levels of consumption increased among those with higher status occupations and among those with higher levels of income and education, for both men and women¹³. It appears that higher SES smokers in India tend to consume more cigarettes, which are relatively more expensive, while lower SES smokers tend to consume tobacco in the relatively inexpensive form of bidis¹⁴. Comparing India to Western countries such as Canada, however, the average levels of tobacco consumption among Indian men were about half as high as in Canada; and among women, about a quarter as high. For example in Canada, men and women consumed an average of 15.5 and 14.1 cigarettes per day, respectively and had 28 and 23.9 pack years of exposure, respectively¹⁵.

Methods

GATS India was a household survey designed to produce internationally comparable data on tobacco use (smoking and smokeless) and tobacco control indicators. It covered household residents aged 15 years and older in all 29 states and two Union Territories (Chandigarh and Puducherry [Pondicherry]) in India. The survey was conducted in 2009–2010 and collected information from 33 723 men. Additional details of the survey design and sampling strategy are available^{5, 16}. All male respondents had complete information on current smoking status although 47 (0.2%) had missing data on one or more covariates and were excluded. Former (ex-daily and ex-occasional) smokers (n=1733, 5.1%) and those smoking multiple types (n=1334, 4.0%) were removed from the analyses in order to make the most straightforward estimate of the SES-current smoking relationship, yielding a final sample size of 30613.

Forms of tobacco use

The primary outcome, current smoking, was defined as the regular consumption of at least 1 cigarette and/or bidi per week. This level of tobacco exposure was chosen in order to classify occasional, non-daily smokers as smokers rather than non-smokers. Additional sensitivity analyses treating the non-daily smokers as non-smokers yielded similar findings¹⁶. Bidi and cigarette smoking were separately considered as distinct outcomes. Non-smokers were considered as lifelong non-smokers. Daily or occasional use of chewing tobacco was included as a covariate in regression models. Sample sizes and weighted prevalence of current bidi and cigarette smoking according to socio-demographic characteristics of the survey population are given in Table 1.

Socioeconomic inequalities in the prevalence of cardiovascular disease and risk factors in India

Table 1:
Sample sizes, weighted prevalence, odds ratios (OR) and 95% confidence intervals for current cigarette and bidi smoking by socio-demographic characteristics of men aged 15 and higher

Socio-demographic characteristics	Total	Current bidi smokers				Current cigarette smokers			
	n	n	%	OR*	95% CI	n	%	OR*	95% CI
Total	30613	4317	13.7			3331	6.3		
Age group (years)									
15–24 y	5914	181	2.9	1.00		420	4.5	1.00	
25–34 y	7482	760	10.4	4.65	(3.85–5.62)	925	7.4	1.98	(1.73–2.27)
35–44 y	7882	1326	19.2	9.97	(8.30–11.97)	1015	7.9	2.09	(1.82–2.39)
45–54 y	4761	987	24.8	14.87	(12.30–17.97)	616	8.5	1.97	(1.70–2.28)
55–64 y	2553	588	26.0	16.94	(13.82–20.75)	233	5.6	1.42	(1.17–1.71)
65+ y	2021	475	25.4	17.53	(14.20–21.65)	122	3.8	0.93	(0.73–1.17)
Place of residence									
Urban	12579	1046	7.2	1.00		1662	9.8	2.06	(1.82–2.33)
Rural	18034	3271	16.5	2.86	(2.52–3.24)	1669	4.9	1.00	
Occupation									
Government employee	2707	142	5.1	0.27	(0.22–0.33)	520	13.3	1.68	(1.48–1.92)
Non-government employee	7932	1107	15.3	0.81	(0.73–0.89)	890	8.1	1.27	(1.14–1.42)
Self-employed	14489	2595	17.3	1.00		1536	5.8	1.00	
Student	2998	20	0.3	0.02	(0.01–0.04)	161	2.5	0.35	(0.29–0.43)
Unemployed/retired	2458	449	17.0	1.15	(1.00–1.31)	224	6.0	0.78	(0.66–0.93)
Education									
None	5405	1643	30.1	33.15	(25.42–43.22)	275	3.4	1.00	
Primary	7450	1604	19.0	18.33	(14.09–23.83)	698	6.0	1.71	(1.45–2.01)
Secondary/high school	13374	992	6.2	4.51	(3.47–5.86)	1706	7.1	2.23	(1.91–2.59)
University/college	4384	78	2.2	1.00		652	9.3	2.57	(2.16–3.06)
Household wealth									
Poorest 20%	4941	1236	21.4	10.13	(8.66–11.85)	216	2.4	1.00	
2nd	4577	985	17.8	7.23	(6.19–8.44)	329	4.2	1.63	(1.33–1.99)
3rd	5458	953	14.5	5.31	(4.57–6.16)	551	5.9	2.18	(1.81–2.63)
4th	6849	725	10.1	2.83	(2.44–3.29)	901	8.1	2.97	(2.47–3.57)
Richest 20%	8788	418	4.1	1.00		1334	11.5	3.69	(3.07–4.44)
Current tobacco chewing									
No	21688	3046	13.1	1.00		2160	5.7	1.00	
Yes	8925	1271	15.0	1.00	(0.92–1.09)	1171	7.6	1.55	(1.41–1.70)

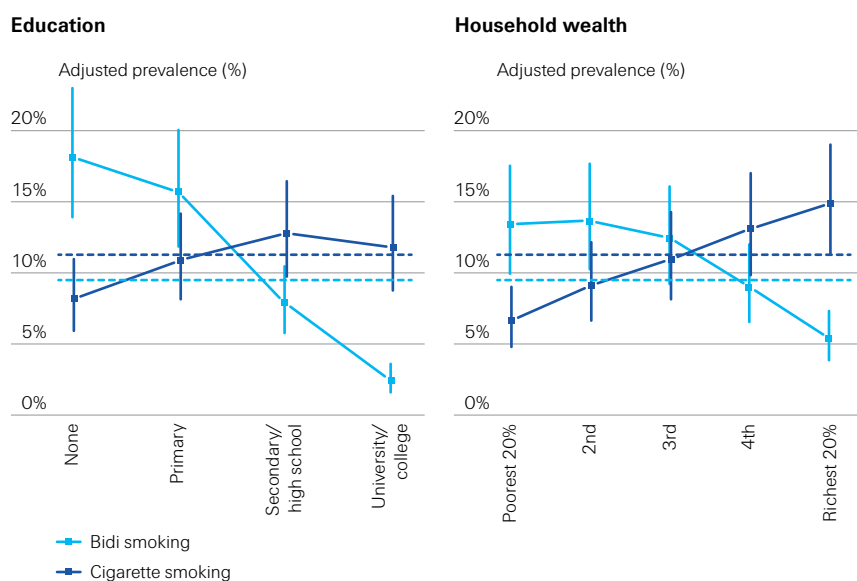
*Odds ratio adjusted for survey design effects

Source: Corsi (2014), Global Adult Tobacco Survey, India 2009-2010¹⁰

Unlike bidi smoking, cigarette smoking was positively associated with education and household wealth.

