Social patterning of chronic disease risk factors: Cross-national and within-country comparisons

by

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Dedication

To my North Dakota roots:
My grandparents, who sacrificed for my parents to attend school, and taught me that one can be a life-long learner without a fancy degree.
And my parents, both educators, who taught me the beauty of learning.

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Abstract

Chronic diseases are traditionally thought to be more important in high-income countries, although most of the burden occurs in low- and middle-income countries. Despite a recent global focus on the social determinants of health, few studies have examined socioeconomic gradients in chronic disease risk within poor countries or across countries at different levels of development. This dissertation uses data from the 2002-2003 WHO World Health Surveys (WHS) and the 2005 National Survey of Risk Factors for Non-communicable Diseases in Argentina to examine (1) differences associated with urbanicity in the prevalence and social patterning of chronic disease risk factors across countries (using WHS), (2) differences associated with urbanicity in the prevalence and social patterning of chronic disease risk factors across regions within a middle-income country (Argentina survey), and (3) differences over time (i.e. by age cohort) in the social patterning of smoking behavior within a country in transition (Argentina survey). The WHS study showed that body mass index (BMI), obesity and diabetes were higher at higher levels of urbanicity for both genders. For men, there was little association between urbanicity and prevalence of smoking; for women, higher prevalence of smoking was associated with higher urbanicity. In the least urban countries those of higher socioeconomic position (SEP) had higher BMI, while the opposite pattern was seen in the most urban countries, especially among women. In contrast, smoking was consistently concentrated among those of lower SEP, especially among men, regardless of level of urbanicity. The studies from Argentina found that the socioeconomic patterning of risk

factors was modified by provincial-level urbanicity, such that the inverse patterning became stronger or only emerged in more urban settings, particularly for BMI, high blood pressure and diabetes. There was also evidence that the socioeconomic patterning of smoking was changing with successive birth cohorts, and was increasingly concentrated among those of lower SEP, particularly among women. Taken together, these results highlight a trend, globally and within countries, toward increasing burden of chronic disease risk among those of lower socioeconomic position. This is certain to impact future inequities in chronic disease outcomes unless interventions addressing health disparities are undertaken.

Chapter 1 : Introduction

Rationale

Globally, chronic diseases are the primary cause of mortality, and their significance relative to injuries and communicable diseases is projected to increase in the next two decades (1, 2). Cardiovascular disease (CVD) is the most significant killer, causing 17 million deaths in 2002 (1). While chronic diseases are traditionally thought to be more important in affluent countries, the majority of the increase in these diseases globally is occurring in poor countries (3). In fact, cardiovascular disease already causes more deaths than any other disease in low- and middle-income countries (4).

Although economic development is generally associated with improvements in health, the processes of globalization highlight its role in the increase of chronic disease risk factors as well. Risk is changing globally due to increased availability of tobacco products, saturated fat, and sugars; a general change in food production; and a decrease in physical activity at work and home (1, 5, 6). Economic development, per se, does not always improve health and may in fact cause major health problems at the population level.

As part of globalization, the world is becoming more urbanized. As of 2008, more than half of the world's population was living in urban areas; by 2030 80% of the urban population will live in low- and middle-income countries. This urban population growth will be mostly made up of poor people, who are often disregarded during urban planning (7). Urbanization affects human health through conditions in which people live, where they work, the food they eat, and the environmental factors to which they are exposed (8). While those in urban settings who are better off financially may be able change their levels of risk factors (e.g. tobacco, excess calories from saturated fats and sugars), the poor may find it difficult to live healthy lives in urban areas (8).

Many chronic disease risk factors are undergoing a "risk transition" in which the prevalence and social patterning are changing globally. This includes large increases of, for instance, smoking and obesity in poor countries (1, 6). While socioeconomic inequalities in chronic diseases and their risk factors have been studied extensively in the U.S. and other high-income countries, there is growing evidence from low- and middle-income countries that poor populations, especially in fast-growing urban areas, are at increasing risk for chronic disease risk factors while also suffering from poorer access to medical care and other afflictions (1, 5).

The dissertation research presented here investigated cross-national and within-country comparisons of the social patterning of chronic disease risk factors, with particular attention to overweight and obesity, diabetes, high blood pressure, diet, physical activity, and smoking. The goal of the research was to help elucidate the populations most at risk globally for future chronic diseases, and to determine the extent of the inequalities in risk factors that will likely contribute to the subsequent inequalities in morbidity and mortality.

Specific Aims and Hypotheses

Specific Aim 1

To explore the differences in prevalence and social patterning of chronic disease risk factors (body mass index (BMI), obesity, diabetes, smoking) in a cross-national comparison of 70 low-, middle-, and high-income countries.

Hypothesis A. Country-level urbanicity will be positively associated with the prevalence of chronic disease risk factors.

Hypothesis B. The socioeconomic patterning of chronic disease risk factors will differ according to the level of urbanicity within a country. Within the most urban countries, socioeconomic position (SEP) will be inversely associated with chronic disease risk factor prevalence; within countries with middle levels of urbanicity there will be no distinct socioeconomic patterning; within the least urban countries, SEP will be positively associated with chronic disease risk factor prevalence.

Specific Aim 2

To investigate heterogeneity in the prevalence and social patterning of chronic disease risk factors (BMI, high blood pressure, diabetes, smoking, diet, physical activity) according to urbanicity within countries in transition. Argentina, a middle-income country in transition, will serve as the case study for within-country heterogeneity in the social patterning.

Hypothesis A. Provincial-level urbanicity will be positively associated with the prevalence of chronic disease risk factors in Argentina.

Hypothesis B. Socioeconomic position will be inversely associated with chronic disease risk factor prevalence in urban areas but positively associated with risk factor prevalence in rural areas in Argentina.

Specific Aim 3

To describe the social patterning of smoking behavior within countries in transition, and to determine the heterogeneity in the patterning over time (i.e. by age cohort). Argentina will again serve as a case study.

Hypothesis A. Socioeconomic position will be inversely associated with smoking for men, and will not be associated with smoking for women in Argentina as a whole.

Hypothesis B. Socioeconomic position will be inversely associated with smoking in younger age groups, but will not be associated with smoking in older age groups in Argentina.

Background

Public health significance

By 2030, deaths due to noncommunicable diseases are projected to account for 69% of all deaths globally, compared to 59% in 2002 (2). Nearly 80% of these deaths already occur in low- and middle-income countries (9). The two leading causes of death for both 2002 and 2030 are ischaemic heart disease and cerebrovascular disease, two of the major cardiovascular diseases. CVD will be the primary cause of death for countries at all levels of development by 2030; it will also be the largest contributor to the loss of Disability Adjusted Life Years (DALYs) in middle- and high-income countries, but will still fall behind HIV/AIDS in low-income countries (2).

The projections for global chronic diseases are based on changing demographics (the aging population structure of most countries) and do not take into account an increase in chronic disease risk factors in low- and middle-income countries. However, it is likely that many of these risk factors will increase, due in part to urbanization, economic development, and globalization (10). Urbanization, supported by advances in agricultural production, has led many formerly rural workers to move to urban centers for work. In addition, food consumption patterns have altered to an increase in calories and a change in the types of calories consumed; meanwhile, physical activity levels have decreased (10, 11). The effect of the increase in chronic disease risk factors, however, will not be seen immediately; only as populations age and individual disease processes unfold will the real damage be seen (10).

There is already evidence that changes in diet (more fat, salt, calories) and environment (less opportunity for exercise) in low- and middle-income countries are most prominent in urban areas compared to rural areas, which leads to increasing rates of obesity due to urbanization (6, 11). Although poorer diets and less physical activity increase with income in some poorer countries, making those of higher SEP more at risk, it can already be seen that risk factors such as smoking are more common among those of lower incomes. Again, these patterns are more common in urban than rural areas (10).

While chronic diseases are typically thought to be diseases of more affluent countries and people, low- and middle-income countries now contribute a larger proportion of CVD globally than do high-income countries (12). The prevalence of chronic disease risk factors is a major contributor to global trends. For instance, tobacco is projected to account for 10% of all world deaths and 50% more deaths than HIV/AIDS by 2015. Of these deaths, most will be in low- and middle-income countries, and 29% will be due to cardiovascular diseases (2).

A series of global transitions

<u>Epidemiologic transition</u>

Classic epidemiologic transition theory states that non-communicable chronic diseases displace communicable diseases as the primary drivers of population health once countries achieve a certain level of development. In his classic paper, Omran describes three stages in the epidemiologic transition: the Age of Pestilence and Famine, the Age of Receding Pandemics, and the Age of Degenerative and Man-Made Diseases. In the Age of Pestilence and Famine, mortality is high and volatile, with a low life expectancy. The Age of Receding Pandemics sees fewer pandemics, declines in mortality, and increases in life expectancy, with steady population growth. The third stage, the Age of Degenerative and Man-Made Diseases includes continuing decreases in mortality, increases in life expectancy, and a shift to cancer and cardiovascular diseases (13). A fourth stage, described by Olshansky and and Ault, is referred to as the Age of Delayed Degenerative Diseases. In this stage, death rates decline rapidly among people of advanced ages, deaths from chronic diseases shift toward older populations, and survival increases among the oldest people as well (14). Olshansky later suggested a fifth stage to incorporate the impact of HIV/AIDS and emerging infectious diseases, although it has not been widely recognized (15). More recently, a different fifth stage has been suggested: the Age of Obesity and Inactivity. In this proposed stage, the rapid increases in overweight and obesity over the past two decades threatens the gains in morbidity and mortality related to chronic diseases associated with older ages described in the fourth stage (16).

