## Swiss Re
Centre for Global Dialogue

Risk Dialogue Series

# Health Risk Factors
# Brazil

In collaboration with

**HARVARD**
**SCHOOL OF PUBLIC HEALTH**

# Contents

# Preface

Dear reader

We are very pleased to welcome you to this edition of the Risk Dialogue Series on Health Risk Factors in Brazil.

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

This publication is part of the joint research collaboration by Swiss Re and the Harvard School of Public Health (HSPH). It describes the research undertaken by 45 colleagues from both institutions. It is an important component of what we call the Systematic Explanatory Analyses of Risk factors affecting Cardiovascular Health (SEARCH) project. The aim of our collaboration is to clarify the relationship between risk factors and health outcomes in the rapidly evolving countries of Brazil, China, India and Mexico. Their health profile is changing swiftly and significantly with economic growth. NCDs are rising rapidly, creating a major challenge for public and private providers and funders of health care.

Brazil is a vast country. Despite extensive public health campaigns, parts of Brazil still struggle with infectious diseases that are characteristic of developing countries. At the same time, it is beset by a rising rate of NCDs, a situation compounded by the country's ageing population. As with other emerging markets, Brazil has a rapidly growing middle class. This middle class has already expressed frustration at the insufficient public services, such as public transport. With increasing demands on the health system, access to adequate healthcare has the potential to become another divisive political issue.

These challenges are not insurmountable. Swiss Re believes the need for greater health coverage can be as much an opportunity as a threat. Insurance can play a valuable role in expanding access to healthcare in an affordable and reliable manner. With the SEARCH articles, we hope to improve our understanding of the state of health in Brazil.

With best regards

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# SEARCH – The search for health data and insights from Brazil

Eduardo Lara di Lauro, Rolf Steiner

**Brazil offers universal health coverage. However, its health services are under pressure from demographic change and the rise in chronic conditions. Private insurance schemes could be a valuable component in the provision of future health service solutions. Insurers can only improve products and pricing with good data and an understanding of future trends. The SEARCH project attempts to provide a basis for improved understanding of the major health drivers in Brazil.**

## Life and health insurance and data

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

Life and health insurance is the provision of coverage from 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 dramatic increase in the prevalence of 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: Voluntary private 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 and create differentiated rating systems, classifying applicants as preferred, normal or subnormal risks. A notable success in recent years has come with extending coverage to HIV infected individuals in South Africa[1].

… and create new products.

(iii) Creating new products: Life and health 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 and health products that can quickly and easily be offered with minimal underwriting[2].

## Data and emerging markets

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

Emerging markets are relatively underinsured. In 2012, they accounted for only 15% of the USD 2621 billion in global life and health premiums[3]. With economic growth, and particularly the growth of the middle class, this figure is expected to grow substantially in the coming years.

However, data is often lacking in emerging markets.

Major insurers are already well placed in the competitive market for new emerging 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.

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

Even where data is quite good, the health of many emerging markets is in a state of flux. Throughout 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, chronic diseases are becoming more prevalent. Diabetes, for example, was virtually unknown in many emerging markets only thirty years ago. However, due to significant changes in diet, it is now quite commonplace (Figure 1).
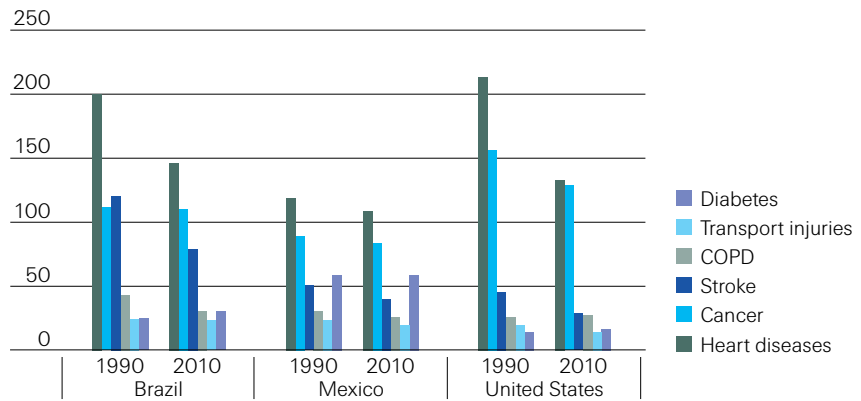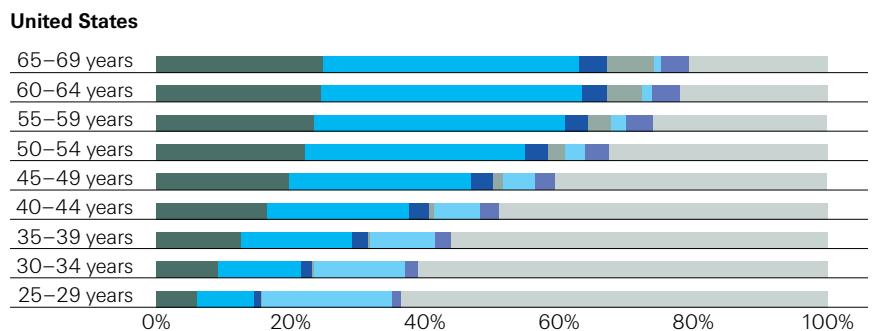
Figure 1:
Stroke in Brazil and diabetes in Mexico are the third leading causes of death right after heart disease and cancer; mortality rates per 100 000 (age adjusted)
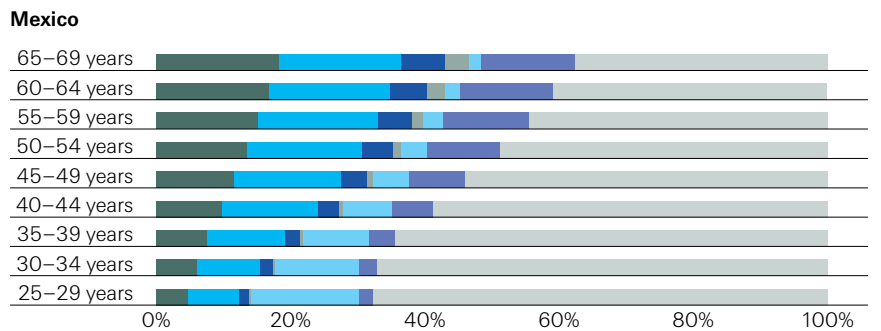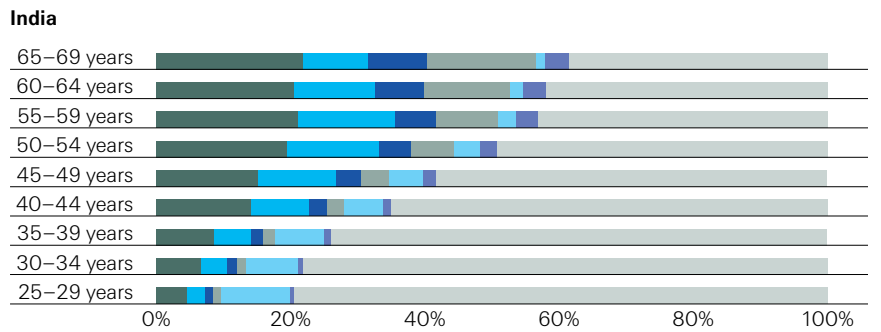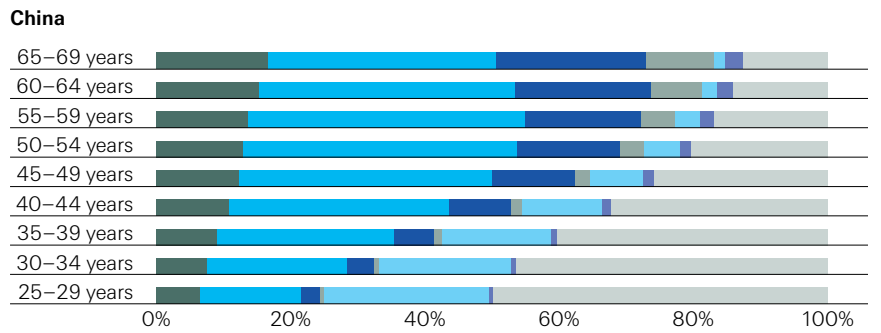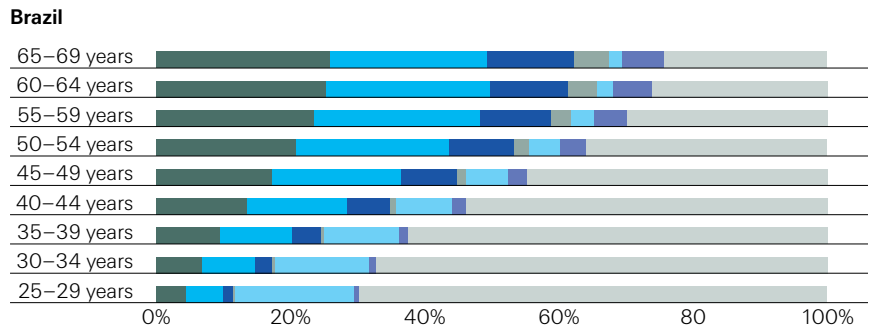


Note: When comparing the 20 year transition of the leading causes of death in Brazil, Mexico and the USA from 1990 to 2010, one can see distinctive differences. While mortality rates of heart diseases declined by 27% in Brazil and 38% in the USA, they only decreased by 8% in Mexico. While stroke mortality rates declined in all countries at similar rates, the total mortality rate per 100 000 in 2010 is about twice as high in Brazil as in Mexico, and almost threefold higher than in the USA. This suggests a difference in stroke management practices or accessibility to stroke treatment in the three countries. Interestingly, diabetes mortality rates only slightly increased in all countries over the observed 20 year time horizon; however, total diabetes mortality rates in 2010 in Mexico were twofold higher than those in Brazil and 3.5 fold higher than in the USA. Note that part of the differences in mortality rates may be due to differences in death certificate reporting practices in the three countries.

Source: Global Burden of Disease 2010

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

The displacement of infectious disease with chronic conditions has evolved over many decades in developed markets. The pace of change is far more rapid in many emerging markets; to the point that some emerging 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 2).

Figure 2:
Causes of death in 2010 in insurance
relevant age intervals in selected countries
(% total mortality by age band)

**Brazil**



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

**China**



**India**



Notes: In the younger age bands, death due
to transport injuries is 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%
non-communicable diseases; across all age
groups) and has 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 rate
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

**Mexico**



**United States**

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

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 emerging markets, from the relatively sophisticated to those with considerable scope for improvement. This is another factor insurers must anticipate in their modelling.

## SEARCH and Brazil

Chronic diseases such as cardiovascular disease (CVD) and diabetes are on the rise in Brazil.

In many respects, Brazil exhibits the classic health transition of an emerging market. Chronic diseases such as cardiovascular disease (CVD) and diabetes have emerged as the major causes of mortality. This is a result of the rapid change in age structure and has been fuelled by physical inactivity and a significant shift in diet towards the consumption of processed foods, resulting in significant increases in the number of individuals who are overweight, obese and diabetic. Although the country is vast, it is significantly urbanised. That has brought with it high levels of air pollution to the mega cities, which is associated with an increase in cardiovascular and cerebrovascular mortality. The health transition the country has gone through over the last decades is summarised in this publication, followed by specific articles addressing risk factors and conditions contributing to the country's health shift.

## Public health measures

Brazil has been ahead of much of the world in implementing legislation against smoking. The authorities are also actively promoting healthier diets and more exercise.

There are more distinct factors in the overall health landscape in Brazil. One of those is that parts of the vast country, notably the North and East, were historically vulnerable to outbreaks of infectious diseases. Although this has not quite been conquered, public health officials have made impressive strides against communicable illnesses since the start of the twentieth century. That spirit of public health activism is still alive and is being used to address chronic conditions. Despite being the second largest producer of tobacco, Brazil has been ahead of much of the world in implementing legislation against smoking. The authorities are also actively promoting healthier diets and more exercise.

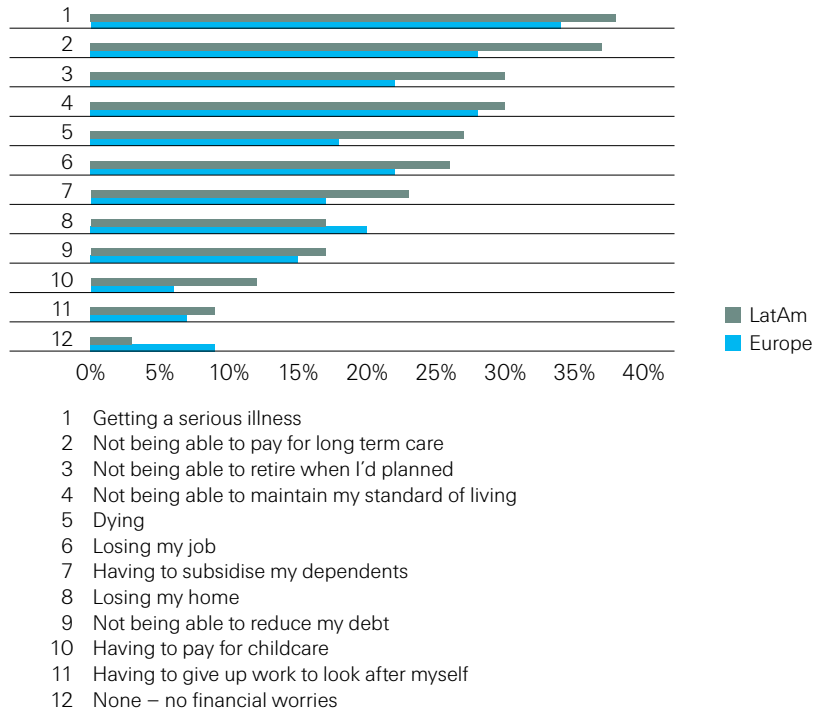Traffic accidents and homicide are also prevalent in Brazil.