The prevalence of exclusive bidi and cigarette smoking was 13.7% (95% confidence interval [CI]: 13.3–14.1), and 6.3% (95% CI: 6.1–6.6), respectively. Education and household wealth showed an inverse association with bidi smoking. Cigarette smoking, however, was positively associated with education and household wealth. Figure 3 summarises the SES-smoking associations from the models for current bidi and cigarette smoking. The adjusted prevalence of bidi smoking declined with increasing categories of education from 18.2% (95% CI: 13.9–23.0) in those with no education to 2.5% (95% CI: 1.6–3.6) in those who had completed university/college. Cigarette smoking increased from 8.2% (95% CI: 5.9–11.0) among the uneducated to 12.8% (95% CI: 9.7–16.5) among those who had completed secondary/high school, and was 11.8% (95% CI: 8.8–15.4) among university/college educated individuals. A similar pattern was observed using household wealth as the marker of SES. The adjusted prevalence of bidi smoking decreased with increasing categories of household wealth, while cigarette smoking increased.

Figure 3: Adjusted prevalence of bidi smoking and cigarette smoking by education (left) and household wealth (right) among men aged 15 and higher, Global Adult Tobacco Survey, India 2009-2010



Notes: Horizontal lines represent the overall adjusted prevalence of current bidi smoking (light blue) and cigarette smoking (dark blue).

Source: Corsi (2014)¹⁰

Diabetes

It has been suggested that the prevalence of type-2 diabetes and other cardiovascular disease risk factors may increasingly become concentrated among low SES groups in India.

The prevalence of type-2 diabetes in India has been investigated in numerous population based surveys conducted across a range of settings since the 1970s^{17–22}. In our systematic review of existing studies, which have reported the prevalence of type-2 diabetes by SES and/or associations between SES and type-2 diabetes, all were found to have been based on local or regional samples, and a majority were done in urban areas^{20, 22–35} (Table 2). It has been suggested that the prevalence of type-2 diabetes and other cardiovascular disease risk factors may increasingly become concentrated among low SES groups in India³⁶ and other low- and middle-income countries³⁷, although to date the empirical evidence from India in support of this hypothesis remains limited. The majority of studies reviewed in Table 2 have provided evidence of a positive association between SES (defined as education, household wealth, social caste, or a composite of 2 or more markers) and diabetes among populations from selected geographic regions in India^{22, 27, 33}. There is controversy around the validity of some of the studies by Dr R.B. Singh, even though none of his publications have ever been formally retracted⁵⁶.

Socioeconomic inequalities in the prevalence of cardiovascular disease and risk factors in India

Table 2:

Overview of studies reporting prevalence of type-2 diabetes by markers of socioeconomic status (SES) and the association between increasing SES and diabetes in India

Author	Study period	Coverage	Setting	Age	Sample size	Diabetes assessment	SES marker
Singh ²³	1994	Local	Rural	25–64	1 769	blood glucose	Composite
Singh ²⁴	1994	Local	Rural	25–64	1 806	blood glucose	Composite
Singh ²⁵	1994	Local	Combined	25–64	3 575	blood glucose	Composite
Singh ²⁶	1998	Regional	Urban	25–64	3 257	blood glucose	Composite
Ramachandran ²⁰	2000	Regional	Urban	20+	11 216	blood glucose	Income
Ramachandran ²⁷	1999–2000	Local	Urban	40+	2 383	blood glucose, drug treatment	Income
Gupta ²⁸	1999–2001	Local	Urban	20+	1 123	self-report	Education
Reddy ²⁹	2002–2003	Regional	Urban	20–69	19 973	blood glucose, drug treatment	Education
Mohan ²²	2003–2005	Regional	Combined	15–64	44 523	self-report	Education
Ajay ³⁰	2002–2003	Regional	Urban	20–69	10 930	blood glucose, drug treatment	Education
Vijayakumar ³¹	2007	Local	Rural	18+	1 990	blood glucose, self-report	Social caste Wealth
Gupta ³²	1999–2003	Local	Urban	20–59	1 289	blood glucose, self-report	Education
Kinra ³³	2005–2007	Regional	Rural	20–69	1 983	blood glucose, self-report	Wealth
Samuel ³⁴	1969–2002	Regional	Urban	26–32	2 218	blood glucose†, drug treatment	Wealth
			Rural				
			Combined				
			Urban				Education
			Rural				
			Combined				
Zaman ³⁵	2005	Regional	Rural	30+	4 535	blood glucose, self-report	Income Education

Notes: Socioeconomic status (SES) markers defined as education, household wealth, social caste, or a composite of 2 or more measures;

*P<0.05; – indicates not reported; †includes impaired glucose tolerance and impaired fasting glucose.