Omran's initial paper also described three models for the epidemiologic transition: the Classical (Western) model, the Accelerated model, and the Contemporary (or Delayed) model. The Classical model, characterized by a slow transition through the stages from high mortality and fertility to low mortality and fertility, was seen in Western Europe. Omran asserted that the transition was driven by economic development, supported by changes to sanitation followed by medical and public health interventions. In the Accelerated model, seen in Japan, the first two phases were similar to the Classical model, although mortality decreased much more rapidly and the transition to the Age of Degenerative and Man-Made Diseases was quicker. Sanitary and medical advances, and social improvements characterize the faster transition. The Contemporary model described the situation of developing countries (e.g. Chile, Ceylon) that had yet to undergo the transition to a concentration of chronic diseases. Public health initiatives and international aid assisted in the rapid declines in mortality, although fertility remained high (13).

Despite the importance of the epidemiologic transition theory in describing population changes to the major causes of mortality and the various models of the transition, Omran's model has been supplemented (as noted above) and critiqued since its original appearance in 1971. Omran also expanded on his theoretical work with an application to the U.S. situation, finding that the mortality declines and shift to chronic diseases were seen most strongly among children (due to a decrease in infectious disease), women over men (due in part to fewer pregnancies and reduced maternal mortality), and whites over blacks (since whites had better social conditions) (17).

A number of researchers have critiqued the epidemiologic transition theory. Caldwell, in a review of the 1971 work, disputes Omran's assertion that the mortality declines in western Europe were due mainly to ecobiological and socioeconomic factors, discounting other aspects of global economic growth, modernization, public health interventions, and medical breakthroughs, including antiseptic use, pasteurization, and controls on crowding. In addition, he criticizes the three models of the transition, noting the vast heterogeneity in moving through the epidemiologic transition, and the importance of globalization. A final critique relates to the focus on mortality, rather than morbidity (18). In a critique of the "western model," Mackenbach criticizes the vagueness of the theory; the difficulty of determining changes in the "Age of Pestilence and Famine," the timing of moving between stages and reaching and end; the issue of using mortality patterns as the key component of the epidemiologic transition; and the ambiguity of what is meant by "degenerative and man-made diseases" and whether they would more appropriately be termed non-communicable diseases and injuries, chronic diseases, or some variation of diseases of affluence/civilization or western diseases, all of which have their own problems. However, Mackenbach also makes the case that the epidemiologic transition theory may be most useful for studying historical and future disease patterns, and differences across countries, which may be related to processes of economic development (19). In another analysis, Caselli et al call for a revised epidemiologic transition theory, noting important exceptions to the models of the theory, including the massive changes in mortality and morbidity after the fall of the Soviet Union and in sub-Saharan Africa in particular due to HIV/AIDS, and the unexpected gains in longevity in Western countries. The authors also point to the importance of historical, cultural, and economic development in the patterns of countries undergoing the epidemiologic transition in defining distinct models (20).

Other researchers indicate that the theory lacks attention to social conditions (e.g. poverty, income inequality) and subgroup differences (e.g. by race, sex or place) (21, 22, 23, 24, 25, 26, 27); that it doesn't account for the diverging global mortality patterns (28, 29); that it does not allow for emerging (e.g. HIV/AIDS) and re-emerging infections or problems such as antibiotic resistance (21, 22, 24, 26, 27); that it does not distinguish between the risk of dying from different causes, and the proportion of people who die in a particular population due to the causes (21, 23); that many chronic disease processes have infectious origins (e.g. cervical cancer due to HPV) (21); and that, to echo the argument above, it focuses too much on mortality without attention to morbidity, disability, and quality of life (21). In terms of the lack of attention to social conditions, Pearson in particular addresses the issue of those of higher socioeconomic position being early adopters of behaviors that lead to an increase in chronic disease risk, but also the first people to adapt to the health risks leading to a subsequent decline in morbidity and mortality, leaving those of lowest socioeconomic position with the greatest burden of chronic disease. This corresponds to the idea that those of higher SEP moving through the epidemiologic transition before those of lower SEP in any given society (23).

In addition to these critiques, other aspects affecting the classic epidemiologic transition theory must be considered. For instance, many poorer countries face a double burden of chronic and infectious diseases, and are not transitioning to a pattern of mostly chronic disease (30), despite often declining mortality and fertility. In addition, a rapidly aging world population, the processes of globalization, and nutrition and physical activity transitions are changing the nature of the epidemiologic transition. The increasing chronic disease burden in low- and middle-income countries is outpacing past transitions in high-income countries (31), with health service reform (1) and behavior change (32) lagging.

Aging

Demographic shifts are part of the driving force behind the increase in chronic diseases. The global population as a whole is aging, but developing countries are aging at a faster rate than developed countries (2, 31). Also troubling is that morbidity and mortality from chronic diseases are already higher and affect younger populations in developing compared to developed countries (10, 33, 34, 35, 36).

Nutrition and physical activity transitions

The nutrition and physical activity transitions are contributing to the rapid increase in chronic disease risk globally. The nutrition transition refers to an increased consumption of processed foods and higher intake of salt, sugar, and fat (37), whereas the physical activity transition describes a trend toward more sedentary work and leisure activities (38, 39, 40). These behavioral transitions are impacting even the poorest countries.

Social transition

In conjunction with the epidemiologic, aging, nutrition, and physical activity transitions, a social transition of chronic disease risk is also occurring. Historically within the U.S. and other high-income countries, chronic disease was once associated with affluence. Studies assessing social gradients in chronic disease risk between generations (41), and reviews of work over time (42), show a transition from a higher burden among those of higher socioeconomic position for past cohorts to a higher burden among those of lower socioeconomic position for more recent cohorts. Researchers expect a reversal in the social gradient in poor countries to mirror what happened in high-income countries, such that the poor in all places will eventually bear the major burden of chronic disease. This social transition occurs because those of high SEP, who were early adopters of poor health behaviors, recognize more rapidly that their lifestyles are not conducive to a healthy life, and have the resources to change their behaviors and potentially their environments (10, 12).

Globalization

Economic development and urbanization

Globally, there is evidence that chronic disease burden varies according to economic development, although patterns are changing. For example, economic development has allowed even low-income countries to have access to higher-fat diets in recent years (43). Just as chronic disease risk varies between countries, different areas within countries can also experience different levels of chronic disease risk. For instance, areas of rapid urbanization will experience chronic disease before rural areas (11).

Urbanization is a major concern in relation to increasing chronic disease risk. As of 2008, more than half of the world's population was living in urban areas for the first time in human history. This figure is expected to increase to 80% by 2030, with most of the growth in urban populations happening in poor countries, especially in Africa and Asia (7). Although moving to urban areas offers greater economic opportunities and access to services, particularly in low- and middle-income countries, it is also associated with increases in chronic disease risk (44). Urbanization affects human health through conditions in which people live, where they work, the food they eat, and the environmental factors to which they are exposed (8). Both nutrition and physical activity transitions, for instance, have been associated with the process of urbanization. Rapid urbanization is linked to diets of more processed foods that have higher fat, sugar and sodium content (37). The types of jobs available in urban areas are often more sedentary than those in rural areas, causing changes in physical activity levels. Likewise, changes in leisure-time activities and the different types of transportation available (e.g. buses, cars) result in more sedentary lifestyles (10, 11, 32). These factors contribute to the physical activity transition toward more sedentary work and leisure-time behavior (38, 39, 40). In addition, urbanization increases the participation of women in the labor force, which subsequently changes the amount of money households have as well as time available for food preparation (45). Not surprisingly, then, those living in urban areas in most developing countries have higher levels of chronic disease risk factors such as overweight, hypertension, and diabetes compared to their rural counterparts (9).

Yusuf et al describe how countries at various stages of development and urbanization experience different health outcomes related to the epidemiologic transition. In the first stage, countries experience circulatory diseases due to rheumatic fever, those from infections, and those due to nutritional deficiency (e.g. sub-Saharan Africa, rural South America). Countries in the second stage see a reduced burden of infectious diseases and improved nutrition, but increases in diseases due to hypertension, such as stroke (e.g. China). In the third stage, risk factors such as high-fat diets, smoking, and lack of exercise are more common, and CVD causes the most mortality, especially below age 50, even though life expectancy improves overall (e.g. urban India, Latin America). These countries have a double-burden of chronic and infectious diseases. The fourth stage includes countries in which prevention and healthcare for chronic diseases improve, delaying death to later ages (e.g. Western Europe, US, Canada, Australia, New Zealand). The fifth stage is one in which societal changes such as war cause a collapse of social and health infrastructure, and there is a rise in diseases from the first two stages while chronic diseases more common in stage three and four continue as well, causing a decrease in life expectancy (e.g. Russia) (11).

A few cross-national studies have investigated the role of economic development and urbanization with CVD and its risk factors. In a recent study of more than 100 countries, BMI and cholesterol were both initially positively associated with national income but the upward trends of the associations with BMI and cholesterol flattened and then reversed at the upper end of national income levels. BMI and cholesterol were also found to increase with the proportion of urban population. However, blood pressure did not show statistically significant effects with national income or urbanicity (46). Another study, though, did find effects between blood pressure and national income and urbanicity when looking within developing countries only. In this cross-national comparison, a study of hypertension in population-based studies in developing countries (defined as low- and middle-income economies) found that hypertension was more common in urban than rural areas. The study also found a positive relationship between GNP per capita and prevalence of hypertension across developing countries (47).