Although not health related, two further factors significantly distinguish longevity in the country from other emerging markets. One is the high prevalence for death in traffic accidents; the other is homicide. Both are more common in Latin America than elsewhere.

## Brazil and insurance

With a population close to 200 million, Brazil has gone through a prosperous decade in which the middle class has grown from 38% to 54% of the population between 2002 and 2012[4]. However, Brazil is not a well insured market. Only 25% of the population is covered by some type of private health plan; and that is largely through employment. A Swiss Re survey in 2013 found that only 10% of Brazilians had insurance cover that would provide income protection in the case of serious illness (Figure 3)[5].

Figure 3:
What are your main worries or concerns for the future that might lead you to consider buying insurance?



1   Getting a serious illness
2   Not being able to pay for long term care
3   Not being able to retire when I'd planned
4   Not being able to maintain my standard of living
5   Dying
6   Losing my job
7   Having to subsidise my dependents
8   Losing my home
9   Not being able to reduce my debt
10  Having to pay for childcare
11  Having to give up work to look after myself
12  None – no financial worries

Notes: The threat of not receiving necessary healthcare treatment is the major concern, with respondents feeling highly vulnerable. People feel least concerned about becoming unemployed; a quarter of respondents feel fully secure about their employability.
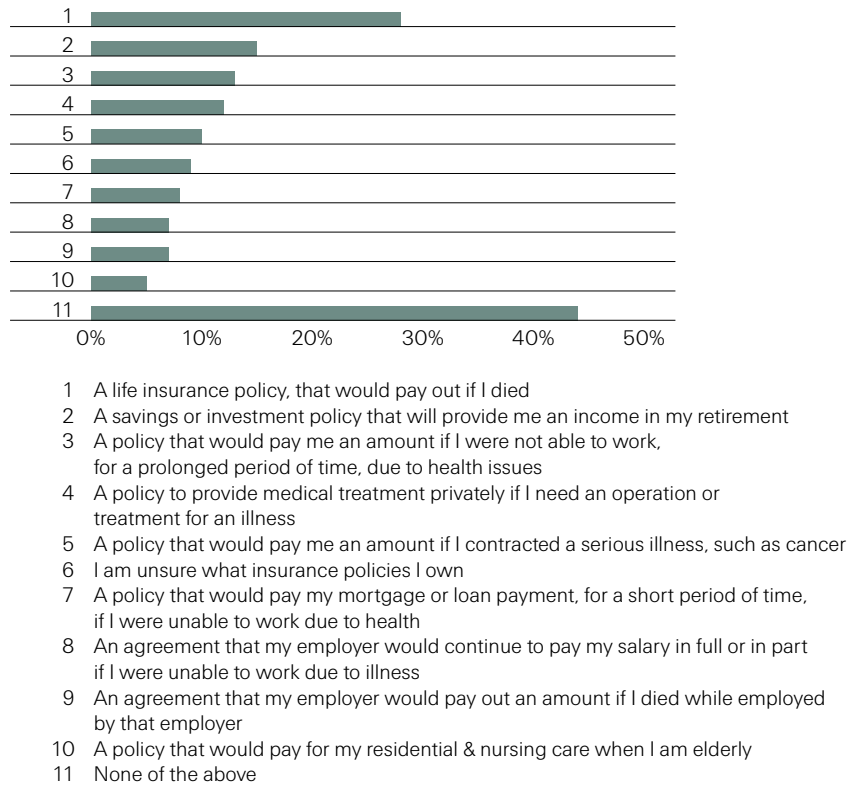
Source: Swiss Re[5]

Most Brazilians hope their savings would be adequate in case of illness.

In the event of a debilitating condition, most hoped that their savings would cover any eventuality; others placed (a somewhat optimistic) faith in social security. Brazil has a unitary health system, underfunded through general taxation.

Figure 4:
If you were to require care and support in later life, in your own home or in a care home, how would you pay it?



1 A life insurance policy, that would pay out if I died
2 A savings or investment policy that will provide me an income in my retirement
3 A policy that would pay me an amount if I were not able to work, for a prolonged period of time, due to health issues
4 A policy to provide medical treatment privately if I need an operation or treatment for an illness
5 A policy that would pay me an amount if I contracted a serious illness, such as cancer
6 I am unsure what insurance policies I own
7 A policy that would pay my mortgage or loan payment, for a short period of time, if I were unable to work due to health
8 An agreement that my employer would continue to pay my salary in full or in part if I were unable to work due to illness
9 An agreement that my employer would pay out an amount if I died while employed by that employer
10 A policy that would pay for my residential & nursing care when I am elderly
11 None of the above

Notes: The research showed that 40% of Brazilians fear that they would suffer and struggle financially if they were affected by a long-term illness or disability, and that their families would not have any means of ensuring financial stability in the first years following their death. Most of those surveyed said that this is mainly due to a lack of sufficient savings/investments (47%); only 18% of the respondents mentioned insufficient insurance protection. This is an indication that in many cases insurance is still not considered a valid option to bridge a critical life situation, even less so in light of Brazil's well-developed culture of saving.

Source: Swiss Re[5]

Many Brazilians seem willing to pay the cost of critical illness cover, but cite complexity of insurance as the reason for not purchasing it.

The irony of this was, when asked what they might pay for critical illness cover*, many respondents named a figure for which coverage already exists. When asked why they did not purchase cover, most cited the complexity of insurance. This suggests that insurers should develop products that are simpler, more easily distributed and understandable.

## Healthcare in Brazil

In 2012, total health expenditure stood at 8.9% of Brazil's GDP.

In 2012, total health expenditure stood at 8.9% of Brazil's GDP; public expenditure accounted for 46% of the total, while private expenditure accounted for the remainder. Of the private expenditure, 58% was directly out-of-pocket, 40% was through private health insurance and 2% through other types of financing[4].

* Critical illness cover is an insurance product, where the insurer is contracted to typically make a lump sum cash payment if the policyholder is diagnosed with one of the critical illnesses listed in the insurance policy.

Brazil's current health system, "Sistema Único de Saúde" (SUS) was created in 1988 in order to rectify the inequality that existed in health assistance among the population.

The current healthcare system in Brazil, called Single Health System, "Sistema Único de Saúde" (SUS) was created in 1988 in order to rectify the inequality that existed in health assistance among the population. In theory, public health assistance is mandatory and universal for any Brazilian citizen. The SUS is supposed to provide every citizen comprehensive healthcare services in public health units at the county, state and federal levels, or in private health units contracted by the public administration. The SUS is financed through general taxation and social security contributions. Due to budget issues, the funding of SUS is not sufficient to provide quality healthcare to the entire population.

## Private health insurance

Almost 50 million Brazilian citizens have some kind of private healthcare coverage, paying additionally for similar or overlapping health coverage.

As an option to the failings of the public health care system, almost 50 million Brazilian citizens have some kind of private healthcare coverage, paying additionally for similar or overlapping health coverage. Private companies that offer this kind of coverage in exchange for a monthly payment are called Health Plan Operators, "Operadoras de Planos de Saúde" (OPS). There are also specialised health insurance companies offering private healthcare plans. Other players are medical cooperatives, self-insurance schemes and not-for-profit plans.

The total numbers of health operators decreased in the last decade.

The total numbers of health operators decreased in the last decade to around 1100; further market consolidation is expected due to growth plans of dominant market players, foreign investment, and more restrictive regulations affecting smaller operations.

Health insurance premiums are estimated at USD 48bn.

Health insurance premiums are estimated at USD 48bn, a figure that has steadily grown in recent years, but with considerable room for further growth. However, profitability remains low, due to a high claims ratio of around 80–85% (claims to premiums) over the last 10 years. Once administration and acquisition costs are discounted, the combined ratio is about 100%, which means health insurers are breaking even[6]. This is in large part due to mandatory restrictions which curtail risk selection (underwriting). The highest cost claims made on private health insurers come from cancer, nervous system and cardiovascular diseases (Figure 5).

Figure 5:
Private health insurance conditions based on total claims cost
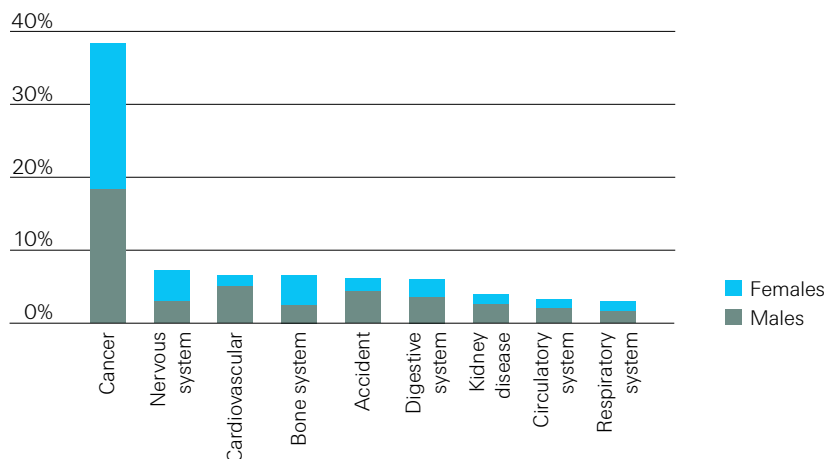


Notes: By far the biggest private health claims arise from cancer treatment (38.4% of total claims; males and females combined). The second and third largest health insurance claims are from cardiovascular disease in males (5.0%), followed by nervous system claims in females (4.3%).

Source: ANS (National Health Agency) and FENSAUDE (Association of Brazilian Health Operators) – periodical reports

## Providing improved insurance products

Many citizens feel insecure about the cover they have; the universal health system struggles to provide health for all; and the health insurance system is constrained with little room to innovate and a lack of incentive to control costs.

We are thus left in Brazil with a scenario where many citizens feel insecure about the cover they have; a universal health system that struggles to provide health for all; and a constrained health insurance system with little room to innovate and a lack of incentive to control costs. A number of trends suggest that these conditions are set to deteriorate. The population is ageing, which will increase chronic conditions. With low birth rates, the dependency ratio will deteriorate. Social trends are in flux, with a decline of family units and elderly care which frequently accompanies them.

Health may well be a future political pressure point, as public health services struggle to offer what they promise; and private insurers are restricted in the services they provide.

At the same time, the growing middle class in Brazil have been frustrated at their inability to realise the expectations of their new social status. In 2013, there were significant middle class riots, mainly due to the cost of public transport. Health may well be a future political pressure point, as public health services struggle to offer what they promise; and private insurers are restricted in the services they provide. The excess demand on health provision is in part helping fuel medical inflation, running at around twice the rate of general inflation. Increasing costs will exacerbate an already difficult situation.

Future products to cover life and health will go beyond traditional offerings and encompass the health and social care spectrum.

In Brazil, as in many other markets, the convergence of social and demographic trends is creating an exciting time for growth in health insurance. Future products to cover life and health will go beyond traditional offerings and encompass the health and social care spectrum. Insurers can capitalise on these trends, utilising new technologies to help close societies' health protection gaps.

One potential solution in Brazil would be to encourage employers to contribute to voluntary group insurance schemes.

One potential solution in Brazil would be to encourage employers to contribute to voluntary group insurance schemes, supported by the right tax breaks and incentives. These schemes should be on an 'opt out' rather than 'opt in' basis. Individuals would have the chance to pay into insurance schemes in early adulthood when premiums are low. Medical plans could also include a savings component. These products could be distributed together with public services or private health plans.

Translating frequency and average cost data into knowledge and counting with solid evidence-based tools enable insurers to improve risk assessment and risk selection skills and therefore provide fair pricing and affordable rates.

Translating frequency and average cost data into knowledge and counting with solid evidence-based tools enable insurers to improve risk assessment and risk selection skills and therefore provide fair pricing and affordable rates. Insurers can stabilise premiums through higher customer retention, supported by knowledge-backed underwriting. The analysis and data provided by the SEARCH project done in collaboration with the Harvard School of Public Health is a valuable tool in supporting this expansion of the insurance knowledge base.

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## About the authors

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Eduardo Lara di Lauro is the Head of Health Insurance Latin America at Swiss Re. He is responsible for developing and implementing Swiss Re's Primary Medical Insurance strategies in Latin America, and has over 27 years of experience in the insurance industry. Prior to joining Swiss Re, he was Principal and Managing Director of a large US Healthcare Consulting Practice based in Mexico. He has published several articles and spoke at numerous forums on issues related to Life & Health insurance, health systems and managed care topics in Mexico, USA, Chile, Panama, Peru and Colombia. He served as the President of the Mexican Association of Actuaries and is a board member of the Health Committee of the International Actuarial Association. He is a Certified Actuary by the Mexican National College of Actuaries, and graduated from the Science Faculty of Mexico's National Autonomous University (UNAM).