Source: Corsi (2012)⁶⁴

Gender	Diabetes prevalence: low SES (l); high SES (h)	SES-diabetes association: Odds ratio (95% confidence interval) for high SES vs low SES
Male	0.9% (l); 6.1% (h)*	–
Female	0.9% (l); 6.9% (h)*	–
Male	2.5% (l); 8.6% (h)*	2.03 (1.86–2.51)*
Female	1.2% (l); 6.9% (h)*	1.97 (1.67–2.36)*
Male	–	4.07 (1.89–10.01)* (Urban)
	–	3.75 (1.37–12.78)* (Rural)
Female	–	1.48 (0.64–4.00) (Urban)
	–	2.55 (0.91–8.83) (Rural)
Female	0.5% (l); 4.8% (h)*	–
Combined	12.5% (l); 21.6% (h)*	1.43 (1.30–1.57)*; 1.16 (1.05–1.30)*
Combined	12.6% (l); 25.5% (h)*	2.15 (1.70–2.72)
Male	6.8% (l); 7.9% (h)	–
Female	6.6% (l); 8.3% (h)	–
Male	7.6% (l); 8.4% (h)	1.11 (0.71–1.67)
Female	11.2% (l); 4.2% (h)*	0.36 (0.23–0.56)*
Combined	3.4% (l); 5.6% (h)*	3.02 (2.45–3.71)*
Combined	11.6% (l); 6.9% (h)*	0.69 (0.54–0.89)*
Combined	5.9% (l); 17.4% (h)	–
Combined	–	1.43 (1.04–1.95)*
Male	8.0% (l); 18.8% (h)*	–
Female	6.0% (l); 34.7% (h)*	–
Combined	6.9% (l); 26.4% (h)*	–
Male	1.8% (l); 8.0% (h)*	–
Female	3.9% (l); 5.1% (h)	–
Male	26.2% (l); 31.9% (h)*	–
Female	12.1% (l); 30.3% (h)*	–
Male	10.9% (l); 31.8% (h)	–
Female	16.1% (l); 32.1% (h)*	–
Combined	–	2.8 (1.9–4.1)*
Male	15.0% (l); 34.7% (h)	–
Female	31.5% (l); 32.2% (h)*	–
Male	25.7% (l); 19.7% (h)	–
Female	19.1% (l); 50.0% (h)	–
Combined	–	1.0 (0.6–1.6)
Male	16.2% (l); 21.2% (h)*	–
Female	12.1% (l); 15.0% (h)*	–
Male	12.4% (l); 20.1% (h)*	–
Female	12.8% (l); 13.1% (h)	–

Socioeconomic inequalities in the prevalence of cardiovascular disease and risk factors in India

The authors of this paper have comprehensively investigated the socioeconomic and geographic distribution of type-2 diabetes in the Indian population using a large-scale nationally representative survey.

Data from the 3rd National Family Health Survey (NFHS), conducted in 29 states in India between November 2005 and August 2006, were used.

Interviews were conducted in 1 of the 18 Indian languages in the respondent's home.

The authors examined BMI across the three categories of diabetes status.

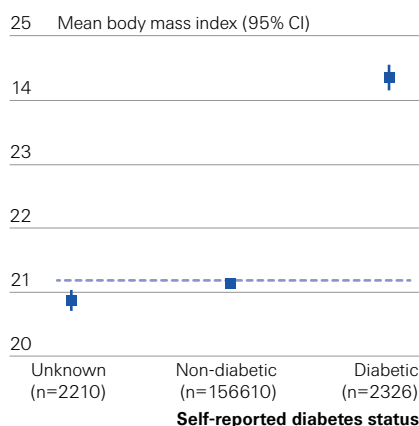
Concern has been raised over the anticipated rapid increase in type-2 diabetes prevalence in India^{38, 39}. Evidence on the secular increases in diabetes prevalence in India, however, have been limited to urban areas of Southern India^{20, 40, 41}, and have focused on the mean rates of diabetes, rather than how it is distributed in the population. Our work in this area has comprehensively investigated the socioeconomic and geographic distribution of type-2 diabetes in the Indian population using a large-scale nationally representative survey. Specifically, we investigated the SES-diabetes association through the SES markers of social caste, household wealth and education.

Data from the 3rd National Family Health Survey (NFHS), conducted in 29 states in India between November 2005 and August 2006⁴², were used. NFHS-3 is a major national health survey in India, which collected information on a range of indicators including reproductive health, nutritional status of adults and children, utilisation of health care services, and blood testing for HIV prevalence. NFHS-3 covered all states in India, which comprise nearly 99% of the population, but excluded Union Territories. All women aged 15–49 in selected households were invited to participate in the survey. In 22 states, men aged 15–54 in a random subsample of households – drawn from each Primary Sampling Unit (PSU), ie about 6 households per PSU – were eligible for the men's survey. In the remaining seven states (Andhra Pradesh, Karnataka, Maharashtra, Manipur, Tamil Nadu, Uttar Pradesh, and Nagaland), eligible men all in selected households were invited to participate. The additional men recruited in these states was for the purpose of HIV testing to provide reliable state level estimates of HIV prevalence in certain states.

Interviews were conducted in 1 of the 18 Indian languages in the respondent's home and the response rates were 95% for women and 87% for men⁴². During interviews, the weights and heights of survey respondents were measured by trained field technicians using standardised measuring equipment designed for survey settings⁴³. In total, NFHS-3 collected information from 109 041 households, 124 385 women aged 15 to 49, and 74 369 men aged 15 to 54. We restricted our analyses to adults aged 18 years and older and non-pregnant women (n=171 207). Respondents who did not report or know their diabetes status (n= 2373) or with incomplete information for any of the independent variables considered in the analysis (marital status, religion, caste, education, household wealth) were excluded (n=699). Main analyses were conducted on a sample of 168 135 respondents, (65 255 men and 102 880 women). Additional analyses considering body mass index (BMI) were restricted to a sample of 158 936 due to missing and/or implausible values for height and/or weight.

The primary outcome was diabetes, assessed on the basis of self-reports by survey respondents. A clinical threshold for the diagnosis of diabetes was not available through this survey and, further, clinical practice standards are more likely to vary in India, compared to Western countries, making the diagnosis of diabetes based on self-reports potentially problematic or misleading⁴⁴. We therefore examined BMI (which was measured and not self-reported in the NFHS) across the three categories of diabetes status (Figure 4). This revealed that those with unknown diabetes had the lowest BMI (mean 20.9 kg/m², standard deviation [SD] 3.7), which was largely consistent with the non-diabetic group (mean 21.1 kg/m², SD 3.9) and substantially lower than those with self-reported diabetes (mean 24.4 kg/m², SD 4.9).

Figure 4:
Mean body mass index across three possible responses for self-reported diabetes, Indian National Family Health Survey 2005–2006



Notes: Vertical lines represent 95% confidence intervals. Body mass index (in kg/m²) calculated from measured height and weight values. The horizontal line represents overall mean body mass index (21.2 kg/m², SD 3.9).