Liberalization of trade policies

The globalization of food and tobacco processing and marketing has made these health-harming products more available, even in poor countries (48, 49, 50). Trade liberalization and foreign direct investment have contributed to changes in agricultural production and the processing and distribution of energy-dense and processed foods globally, and marketing that promotes the consumption of these foods (48, 49). In addition, trade liberalization has led to rapid increases in tobacco exports, with an associated increase in cigarette smoking (50).

Gender differences in chronic disease risk factors

The factors influencing population levels of chronic disease may also impact women and men differentially. For instance, social norms may prevent women from beginning to smoke in countries where there are greater restrictions on women's behavior, whereas women in other societies may see smoking as a way to control weight gain (51, 52). In terms of obesity and its biomedical sequelae, including diabetes, several factors related to diet and physical activity are different for men and women. Household activities, such as water collection and preparing food, which are typically women's domain, require much less physical activity in urban than rural areas. Women are also more likely to work outside the home in urban areas, leading to less time for food preparation, and the likelihood of increased consumption of processed foods. In addition, work outside the home is more sedentary, particularly for men, leading to increases in BMI (38, 39).

Socioeconomic patterning of chronic diseases

The increasing burden of chronic diseases does not affect all people equally (53). Although those of higher SEP are usually the early adopters of lifestyles associated with greater risk for chronic diseases, they are also the first to respond to health messages and are able to change their behavior and environment to decrease their risk (54). Thus, social gradients in chronic disease risk factors may change over time. Most research on SEP and chronic diseases has occurred in high-income countries where numerous studies have shown inverse socioeconomic gradients for chronic diseases such as cardiovascular disease (42). While few studies have examined this trend in developing countries, there is evidence that despite an initial greater risk among those with higher SEP, some countries have already transitioned to a pattern in which the poor carry the greater burden of chronic disease risk (35).

Evidence from high-income countries

Most data on social patterning of chronic disease risk within countries come from more affluent nations. In a 1993 review article, Kaplan and Keil summarized the relationship between socioeconomic status (SES) and CVD risk within high-income countries. In general, there was a negative association between CVD disease or mortality and SES. However, even though the data were all from affluent countries, the countries were from parts of world with varying cultural, political, and socioeconomic histories that influenced the relationship of socioeconomic position on health. For instance, while Canadian studies often found inverse associations between income and CVD, education was often not associated; in contrast, housing tenure was the most relevant measure of SEP for CVD risk in a study in Scotland. In the U.S., several studies found relationships between education, income, and occupation and CVD (42).

Since the review, researchers have continued to investigate these associations. In a 2000 cross-national comparison of the U.S. and 11 western European countries, researchers found that CVD mortality is higher among men and women of lower social class or lower educational level, with variation between countries on the magnitude of the gradient. On an ecologic level, inequalities in CVD mortality were correlated with inequalities in smoking and excessive alcohol consumption (55).

Socioeconomic position is also related to chronic disease risk factor prevalence. In the 1993 Kaplan and Keil article, various socioeconomic factors (e.g. education, income, occupation) showed inverse relationships with hypertension, smoking, total cholesterol level, BMI, obesity, physical activity, excess alcohol use, and diabetes within studies that investigated individual and multiple risk factors. However, the relationship between SES and cholesterol was not clear (42). Other studies have since found similar results. For example, a study of adults in an urban area in the U.S. found that income and education were inversely associated with hypertension, smoking, and physical activity, and that the risk factors often clustered, especially according to education (56). In the 2000 U.S. and western European cross-national study, men and women of lower SEP were more often overweight and ate fresh vegetables less frequently. However, cigarette smoking was inversely associated with SEP in all countries but Spain and Portugal for men and Spain, Portugal, and Italy for women, where the opposite patterns were found. Also, for men, lower SEP was associated with higher rates of excessive alcohol intake (55).

In 2007, McLaren (57) updated the often-cited 1989 Sobal and Stunkard review (58) on socioeconomic status and obesity. In the updated review, McLaren found that overall, of the 333 published studies included, the patterns of the associations between SES and obesity varied depending on level of development of the country and the particular SES indicator investigated. There was a general trend for both sexes of more positive associations and fewer negative associations between SES and obesity when shifting from highly developed countries to those of low and medium development levels. In countries of high socioeconomic development, negative associations for women were most often found when using education and occupation. In less developed countries, income and material possessions showed positive associations with obesity among women (57).

Several studies in high-income countries have also begun to look at chronic disease risk and differences in socioeconomic factors other than adult education, income, or occupation. These include variations in childhood and life course SEP and area-level effects such as poverty. In a recent review of 40 studies concerning the effect of childhood SEP on CVD in adulthood, all but two (China, Czech Republic) of the studies were from high-income countries. The authors observed that 31 of the studies found an inverse relationship between childhood SEP and CVD risk, independent of adulthood SEP, although case-control studies gave varied results (59). Another review looked at life course socioeconomic factors and chronic disease risk. Although the reviewed studies used various definitions of life course SEP and different study designs, they provided evidence for the inverse relationship between chronic disease risk and early-life SEP as well as the negative effect of accumulating poor SEP conditions across the life course on chronic disease risk, but little proof for the potential effect of social mobility on chronic disease risk (60). A study published in 2006 also found that regardless of the life course model used (i.e. critical period, social mobility, cumulative), there was a strong inverse relation between SEP and CVD mortality (61). In terms of area-level effects, a recent review of the effects of neighborhood-level socioeconomic disadvantage and chronic disease risk found an inverse association between area-level SEP and the incidence and prevalence of CHD, CVD mortality, and risk factors such as smoking, diet, blood pressure, blood lipids, and BMI (62).

In summary, most studies of within-country socioeconomic patterning of CVD risk are from high-income countries and show that CVD risk is negatively associated with SEP. Life course SEP and area-level poverty have also been shown to have a negative association with chronic disease risk within high-income countries.

Shifting of social patterning – Social conditions as fundamental causes of chronic disease risk

Evidence exists for high-income countries going through a social transition from those of higher social class having a larger burden of chronic disease to those of lower social class, even though most of the current data show the final stage of the inverse gradient. For instance, in Cassel et al's 1971 manuscript, the researchers reported opposite associations between SEP and incident coronary heart diseases in different generations of men: among older men, those of higher SEP had higher incidence rates, while among younger men lower SEP was associated with higher incidence rates (41). Studies in the 1930s and 1940s in the U.S. and UK showed higher rates of coronary heart disease in men in higher SEP groups. The trend seemed to change between the 1940s and 1960s, with several other studies reporting declines in mortality from CVD being related to differences in SEP, with social inequalities widening since the 1960s. In addition, researchers have shown that socioeconomic development in the U.S. was also related to CHD, with poorer areas showing a decline in mortality later than richer areas. However, the inverse relationship between CVD mortality and SEP had apparently been present for women throughout these studies; only men transitioned from higher mortality in the higher SEP groups to the lower SEP groups (42).

The shift in the social gradient is expected to occur in low- and middle-income countries, just as it did in high-income countries (10, 12). This social transition in chronic disease risk can be interpreted within the context of social conditions as "Fundamental Causes of Disease." In Link and Phelan's theoretical framework, social conditions can be seen as fundamental causes of disease due to their persistence in relationship to multiple risk factors and multiple diseases, regardless of the prevailing mechanisms. Social conditions represent access to resources, including money, education, power, prestige, and social relationships and networks, which give individuals the wherewithal to combat any given disease (63). Although individuals with better social conditions may initially adopt new behaviors (such as smoking a generation ago, or diets rich in processed foods with more fat, sugar, and salt more recently), they will also be the first to adapt their behavior and environments to more healthful situations (54). The diffusion of these patterns, whereby social conditions reassert themselves as fundamental causes of disease, happens within societies, and potentially between societies, as will be investigated within this dissertation.

Evidence from low- and middle-income countries

While most of the data on social patterning of chronic disease risk are from high-income countries, there has been a recent increase in studies focusing on investigations between and within developing countries. For instance, several studies and reviews have investigated the social patterning of BMI and overweight/obesity in developing countries. A cross-national study of health disparities of women's obesity in 27 developing countries found that SEP, measured by education, was positively associated with obesity in low-income economies, but negatively associated in upper-middle-income developing countries (64). A review article on SES and obesity in developing countries supports these findings noting that as economies develop, obesity become more prominent among lower SES groups. Also, the shift toward lower SES occurs earlier for women than men (65). In a study of overweight and underweight among women aged 20-49 years in 36 developing countries from 1992 to 2000, the authors found that the prevalence of overweight was higher than underweight in urban and rural areas, particularly in countries with more developed economies. The prevalence of overweight among women of low SES was high in the economies with higher levels of development, with 38% prevalence in rural areas and 51% in urban areas (66).

Since developing countries are undergoing the chronic disease risk transition at different times in different regions, study results are often mixed. For example, a review of literature in Africa on noncommunicable diseases found 57 studies between 1964 and 2005, though not all were used in the review. In general, urban residents had higher prevalence of hypertension and glucose intolerance. However, two studies in Zimbabwe and Tanzania, both low-income countries, found that both women and men had a positive association between hypertension and level of rural living. Across studies, urban men had the highest prevalence of smoking and rural women had the lowest (67). Another country-specific study in a low-income country in Africa published in 1988 investigated people employed in six companies in Dakar, Senegal, and found that age-adjusted blood pressure was inversely associated with education among men and that male shift workers had a higher prevalence of hypertension than did those working a regular schedule (68).