**Rolf Steiner**

Rolf Steiner is a Senior Consultant in Life & Health at Swiss Re. Based in Sao Paulo, Brazil, he is responsible for Life & Health Primary Value Chain operations in Latin America. He joined Swiss Re in 1997 as a Marketing Actuary. He became the head of the Swiss Re office in Buenos Aires in 2002 and was responsible for all of Swiss Re's Life & Health business in South America. In 2005, he moved to Rome to manage Swiss Re's Life & Health operations in Italy. In 2008, Steiner took over responsibility for Swiss Re's Latin American operations covering Puerto Rico and Global Risks. Then in 2010, he again headed Swiss Re's office in São Paulo, where he was responsible for reinsurance operations in Brazil and the Southern Cone. Prior to joining Swiss Re, he was a Life Actuary at Union Re and holds a degree in mathematics from ETH Zurich.

# Overview of health risk factors in Brazil

Marcia C. Castro

**Brazil has made significant progress in reducing infectious diseases, although problems still persist. Currently non-communicable diseases (NCDs) represent the largest mortality and morbidity burden in the country. This situation may become more critical as the population ages and the prevalence for being overweight and obese increases. Brazil has a historically good record of facing health challenges through large scale campaigns. It most recently became the global leader in tobacco control, despite being among the top 5 producers of tobacco in the world. This article discusses historical and current pattern of mortality, morbidity and associated risk factors in Brazil, particularly when faced with structural demographic change. It also discusses government programmes, such as the Family Health Strategy and the Strategic Action Plan to tackle NCDs.**

## Health campaigns in Brazil: A brief history

A series of historical events including a 1916 speech by Miguel Pereira, a leading physician, shaped the discourse on public health in Brazil.

Several historical events related to public health in Brazil since the Republic era, ranging from discovery of new diseases, to novel control methods of malaria, to large scale campaigns, played an important role in the past and to some extent set the context for what we observe now in the country. An important event in creating a momentum for change was a speech delivered by a physician named Miguel Pereira in 1916 at the Medical School in Rio de Janeiro. While referring to expeditions that assessed the health conditions of rural areas in the North and Northeast regions[1–6], he stated that rural Brazil was an enormous hospital[7].

At one time, poor health conditions were seen as an obstacle to economic development.

Poor health conditions of the poor and rural populations were seen as an obstacle to economic development. Sanitation movements, which brought together physicians, scientists, intellectuals and politicians, resulted in major reforms of the sanitary services in the country. Important milestones included the start of the Pro-Sanitation Movement in 1916, as well as the creation of the National Department of Public Health in 1920 and the Ministry of Education and Public Health Affairs in 1930[8].

Campaigns were launched to combat specific diseases such as yellow fever, bubonic plague, smallpox and malaria.

Large scale (and mostly vertical) campaigns were launched to address specific diseases such as yellow fever, bubonic plague, smallpox and malaria. This model of intervention gained momentum, and many of these campaigns received support from the Rockefeller Foundation. There are campaigns still present in Brazil, such as the National Immunization Day against Poliomyelitis[8].

## Demographic transition

Demographic changes in Brazil have had an impact on current health risk factors.

Crucial to the understanding of current health risk factors in Brazil is the demographic transition that brought about major changes to the structure of the population, coupled with patterns of economic growth and social changes that have been observed since the mid-20th century.

Brazil's population grew rapidly between 1940 and 1970. However, the total fertility rate from dropped from 6.3 in 1960 to 1.9 in 2010.

Brazil experienced high population growth between 1940 and 1960, an average of 2.8% per year. After a similar growth between 1960 and 1970, the growth started to decline in the 1970s (2.5%), reaching an average of 1.64% per year during 1991 and 2000[9], and 1.17% between 2000–2010. The total fertility rate (TFR) remained at high and relatively constant levels between 1940 and 1960[10]. A modest and slow decline since the early 1900s and small oscillations in fertility in the 1950s and 1960s have been reported[9,11]. Nevertheless, important demographic transformations started in the mid-1960s. In four decades, the TFR experienced a dramatic decline: from 6.3 in 1960 to 2.3 in 2000[9,10,12], and the 2010 Population Census indicated a TFR of 1.9. This decline occurred in all regions and across different socioeconomic groups.

Life expectancy has steadily increased since 1940 and by 2012 was 74.6 for males and 78.3 for females.

Regarding mortality, in the 1940s life expectancy in Brazil was below 50 years[13]. By 2012, the number increased to 74.6 (71 for males and 78.3 for females)[14]. Most of the gains in life expectancy were a direct result of the decline in infant mortality (IMR)[15]. Brazil had an IMR of 162 per 1000 live births in 1930; between 1930 and 1970, IMR declined by 29.2%, and between 1970 and 2005, it fell 79.7%[16]. According to the 2010 Population Census, IMR was 15.6.

Due to changes in mortality and fertility, the median age of the population has increased.

As a result of these changes in mortality and fertility, the age structure of the population became older. In 1950, the median age of the population was 18, with 41.8% of the population concentrated in ages younger than 15, and 4.3% aged 60 or older. In 2010, the median age increased to 27, with 24.1% of the population younger than 15, and 10.8% aged 60 or older. In the wealthiest regions of the country (Southeast and South), the median age of the population is even higher at 32[17].

Brazil's population has become more urbanised since 1950 and now has better access to infrastructure.

In addition, it is worth highlighting that: (i) the population became more urbanised: from 36.2% in 1950 to 84.4% in 2010; and (ii) the population had better access to infrastructure. Access to electricity increased from 68.5% in 1980 to 99.5% in 2012; 25.8% of the population had access to sanitation in 1980 and 97.4% had access in 2012. In 1980, 47.5% had access to piped water, while in 2012 this figure increased to 84.3%.

National income has risen since the 1960s; however, economic inequality also increased.

National income increased between the 1960s and 1990s more than 3 times, accompanied by an augmentation of social disparities[18]. Brazil became one of the most unequal countries worldwide – it ranked 2nd in income concentration in 1998[19], and in 1999, it was the country with the highest ratio between the average income of the 20% richest and the 20% poorest, above 30[20].

Since 2001, economic inequality has improved.

Since 2001, a steady decline in inequality has been observed, with the Gini Index decreasing from 57.1 in 2001 to 50.5 in 2012 [21,22]. This decline was observed in 80% of Brazilian municipalities.

## Epidemiological transition

Disease burden has changed. By 2007, nearly 75% of deaths were attributable to non-communicable diseases.

The pattern of disease burden in Brazil has also been changing, particularly since the 1950s. The proportion of total deaths due to infectious diseases decreased from almost 50% in 1930 to about 5% in 2007[23,24]. In contrast, in 2007 approximately 72% of all deaths were attributable to non-communicable diseases (NCDs) including cardiovascular diseases (the main cause of death), chronic respiratory diseases, diabetes, cancer, and others, including renal diseases[25].

Infectious diseases are in decline, although the control of dengue and visceral leishmaniasis is still a challenge.

Regarding infectious diseases, Brazil observed important successes/partial successes, and some failures. Among the successes are: the control of vaccine-preventable diseases, the reduction in mortality by diarrhea, and the control of Chagas disease. Partial successes include the control of leprosy, schistosomiasis, malaria, hepatitis, HIV/AIDS and tuberculosis. Among the failures are the control of dengue and visceral leishmaniasis[23].

Mortality due to cardiovascular and chronic respiratory diseases is on the decline, but diabetes and hypertension have increased.

Mortality and morbidity for NCDs are greatest among the poor. Age-standardised mortality due to NCDs registered a 20% decline between 1996 and 2007, mostly for cardiovascular and chronic respiratory diseases[26]. The decline was associated with reductions in smoking and expansion of primary health care. Indeed, standardised mortality rates for cardiovascular disease decreased from 287.3 per 100 000 people in 1980 to 161.9 in 2003 (the disease with the largest decline in the same period was stroke: from 95.2 to 52.6 per 100 000 people[26]). However, diabetes and hypertension are increasing, as is the prevalence of overweight and obesity in the population[25].

Figure 1:
Temporal trends of some factors
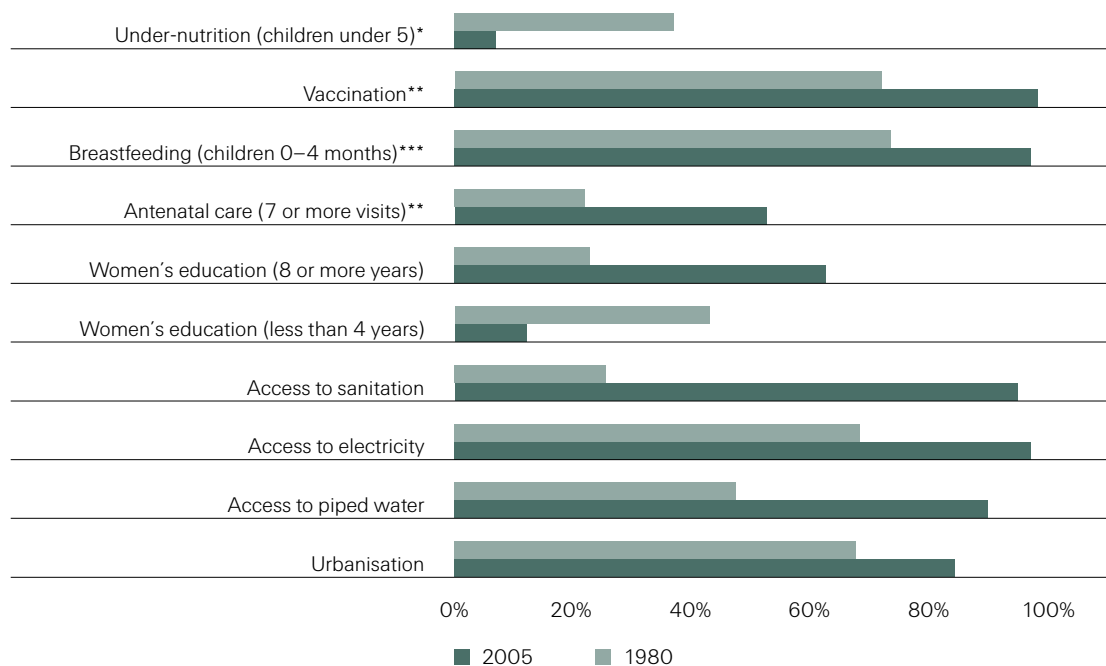


Source: Castro MC, Simões CCS. Spatio-temporal trends in infant mortality in Brazil.
Population Association of America, 2010 Annual Meeting, Dallas, TX. 2010:248

## Current situation regarding risk factors

Since 2006, the Brazilian Ministry of Health has conducted telephone based surveys to monitor risk factors of non-communicable diseases.

In 2006, the Brazilian Ministry of Health established the annual Telephone-based Surveillance of Risk and Protective Factors for Chronic Diseases (VIGITEL), comprising state capitals and the Federal District (about 54 000 interviews a year). It allows the analysis of risk and protective factors of NCDs found in the adult population (aged 18 years or older)[27].

Smoking has decreased significantly among the population due to preventative legal actions.

Brazil has made important progress towards reducing smoking: the prevalence of smoking in 2011 was 14.8%, a major decline from 34.8% in 1989 (as reported by the National Survey on Health and Nutrition (PNSN))[25,28,29]. This was achieved through several preventative legal actions began in 1996 (eg tax increases, use of picture warnings on cigarette packs, and bans/restrictions on advertising)[30].

About 15% of adults in Brazil engage in at least 30 minutes of physical activity five times per week.

While a long time series on physical activity in Brazil is not available, data from VIGITEL shows that about 15% of the adult population engaged in at least 30 minutes of some type of physical activity for at least five days a week in 2010, with the most active being young and well educated males. About 14% were inactive, and 28.2% reported watching three hours or more of television a day[31].

In recent years, more and more Brazilians have become overweight or obese.

The nutritional transition in Brazil is of crucial importance and one of the greatest challenges ahead[18]: while the prevalence of child stunting declined, the prevalence of overweight and obesity has significantly and steadily increased in the recent past[32,33]. In 2011, the overweight incidence among adults was 48.5% (52% among men and 45% among women); in 1974–75, the overweight incidence was 18.6% among males[34,35]. The prevalence of obesity has increased from 11.4% in 2006 to 15.8% in 2011. This is also a concern among children aged 5–9: in 2008–9, 33.5% and 14.3% of these children were overweight and obese, respectively[36].

The distribution of risk factors differs by social group; smoking, consumption of high fat meat and obesity are more common among the less educated.

The distribution of risk and protective factors is not equal among social groups. Smoking, consumption of meat with visible fat, and obesity are more common among the less-educated, while physical activity during leisure time and the recommended consumption of fruits and vegetables (five portions a day, five or more times a week) are higher among the population with 12 or more years of schooling. In addition, the highest increase in the prevalence of being overweight was observed in the North and Northeast regions (the poorest), while the increase in the prevalence of obesity was higher in the South and Southeast (the wealthiest)[29].

## Discussion

Although major achievements in health have been observed, some challenges remain.

Brazil has gone through major demographic, economic and social changes, and the epidemiological transition is still ongoing. While major achievements on the health arena have been observed, important challenges remain. Regarding NCDs, for example, the number of deaths due to cardiovascular disease has increased since 1980, mainly a result of the changes in the age structure of the population that is becoming older (and thus more elderly are exposed to the risk of chronic diseases)[26]. The standardised mortality rates, however, have been declining, mainly a reflection of declines in smoking and improved access to basic health care[25].