Source: Corsi (2012)⁶⁴

The markers of socioeconomic status – ie social caste, household wealth and education – were also used.

The markers of socioeconomic status were social caste, household wealth and education. Social caste was reported by the household head. The categories were Other/General Caste, Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Class (OBC) and No Caste. Other/General Caste is a heterogeneous group that is traditionally viewed as having higher social status. Scheduled castes and scheduled tribes are considered lower, socially marginalised groups in India⁴⁵. Household wealth was defined by an index based on indicators of asset ownership and housing characteristics⁴⁶. This index has been developed and validated in a number of countries to be a robust measure of wealth and has been found to be consistent with measures of income and expenditure⁴⁷. Briefly, the measure was constructed as follows. Information on 33 indicators of housing characteristics (eg type of windows and flooring, water and sanitation facilities) and assets (eg ownership of home, car, computer, mobile phone) were weighted and combined with weights derived from a principal component analysis procedure⁴². The resulting variable was standardised to a mean of 0 and standard deviation of 1, and using this index the household population was divided into fifths from poorest to richest. Education was categorised in four levels as no education, primary, secondary, or higher education.

Based on the survey results, diabetes prevalence appears to increase with age, education, household wealth and BMI.

Characteristics of survey respondents by their self-reported diabetes status are given in Table 3. The overall prevalence of diabetes in this sample was 1.5% and this was higher in urban areas and among men (diabetes prevalence 2.0% in urban versus 1.0% in rural areas; 1.8% in men versus 1.3% in women). Although some of this difference could be due to variation in clinical training between urban and rural areas, our sensitivity analyses suggest that this is unlikely. Diabetes prevalence increased with age (7.5% in those aged 50–54 versus 0.3% in those aged 18–29), education (1.9% in those with higher education versus 1.0% for those with no education), household wealth (2.5% for the richest versus 0.4% among the poorest), and BMI (4.8% for those with 27.5+ kg/m² versus 0.6% among those with <18.5 kg/m²).

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Table 3:
Characteristics of survey participants and
frequency distribution of self-reported
diabetes in India

	Self-reported diabetes		Total
	n	%	n
Participants	2 439	1.5	168 135
Residence			
Rural	818	1.0	86 013
Urban	1 621	2.0	82 122
Age group			
18–29 y	266	0.3	76 174
30–39 y	602	1.2	51 132
40–49 y	1 238	3.4	36 402
50–54 y	333	7.5	4 427
Gender			
Male	1 144	1.8	65 255
Female	1 295	1.3	102 880
Marital status			
Single	132	0.3	38 078
Married	2 165	1.8	123 457
Widowed	108	2.5	4 320
Divorced or separated	34	1.5	2 280
Religion			
Hindu	1 775	1.4	123 411
Muslim	340	1.6	21 510
Christian	213	1.4	14 779
Sikh	49	1.5	3 236
Buddhist	34	1.4	2 451
Other	28	1.0	2 748
Social Caste			
Other caste	1 026	1.8	56 063
Scheduled caste	349	1.3	27 677
Scheduled tribe	167	0.8	21 372
Other backward class	781	1.4	55 641
No caste	116	1.6	7 382
Education			
No education	464	1.0	44 856
Primary	358	1.4	24 969
Secondary	1 166	1.6	74 715
Higher	451	1.9	23 595
Household wealth			
Poorest	77	0.4	17 252
2nd quintile	175	0.8	22 948
3rd quintile	278	0.9	32 070
4th quintile	573	1.4	42 091
Richest	1 336	2.5	53 774
Body mass index (kg/m²)			
<18.5	243	0.6	42 128
18.5–22.9	703	0.9	74 089
23–27.4	833	2.7	31 217
27.5+	547	4.8	11 502

Source: Corsi (2012)⁶⁴ 3rd National Family Health Survey

The data appears to suggest that those with higher social status were more likely to have diabetes.

In separate models that adjusted for age, marital status, religion, and place of residence, statistically significant associations were observed between SES and self-reported diabetes for each of the primary markers of SES in this study: social caste, household wealth and education. Compared to the other caste group, scheduled castes, scheduled tribes, and other backward classes had reduced odds of having diabetes with odds ratios (OR) of 0.81 (95% CI: 0.71–0.94), 0.57 (95% CI: 0.46–0.70), and 0.84 (95% CI: 0.75–0.94), respectively (Table 4, Models 1-3). Education showed a graded relation with diabetes and an odds ratio of 1.87 (95% CI: 1.61–2.18) for those with higher education versus those with no education. Household wealth showed a graded association with diabetes: individuals from the richest households had an odds ratio for diabetes of 4.04 (95% CI: 3.08–5.30) compared to those from the poorest households. This finding could potentially be related to surveillance bias if differential uptake of health services exists between rich and poor households. Although this bias is difficult to assess directly with the currently available data, it is clear that wealthier households are more likely to have health insurance coverage either through their employers or the private sector (rates of coverage were about 16% in the richest households versus <1% in the poorest in 2005–6).

Table 4:
Associations between socioeconomic status and self-reported diabetes in India;
3rd National family health survey, 2005-6

Variable	Models 1–3		Model 4		Model 5	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Social Caste						
Other caste	1.00		1.00		1.00	
Scheduled caste	0.81	(0.71–0.94)	1.05	(0.91–1.21)	1.07	(0.93–1.24)
Scheduled tribe	0.57	(0.46–0.70)	0.72	(0.58–0.90)	0.73	(0.57–0.92)
Other backward caste	0.84	(0.75–0.94)	0.95	(0.85–1.07)	0.96	(0.86–1.08)
No caste	0.89	(0.71–1.11)	0.94	(0.75–1.17)	0.95	(0.76–1.20)
Wealth						
Poorest	1.00		1.00		1.00	
2nd quintile	1.59	(1.20–2.12)	1.57	(1.21–2.07)	1.49	(1.14–1.96)
3rd quintile	1.63	(1.23–2.16)	1.55	(1.21–2.02)	1.39	(1.07–1.81)
4th quintile	2.42	(1.85–3.17)	2.25	(1.76–2.92)	1.79	(1.40–2.34)
Richest	4.04	(3.08–5.30)	3.65	(2.83–4.78)	2.58	(1.99–3.40)
Education						
No education	1.00		1.00		1.00	
Primary	1.23	(1.06–1.43)	1.06	(0.91–1.22)	1.00	(0.86–1.17)
Secondary	1.68	(1.49–1.90)	1.18	(1.04–1.35)	1.12	(0.98–1.28)
Higher	1.87	(1.61–2.18)	1.12	(0.95–1.32)	1.01	(0.86–1.20)
Body mass index (kg/m²)						
<18.5					1.00	
18.5–22.9					1.25	(1.08–1.46)
23–27.4					2.08	(1.79–2.44)
27.5+					2.98	(2.51–3.54)

Notes: In models 1-3 one SES marker (social caste, household wealth, education) was modelled at a time, while adjusting for age, gender, religion, and place of residence. In model 4, all SES markers were included along with covariates from models 1-3. In model 5, BMI was included with markers of SES and covariates from model 4.