Several country-specific studies in different parts of Asia look at various aspects of the socioeconomic patterning of chronic disease risk. A study of the National Health Survey of Pakistan (low-income country) from 1990-1994 found that there was a positive social gradient between economic status and being overweight in both urban and rural areas, though the prevalence of overweight was greater in urban areas (ranging from 21-42% in urban areas and 9-27% in rural areas). Hypertension (22-52% rural; 30-46% urban) and high cholesterol (14- 27% rural; 22-28% urban) exhibited the same relationships. In terms of smoking, few women smoked, but more than one third of men smoked. Smoking was inversely associated with economic status in urban areas (57-33%), but showed at best a slight social gradient among men in rural areas (36-34%) (69). These findings are consistent with the expected effects of urban areas undergoing the risk transition before rural areas, and a reversing of the SEP gradient with smoking before other risk factors.

Another study in Asia, though, found data suggesting a low-income country has already undergone the social transition of chronic disease risk. A population-based cohort study in rural Vietnam (low-income country) from 1999-2003 found that CVD was the most common reason for death, causing 31% of female and 33% of male deaths. CVD mortality rates were inversely associated with education (measured as having formal education or not) even after adjusting for age, sex, and economic status. These findings are likely due to inverse relationships between smoking and hypertension, and education in this area (70).

Besides individual SEP, some researchers are beginning to look at area-level socioeconomic effects on chronic disease risk. A multilevel study, adjusting for individual-level characteristics, in rural China (lower middle-income country) in 2004 found positive relationships between village population size and mean individual systolic blood pressure and waist-to-hip ratio; inverse associations between community literacy rate and smoking and waist-to-hip ratio; inverse associations between village income and systolic blood pressure and BMI, but positive associations with fasting blood sugar; and inverse relationships between remoteness and mean SBP, fasting blood sugar, and current smoking. Researchers also found the following age- and sex-adjusted prevalence of chronic disease risk factors among the 30 villages in the study: overweight ranged from 10-25% in men and 9-21% in women; hypertension was between 10-34% for men and 10-32% for women; diabetes prevalence was 4-10% in men and 4-9% in women; current smokers was 31-72% in men and 0.2-3% in women; current drinkers was 35-68% in men and 0.2-7% in women (71). These area-level results indicate mixed associations with chronic disease risk factors.

Also in Asia, a study of health inequalities in Korea using death certificates between 1995 and 2005, during which time Korea transitioned from an upper middle- to a high-income country, found patterns between education level and the 10 leading causes of death. Among men and women, education and mortality by cerebrovascular accidents and diabetes mellitus were inversely associated. For older men (aged 55-64), education was positively associated with ischaemic heart disease mortality, whereas among younger men (aged 35-44 and 45-54), the pattern was inversed. Women aged 55-64 showed no association between education and ischaemic heart disease mortality (72). These data suggest that Korea has started to undergo the social transition of chronic disease risk, which is driven by the shift of risk to lower SEP groups among younger generations.

There are few studies from the Middle East. In one study from Turkey, , a middle-income country, a cross-sectional survey from 2001-2002 of chronic disease risk factors among 12- and 13-year-olds in three urban areas found that father's and mother's education levels were positively associated with having "borderline or high risk" serum lipid levels for boys and girls. Higher paternal education levels were also associated with higher intakes of energy from protein and fat for boys and girls (73).

In Latin America, investigators have looked at chronic disease risk and SEP within mostly middle-income countries. For instance, a cross-sectional study of adults in Rio de Janeiro, Brazil (upper middle-income country), in 1995-96 found that 42% of men and 65% of women were at risk for CVD, based on a composite measure using risk factors. Also, for men, education was positively associated with CVD risk, whereas family per capita income was negatively associated with the risk. For women, education was also positively associated with CVD risk (74). Another study looked at the effect of childhood conditions on obesity, diabetes, and CVD amongst elderly Puerto Ricans and found some limited evidence that obesity and diabetes were associated with malnutrition and that heart disease was inversely associated with childhood SEP (75). During their lifetimes, Puerto Rico transitioned from a middle-income to a high-income country.

Several studies have been done in Mexico, an upper middle-income country, in recent years. A study of behavioral risk factors among older adults in Mexico in 2001 found urban/rural differences for social patterning of obesity, smoking, and alcohol consumption. The researchers found an inverse relationship between education and obesity in urban areas but a positive relationship in less urban areas. Regardless of urbanicity, though, they found that income was positively associated with obesity, smoking, and excessive alcohol consumption and wealth was negatively associated with smoking and drinking. Also, SES differences for the risk factors were smaller for older women than men, especially in urban areas (76). Another study among low-income adults in rural Mexico surveyed in 2003, Fernald found positive associations between education, occupation, housing conditions, and household assets and BMI in men and women (77). Among young women in semi-rural Mexico from 1997-2005, the prevalence of obesity tripled from 10% to 30% over an average of 6.4 years of follow-up. Also, the rate of change of BMI was associated with lower education (78). These results show clear evidence of a country under transition.

In summary, studies suggest that as countries develop the socioeconomic gradient of obesity shifts, and that this happens for women before men. Over- and undernutrition coexist in some developing countries, and the superposition is associated with economic development and urbanization, depending on the area of the world. Urban areas in developing countries are the first to experience higher chronic disease risk. A limited number of within-country studies show both positive and negative associations between SEP and chronic disease risk, depending on the country, region within the country (e.g. urban/rural), risk factor (e.g. smoking is often inversely related, whereas other risk factors maybe not be), age group, and gender. The global picture, particularly in developing countries, is certainly one of flux.

Summary of background

A series of transitions, in light of globalization, are contributing to the changing cross-national and within-country trends in chronic disease risk. Aging populations, rapidly urbanizing areas, the nutrition and physical activity transitions, and trade liberalization affect the prevalence and socioeconomic patterning of chronic disease factors, which will in turn affect the future patterning of noncommunicable diseases.

Chronic disease risk is becoming increasingly prevalent in low- and middle-income countries. However, chronic disease risk still increases with country-level income. In addition, urban areas see greater risk than rural areas, particularly in developing countries. High-income countries have already seen a transition in the relationship of SEP with chronic disease risk from positive associations to negative associations, and researchers expect that the same will happen within poorer countries.

While previous studies have given clear indication that chronic disease risk is shifting from high-income to middle- and low-income countries, and that the inverse socioeconomic gradient in high-income countries will likely transfer to low-income countries, few studies demonstrate this with empirical evidence. No study looks at the cross-national comparison of socioeconomic patterning of chronic disease risk, and few studies look at these patterns for nationally-representative samples within low- and middle-income countries. Aim 1 addresses this specifically, using data from 70 low-, middle-, and high-income countries to examine the impact of urbanicity on the socioeconomic patterning of chronic disease risk factors. In addition, few studies have examined differences in the social patterning of chronic disease risk by regions, or between cohorts within low- and middle-income countries. Middle-income countries, in particular, are likely to be experiencing global transitions most acutely and are likely to be in the midst of a social transition in chronic disease risk. By examining the heterogeneity in the social patterning within these countries, researchers can gain insight into the many global processes affecting the patterning of chronic disease risk. Aims 2 and 3 address these issues by investigating differences in the social patterning of chronic disease risk factors across regions with different levels of urbanicity and over time (i.e. age cohorts) within one middle-income country, Argentina.

Significance

Population differences in chronic disease occur due to variation in demographic effects (e.g. older age structures, migration to urban areas), environmental factors, early childhood programming, and gene frequency and expression (11). Global social and economic changes have caused major changes in the structures of populations, the types of jobs available, incomes, expenditures, education, diet, and physical activity levels, which have in turn increased chronic disease risk factors, morbidity and mortality (79).

Researchers have called for increased understanding of chronic disease risk factors in developing countries, and for reductions of their prevalence before the disease process takes full effect and the death and disability due to chronic diseases overwhelms societies undergoing rapid urbanization and economic development (10, 12). By investigating the social patterning of chronic disease risk factors, this dissertation adds to the limited knowledge in developing countries, and between countries at different levels of development, about this critical public health issue, while also highlighting the needs of those most vulnerable in the various societies. Since macroeconomic and social policies are closely linked to the prevalence of chronic disease risk factors through urban planning, education, agriculture policy, availability and economics of tobacco products, and food marketing (10), these analyses begin to shed light on cross-national and within-country differences that policy makers can use to inform their approaches toward chronic disease risk.

Chapter 2 : The impact of urbanicity on chronic disease risk factors – a cross-national investigation using the World Health Surveys

Introduction

Chronic diseases, once considered markers of affluence on both the individual and population levels, are increasingly concentrated among the poor. Globally, deaths from non-communicable chronic diseases are expected to account for nearly 70% of all deaths by 2030 (2); almost 80% of these deaths already occur in low- and middle-income countries (9). Although classic epidemiologic transition theory states that non-communicable chronic diseases displace communicable diseases as the primary drivers of population health once countries achieve a certain level of development (13), many poorer countries face a double burden of chronic and infectious diseases (30), with health systems poorly equipped to deal with the former (1).