Brazil implemented the Family Health Program in 1994 to improve access to primary health care.

Regarding access to health care, the Family Health Program, implemented in 1994, aims to improve access to primary health care, utilising a community-based approach for local care provision. Health care services are provided by a team comprised of at least one physician, one nurse, one nurse assistant, and up to six community health workers; some teams may also include a dentist and two assistants. Each team is responsible to provide care for up to 1000 families (or approximately 4500 people) in a determined geographical area[37]. As of December 2013, 64.7% of the population was reached by community health agents, and 56.4% covered by family health teams (with marked regional differences).

To address the steady increase in the number of overweight and obese individuals and to cope with the rise in non-communicable diseases, the Ministry of Health launched the Strategic Action Plan.

Currently, one of the most pressing challenges regarding NDCs is the significant and steady increase in the overweight and obese population (children, adolescents and adults). To address that challenge and others, in 2011 the Brazilian Ministry of Health launched the Strategic Action Plan to tackle NCDs in the country. The Plan aims at preparing Brazil to cope with and restrain NCDs in the next 10 years. It addresses four main groups of diseases (cardiovascular, cancer, chronic respiratory, and diabetes) and their shared modifiable risk factors (smoking, alcohol abuse, physical inactivity, unhealthy diet, and obesity). It describes guidelines and measures to be taken concerning: a) surveillance, information, evaluation, and monitoring; b) health promotion; and c) comprehensive care[29].

The programme also stresses the importance of physical activity and increased fruit and vegetable consumption.

The suggested national goals of the programme are to: reduce premature mortality rate (< 70 years old) caused by NCDs at 2% a year; reduce prevalence of obesity among children; reduce prevalence of obesity among adolescents; restrain obesity among adults; reduce prevalence of alcohol abuse; increase leisure time physical activity levels; increase fruit and vegetable consumption; reduce the average salt consumption; reduce prevalence of smoking; increase coverage for mammograms exams among 50 to 69-year-old women; increase coverage for cervical cancer preventive exams among 25 to 64-year-old women; and treat 100% of women diagnosed with precursory lesions of cancer.

Brazil continues to make significant progress in reducing infectious diseases, but is still looking to reduce non-communicable diseases.

In summary, Brazil has made significant progress in reducing infectious diseases, although problems still persist. NCDs currently represent the largest mortality and morbidity burden in the country, which can become more critical considering the ageing population and the increasing number of overweight and obese individuals. The successful implementation of the Strategic Action Plan to tackle NCDs (described above) will be crucial in the years to come. Historically, Brazil has shown a good record of facing health challenges, and most recently became the world leader in tobacco control, despite being among the top 5 producers of tobacco in the world[30,38]. The future is yet to be written.

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# Risk factors for cardiovascular disease in Brazil:
# Time trends and current status

Marcia C. de Oliveira Otto

**As in other emerging economies, chronic conditions such as cardiovascular disease (CVD) and diabetes have emerged as the major causes of mortality in Brazil, accounting for 37% of deaths in the country. Although there has been a considerable reduction of smoking and physical inactivity, the epidemiological transition in Brazil is marked by trends toward unhealthy diet patterns and a poor cardio-metabolic profile. This is characterised by increased consumption of processed foods, as well as a higher prevalence of overweight individuals, obesity, impaired fasting glucose and diabetes, potentially reversing the decline in CVD mortality in the medium-to long-term.**

Brazil's recent political and economic changes have had an impact on demography, social structure and lifestyle.

Brazil has recently experienced political and economic changes that have greatly influenced its demography, social structure and lifestyle. As mortality and fertility rates decreased over the past 40 years, life expectancy in Brazil has increased from 52 to 73 years of age; the proportion of people living in urban settings has increased from 55% to 80%; and the percentage of Brazilians with higher education (≥10 years of formal schooling) has nearly doubled[1].

The population is mostly non-white, older and middle class. Cardiovascular disease and diabetes are the major causes of mortality.

The modern Brazilian population is predominantly non-white, older and has a greater proportion of middle class inhabitants compared to 1970[2]. As in other emerging economies, chronic conditions such cardiovascular disease (CVD) and diabetes have emerged as the major causes of mortality in Brazil, accounting for 37% of deaths in the country[3,4]. Improvements in health care quality and access over the past two decades have successfully contributed to the reduction of CVD mortality[1]; however, current trends in lifestyle and metabolic risk factors show a shift toward unhealthy dietary patterns and poor metabolic health. This may reverse the decline in CVD mortality in the medium to long-term. Understanding time trends and the current status of modifiable risk factors relevant to cardiometabolic health may provide relevant information to inform strategies focused on disease prevention in Brazil.

## Dietary factors

Rising income and the availability of highly processed foods have influenced dietary patterns.

Increasing income and the availability of highly processed foods in Brazil, among other factors, have influenced the dietary patterns in the country, particularly in urban environments. Between 1999 and 2009, the household income per capita in Brazil increased by 25%[2,5], which paralleled an increase in dining out[6]. Between 1974 and 2009, there was a 15% decrease in energy intake from rice, and a 33% decrease in energy from beans, two of the major traditional food staples in the country[7–9] (Figure 1). Similarly, a considerable decrease in mean energy intake from vegetables (27%) and fish (20%) were observed during the same period. There was, however, a substantial increase in energy intake from less healthy foods such as processed meat (102%) and ready-to-eat meals (250%) (Figure 1).

Figure 1:
Energy intake from different foods in Brazil,
1974–2009
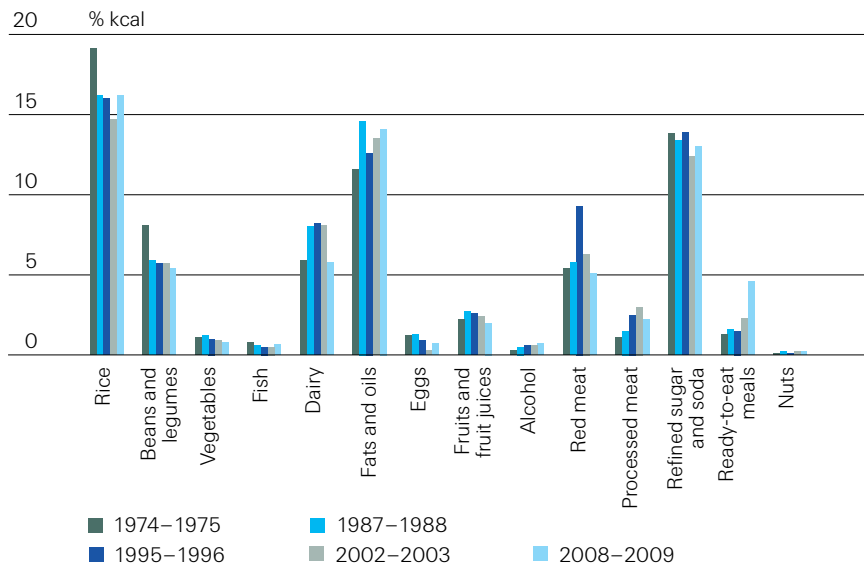


Sources: Levi-Costa et al (2005); Levy et al (2012)

As income increases, Brazilians tend to consume less rice, beans and fish and more processed meat and ready-to-eat meals.

Data from the same study suggests that diet patterns differ according to income levels. As purchasing power increases, Brazilians tend to consume less rice, beans and fish, and more red meat, processed meat and ready-to-eat meals[8]. Higher income levels were also associated with higher consumption of vegetables, fruit and fruit juices, dairy products and alcohol[8] (Figure 2). Overall, time trends and analysis by income levels are consistent with a transition to lower consumption of traditional Brazilians foods and higher consumption of industrialised foods, as well as increased consumption of vegetables and fruits among Brazilians in higher income strata.

Figure 2:
Energy intake from selected foods by income levels in Brazil (2002–2003)
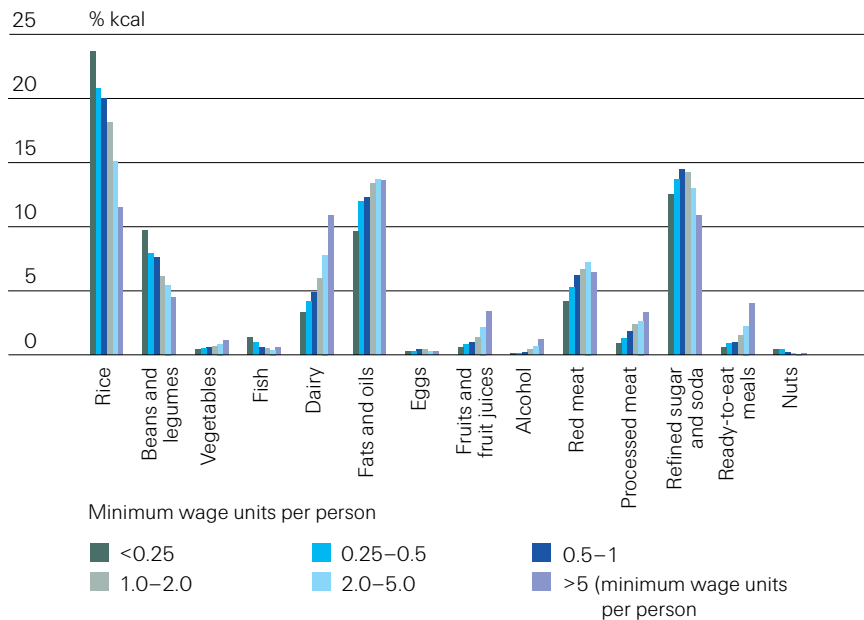


Source: Levi-Costa (2005)

## High body-mass index and obesity

Consistent with a worldwide trend, the prevalence of overweight and obese individuals has increased considerably in Brazil in recent decades. Results from surveys using anthropometric measurements in a nationally representative sample showed an over twofold increase in the prevalence of overweight individuals (from 18.5% to 50.1%) and a fourfold increase in the prevalence of obesity (2.8% in 1975 to 12.4% in 2008) among adult men between 1975 and 2008. During the same period, the prevalence of overweight in adult Brazilian women increased from 28.7% to 48%, while the prevalence of obesity in women doubled[6,10]. A study evaluating income-specific trends reported that changes in the prevalence of obesity in Brazil between 1975 and 1989 were 66% higher in men in the lower quintile of family income, compared to those in the highest quintile[8].

More and more children are either overweight or obese.

Consistent with the changes observed in adults, one third of Brazilian children between 5-9 years of age were overweight in 2008, while 17% of boys and 12% girls were considered obese[10] (Figure 3). Excessive adiposity is higher in children living in urban areas, as well as in the southeast, the region with the highest population density in the country. On the other hand, between 1974 and 2009, childhood under nutrition, assessed as low height for age, decreased from 29% to 7% in boys and from 27% to 6% among girls 5−9 years of age[6,10].

Figure 3:
Prevalence of overweight and obesity among Brazilian children 5−9 years of age 1974−2009
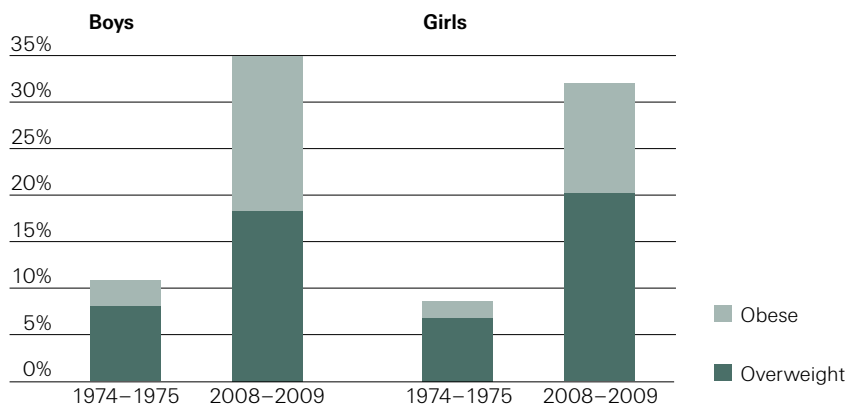


Source: Melo et al (2010)

## Dyslipidemia

Data on lipid levels in Brazil is limited. There are indications, however, that improvements in health care have not had a major impact on cholesterol levels.

Very few studies have reported lipid levels in the Brazilian population. According to a recent report from the World Health Organization, the prevalence of high total cholesterol levels (≥5.28 mmol/L) among Brazilian adults in 2008 was approximately 43%, with no major differences between men and women[11]. Data from 1980 to 2008 showed no major changes in the mean total cholesterol levels over the years, which suggests that recent improvements in health care have not affected hypercholesteromia levels in the country[11]. In a study which included over 1500 children 7–14 years of age living in the large city of Campinas, the prevalence of high total cholesterol was 11% among girls and 8% among boys. Compared to boys, girls had higher mean triglycerides and a total:HDL-C ratio[12], which is a predictor of cardiovascular disease risk in adult populations.

## High fasting glucose and diabetes

In nine large cities, the prevalence of each type II diabetes and impaired glucose tolerance was approximately 8%.