Source: Corsi (2012)⁶⁴

In separate mutually adjusted models that were stratified by gender, education showed a graded association in men, although it was not statistically significant.

The effects of social caste and education were attenuated in the mutually adjusted model (model 4), suggesting that their independent effects on self-reported diabetes were at least partially mediated by the inclusion of household wealth in this model. The reduced odds for diabetes remained consistent for scheduled tribes versus other caste groups (OR 0.72, 95% CI: 0.58–0.90) as did increased odds for those with secondary education versus no education (OR 1.18, 95% CI: 1.04–1.35); however, the graded relation with education was less consistent. In separate mutually adjusted models that were stratified by gender, education showed a graded association in men, although it was not statistically significant; the odds ratio for diabetes was found to be 1.27 (95% CI: 0.98–1.70) for men with higher versus no education. Among women, those with secondary education continued to show an increased odds of self-reported diabetes compared to those with no education (OR 1.28, 95% CI: 1.08–1.50). Overall, the strong and graded relation between household wealth and diabetes remained consistent in model 4 with an odds ratio for diabetes of 3.65 (95% CI: 2.83, 4.78) for the richest versus the poorest groups; similar associations were found in the gender-specific models. Type-2 diabetes is strongly influenced by body weight^{48–50}. Therefore, BMI was added to model 5 to control for potential confounding of the SES-diabetes relationship by BMI in this sample. In addition, BMI was added separately in this model because its inclusion resulted in the reduction of sample size by ~5% due to missing values for BMI. The odds ratios for caste and education remained consistent between the mutually adjusted model and final model which included BMI. The odds ratios for household wealth were further attenuated in the final model; however, the positive graded association remained statistically significant, with an adjusted odds ratio for those in the richest compared to the poorest households of 2.58 (95% CI: 1.99–3.40).

Although the economically advantaged groups may have a higher burden of morbidity in India, the mortality burden might be higher among the economically disadvantaged groups.