A number of factors have contributed to the global increase in chronic disease burden. Globalization, aging populations, and urbanization are all major factors, as are global economic changes and trade liberalization. The rapidly aging global population is contributing to the increase in chronic diseases, especially in poor countries (2, 31); morbidity and mortality from chronic diseases are already higher and affect younger populations in these countries (10, 33, 34). Trade liberalization, another important contributor, has led to rapid increases in tobacco exports and an associated increase in cigarette smoking (50). It is also a factor, along with foreign direct investment, in elevated consumption of processed foods (48, 49).

Urbanization is another major concern in terms of chronic disease risk. As of 2008, more than half of the world's population was living in urban areas for the first time in human history. This figure is expected to increase to 80% by 2030, with most of the growth in urban populations happening in poor countries, especially in Africa and Asia (7). Although moving to urban areas offers greater economic opportunities and access to services, particularly in low- and middle-income countries, it is also associated with increases in chronic disease risk (44). Urbanization affects human health through conditions in which people live, where they work, the food they eat, and the environmental factors to which they are exposed (8). Both nutrition and physical activity transitions have been reported as part of the process of urbanization, whereby people eat more processed foods with higher fat, sugar and salt content (37), and engage in more sedentary work and leisure-time behavior (38, 39, 40), contributing to increases in obesity and other chronic diseases.

Urbanization may also impact women and men differentially. For instance, social norms may prevent women from beginning to smoke in countries, usually less urban, where there are greater restrictions on women's behavior, whereas women in other societies may see smoking as a way to control weight gain (51, 52). In terms of obesity and its biomedical sequelae, including diabetes, several factors related to diet and physical activity are different for men and women. Household activities, such as collecting water and preparing food, which are typically women's domain, require much less physical activity in urban than rural areas. Women are also more likely to work outside the home in urban areas, leading to less time for food preparation, and the likelihood of increased consumption of processed foods. In addition, work outside the home is more sedentary, particularly for men, leading to increases in body mass index (BMI) (38, 39).

Few studies have investigated differences across countries in chronic disease, and its relationship with the processes of globalization, including urbanization. This paper uses data from the WHO World Health Surveys (WHS). Using data from the 70 low-, middle- and high-income countries that participated in the 2002-2003 WHS, we investigated the association of country-level urbanicity with the prevalence of several chronic disease risk factors (BMI, obesity, diabetes and current smoking). We examined the ecologic relationship between urbanicity and the risk factors, as well as the contextual relationship of urbanicity on the risk factors, controlling for individual-level variables, in order to take full advantage of the rich individual-level data available in the WHS. Due to differences in the impact of urbanization on men and women, we conducted all analyses stratified by gender.

Methods

Data Sources

The main data source for this study is the WHS, which were conducted in 70 countries from 2002-2003. The purpose of WHS was to provide reliable, comparable information across countries to policy-makers and to monitor health systems (80). Countries participating in WHS were required to use a probability sample, with either a single stage random sample or multiple stage cluster sample design; the sampling frame was intended to cover 100% of the eligible population in each country (i.e. all adults 18 years and older) (81). The targeted sample sizes for each country were between 1,000 and 10,000 (80); however, the sample sizes for the 70 countries who did participate ranged from 585 (Slovenia) to 38610 (Mexico). Data from a total of 273,692 people were used in this study.

WHS employed several versions of the questionnaire depending on the relative wealth of the countries, so not all of the data elements were available in all countries. The questionnaires were standardized, and included household questionnaires for both low-income and high-income countries, as well as individual questionnaires. Surveys were conducted in person or over the telephone, depending on the country.

We investigated several markers of chronic disease risk. BMI (measured in kg/m^2) was calculated from self-reported height and weight. Obesity was defined as having a BMI of $>=30$ kg/m^2, according to the WHO classification (82). Diabetes status was determined from the question "Have you ever been diagnosed with diabetes (high blood sugar)" during the last 12 months. Participants were classified as current smokers if they answered yes to the question "Do you currently smoke any tobacco products such as cigarettes, cigars, or pipes?" While BMI and obesity were available for all 70 countries, diabetes and smoking status were only available for 52 and 53 countries, respectively. The 17 countries that did not have information on smoking status were all high-income countries with urbanicity levels ranging from 56% to 90%. The same 17 countries did not have information for diabetes, nor did Turkey, a lower middle-income country with 66% of its population in urban areas. BMI, although available in all 70 countries, had a high degree (>25%) of missingness in 18 countries. These countries were mostly low- and lower middle-income countries, with urbanicity ranging from 15% to 75%.

Country-level urbanicity was defined as the percentage of the midyear population that lives in urban areas in each country and reported by each country to the United

Nations (83). The value for 2003 was used for all countries. Countries were categorized as 0-25% , 25-50%, 50-75%, and 75-100% urban for analyses.

Two individual measures of socioeconomic position (SEP) were used as control variables in the contextual analyses. Education was defined as the total number of years of formal education completed. When data were available for level of education completed (i.e. no formal schooling, less than primary school, primary school completed, secondary school completed, high school (or equivalent) completed, college/pre-university/university completed, post graduate degree completed) but not the number of years, years of formal education completed were imputed using the mode of the years per category of education level of the population as a whole by country. A measure of wealth was generated for each individual in each country using the same methodology across countries, and was subsequently rescaled to a global wealth measure that was comparable across countries. The country-specific wealth measures were created by constructing a variable for each person, by country, that combined information on a number of predictors including asset ownership (e.g. bicycle, refrigerator), availability of services (e.g. electricity), housing characteristics (e.g. water source), and demographic information on the head of household (i.e. age, sex, education level). Thirteen assets were common to all countries; high-income countries had 10 additional assets and low-income countries had 11 additional assets plus five extra country-specific assets. A random effects probit model approach was used to predict wealth for each person in each country. Initial wealth estimates were based on sociodemographic variables, and then adjusted in a second step based on the household assets, services, and housing characteristics. The random effect captured the systematic variation across households not explained by the sociodemographic predictors. These country-specific wealth measures were then rescaled using data from all of the surveys to make the global wealth measure comparable across all countries. Global cut points were obtained from the weighted means (by sample size) for the country-specific cut points, country-specific cut points were regressed against the global cut points, and a linear transformation using the coefficients was applied to the country-specific wealth measures to determine the globally-comparable measure by country. The globally-comparable wealth measures were formed into deciles (84).

Statistical Methods

Age-standardized prevalence and means, and their associated standard errors (SE), were calculated, by gender, for each risk factor using survey methods to take into account the complex sampling design (including weights, sampling units, and strata) in each country using Stata. The WHO World Standard Population distribution 2000-2025 was the reference population for age-standardization (85). Regional summaries were calculated as simple means of the age-standardized estimates for each country in the region.

Locally weighted regression (lowess smoothing) (86) was used to examine the ecologic relationship, by gender, between country-level urbanicity and country-level mean BMI and prevalence of obesity, diabetes, and smoking. Generalized estimating equation (GEE) models (87) were used to account for the clustering of outcomes at the country-level when determining the contextual relationship of country-level urbanicity with the risk factors, before and after adjustment for individual-level SEP. In order to compare across countries with vastly different sample sizes, weights for each country were generated, based on the complex survey design, such that the sum of the weights in each country was one. All GEE models were age-adjusted and gender-stratified, and were implemented in SAS. Sensitivity analyses were conducted excluding countries with a high amount of missingness for BMI (<75% reporting) for the lowess graphs and GEE models.

Maps of the country-level mean and prevalence data were created using ArcGIS. Univariate kernel density estimation was used to plot smoothed histograms of the population distribution of BMI by level of urbanicity.

Results

Descriptive analyses

Age-standardized mean BMI and prevalence of obesity, diabetes, and current smoking are displayed by gender for each country in WHS in Table 2.1. Mean (SE) BMI ranged from 20.20 (0.09) kg/m^2 (Vietnam) to 30.99 (1.28) kg/m^2 (Mali) for men, and 19.86 (0.10) kg/m^2 (Vietnam) to 31.19 (0.82) kg/m^2 (South Africa) for women. Obesity trends were similar, with no obese men and a prevalence of only 0.5 (0.2)% obese women in Vietnam, while South Africa had the highest prevalence of obesity for men and women, at 28.7 (2.9)% and 41.1 (2.9)%, respectively. Women had a higher prevalence of obesity than men in the majority of countries (55/70), despite men having a higher mean BMI than women in more than half of the countries (46/70). Diabetes ranged from a prevalence of 0.04 (0.03)% (Vietnam) to 9.4 (0.8)% (Mauritius) for men, and 0.3 (0.1)% (Malawi) to 12.4 (1.2)% (South Africa) for women. Smoking prevalence was much higher for men than women, ranging from 7.8 (1.0)% (Ethiopia) to 66.5 (1.4)% (Lao People's Democratic Republic) for men and 0.3 (0.1)% (Morocco) to 35.4 (2.2)% (Hungary) for women. Figure 2.1 shows maps of the prevalence of obesity, diabetes and current smoking by gender. By region, mean BMI was lowest in Southeast Asia for men and women (20.90 kg/m^2 and 20.08 kg/m^2, respectively) and highest in Europe for men (25.30 kg/m^2) and the Americas for women (25.09 kg/m^2); obesity showed the same pattern (Table 2.2). The Western Pacific region had the lowest prevalence of diabetes for men (1.9%), while Southeast Asia had the lowest for women (2.0%); the highest diabetes prevalence was in the Eastern Mediterranean region for both men and women (4.1% and 6.2%, respectively). Current smoking prevalence was lowest in Africa (24.4%) and highest in the Western Pacific (55.8%) for men, and lowest in the Eastern Mediterranean region (3.2%) and highest in Europe (22.9%) for women. Africa had the greatest variation in BMI, obesity and diabetes for both genders and smoking for men, but the Americas, Europe and Southeast Asia all had large ranges in current smoking for women.