In a multi-centre study conducted in 1988, which included over 20 000 participants aged 30–69 living in 9 large cities in Brazil, the prevalence of each type II diabetes and impaired glucose tolerance was approximately 8%[13]. Nearly 46% of diabetes cases had not been diagnosed before, and 23% of previously diagnosed cases were untreated. The study showed no major differences in age-adjusted diabetes prevalence across sex, race or social-economic status categories[13]. Two cross-sectional studies, which included participants of similar ages, have subsequently been conducted in two large cities located in the state of Sao Paulo. In 1997, in Ribeirao Preto, the prevalence of diabetes and impaired fasting was 12% and 8% respectively[14]. A study conducted in Sao Carlos in 2007 reported 13.5% of participants having diabetes and 5% having impaired fasting glucose levels[15]. The prevalence of metabolic disorders among obese participants in Ribeirao Preto was over two times greater compared to the non-obese participants. In addition, the proportion of undiagnosed diabetes was 60% greater in obese participants compared to non-obese adults[14]. The lack of recent national data on metabolic risk factors including blood lipids and fasting plasma glucose level by sex, age and geographic location is a major limitation to the understanding of the potential impact these variables have on cardio-metabolic mortality and morbidity.

## Hypertension

The prevalence of hypertension was 36% in the 1980s, 33% in the 1990s and 29% in the 2000s.

Time and regional trends on hypertension (blood pressure >140/90 mmHg) in Brazil were recently reported in a systematic review including data from over 120 000 participants in cross-sectional and cohort studies[16]. Combining data from studies published in different decades, investigators estimated the prevalence of hypertension as 36% in the 1980s, 33% in the 1990s and 29% in the 2000s[16]. Although the authors suggested a trend toward a lower prevalence of hypertension in Brazil, there are limitations to the generalisation of early estimates that might prevent such a straightforward conclusion. In fact, results from a survey including adults living in 27 Brazilian state capitals reported a 3% increase in the prevalence of self-reported hypertension between 2006 and 2009 among men and women[17,18]. The high prevalence of hypertension in Brazil and its potential impact on cardiovascular health suggests the need for appropriate measures to reduce the prevalence of this important CVD risk factor in the country.

## Smoking and physical activity

Anti-tobacco policies such as raising the price of tobacco have reduced tobacco use.

Brazil was one of the first countries to implement national anti-tobacco policies. Pricing policies implemented between 1991 and 1993 led to a nearly 80% increase in the price of tobacco products, and a subsequent 20% reduction in tobacco use. A study using national household survey data reported age-adjusted smoking prevalence decreased from 35% in 1989[19] to 12.1% in 2012[20]. In addition, the average daily number of cigarettes consumed by adults in Brazil decreased from 13.3 to 11.6[19]. The reduction in cigarette smoking consumption was similar across sex, living conditions (urban vs rural), education and income levels, which suggests a significant impact of anti-tobacco policies across different strata of society.

Between 2006 and 2012, the percentage of Brazilians who met the WHO guidelines for physical activity doubled.

Although there has been a considerable reduction in work-related physical activity due to the use of modern technology in the work place[21], data from cross-sectional surveys in 27 state capitals showed a rise in physical activity in the country. In 2012, 35% of Brazilians met the WHO guidelines for physical activity (≥150 min/week of moderate to vigorous activity), an almost twofold increase compared to the estimates in 2006. Cross-sectional surveys, including over 2000 adults living in Sao Paulo city, showed an increased prevalence of people meeting WHO guidelines for physical activity from 16% in 2002 to 61.5 % in 2008[22].

Improvements in physical activity levels were similar among men and women.

Improvements in physical activity levels were similar among men and women, and interestingly, the greatest change was observed among those in low income categories[22]. According to the authors, changes in physical activity levels were largely influenced by the implementation of "Agita Brasil", a national programme to promote physical activity in 1997. Overall, improvements in national smoking prevalence and physical activity levels in large cities following implementation of health policies support the important role of population strategies to change behaviour.

## Conclusion

Even though smoking decreased and physical activity increased, concerns about dietary patterns, obesity and diabetes remain.

Although there has been a considerable reduction in smoking and physical inactivity, the epidemiological transition in Brazil is marked by trends toward unhealthy diet patterns and a poor cardiometabolic profile. This is characterised by increased consumption of processed foods, as well as a higher prevalence of overweight individuals, obesity, impaired fasting glucose and diabetes. Consistent with suboptimal lifestyle and health care management, recent data shows that 29% of Brazilian adults have hypertension and 43% have hypercholesteromia. In 2011, the Brazilian Ministry of Health launched a national plan to reduce the incidence of non-communicable chronic diseases, with a focus on physical activity, tobacco control, food guidance and policy, treatment of diabetes and hypertension, cancer screening, and overall access to health care[23]. Increasing engagement of other segments of the Brazilian society such as the media, the food industry, the service sector and education are necessary to the long term success of this strategy. In addition, the development of epidemiologic studies prospectively assessing relevant risk factors and their impact on health in different groups, including underserved populations, is essential to measure the effectiveness of this initiative, as well as to help design specific interventions for the prevention of cardio-metabolic disease in Brazil.

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# Two decades of research linking air pollution to cardiovascular disease in Brazil: A systematic review

Jennifer L Nguyen, Douglas W Dockery

**Scientific evidence collected over the past twenty years suggests that the Brazilian population experiences increased adverse cardiovascular outcomes from exposure to air pollution. The strongest evidence exists for particulate matter pollution (specifically, particles with a diameter less than 10 µm); particles have been found to be associated with increased numbers of cardiovascular mortality, cardiovascular hospital admissions and stroke. Higher levels of sulphur dioxide, a gaseous air pollutant, have also been found to be associated with increased numbers of cardiovascular-related mortality and hospital admissions among the Brazilian population.**

## Introduction

Ischemic heart disease and cerebrovascular disease rank as the 2nd and 3rd leading causes of years of life lost in Brazil.

Cardiovascular-related morbidity and mortality are major public health problems in Brazil. Ischemic heart disease and cerebrovascular disease rank as the 2nd and 3rd leading causes of years of life lost in Brazil, just after interpersonal violence. These cardiovascular-related diseases were estimated to have shortened lives by almost 5.3 million years among the Brazilian population in 2010. Hypertensive heart disease and other disorders of the cardiovascular and circulatory systems were estimated to have contributed to an additional 1 million years of life lost.[1]

Brazil's megacities – São Paulo and Rio de Janeiro – produce large amounts of pollution.

Brazil is home to two megacities – often defined as metropolitan areas with more than 10 million inhabitants[2] – São Paulo, with 19.9 million inhabitants, and Rio de Janeiro, with 12 million inhabitants in 2011[3]. Megacities are responsible for producing large amounts of pollution, and are also capable of affecting regional and global climate change[2]. As centres of economic growth, education, and technology, large cities are also where effective pollution control strategies could yield maximum benefits[4].

The number of vehicles in Sao Paulo, combined with its climate and elevation, promotes high air pollution levels in the city.

Outdoor air pollution in São Paulo is largely a consequence of emissions from vehicles. In 2011, over 7 million motor vehicles were in operation in São Paulo; car ownership is high (about 1 car per two inhabitants). Strong commercial and industrial activity means many trucks operate in the city, and trucks and buses are generally old and run on low-tech engines that emit high levels of pollutants[5,6]. This density of cars, trucks and buses, combined with the city's climate and high elevation (750 m above sea level), makes São Paulo prone to elevated pollutant concentrations, particularly during winter. Pollutants can become trapped by low dispersion conditions and persist for several days[2,7].

## Two decades of research linking air pollution to cardiovascular disease in Brazil: A systematic review

This article summarises scientific evidence linking cardiovascular health to air pollution in Brazil.

This article describes the scientific evidence that has accumulated over the last two decades (1993 to 2013) linking adverse cardiovascular health effects to air pollution exposure in the Brazilian population (Table 1). We conducted a systematic review using two databases – PubMed and Web of Science – of all relevant population-based observational – ie epidemiological studies on this topic, published in the peer-reviewed English or Portugese scientific literature. Figure 1 displays the cities included in this systematic review.

Table 1:
A summary of the strength of the evidence for an association between air pollution exposure and adverse cardiovascular outcomes in Brazil based on epidemiological studies conducted between 1993 and 2013

| | Particulate Air Pollutants | | | Gaseous Pollutants | | | |
|---|---|---|---|---|---|---|---|
| | Particulate matter <2.5 μm in diameter ($PM_{2.5}$) | Particulate matter <10 μm in diameter ($PM_{10}$) | Total suspended particulates | Sulphur dioxide | Carbon monoxide | Nitrogen dioxide | Ozone |
| Cardiovascular mortality | 4 | 0 | | 5 | 7 | 0 | 6 |
| Hospital admissions | 4 | 7 | | 4 | 7 | 7 | 6 |
| Emergency room visits | 6 | | | 7 | 4 | 7 | 0 |
| Ischemic heart disease | 6 | | | 6 | 6 | 0 | 0 |
| Stroke | 4 | | | 6 | | 0 | 0 |
| Arrhythmias | 7 | | | 0 | 7 | 7 | 0 |
| Heart rate variability | 0 | | | | 7 | 0 | |
| Blood pressure | 6 | 7 | 7 | 7 | | 0 | 7 |

Evidence for an association

4 Strong (consistent across several studies)
5 Good (consistent but few studies)
6 Mixed (conflicting reports)
7 Limited (based on ≤2 studies)
0 None (≤2 studies report no association)

Source: author

Figure 1:
Map of cities in Brazil where studies examining the cardiovascular health effects of air pollution exposure have been conducted. Numbers in parentheses indicate how many studies focused on that area. Several studies involved multiple cities.

Brazil

Itaberai (1)
Santo Andre (1)
São Jose dos Campos (3)
Rio de Janeiro (2)
Sao Paulo (city: 8, state: 5)
Porto Alegre (1)

Source: author

## Air pollution increases cardiovascular mortality

One study found that particulate matter containing particles of a certain size diameter were associated with higher levels of cardiovascular and cerebrovascular mortality.

The strongest evidence of increased cardiovascular deaths from air pollution in Brazil comes from a large, multi-city study of selected Latin American cities. Particulate matter, specifically particles with a diameter $< 10\,\mu m$ ($PM_{10}$), is associated with more cardiovascular and cerebrovascular mortality among inhabitants of São Paulo, Rio de Janeiro and Porto Alegre (by about 0.5%−3% per $10\,\mu g/m^3$ increase in $PM_{10}$)[7]. One other study in São Paulo found an association with $PM_{10}$, but the effect size was much smaller.[8] This large multi-city Latin American study[7] also found some evidence of an adverse effect of ozone on cardiovascular mortality, but the effects were much weaker than that for $PM_{10}$ and contradictory (ie higher ozone levels were found to be protective of cerebrovascular deaths in Rio de Janeiro). Another study in São Paulo found no association of cardiovascular mortality with ozone[8].

Three studies of $SO_2$ have consistently found associations with increased deaths from cardiovascular disease, myocardial infarction and stroke[8–10].

Studies thus far suggest there is no link between cardiovascular mortality and nitrogen dioxide and total suspended particulates.

The limited available evidence suggests no association between cardiovascular mortality and nitrogen dioxide[8] and total suspended particulates[11], and conflicting evidence for carbon monoxide[8, 10].

## Cardiovascular-related hospital admissions increase with higher air pollution levels

Higher levels of $PM_{10}$ and sulphur dioxide have been associated with increased numbers of cardiovascular-related hospital admissions.

Similar to the finding for cardiovascular mortality in Brazil, higher levels of $PM_{10}$ and sulphur dioxide were associated with increased numbers of cardiovascular-related hospital admissions. Studies have consistently found that more people are hospitalised for cardiovascular causes, such as ischemic heart disease, myocardial infarction, stroke and angina, when levels of $PM_{10}$[12–17] and sulfur dioxide[12–13, 15–17] are higher.

Evidence is mixed on the association of ozone with cardiovascular hospital admissions.

The epidemiologic evidence is mixed on associations with ozone,[12–15, 17] and only one or two studies have investigated carbon monoxide[15,17], nitrogen dioxide[15,17], and total suspended particulates[18] in relation to cardiovascular hospital admissions.

## Air pollution might increase the number of emergency room visits

Several studies suggest that carbon monoxide levels have resulted in increased emergency hospital visits for ischemic heart diease, arrhythmias and hypertension.

Currently, the most consistent evidence linking air pollution to increased emergency room visits among the Brazilian population exists for carbon monoxide. Several studies have found that higher carbon monoxide levels are linked to emergency visits for ischemic heart disease (including myocardial infarction and angina), cardiac arrhythmias and hypertension[19–22]. There is conflicting evidence that $PM_{10}$ levels may be related to emergency room visits. Two studies report evidence of a positive association [20,23], while two others do not[19,21]. There is consistent evidence of no association with ozone across several studies[19–21]. Too few studies have investigated sulphur dioxide and nitrogen dioxide at this time to make a conclusion[19–21].

## Sub-clinical effects: increased air pollution is linked to higher blood pressure and reduced heart rate variability

Some evidence suggests that air pollution may be linked to high blood pressure.

There is some evidence that higher air pollution levels are associated with higher blood pressure in the Brazilian population, but at this time, the evidence is sparse and inconsistent. One study found that higher levels of carbon monoxide and sulfur dioxide increased blood pressure among vehicular traffic controllers in São Paulo[24], while $PM_{10}$ and nitrogen dioxide did not. However, in another study that sampled only healthy male traffic controllers, $PM_{10}$ and ozone increased blood pressure[25]. A study investigating heart rate variability found that higher sulphur dioxide levels decreased cardiac variability[24].

## Why is Brazil a particularly interesting location to study air pollution?

Brazil's use of ethanol may be contributing to air pollution and ozone formation.