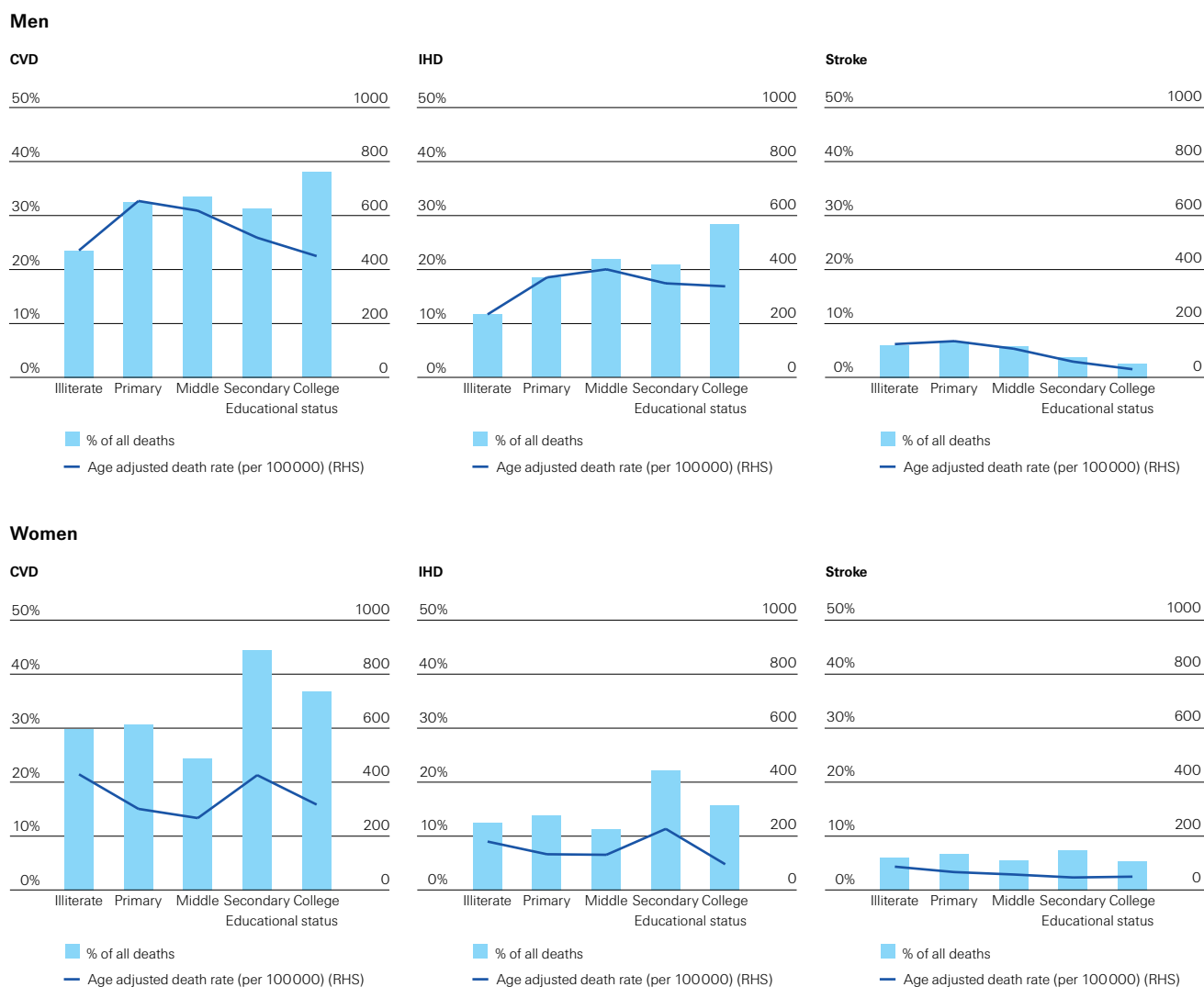
CVD-related mortality

Although the economically advantaged groups may have a higher burden of morbidity in India, the mortality burden might be higher among the economically disadvantaged groups. To explore this issue, we made further analyses of the largest study of SES and CVD-related mortality in India, the Mumbai Cohort Study. In this study, Pednekar and colleagues report the association between levels of educational attainment and cardiovascular mortality in the city of Mumbai (n=148 173; 13 261 deaths)⁵¹, and concluded that a negative association for CVD mortality exists for men, but not for women. Meanwhile, their data shows the following: among men, the age-adjusted rates of CVD were lower among those who were college educated at 450 (per 100 000), but not dramatically different to those who were illiterate (471). Meanwhile, the age-adjusted rates of CVD were 654 for those with a primary education, 618 for those with a middle education, and 518 for those with a secondary education – ie higher than rates observed for illiterates. Among women, the pattern was even less clear as the authors of the study acknowledge: age-adjusted rates of CVD mortality declined from 429 to 267 between illiterates and those with middle school education, before increasing to 426 among those with secondary education and then falling again for those with college education. In short, even in this large study, one cannot observe a robust SES gradient for rates of CVD-related mortality in India.

The authors of this paper found that while the death rates were lower among college-educated for CVD, the percentage of deaths from CVD and IHD was greater among men and women with higher education.

Drawing on the data presented in the study by Pednekar and colleagues⁵¹, Figure 5 shows the age-adjusted death rate (y axis on the right hand side) and the proportion of deaths (y axis on the left hand side) attributable to each of the causes (CVD, IHD, stroke) of the total deaths, by categories of educational status for men and women. The study by Pednekar and colleagues largely focuses on the SES differences in the age-adjusted death rate, as is typical of most epidemiological studies. We additionally present (shown by bars) the fraction of deaths due to CVD/IHD/stroke out of all causes of death by educational categories. We show that while the death rates were lower among college-educated for CVD (though there is no evidence for a clear gradient), the percentage of deaths from CVD and IHD was greater among men and women with higher education. Stroke mortality showed a more consistent negative socioeconomic gradient, in line with evidence that stroke, in particular haemorrhagic stroke, shows an association with deprivation in early life⁵².

Figure 5:
Percentage of deaths from CVD, IHD and stroke according to educational status among 88 658 men aged ≥ 35 years in Mumbai, India in 1997–2003



Source: Subramanian (2013)⁵⁶; data are from Pednekar (2011)⁵¹

The proportion of CVD-related deaths was 30.5% of all deaths in the “lower education groups” versus 34.4% in the “high education groups”.

Using additional data from the Mumbai Cohort Study presented by Gupta and Pednekar in their letter⁵³, the proportion of CVD-related deaths was 30.5% of all deaths in the “lower education groups” versus 34.4% in the “high education groups” (Table 5)⁵⁴. The proportion of IHD deaths (the primary disease which arises from the lifestyle-related cardiovascular risk factors) accounted for 23.5% of all deaths in the “higher education group” compared to 16.4% in the “lower education group” (resulting in a relative difference of 1.4 in the higher educated group (95% CI: 1.27 to 1.60)). The proportion of stroke deaths, as expected, was greater in the lower educated group; stroke has consistently been related to lower socioeconomic position over time and place^{52, 55}. It is also readily apparent that even the age-adjusted IHD mortality rate was higher among the “higher education group” at 326/100 000 versus 284/100 000 for the “lower education group”, while the age-adjusted stroke mortality rate was lower among the “higher education group” (48/100 000) compared to 108/100 000 for the “lower education group” (see Table 1 of the letter by Gupta and Pednekar)⁵³.

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Table 5:
Proportion of cause-specific deaths to total deaths for low and high education groups, absolute and relative differences by education status in the Mumbai Cohort Study

Cause of death	Education group		Education group		Difference H-L (95% CI)*	Ratio H/L (95% CI)†
	Lower	Higher	Lower	Higher		
	n	%	n	%		
All cause	11 905	100.0	1048	100.0	–	–
CVD	3 631	30.5	360	34.4	3.9 (0.9; 6.8)	1.13 (1.03; 1.22)
IHD	1 957	16.4	246	23.5	7.0 (4.5; 9.7)	1.43 (1.27; 1.60)
Stroke	747	6.3	37	3.5	–2.7 (–4.0; –1.6)	0.56 (0.39; 0.74)
Other CVD	927	7.8	77	7.3	–0.4 (–2.2; 1.1)	0.94 (0.73; 1.15)
Non-CVD causes	8 274	69.5	688	65.6	–3.9 (–6.9; –0.9)	0.94 (0.90; 0.99)

* H0 : H-L = 0

† H0 : H/L = 1

Source: Gupta P, Pednekar M (2013)⁵³

68.3% of CVD deaths were due to IHD in the “higher education group” compared to 53.9% in the “lower education group” and the proportion of stroke was twice as high in the “lower education group.”

Further, if we focus on the proportion of deaths contributed by subtypes of CVD of the total CVD deaths (Table 6), 68.3% of these deaths were due to IHD in the “higher education group” compared to 53.9% in the “lower education group” and the proportion of stroke was twice as high in the “lower education group” (20.6% vs 10.3%). About a quarter (25.5%) of CVD deaths among the lower educated were not due to IHD or stroke compared to 21.4% in the higher educated group, underscoring the need to understand the particular type of cardiovascular conditions as the socioeconomic gradient clearly differs between the specific cardiovascular causes^{54,56}.