Ecologic analyses

The ecologic relationships between country-level urbanicity and the mean and prevalence data for each of the four risk factors are displayed in Figure 2.2. Increasing country-level urbanicity was associated with an increase in mean BMI for men and women, although the relationship flattened around 70% urban for men and 60% urban for women. South Africa and Swaziland were clear outliers for men and women, and Mali was also an outlier for the men, with much higher mean BMI than countries with similar levels of urbanicity. Obesity showed similar trends, although the relationship was less steep, especially for women. The prevalence of diabetes increased with urbanicity for men and women, across the entire range of urbanicity. South Africa, Mauritius, and Swaziland were outliers for both genders, as was Slovakia for men, with much higher levels of diabetes than countries at the same level of urbanicity. Current smoking among men was generally not associated with urbanicity, except a slight increase for countries with 60-80% of their population living in urban areas. However, higher urbanicity was associated with a higher prevalence of smoking for women, especially starting at approximately the 50% urban mark.

The relationship between BMI and urbanicity was also examined using smoothed histograms of the entire population distribution of BMI (Figure 2.3). Both men and women showed a clear shift toward higher BMI in countries with higher levels of urbanicity. Countries with urbanicity levels of 50% or lower have a markedly lower population distribution of BMI compared to countries with urbanicity greater than 50%. There is also a slight separation in the population distributions of countries with 50-75% urban and 75-100% urban, with the most urban shifted to the right. When examining the differences in the distributions by age group (18-35, 36-50, 51-65, and 66 and older), older ages showed stronger separation in the population distributions by urbanicity. Only women aged 18-35 years showed mostly overlapping curves at all levels of urbanicity except the highest (results not shown).

Contextual analyses

Age-adjusted, gender-stratified associations of country-level urbanicity with the four risk factors are shown in Table 2.3. Before adjusting for individual-level SEP, mean BMI and odds of obesity and diabetes were higher at higher levels of urbanicity for men. The odds of smoking was also higher with higher urbanicity, although this relationship was most pronounced among men living in countries with 50-75% of their population in urban areas. After adjusting for individual-level SEP, there was still evidence for a trend of higher BMI and obesity with higher urbanicity, although the results for diabetes were not as strong. The relationship between smoking and urbanicity was actually made stronger by the adjustment. For women, before adjusting for individual-level SEP, BMI and obesity were higher at the two highest levels of urbanicity compared to the least urban category. Higher odds of diabetes and smoking were associated with higher levels of urbanicity. After adjustment for individual-level SEP, however, increasing trends of BMI and obesity with higher urbanicity were no longer present, although there was still a trend, albeit muted, with higher diabetes at higher levels of urbanicity. The smoking-urbanicity relationship, however, was unaffected by the adjustment for SEP.

Discussion

This study of the 70 low-, middle- and high-income countries that participated in the World Health Surveys demonstrates generally higher levels of chronic disease risk factors in countries with higher levels of urbanicity, with variation depending on gender and the specific risk factor. The ecologic loess analyses show that BMI, obesity and diabetes are higher at higher levels of urbanicity for men and women, although BMI and obesity level off between 60-70% urban, whereas diabetes does not. The population curves of BMI, though, show a distinct shift toward higher BMI in countries with at least 50% urban compared to those with less than 50% urban for both men and women. For men, there is little association between urbanicity and prevalence of smoking, except for higher prevalence around 60-80% urban. However, for women, there is a distinct rise in the prevalence of smoking with higher urbanicity, starting at about 50% urban.

In examining the contextual relationship between country-level urbanicity and the risk factors, we found similar results to the ecologic analyses with regards to BMI, obesity, and diabetes for men and women before adjusting for individual-level SEP. After adjustment, the trends of higher BMI and obesity were attenuated, particularly for women, as was diabetes, particularly for men. For smoking, both before and after adjustment for individual-level SEP, higher smoking was associated with higher urbanicity. This relationship was stronger and increased in a more monotonic fashion among women, whereas for men the peak of smoking was in the 50-75% urban areas compared to 0-25% urban areas. Although adjusting for individual-level SEP in the GEE models allows us to test the contextual relationship between urbanicity and the risk factors, while controlling for potential compositional effects, this may be an over-adjustment of the models. Since access to education and wealth increase at the population level as countries become more urban and more developed, individual-level SEP may actually be on the causal pathway between urbanicity and levels of chronic disease risk factors. The next chapter of this dissertation will explore the relationships between SEP and the risk factors, and how this is modified by country-level urbanicity. Another potential problem with the contextual analysis relates to the exchangeability assumption. Since we only see each country with its specific level of urbanicity, in order to draw inferences about the effects of urbanicity we assume that countries are exchangeable after controlling for individual-level confounders. Our conclusions are based on the assumption that the effect of urbanicity on the various risk factors is the same across all levels of the individual-level confounders (i.e. age, SEP), and that it is appropriate to use the between-country differences to estimate the potential within-country change we would observed if that country were to have a different level of urbanicity.

Few studies have examined cross-national comparisons of chronic disease risk and country-level factors. A recent ecologic study assessed the relationship between national income and urbanization and population levels of mean BMI, systolic blood pressure and total cholesterol of 69, 85 and 64 countries, respectively. The researchers found that BMI and cholesterol had an inverse U-shaped relationship with national-level income, with increases at lower levels, followed by a flattening and decline at higher levels of national income for men and women. Blood pressure showed no distinct relationship. Mean BMI and cholesterol showed increasing levels with higher urbanicity, with a slight flattening at the highest levels; blood pressure had an inverse U-shaped relationship with urbanicity (46). The BMI result is similar to our findings with the ecologic analysis, in which we saw higher BMI with higher urbanicity until a flattening of the relationship at earlier levels (around 60-70% urban). The leveling-off of the relationship between BMI and urbanicity at lower urbanicity in our study compared to the other study could reflect the differences in countries assessed or the years the data were collected. Another study, focusing on obesity in women of childbearing age in developing countries found higher obesity with higher levels of national income, followed by a leveling off (88), while another similar analysis focusing on the urbanicity found higher prevalence of overweight with higher urbanicity with a similar sample (89). Although our study included a larger age range and countries with higher incomes as well, these results are similar to our findings given that urbanicity and GNI per capita were so highly correlated in our sample (Spearman correlation = 0.83). No similar studies have been conducted with diabetes or smoking, due in part to limited data of comparable quality across countries, by gender.

A limited number of studies have investigated the differences in chronic disease risk factors between urban and rural areas in specific countries. These studies generally reported higher levels of chronic disease and its risk factors in more urban areas. BMI and obesity has been shown to be mostly higher and increasing faster in urban versus rural China (43, 90); India (91, 92, 93, 94); Western Samoa (43); Cameroon (95, 96); South Africa (97); Palestinian West Bank (98); in several countries in Central America and the Caribbean, and for poorer countries in South America (99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112); and among women in 20 sub-Saharan Africa countries, seven of eight Latin American and Caribbean countries, and six of eight North Africa/West Asia/Europe, Central Asia, and South and Southeast Asia countries (89). However, more recent data from some middle-income countries in Latin America (such as Mexico and Argentina) show that urban/rural differences are not homogenous across all countries and social groups, and may be changing (113, 114, 115, 116, 117, 118, 119, 120). Diabetes follows similar trends, with higher prevalence among urban populations in India (91, 92, 93), in Cameroon for women but not men (95, 96), and in Costa Rica for men but not women (100). The relationship between smoking and urbanicity is more varied. Smoking is more prevalent in rural India (91, 92) and shows no difference by urbanicity in Estonia for either gender (121). However, smoking is higher with more urban living in China (122), South Africa among younger women only (123), Germany (124), Lithuania and Russia for women but not men (121, 125), Latvia for both genders (121), and Guatemala for men only (112). Our results are generally consistent with these studies, which are not necessarily population-based studies. We found higher BMI and obesity with higher urbanicity at the ecologic level for both genders, and utilizing individual-level data for men in particular. We also saw higher levels of diabetes with higher urbanicity for both genders. In terms of smoking, urbanicity was associated with higher odds of smoking for women, was highest in the 50-75% urban areas for men.

As countries become more urban, populations seem to be shifting toward higher levels of BMI, obesity and diabetes for both genders, and smoking for women. The population BMI curves shown in Figure 3 highlight that these trends are not constant, and that population-level strategies must be taken into consideration when tackling chronic disease risk globally (126). With the rapid pace of urbanization, low- and middle-income countries, in particular, are increasingly susceptible to enormous health and economic consequences due to the increase in chronic disease burden (36). However, health systems in these countries are poorly equipped to deal with the epidemic of chronic diseases (1). In addition to improving individual-level treatments, though, poorer countries especially would benefit from a number of population-level interventions, such as implementing tobacco control policies and salt reduction, if they hope to avert greater consequences from chronic diseases (127, 128, 129). Urbanization affects chronic disease risk through a variety of mechanisms including increased availability of processed foods and tobacco; shifts toward more sedentary lifestyle; greater exposure to food and tobacco advertising; changing cultural norms of body images toward a preference for smaller bodies, especially among women; but also increased access to healthcare and knowledge of prevention (10, 11). The differences in patterns for men and women, particularly in regard to smoking, indicate that these processes do not affect all people in the same way.