Brazil is the only country in the world that extensively uses ethanol. Ethanol is a renewable fuel made from plant materials. Unlike other nations where air pollution is mostly from petroleum or natural gas-based fuels, air quality in Brazil is strongly determined by ethanol-derived emissions. In 2005, 70% of the light duty vehicles sold in Brazil had flex-fuel (ie dual-fuel) engines that can run on any mix of ethanol and gasoline[7]. Ethanol, sometimes called the 'green fuel', is thought to be a cleaner alternative to gasoline. But the picture is not quite so clear. Ethanol fuels increase atmospheric concentrations of substances called acetaldehyde and nitrogen oxides, which are significant contributors to photochemical air pollution and ozone formation.

Countries such as the US that are considering expanding the use of ethanol should be aware of its potential effect on air pollution.

A recent study showed that ozone levels dropped when gasoline use increased (relative to ethanol use) in São Paulo, but concentrations of other air pollutants – nitric oxide and carbon monoxide – increased[26]. These results have important policy implications for countries like the US and other industrialised nations that are considering expanded use of ethanol for energy needs. In the US, gasoline contains about 10% ethanol by volume. The experience in São Paulo may not directly apply to other areas however, because air pollution mixtures vary depending on the local climate, vehicle fleet, industrial activity and traffic. Regardless, the experience in Brazil demonstrates that ethanol may not be as 'green' as predicted.

## Conclusion

Evidence from studies conducted between 1993 and 2013 suggestd that PM$_{10}$ is highly correlated with increased cardiovascular-related mortality, hospital admissions and stroke in Brazil.

Evidence from studies conducted between 1993–2013 suggests that PM$_{10}$ is associated with increased cardiovascular-related mortality, hospital admissions and stroke among the Brazilian population. One study has estimated that a 10% reduction in the expected levels of PM$_{10}$ in 2020 could avoid 11 225 deaths, 1365 cardiovascular-related hospital admissions, 140 133 hospital visits, and 2.2 million days of lost work[27]. Most of the evidence linking air pollution to cardiovascular events comes from studies conducted in São Paulo (city and state). Notably, research is lacking on the cardiovascular health effects of particulate matter less than 2.5 μm in diameter (PM$_{2.5}$). Worldwide, the strongest associations between air pollution and cardiovascular events are found for PM$_{2.5}$. There is also a lack of research on household air pollution, despite it being recognised as a major global public health problem[28] and the 12th leading contributor to the total disease burden in Brazil[1]. Brazil is an especially interesting locale to study the health effects of air pollution due to its unique position as the only nation that extensively uses ethanol.

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# Understanding the global risk of the tobacco epidemic and its trajectory in an emerging market nation

Hillel R. Alpert

**The tobacco epidemic is a "chronic global risk" and may be the single most important risk to determine longevity and mortality in the 21st century. This report closely examines how Brazil has been confronting its tobacco problem and provides insight into the societal characteristics and external and internal influences that will determine the course of the epidemic in Brazil and other emerging market nations.**

## Introduction

Brazil is the world's second largest producer and leading exporter of tobacco.

Brazil is both the second largest producer and leading exporter of tobacco, and the second country to fully sign the Framework Convention on Tobacco Control, which sets forth multi-sectorial and trans-frontier actions to combat the epidemic worldwide. Brazil's tobacco control efforts to date have decreased male and female smoking prevalence by 50%; however, the early age of smoking initiation and relatively high prevalence of smoking among women are still of major concern. Brazil's recent ban on the use of menthol and other flavors in tobacco products may spearhead how product regulation decreases tobacco use by reducing product addictiveness, attractiveness and abuse potential. Future trends will depend on tobacco marketing and promotion on one hand, and public health policies on the other, and their influences on the societal acceptability versus denormalisation of smoking.

## The global risk of smoking

Tobacco was responsible for an estimated 110 million deaths worldwide during the twentieth century and USD 500 billion in yearly losses due to illnesses, decreased productivity and premature deaths.

The tobacco epidemic is clearly a "global risk" of catastrophic proportions with large-scale implications for mortality and longevity in nations. Meeting the World Economic Forum's definition of a global risk, the tobacco problem is global in scope, has economic impact, cross-industry relevance, requires a multi-stakeholder approach, and is associated with uncertainty[1]. Tobacco was responsible for an estimated 110 million deaths worldwide during the twentieth century and 500 billion dollars in yearly losses due to illnesses, decreased productivity, and premature deaths[2]. Its future trajectory depends on many competing variables and thus entails considerable uncertainty. Because the harms of tobacco use and the benefits of cessation are well-established, it is the single most preventable cause of death worldwide. However, if current trends continue, tobacco use will grow and result in approximately one billion deaths from diseases during the 21st century[2]. In contrast to acute or "event-driven" global risks, tobacco use is a "chronic" risk[1] whose future course will be determined by private and public sector activities and developments at the global, national and local community levels. Uncertainties regarding its future course may be diminished with insightful analyses based on a clear understanding of its nature, knowledge of the factors that either promote or mitigate tobacco use in nations, and the wisdom of experience.

## The nature of the tobacco epidemic

An estimated 1.2 billion persons in the world currently smoke, while nearly 80% of tobacco-attributable deaths occur in low and middle-income countries[3]. In order to anticipate or predict the course of the epidemic in nations or globally, tobacco use must be understood as a societal phenomenon, with the key influences on individual smoker's behaviour occurring at the social, community and population levels. The tobacco industry has long known this and set maintaining the social acceptability of smoking as a strategic goal[4] and formed a working party in the 1970s to "improve the climate of social acceptability"[5]. The result has been the creation of social norms that treat smoking behaviour as acceptable, desirable and sometimes even expected for a member of society.

Similarly, research in California and Massachusetts has demonstrated that population interventions, such as clean indoor air laws, advertising restrictions and counter-marketing, have been far more successful in decreasing smoking prevalence than are individual level interventions[6–8]. Public health experts have noted that notwithstanding the significant role of cessation therapies, the use medications or cognition to fight a larger group behaviour does not appear to be effective in bringing about large-scale changes, whereas changing social norms is[8]. This report closely examines how Brazil as an emerging market nation has been confronting its tobacco problem in order to illustrate and provide insight into the societal characteristics as well external and internal influences that may determine the course of the epidemic in similar nations and globally.

## Risk mitigation

Collective experience from local, state and national efforts to curb the tobacco epidemic led to the first international public health treaty, the WHO Framework Convention on Tobacco Control (FCTC)[9], which was negotiated under the auspices of the WHO in 192 countries. The FCTC sets forth multi-sectorial and trans-frontier actions to combat the epidemic worldwide. It obliges parties to implement a variety of tobacco control measures, which include both tobacco product supply and demand reduction strategies. Each of the strategies is intended to have a direct effect on reducing tobacco use. For example, increasing cigarette pricing through taxation has been a highly effective intervention in many places for reducing the demand for cigarettes, especially among young people and persons from lower income brackets. Studies by the World Bank and others have showed that increases in taxes and prices have reduced per capita cigarette consumption in Brazil and other nations[10]. Further effective measures include protecting the public from exposure to tobacco smoke; requiring tobacco product disclosures; regulating tobacco product packaging and labelling; restricting tobacco advertising, promotion and sponsorship; regulating the contents of tobacco products; and advancing public education, communication, training and awareness programmes. Over and beyond the effects of the individual policies, these measures have a collective, synergistic effect to socially denormalise smoking.

Smoking prevalence has decreased in nations that have adopted and successfully implemented the FCTC tobacco control policies. Yet, declines in prevalence have been limited as a result of continued tobacco industry marketing and promotion activities, the addictive nature of the product, and enduring social acceptance, even in nations where substantial progress has been made. Of the strategies available, tobacco product regulation has been used relatively little to date, but could potentially have far-reaching effects on smoking. Although some nations have set limits on tar levels and banned the use of misleading "lights" descriptors on packaging and in advertising, not much evidence exists to show significant effects on smoking prevalence as a result of these measures. Possible reasons are that low-tar cigarettes are no less harmful or addictive than other cigarettes, and "lights" descriptor bans appear to have been circumvented by substitution of alternative, color-coded descriptors that are recognised by consumers. The design and characteristics of tobacco products could be regulated in numerous ways, at least some of which could have significant effects on use by reducing product addictiveness and abuse potential.

The U.S. Food and Drug Administration (FDA) has been authorised by the Family Smoking Prevention and Tobacco Control Act (FSPTCA) in 2009 to set standards for tobacco product design, contents and constituents; including banning the use of menthol and other flavors and additives that affect the appeal, attractiveness, and abuse potential of products particularly to youth, women and other potentially susceptible persons; as well as to set other product regulations[11]. The FSPTCA provides a population-based set of criteria for the FDA to use in determining whether a tobacco product or design feature is "appropriate for the protection of the public health". These include an assessment of the "increased or decreased likelihood that existing users of tobacco products will stop using such products; and the increased or decreased likelihood that those who do not use tobacco products will start using such products." Once the FDA enacts its authority, the US experience with product regulation should be instructive to other nations in the future. In the meantime, Brazil has already recently implemented some tobacco product regulations whose results will be of interest to other emerging market nations.

## Tobacco control in an emerging market nation

Brazil is ironically the second largest producer and leading exporter of tobacco, as well as the second country to fully sign the FCTC. It now has one of the strictest tobacco control legislations in the world. Brazil has implemented a societal, population-oriented approach to tobacco control since the Ministry of Health established the National Tobacco Control Program (NTCP) in 1989 through the Instituto Nacional de Câncer[12]. The programme's initial dissemination approach was motivated by the need to reach opinion makers and form a critical mass with the aim of changing social acceptance of smoking[12]. Smoking was seen at that time as a lifestyle choice and it had broad social acceptance in an environmental context of extensive advertising[12]. The programme prioritised reaching three major community channels: schools, work environments and health units[12]. The local media was included in this network as an important vehicle for increasing the population's knowledge about the harms of smoking in order to reduce the social acceptance of smoking and motivate smokers to quit[12].

Tobacco control efforts began with large price increases followed by strong advertising restrictions and health warnings, and later by partial smoke-free air laws and increased availability of cessation programmes[12]. Tobacco advertising is now banned, including mass media, internet and any other electronic means, as well as sponsorship at cultural or sporting events. The country has compulsory graphic warnings and insertions in packaging and advertising. Brazil's states and municipalities have also widely adopted local laws banning smoking in closed public environments, including bars, restaurants, and public and private organisations. Strong public health campaigns continue to be conducted promoting adoption of healthy behaviours and lifestyles.

Since 1989, smoking prevalence among men and women has decreased nearly 50%.

Major accomplishments of Brazil's tobacco control efforts include an almost 50% decrease among both male and female smoking prevalence since 1989[13, 14]. A policy simulation model called "Simsmoke", which is designed to isolate the effect of tobacco policies from previous trends in smoking prevalence, estimated a 46% relative reduction in smoking prevalence from 1989 to 2010 associated with the policies implemented (Refer to Figure 1)[14]. Evidence suggests that the tobacco control efforts have also been effective in changing the social acceptability of smoking. Eighty-eight percent of both smokers and non-smokers reported to be against smoking in enclosed public places, and a similar percentage of the population is extremely supportive of even stronger than existing regulations for tobacco products[15].

Figure 1:
Brazil smoking prevalence for individuals aged 18 years and above, 1989–2010: SimSmoke predictions and various surveys
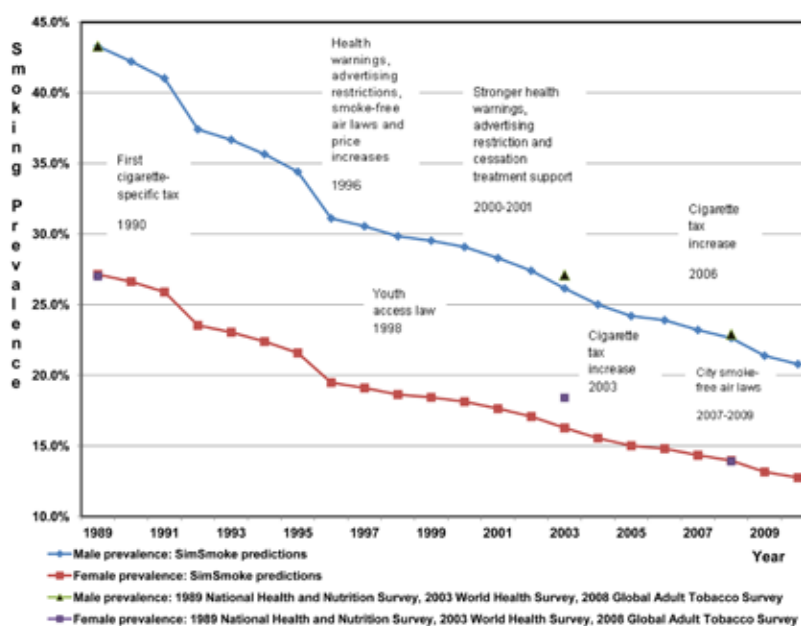


Source: Levy D et al [14]

Flavor additives have also been banned from cigarettes.

Brazil's most recent tobacco product regulations may be groundbreaking. The ANVISA (Health Surveillance Agency) banned flavour additives to cigarettes, such as menthol, mint, clove, cinnamon, cocoa, vanilla, and others by March 2014[16]. Ingredients such as these, when added to cigarettes, can make them more attractive to young people as well as mask the strong smell and flavour typical of the tobacco leaf[15, 17]. ANVISA also prohibited commercialisation, importation, and advertisement of any electronic smoking devices (ie e-cigarettes), while the sales and popularity of these devices have been growing rapidly in other countries[15].