Table 6:
Proportion of subtypes of CVD-related deaths to total CVD deaths for low and high education groups, absolute and relative differences by education status in the Mumbai Cohort Study

Cause of death	Education group		Education group		Difference H-L (95% CI)*	Ratio H/L (95% CI)†
	Lower	Higher	Lower	Higher		
	n	%	n	%		
CVD	3 631	100.0	360	100.0	–	–
IHD	1 957	53.9	246	68.3	14.4 (9.4; 19.6)	1.27 (1.17; 1.37)
Stroke	747	20.6	37	10.3	–10.3 (–13.7; –6.9)	0.50 (0.34; 0.65)
Other CVD	927	25.5	77	21.4	–4.1 (–8.7; 0.3)	0.84 (0.67; 1.01)

* H0 : H-L = 0

† H0 : H/L = 1

Source: Gupta P, Pednekar M (2013)⁵³

Relationships may have shifted over time due to a lack of robust time series data on CHD death rates by SES in India.

It is not clear whether these relationships may have shifted over time due to a lack of robust time series data on CHD death rates by SES in India, although studies prior to 1980 have indicated a distinct positive association between markers of SES and CHD in India^{56–58}.

Socioeconomic status and CVD and CVRF in the Longitudinal Aging Study in India

We sought to quantify the relationship between SES and other CVRF among adults participating in the Longitudinal Aging Study in India (LASI), a recently launched national longitudinal survey on aging and health. Data were used from the pilot phase of LASI, conducted in 2010 and designed to sample 1500 individuals across four Indian states. Individual surveys were completed by household members at least forty-five years of age and their spouses. Table 7 describes the study population. Outcomes in LASI were self-reported CVD and CVRF. As with the NFHS, there may be differences in physician backgrounds assessing the survey respondents which may affect the prevalence estimates. There are plans to undertake additional sensitivity analyses to investigate whether this may have any meaningful influence on the prevalence estimates generated through self-reports of CVD and CVRF. Explanatory variables were a range of social and economic situation indicators. Analyses were conducted on the pilot dataset of 1683 individuals from four states. Logistic regression was used to model the association between several markers of SES and indicators of CVD and CVRF in this population.

Table 7:
Characteristics of the Longitudinal Study of
Aging in India (LASI) pilot sample (n = 1683)

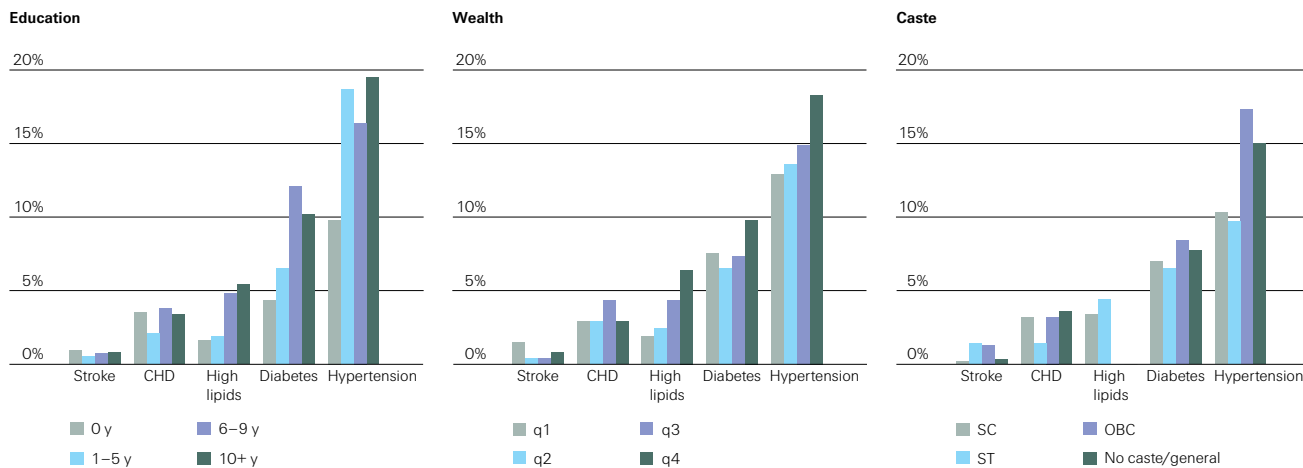
Characteristic	
Age, M (SD)	55.4 (12.3)
Male (%)	43.2
Education (years), M (SD)	3.7 (4.6)
HH expenditure (Rs), M (SD)	57468.1 (79490.0)
Caste (%)	
Scheduled Caste	13.8
Scheduled Tribe	13.0
OBC	40.4
Other/No caste	32.8
Urban (%)	27.0
State	
Punjab	12.6
Rajasthan	31.3
Kerala	22.6
Karnataka	33.4

Source: author

The prevalence of stroke, CHD, elevated lipids, diabetes and hypertension was higher among the better off SES groups.

The weighted prevalences of stroke, CHD, elevated lipids, diabetes and hypertension were 0.8%, 3.3%, 2.9%, 7.9%, and 15.2% respectively. The prevalences were higher among the better off SES groups with shallow gradients for CHD and stroke (Figure 6).

Figure 6: Socioeconomic patterning of metabolic related cardiovascular disease risk factors in LASI

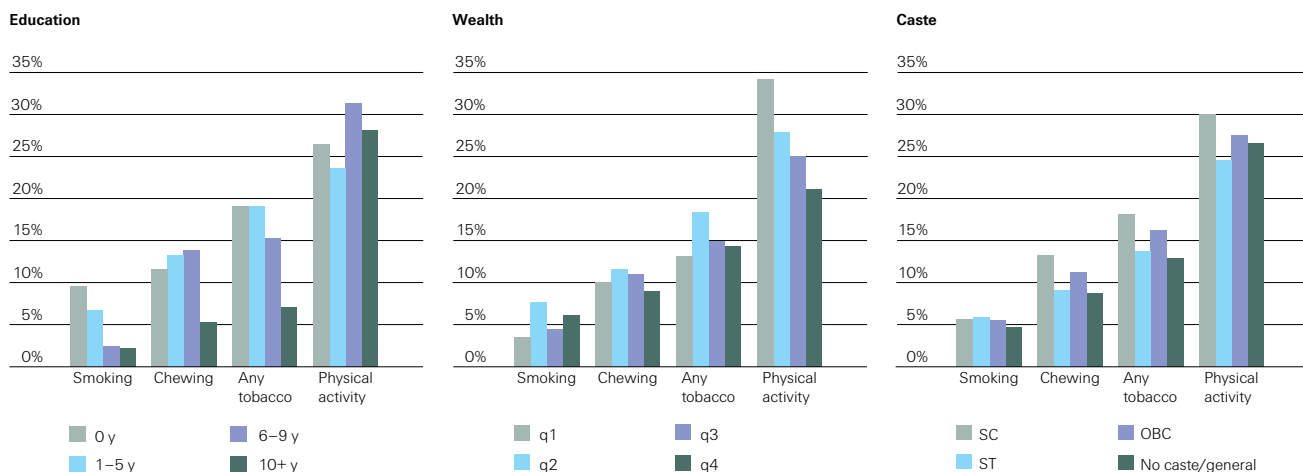


Source: Author's calculation from the LASI pilot dataset

Diabetes prevalence was 4.3% among those with no education compared to 10.2% among those with 10+ years of education.