This study is among the first to examine both the ecologic and contextual relationships of urbanicity with a number of chronic disease risk factors across countries with a range of urbanicity levels. The WHS data allow for direct comparisons of these relationships since the data were collected during the same time period and using the same protocols across countries. However, this study has a number of limitations as well. Due to the cross-sectional nature of the data, we cannot assess how the speed of urbanization is impacting chronic disease risk, or if this differs by region. We also cannot see how risk factor trends have changed within countries (data which are particularly sparse in low- and middle-income countries), which may give additional insight into population-level factors affecting chronic disease risk. Since all data were self-reported, some of the estimates may not accurately reflect the true situation in the countries if people, particularly in less developed countries, do not know their weight or height. Detection may also be an issue in terms of diabetes reporting if people in poorer areas do not have access to healthcare, leading to underestimates in these countries. As a result, the differences we see by urbanicity may be overstated. In addition, we had smaller samples of high-income/high urbanicity countries for diabetes and smoking, which are potentially affecting the overall trends. For instance, many higher income countries have started to address chronic disease risk factors, and the levels have started to decline; this is especially true in the case of smoking (130). We do not report analyses by other country-level factors, although analyses by country-level development were similar to those reported for urbanicity. Urbanicity and GNI per capita were highly correlated (Spearman correlation = 0.83), however, and it may be difficult to tease apart the impact of urbanization and development in light of globalization. In addition, there are high levels of missingness for BMI in some countries. Eighteen of the 70 countries had less than 75% reporting for BMI. In order to investigate this missingness, we compared the age, gender, education, and wealth levels of those with and without data for BMI in each country. Most of the countries with high levels of missing data were low- or lower middle-income countries, and the majority (10/18) had populations with less than 50% living in urban areas. In general, those with missing BMI data had lower levels of wealth and education, were older, and had a greater proportion of female participants compared to those with BMI data. Since the analyses were gender-stratified and age-standardized, the main concern is regarding the differences in SEP. However, in sensitivity analyses excluding those countries that had high levels of BMI missingness and statistically different mean levels of SEP between persons with and without data, the GEE results were qualitatively similar, as were the ecologic analyses, except that the lowess curves were a bit less steep in the least urban areas due to fewer countries represented. An additional limitation is that patterns for other risk factors are not reported here. WHS did not collect information on hypertension or high cholesterol, and although there were measures for diet and physical activity, they were relatively unsophisticated measures, and we do not report the results here.

Conclusions

This paper highlights the growing burden of chronic disease risk factors as countries become more urban. Population-level interventions will be critical to stymie these trends, particularly in low- and middle-income countries. Additionally, we found evidence in our contextual analyses for socioeconomic position to be a potential pathway through which urbanicity may be working. The next chapter will explore in detail the impact of urbanicity on the socioeconomic patterning of two of the risk factors investigated here – BMI and smoking.

Table 2.1 Economic development and urbanicity indicators and age-standardized mean and prevalence of BMI, obesity, diabetes, and current smoking by gender, World Health Surveys 2002-2003

Country	Urbanicity 2003 (83)	GNI per capita 2003 (83)	Country income classification (131)	Percent Male (not weighted)	Age Mean (SD)		BMI mean in kg/m^2 (SE)			Obesity prevalence (SE)	
					N		N	Men	Women	Men	Women
Nepal	14.84	250	low	42.6	8686	37.0 (15.3)	3189	21.13 (0.10)	21.05 (0.17)	1.96 (0.38)	2.88 (0.71)
Sri Lanka	15.34	930	lower middle	46.6	6275	40.5 (16.1)	5709	21.07 (0.13)	20.95 (0.14)	2.22 (0.46)	3.96 (0.45)
Ethiopia	15.56	110	low	48.4	4934	35.5 (15.0)	972	21.75 (0.16)	21.31 (0.30)	1.22 (0.43)	4.25 (2.04)
Malawi	16.36	180	low	41.7	5225	35.8 (15.5)	5207	24.10 (0.21)	23.56 (0.13)	7.11 (1.35)	7.11 (0.64)
Burkina Faso	17.58	280	low	47.1	4819	34.6 (14.9)	1729	22.58 (0.15)	22.23 (0.15)	1.36 (0.46)	1.97 (0.62)
Lao People's Democratic Republic	19.92	350	low	46.9	4888	36.8 (15.2)	4874	21.38 (0.07)	21.15 (0.09)	0.78 (0.20)	1.65 (0.30)
Kenya	20.30	420	low	42.3	4345	33.4 (13.6)	4229	21.84 (0.23)	23.40 (0.23)	2.83 (0.69)	9.19 (1.22)
Swaziland	23.78	1350	lower middle	45.9	3041	35.8 (15.8)	1857	28.06 (0.40)	29.13 (0.38)	25.05 (2.04)	34.94 (1.95)
Bangladesh	24.34	370	low	46.5	5550	36.3 (14.6)	864	21.06 (0.17)	22.37 (0.59)	1.28 (0.35)	4.72 (2.54)
Chad	24.54	210	low	47.2	4632	35.8 (14.9)	3569	25.17 (0.33)	25.23 (0.41)	12.39 (1.21)	13.44 (1.85)
Viet Nam	25.56	470	low	45.0	3490	38.4 (16.1)	3475	20.20 (0.09)	19.86 (0.10)	0	0.54 (0.20)
India	28.30	530	low	48.5	9723	38.4 (16.0)	9132	20.25 (0.09)	19.98 (0.18)	1.18 (0.25)	2.53 (0.37)
Mali	29.46	320	low	57.2	4055	34.2 (15.2)	1067	30.99 (1.28)	21.98 (1.61)	25.06 (2.26)	21.16 (3.38)
Myanmar	29.56		low	43.3	5886	38.4 (15.5)	5886	20.98 (0.11)	21.03 (0.09)	0.90 (0.24)	1.22 (0.24)
Namibia	34.02	2010	lower middle	40.6	4238	37.0 (16.0)	3794	23.32 (0.24)	23.53 (0.22)	7.93 (0.94)	11.64 (1.08)
Pakistan	34.18	560	low	55.9	6101	36.6 (15.1)	3237	23.47 (0.21)	23.95 (0.31)	7.26 (0.77)	10.13 (1.10)
Zambia	34.92	360	low	45.2	3801	35.2 (15.5)	2289	24.06 (0.37)	25.42 (0.62)	6.88 (1.03)	12.05 (1.50)
Zimbabwe	35.06	760	low	36.4	4054	35.2 (16.2)	2609	25.36 (0.34)	26.91 (0.38)	10.37 (1.21)	17.11 (1.25)
Comoros	35.72	470	low	44.7	1758	40.7 (17.7)	1725	22.90 (0.18)	22.98 (0.17)	1.59 (0.64)	4.62 (0.82)
China	38.56	1270	lower middle	48.9	3993	45.1 (15.9)	3984	21.77 (0.12)	21.45 (0.12)	1.07 (0.21)	1.24 (0.41)
Mauritania	40.24	470	low	38.9	3703	35.8 (14.9)	3066	23.16 (0.28)	25.06 (0.30)	8.01 (1.24)	14.95 (1.57)
Senegal	41.20	520	low	52.0	2957	35.3 (14.0)	1567	22.12 (0.17)	23.60 (0.35)	3.48 (0.83)	10.96 (1.88)
Mauritius	42.52	4090	upper middle	48.2	3888	40.6 (15.8)	2520	23.27 (0.19)	23.32 (0.25)	5.92 (0.74)	8.21 (1.07)
Cote d'Ivoire	44.20	620	low	57.2	3173	34.7 (14.4)	2864	23.30 (0.19)	23.53 (0.21)	3.58 (0.66)	7.63 (1.05)