Mexico, like Brazil, has strong anti-tobacco control policies in place.

The effectiveness of Brazil's tobacco product regulations could be evaluated by comparing progress with a similar emerging market country such as Mexico, which does not have these regulations and could serve as a control. Aside from product regulation, Mexico's tobacco control policies are comparable to those in Brazil with only a few differences. In Brazil, 100% smoke-free indoor air policies cover more areas than those of Mexico, more forms of advertising are banned, and larger, graphic, and more informational package warnings are required. Mexico, on the other hand, has: (1) some outdoor smoke-free policies, (2) penalties for not posting smoke-free signs, (3) prescribes steps for owners to take in order to stop persons from smoking, (4) bans cigarette sales through vending machines, and (5) explicitly bans false, misleading, or deceptive advertising, including the printing of tar, nicotine, and carbon monoxide levels on packages[18]. The most prominent difference between the two countries' tobacco control policies is the presence or absence of tobacco product regulations.

## Current and future of risk for smoking in Brazil

Despite the nation's policy advances, Brazil continues to have a serious tobacco problem. While tobacco consumption has decreased over the last decades, the absolute number of tobacco users in the country is still very high (around 25 million among persons 15 years of age or older)[12]. Of continued and major concern are the early age of smoking initiation and the relatively high prevalence of smoking among women. Nine percent of boys and seven percent of girls between ages 14 and 18 are using tobacco[15], and smoking is becoming increasingly popular among women.

Females now account for the majority (54%) of new smokers in the country[15]. As shown by Lopez et al, increases in female smoking prevalence in a country typically lags behind increases in male prevalence[19] (Refer to Figure 2). Female smoking is often driven by: (1) "peer pressure", (2) an association of smoking with being stronger and more mature, (3) images in relation to equal rights with men, (4) a view of smoking as an aid to weight loss (instead of eating) or weight gain often associated with quitting, and (5) increasing numbers of brands for female smokers[15]. Targeted marketing plays a significant role. Following the development and marketing of menthol brands to young women, Japan experienced an upsurge in smoking among high school aged girls, particularly of menthol brands[20].

Figure 2:
Spread of smoking and smoking-related mortality within a country, over time
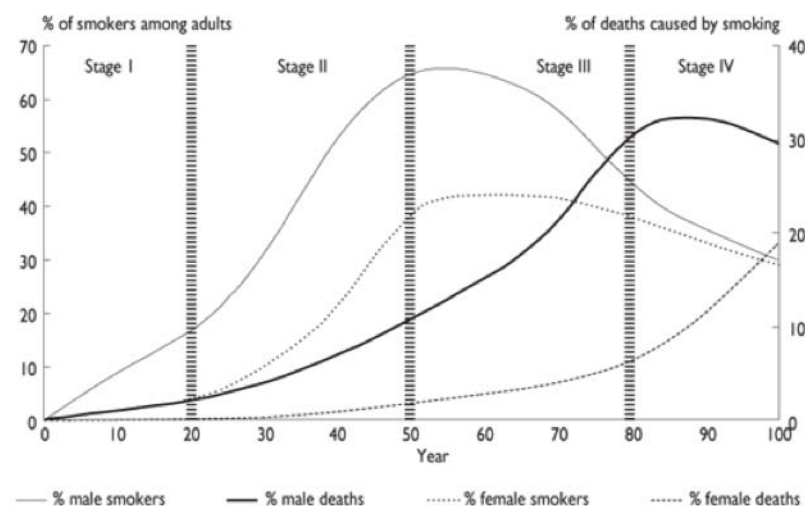


Source: Reproduced from Tobacco Control, Lopez, AD, Collishaw NE, Piha T (1994). A descriptive model of the cigarette epidemic in developed countries. 3: 242-247 with permission from BMJ Publishing Group Ltd.

Brazil still lacks an advertising ban on posters and panels, on the packaging itself, and at points-of-sale[15]. ANVISA proposed regulating advertising at retail points-of-sale and increasing visible warnings on packages, although these policies have not yet been adopted[15]. Brazil's smoke-free laws are ignored in many establishments. Many people continue to smoke in stairwells of public places, such as theatres, hospitals, libraries and cinemas. Enforcement of the Brazilian Federal Tobacco Legislation forbidding the sale to children under 18 years of age remains lax[15]. Increased application of 100% smoke-free policies combined with enforcement, visits by authorities and large fines to increase compliance, could further decrease the country's smoking rate[15].

Spending on cigarettes ranges from 4.8% to 7% of family expenditures.

Cigarette spending in Brazil ranges from 4.8% to 7.0% of family expenditures, suggesting that existing price and tax policies are not optimal and that more could be done to make cigarette purchase less affordable[12]. While monthly income or per capita income is an important indicator of overall purchasing power, a better indicator for the poorest sectors of society is the minimum wage divided by the average price of a cigarette package, which indicates the number of cigarette packages that can be purchased on a minimum wage[12]. As of September 2008, a low-income smoker could buy 150 packages of cigarettes a month, while he or she could buy 83 in January 1996[12]. The Ministry of Health is reportedly planning to implement a tax increase by 2015 to increase the price of cigarettes by 55%[15]. These pricing policies could be significant as the purchasing power of the Brazilian population increases if the policies obtain an acceptable margin for the minimum wage/cigarette price ratio[12].

The future of smoking in Brazil will depend the balance between efforts that promote versus mitigate the social acceptability of tobacco.

The future of smoking in Brazil will depend on the balance between countervailing forces promoting versus mitigating the social acceptability and desirability of tobacco use for individuals. The Simsmoke model was also used to consider the potential effect of policies that had not yet been implemented. The model estimated that if tobacco control policies are strengthened in Brazil to be fully consistent with FCTC, the effect would be to decrease smoking prevalence by the year 2050 by up to 39%[14]. The model does not consider directly the effect of income and purchasing power on smoking rates or feedback through social norms and attitudes, and peer and family behaviours[14]. Brazil's experience with its new tobacco product regulations may provide new empirical data to further refine the model's predictions.

## Globalisation and the potential use of "big data"

The use of "big data" may reveal key factors that are associated with a change in smoking prevalence.

The "big data" approach may be another opportunity to gain insight into trends in smoking in emerging market nations. For example, analyses of a longitudinal, time-series global database of nations' societal, human and economic development characteristics as well other data could reveal key factors that are associated with changing smoking prevalence. Such data are available from a number of comprehensive, global, country-specific sources, including: (a) the KOF Index of Globalization, which was developed at the KOF Swiss Economic Institute and measures three main dimensions of globalisation: economic, social, and political, annually for 207 countries over the period 1970–2011[21, 22]; (b) detailed annual data pertaining to the politics, economy, risk, regulation and business environment of countries worldwide, which are available from the Economic Intelligence Unit[23]; and (c) the WHO's MPOWER reports, which include country level data pertaining to six evidence-based tobacco control measures for reducing tobacco use corresponding to the acronym[24]. The measures are: (M) monitoring tobacco use and prevention policies; (P) protecting people from tobacco smoke; (O) offering help to quit tobacco use; (W) warning people about the dangers of tobacco; (E) enforcing bans on tobacco advertising, promotion and sponsorship; and (R) raising taxes on tobacco.

Predictors of a nation's three year change in smoking prevalence differ by gender.

Preliminary analysis of these data found that predictors of a nation's three year change in smoking prevalence differ for males and females[25]. Changing male smoking prevalence was predicted by a nation's wealth, governance, education and economic globalisation; whereas changing female smoking prevalence was predicted by the single variable, social globalisation, as seen for example by an inverse relationship between change in smoking prevalence and internet use[25]. Mexico's social globalisation index was 33% higher than Brazil's, while Mexico experienced an average 1.2% 3-year decline in female smoking prevalence during 1998–2012 compared to an average of 0.2% in Brazil[25]. Possibly, the more that women in society use internet for telecommunications, social media and non-face-to-face interactions, the less time they might spend with others in-person and the

less exposure they may have to the social, physical, and psychological cues for smoking that encourage and reinforce tobacco use. The definitions and boundaries of communities may be changing in this era of globalisation, which may have important implications for the most common types of social influences on smoking behaviour. Models that are based on "big data" may be further refined by incorporating further data such as measures of promotional, or supply-side, influences. In addition, the path of the tobacco epidemic may be affected by factors having cross-border effects, including trade liberalisation, direct foreign investment, global marketing, transnational tobacco advertising, promotion and sponsorship, and the international movement of contraband and counterfeit cigarettes. Trade liberalisation may increase market competition, which may in turn lead to lower prices and other practices, such as increased marketing to stimulate demand[26].

Country-specific data is being collected to analyse attitudes about tobacco use, marketing, policies and behaviours.

Relevant country-specific data is also being collected through the Global Tobacco Surveillance System (GTSS) organised by the WHO and the U.S. Centers for Disease Control and can be used to describe and analyse attitudes toward tobacco use, marketing and policies, in addition to smoking behaviours among youth and adults[27]. A Global Youth Tobacco Survey (GYTS) analysis of youth aged 13 to 15 years in 115 countries, primarily in the developing world, examined relationships between youth support for smoke-free-policies and smoking status, and exposure to secondhand smoke, controlling for demographic and environmental factors and country-level policy factors[30]. The majority of youth worldwide were found to support smoke-free policies in public places, many of whom are still living in areas still lacking these rules[28]. Youth attitudes data such as these provide a useful window into a society's present and potentially changing social norms pertaining to smoking and might also reflect important future policy directions.

## Conclusions

The risk of using tobacco will be influenced by local, national and global factors and by promotional versus mitigating factors.

Tobacco use is a global risk of major importance and wide-ranging uncertainty. The scope and magnitude of this risk will be influenced by local, national and global factors and by promotional versus mitigating factors. The future trends of tobacco use in low and middle-income emerging market nations such as Brazil and Mexico are likely to depend on the marketing and promotional activities on one hand, and on public health tobacco control policies on the other, and their respective abilities to influence the societal acceptability versus denormalisation of smoking. How effective traditional, evidence-based risk mitigating strategies will be in any nation depends on whether or not the measures are implemented in a comprehensive fashion and accompanied by effective enforcement. These policies where implemented have been embraced by smokers and non-smokers alike, even where smokers were initially reluctant or were opposed to them.

Ongoing tobacco product innovation and development together with marketing and promotion continue to highlight the potential need for progressive tobacco control policies.

However, ongoing tobacco product innovation and development together with marketing and promotion continue to raise the bar and potential need for progressive tobacco control policies, such as lowering addictiveness through product regulation. Brazil's experience in the coming years should be informative for regulatory authorities in other emerging market nations as well as the US and elsewhere. Recent "big data" approaches could be further augmented with data that gauge public opinion, especially the attitudes of youth and women as potential indicators of forthcoming trends. Increasingly large databases and computational resources are becoming available to track and project the future course of the tobacco epidemic, which may be the single most important risk to determine longevity and mortality in the 21st century.

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# Time trends of physical activity practice in Brazil

Grégore I Mielke, Pedro C Hallal and
I-Min Lee

**Due to its harmful health effects and its high prevalence worldwide, physical inactivity is a public health threat. However, little is known about time trends in physical activity, particularly in low and middle-income settings. Brazil is experiencing an increase in the quantity and quality of physical research, including data on time trends. Local and national data indicate a large increase in all domains of physical inactivity, a discrete increase in leisure-time physical activity and a decrease in transportation physical activity in the past years. Changes over time are widening education inequalities.**

## Introduction

The impact of a risk factor on public health depends on the proportion of the population exposed to the factor and the increase in risk associated with exposure to the factor.

Measuring the impact of a risk factor on public health is a complex task that basically depends on the answer to two questions: (a) what proportion of the population is exposed to the factor? and (b) what is the increase in risk associated with exposure to the factor? A set of two studies published in 2012 in The Lancet estimated the impact of physical inactivity for public health using this method. Hallal et al, using data from 122 countries, representing around 90% of the world's population, showed that 31.1% of the adults worldwide do not reach the recommended 150 minutes per week of moderate to vigorous physical activity[1]. Lee et al showed that inactivity – defined as not achieving the recommended level of physical activity – is responsible for 6% of all coronary heart disease deaths, 7% of type 2 diabetes-related deaths and 10% of all breast and colon cancer deaths. Taken together, these findings suggest that over 5 million deaths per year worldwide are attributed to physical inactivity[2].

Regular monitoring of physical activity is important for decision-making in public health.

Because the pandemic of physical inactivity is therefore a major public health threat for modern societies, regular monitoring of population physical activity levels is important for decision making in public health. Hallal et al summarised the progress, pitfalls and prospects of the surveillance of physical inactivity around the world[1]. Among the positive developments were: (a) information is available for two-thirds of the countries around the world; (b) there are at least two standardised instruments that can be used in different cultures for measuring physical activity; and (c) the World Health Organization STEPwise approach to physical activity surveillance has proved to be of great utility, particularly for low and middle-income countries. Among the pitfalls noted were: (a) the lack of data was not random – ie countries with no data on physical inactivity are concentrated in Africa and Southeast Asia; (b) most of the 122 countries contributing data to the publication had only one data point, precluding in-country analyses of time trends; and (c) there are few data available on active transport and sedentary behaviours[1].