Diabetes prevalence was 4.3% among those with no education compared to 10.2% among those with 10+ years of education; odds ratio [OR] 2.7 (95% CI: 1.3 to 5.7). Hypertension was 9.6% among those with no education and 19.5% among the highest educated; OR 2.5 (95% CI: 1.5 to 4.1). Tobacco use was typically lower in the higher educated groups (19.1% in the least vs 7.1% in the highest educated) (Figure 7) although the gradient was less pronounced for household expenditure.

Figure 7: Socioeconomic patterning of lifestyle related cardiovascular disease risk factors in LASI

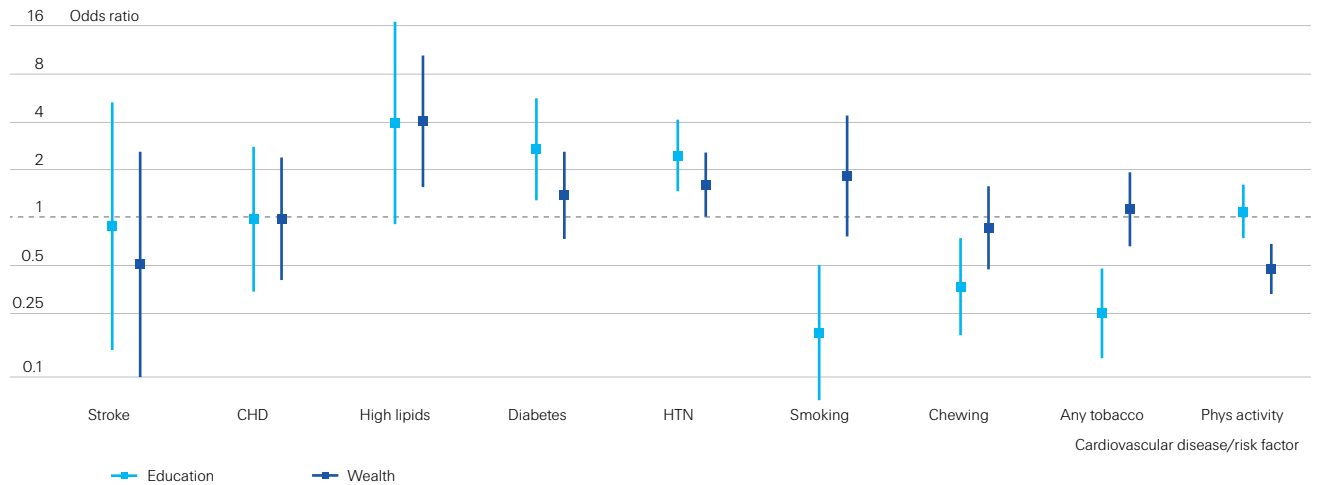


Source: Author's calculation from the LASI pilot dataset

Regular physical activity decreased with increasing household expenditure.

Regular physical activity decreased with increasing household expenditure [34.2% in the bottom vs 21.1% in the top quartile, OR 0.48 (95% CI: 0.33 to 0.69)] (Figure 8).

Figure 8:
Association between a 1-category increase in education or wealth and cardiovascular disease risk factors in LASI



Source: Author's calculation from the LASI pilot dataset

Conclusion

For a reversal in the SES-CVRF/CVD gradient to occur in India, a confluence of factors including the cheap availability of calorie-dense food (and food in general), dramatic shifts in occupational patterns from an agrarian to a service economy, high SES groups cutting down or shifting their dietary patterns, or economic growth spilling over to the low SES groups and improving their incomes in a substantial manner would have to emerge.

There is a hypothesis that the social gradients in CVRF/CVD will eventually 'crossover' such that the positive associations currently observed will invert and resemble the more negative associations observed in Western high-income countries⁵⁸. At present there are several challenges to forecasting when, and if such a reversal will take place in India. For a reversal in the SES-CVRF/CVD gradient to occur in India, a confluence of factors including the cheap availability of calorie-dense food (and food in general), dramatic shifts in occupational patterns from an agrarian to a service economy, high SES groups cutting down or shifting their dietary patterns, or economic growth spilling over to the low SES groups and improving their incomes in a substantial manner would have to emerge. There is currently little evidence for such changes occurring in India. In contrast, inflation in the cost of food has become a critical concern⁵⁹, economic growth has been remarkably uneven and concentrated among a small minority⁶⁰ and more than half of the workforce in India is still engaged in labour-intensive agriculture activities⁶¹. Furthermore, the World Bank estimates that over 40% of the Indian population lives on less than USD 1.25 per day⁶², and 76% are estimated to be living on less than USD 2 per day⁶³. Although such a reversal may yet occur over the long term, it does not seem likely that such changes in the social gradients of CVRF/CVD will occur in the short term.

The findings described in this report suggest a greater burden of CVRF/CVD among the high SES groups, with the exception of tobacco.

Together, the findings described in this report suggest a greater burden of CVRF/CVD among the high SES groups, with the exception of tobacco. Although the mortality data are inconclusive, it appears rates of CVD-related mortality are highest among the poor while the proportional burden of mortality from CVD-related causes is greater among higher SES groups. There is a need for national surveillance and monitoring of CVD and risk factors in India to appropriately prepare for any large shifts in the distribution of risk factors and disease. Furthermore, priorities in public health policy should focus on the health concerns of the majority of the Indian population, which continues to be afflicted by communicable diseases and under nutrition. Resource allocation should reflect the proportional burden of disease on different population groups if it is not to entrench inequity.

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