The quantity and quality of physical activity research is on the rise in Brazil.

Brazil is experiencing a tremendous increase in the quantity and quality of physical activity research[3, 4]. In this report, we present the sources of data on time trends of physical activity in Brazil and highlight some key findings.

## Local data sources

For years the only source of physical activity data was the city of Pelotas.

For years, the only source of data on time trends of physical activity in Brazil was from surveys in the city of Pelotas, in the south of the country. Pelotas is a medium-sized city (~320 000 inhabitants) located in the extreme south of the country, near the border with Uruguay, occupying an area of 1610 km[2,], where 93.3% of the inhabitants live in urban areas. The city is well-known in scientist research due to the existence of birth cohort studies that follow all children born in the city in the calendar years of 1982[5], 1993[6,7] and 2004[8].

The Federal University of Pelotas began conducting health surveys in the early 2000s.

Starting in the early 2000s, the Federal University of Pelotas Graduate Program in Epidemiology conducted periodic health surveys of the city's population. From 2002 onwards, questions on physical activity have been included in the survey instrument. At that point, a recently developed short version of the International Physical Activity Questionnaire was used. In order to maintain comparability over time, the same instrument has been administered to the population in 2007 and 2012.

Between 2002 and 2007, the proportion of participants who did not achieve 150 minutes of physical activity increased.

The proportion of participants that did not achieve 150 minutes per week of moderate to vigorous physical activity (equivalent to 600 kcal/week of energy expenditure) in all domains increased considerably and significantly between 2002 and 2007, and only modestly (not statistically significant) between 2007 and 2012. (Figure 1)[9]

Figure 1:
Prevalence of physical inactivity in Pelotas, Brazil
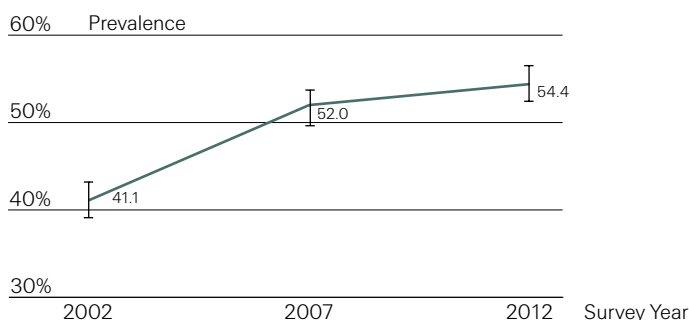


Source: Adapted from Hallal et al (2014)[9]

Lower income participants tended to be less physically active.

Between 2002 and 2007, the increase in physical inactivity was dominated by low-income participants, who became much more inactive over time. From 2007 to 2012, no major differences in the trends were observed according to socioeconomic position. Looking over the ten-year period, it was observed that the increase in the prevalence of physical inactivity was much more marked in low-income individuals as compared to high-income participants; this high-income group actually increased their activity levels over a 10-year period (Figure 2).
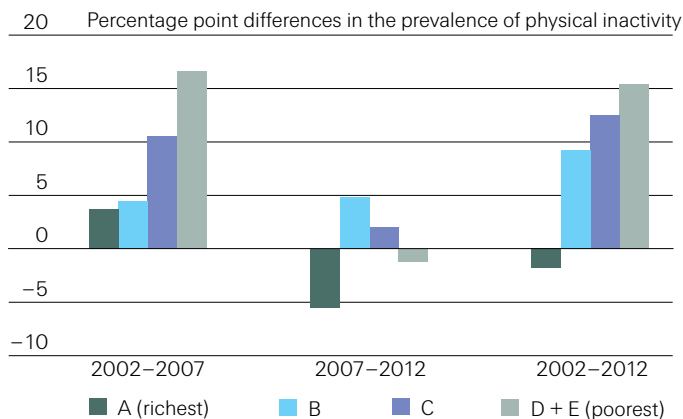
Figure 2:
Changes in the prevalence of physical inactivity according to socioeconomic position, Pelotas, Brazil



Source: Adapted from Hallal et al (2014)[9]

Also in Pelotas, data on leisure time physical activity are available for 2003 and 2010. In 2003, 26.8% of the participants were classified as active (150+ min/wk) in their leisure time, versus 24.4% in 2010. Furthermore, the proportion of subjects reporting zero minutes per week of walking, moderate or vigorous physical activity was virtually the same between 2003 and 2010 (Figure 3).[10]

Figure 3:
Proportion of individuals with zero minutes per week of different intensities of leisure time physical activity
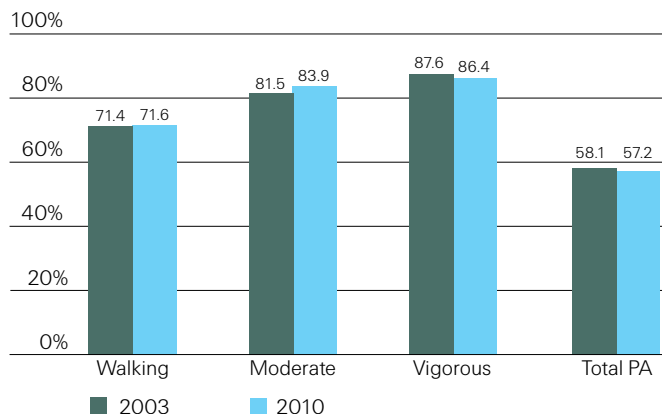


Source: Adapted from da Silva et al (2013)[10]

Surveys found that adolescents whose commute to and from school involved physical activity were less likely to be overweight.

Data on time trends of physical activity among adolescents are also available from Pelotas. Surveys using comparable methodology were conducted in 2005 and 2012, investigating active transportation and leisure-time physical activity. The prevalence of <300 minutes per week of leisure time physical activity was around 74% in 2005 and 72% in 2012. However, the proportion of adolescents using active commuting to and from school declined from 69.0% in 2005 to 56.5% in 2012 (Figure 4)[11]. The potential implications of such a decline are worth considering. Using data from the 1993 Pelotas Birth Cohort, Martinez-Gomes et al showed that boys who reported more time in transportation physical activity through adolescence had, on average, −2.09 cm of waist circumference and −1.11 cm of trunk fat mass compared to boys using passive modes of transportation[17].

Figure 4:
Changes in leisure time and transportation physical activity among adolescents
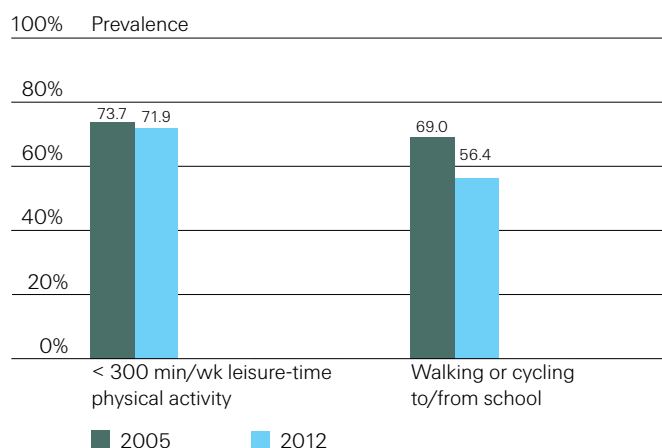


Source: Adapted from Coll et al (2014)[11]

Data on trends of physical activity in the state of São Paulo[12] have also been previously published. However, because the trends in that state are likely influenced by a massive health promotion intervention that occurred in the state, we opted not to present them here.

## National data sources

The VIGITEL study collects data on risk factors for chronic diseases as well as physical activity.

The landmark study in terms of surveillance of physical activity in Brazil is the Surveillance System of Protective and Risk Factors for Chronic Diseases Through Telephone Interviews (VIGITEL). The system was implemented in 2006 and collects data on risk factors for chronic diseases, including physical activity, yearly on approximately 54 000 adults (~2000 in each state capital). Data are collected on leisure-time physical, transportation, work-related and housework physical activity.

Leisure-time physical activity did increase in both men and women from 2006 to 2012, in part due to efforts by the Ministry of Health.

The data on leisure-time physical activity from 2006 to 2012 shows a slight increase in the proportion of adults reporting physical activity at least five days per week for at least 30 minutes per day (Figure 5)[13]. Studies on time trends in leisure-time physical activity have mostly come from high income countries, such as England[14], Canada[15] and the United States[16] – each showing modest increases in leisure-time physical activity, as was observed in Brazil. The increase in leisure-time physical activity in Brazil could be due to efforts by the Ministry of Health to promote physical activity, thereby reducing the burden of non-communicable diseases[17,18].

Figure 5:
Prevalence of leisure-time physical activity (physical activity at least five days per week for at least 30 minutes per day) by gender. Brazil, 2006–2012
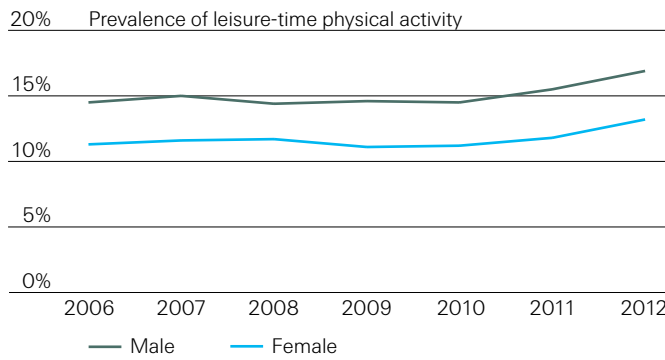


Source: Adapted from Mielke et al (2014)[13]

Transport-related physical activity has declined since 2006, perhaps due to increases in the number of vehicles purchased.

For transport-related physical activity, declining trends were observed between 2006 and 2008 and again between 2009 and 2012 (Figure 6). The two periods need to be evaluated separately due to small changes in the questions asked about such activity from 2009 onwards. The proportion of adults that reported walking or biking for 30 minutes or more per day decreased 12.9% per year from 2006 to 2008 and 5.8% per year from 2009 to 2012[13]. Part of this change could be a consequence of the country's economic growth. There were marked improvements in the proportion of the population that is educated, resulting in a better socioeconomic profile and, consequently, increased likelihood of car ownership. For example, while the Brazilian population increased by 12% between 2000 and 2010[19], the number of vehicles increased by around 140% between 2001 and 2012[20].

Figure 6:
Prevalence of transportation physical activity (walking or cycling to/from work for at least 30 minutes per day). Brazil, 2006–2012
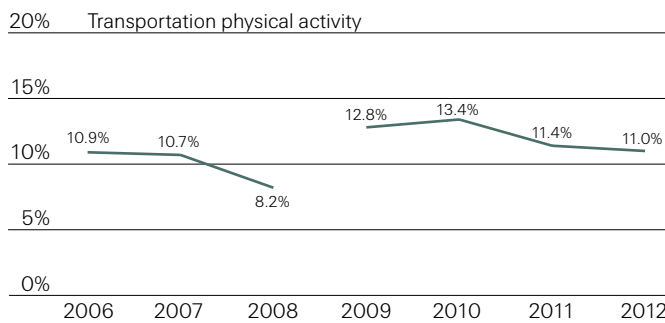


Source: Adapted from Mielke et al (2014)[13]

## Impact of inactivity on the burden of non-communicable diseases in Brazil

Taking into account data presented by Lee et al[2] in 2012, it is possible to estimate the impact of the pandemic of physical inactivity on the burden of non-communicable diseases (NCDs) in Brazil (Table 1). Almost 150000 deaths per year (13.2% of all deaths) could be averted if the entire population of the country become active at recommended levels.

Table 1:
Estimated population attributable fractions (PAF), calculated using adjusted relative risks, for CHD, type 2 diabetes, breast cancer, colon cancer, and all–cause mortality associated with physical inactivity. Brazil, 2009.

| Cause mortality | PAF Adjusted (%)[2] | Absolute deaths[21] | Avoidable deaths |
|---|---|---|---|
| Coronary heart disease | 8.2 | 96,386 | 7,904 |
| Type 2 diabetes | 10.1 | 52,104 | 5,263 |
| Breast cancer | 13.4 | 12,098 | 1,621 |
| Colon cancer | 14.6 | 12,471 | 1,821 |
| All-cause mortality | 13.2 | 1,103,088 | 145,608 |

Source: Lee et al (2012)[2], Ministry of Health[21]

## Conclusion

In summary, it is important to continue monitoring physical activity levels in the country at both the national and local levels. It is equally important to develop policies that promote active lifestyles in an effort to reduce the burden of non-communicable diseases on the Brazilian population.

**Time trends of physical activity practice in Brazil**

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The Swiss Re Centre for Global Dialogue is a platform for the exploration of key global issues and trends from a risk transfer and financial services perspective. Founded by Swiss Re, one of the world's largest and most diversified reinsurers, in 2000, this state-of-the-art conference facility positions Swiss Re as a global leader at the forefront of industry thinking, innovation and worldwide risk research. The Centre facilitates dialogue between Swiss Re, its clients and others from the areas of business, science, academia, and politics.

**Swiss Re**
Foundation

Swiss Re Foundation is a non-profit organisation committed to care and concern for society and the environment. Launched in 2012 by global re/insurer Swiss Re, the Foundation aims to make people more resilient towards natural hazards, climate change, population growth, water scarcity and pandemics, along with other challenges to society's security, health and prosperity. It also supports community projects and employee volunteering in locations where Swiss Re has offices.