Country	Urbanicity 2003 (83)	GNI per capita 2003 (83)	Country income classification (131)	Percent Male (not weighted)	Age Mean (SD)		BMI mean in kg/m^2 (SE)			Obesity prevalence (SE)	
Bosnia & Herzegovina	44.70	1960	lower middle	42.2	1028	44.0 (16.2)	1022	24.51 (0.20)	24.09 (0.20)	7.75 (1.60)	7.97 (1.05)
Ghana	46.28	300	low	45.1	3921	36.1 (15.1)	3680	22.27 (0.16)	23.26 (0.15)	3.52 (0.55)	8.64 (0.79)
Guatemala	46.36	1950	lower middle	38.4	4756	40.0 (16.4)	3281	24.05 (0.13)	26.23 (0.22)	7.31 (0.67)	15.80 (0.86)
Slovenia	50.92	11990	high	46.3	585	47.3 (18.1)	571	25.82 (0.24)	24.24 (0.22)	13.34 (2.11)	10.69 (1.61)
Georgia	52.40	870	lower middle	42.3	2749	45.2 (17.9)	2738	25.32 (0.13)	24.29 (0.12)	8.44 (0.91)	10.25 (0.97)
Croatia	56.14	5480	upper middle	40.5	990	49.5 (16.7)	980	26.08 (0.26)	24.38 (0.22)	16.79 (2.38)	10.06 (1.23)
Slovakia	56.24	5010	upper middle	38.5	2482	44.3 (17.0)	1770	26.76 (0.27)	24.53 (0.25)	17.22 (2.35)	17.01 (2.27)
Portugal	56.32	12560	high	38.0	1030	46.1 (18.3)	896	25.52 (0.21)	25.42 (0.25)	11.10 (1.66)	16.11 (1.79)
Kazakhstan	56.90	1800	lower middle	34.3	4495	41.4 (15.4)	4116	24.42 (0.21)	24.46 (0.24)	6.16 (1.30)	11.99 (1.20)
Paraguay	57.22	1030	lower middle	45.8	5131	37.1 (15.3)	4668	25.16 (0.13)	24.80 (0.15)	11.49 (0.84)	13.29 (0.89)
Morocco	57.26	1500	lower middle	41.5	4472	37.7 (15.2)	1929	23.88 (0.59)	25.18 (0.27)	5.61 (1.30)	16.47 (2.29)
South Africa	58.34	2870	lower middle	47.4	2344	37.4 (15.2)	1585	29.11 (0.81)	31.19 (0.82)	28.73 (2.92)	41.07 (2.91)
Greece	58.92	16970	high	50.0	1000	51.1 (18.7)	961	26.05 (0.18)	24.78 (0.22)	13.10 (1.46)	13.85 (1.45)
Congo	59.44	710	low	46.8	2486	35.3 (14.2)	2197	23.45 (0.19)	23.91 (0.28)	3.92 (1.05)	8.88 (2.04)
Ireland	59.94	28550	high	45.3	1013	43.5 (18.1)	909	25.38 (0.26)	24.52 (0.28)	13.99 (1.92)	13.95 (1.62)
Philippines	61.02	1070	lower middle	46.3	10075	37.2 (15.1)	8184	21.78 (0.07)	21.57 (0.09)	2.77 (0.34)	3.96 (0.40)
Finland	61.10	27480	high	44.6	1013	48.2 (17.9)	1004	25.55 (0.20)	25.10 (0.22)	10.92 (1.47)	13.00 (1.51)
Ecuador	61.80	1930	lower middle	44.2	4605	38.3 (16.1)	4051	25.15 (0.27)	25.30 (0.23)	8.97 (1.01)	13.82 (1.14)
Tunisia	64.54	2260	lower middle	46.2	5068	38.6 (16.0)	4227	23.82 (0.11)	24.48 (0.12)	5.37 (0.56)	11.16 (0.93)
Dominican Republic	65.04	1980	lower middle	46.4	4534	38.5 (15.5)	3119	24.68 (0.16)	24.67 (0.19)	11.16 (1.11)	14.13 (1.44)
Malaysia	65.10	3900	upper middle	44.3	6037	38.8 (15.1)	5016	23.60 (0.15)	23.83 (0.21)	8.55 (0.81)	11.02 (0.84)
Hungary	65.62	6590	upper middle	41.7	1419	46.5 (18.1)	1401	26.14 (0.19)	24.46 (0.18)	18.22 (1.78)	15.07 (1.19)
Austria	65.92	27150	high	37.6	1052	45.1 (16.2)	948	25.38 (0.16)	23.80 (0.18)	10.84 (1.40)	9.96 (1.25)
Turkey	66.26	2800	lower middle	42.8	11217	38.8 (15.7)	8166	25.08 (0.09)	25.31 (0.15)	10.66 (0.61)	16.01 (0.83)
Italy	67.44	22170	high	42.6	999	48.3 (18.2)	958	25.03 (0.16)	23.07 (0.15)	6.90 (1.14)	5.56 (0.86)
Ukraine	67.52	980	lower middle	35.2	2498	46.1 (17.9)	1570	25.05 (0.16)	24.76 (0.20)	7.39 (1.09)	15.05 (1.34)
Latvia	67.92	4450	upper middle	33.4	855	46.5 (18.6)	734	25.21 (0.24)	24.86 (0.21)	10.80 (2.16)	17.10 (1.87)
Estonia	69.22	5750	upper middle	36.3	1010	47.1 (18.0)	1000	25.12 (0.18)	24.41 (0.15)	12.10 (1.61)	14.69 (1.14)

Country	Urbanicity 2003 (83)	GNI per capita 2003 (83)	Country income classification (131)	Percent Male (not weighted)	Age Mean (SD)		BMI mean in kg/m^2 (SE)			Obesity prevalence (SE)	
Russian Federation	73.16	2590	lower middle	36.0	4420	51.4 (17.9)	3503	24.98 (0.14)	24.85 (0.20)	7.59 (1.18)	14.67 (1.23)
Czech Republic	73.70	7340	upper middle	44.8	935	45.8 (17.9)	913	25.9 (0.30)	24.61 (0.25)	19.57 (2.79)	11.81 (1.62)
Germany	75.16	25600	high	40.4	1259	50.4 (17.7)	1180	25.41 (0.20)	24.36 (0.21)	9.96 (1.32)	12.32 (1.25)
Mexico	75.48	6370	upper middle	42.3	38610	38.3 (16.0)	23427	25.56 (0.06)	25.88 (0.07)	11.86 (0.49)	17.71 (0.52)
France	76.34	25290	high	40.1	1000	47.4 (18.6)	944	24.14 (0.19)	22.65 (0.23)	7.61 (1.29)	6.17 (1.04)
Spain	76.54	17560	high	41.2	6275	46.8 (18.4)	6077	25.93 (0.11)	24.60 (0.11)	13.29 (0.85)	12.02 (0.75)
Norway	76.88	44030	high	49.6	972	47.3 (18.2)	959	23.45 (0.18)	25.41 (0.19)	5.23 (0.99)	10.57 (1.52)
United Arab Emirates	76.98	22540	high	52.3	1180	37.6 (11.7)	1141	26.34 (0.33)	26.62 (0.39)	18.90 (2.47)	17.77 (2.36)
Netherlands	78.84	28800	high	32.5	1091	43.6 (18.4)	1085	25.11 (0.17)	24.70 (0.18)	10.91 (1.62)	13.23 (1.34)
Brazil	83.00	2950	lower middle	43.8	5000	39.2 (15.9)	4446	24.52 (0.10)	24.18 (0.11)	8.99 (0.69)	10.62 (0.70)
Luxembourg	83.40	41770	high	48.9	700	46.0 (17.3)	692	25.34 (0.22)	24.09 (0.25)	11.44 (1.50)	11.81 (1.66)
Sweden	84.12	29520	high	41.6	1000	48.8 (18.0)	975	25.02 (0.21)	23.87 (0.28)	9.03 (1.79)	7.87 (2.25)
Denmark	85.40	33970	high	47.4	1003	50.8 (17.0)	974	25.78 (0.24)	24.11 (0.29)	13.94 (1.86)	10.60 (1.89)
Australia	87.80	22820	high	41.7	1753	46.5 (16.5)	1451	25.94 (0.20)	25.02 (0.21)	15.08 (1.59)	16.07 (1.29)
United Kingdom	89.58	28510	high	36.8	1197	50.3 (19.4)	1060	25.81 (0.34)	25.19 (0.22)	14.58 (1.94)	18.17 (1.58)
Israel	91.52	16910	high	42.9	1227	43.0 (17.8)	1182	25.04 (0.21)	24.51 (0.20)	9.60 (1.36)	11.83 (1.23)
Uruguay	91.72	3860	upper middle	48.6	2977	45.0 (18.5)	2966	25.42 (0.12)	24.55 (0.14)	11.86 (0.83)	13.81 (0.86)
Belgium	97.16	26280	high	43.6	1004	45.2 (17.3)	956	24.76 (0.20)	24.04 (0.21)	8.18 (1.20)	11.15 (1.28)

Country	Urbanicity 2003 (83)	GNI per capita 2003 (83)	Country income classification (131)	Diabetes prevalence (SE)			Current Smoking prevalence (SE)		
				N	Men	Women	N	Men	Women
Nepal	14.84	250	low	8165	4.32 (0.44)	1.69 (0.22)	8681	55.35 (1.08)	29.38 (0.95)
Sri Lanka	15.34	930	lower middle	6508	2.52 (0.40)	2.91 (0.47)	6589	37.81 (1.40)	2.81 (0.52)
Ethiopia	15.56	110	low	4624	0.61 (0.16)	0.43 (0.19)	4919	7.76 (1.02)	0.56 (0.20)
Malawi	16.36	180	low	5198	0.11 (0.07)	0.29 (0.13)	5199	27.99 (1.51)	8.07 (1.02)
Burkina Faso	17.58	280	low	4787	0.46 (0.17)	0.72 (0.29)	4807	24.13 (1.54)	14.23 (1.75)
Lao People's Democratic Republic	19.92	350	low	4770	0.60 (0.24)	0.68 (0.21)	4883	66.50 (1.39)	15.62 (1.37)
Kenya	20.30	420	low	4305	2.18 (0.70)	1.56 (0.53)	4337	26.44 (1.77)	2.69 (0.52)
Swaziland	23.78	1350	lower middle	1957	6.40 (1.31)	7.29 (1.29)	2042	17.23 (1.80)	4.10 (0.80)
Bangladesh	24.34	370	low	5486	3.68 (0.50)	2.78 (0.40)	5526	59.38 (1.23)	31.96 (1.38)
Chad	24.54	210	low	4357	2.97 (0.56)	0.89 (0.29)	4586	18.79 (1.61)	3.83 (0.96)
Viet Nam	25.56	470	low	3453	0.038 (0.03)	0.73 (0.25)	3486	50.41 (2.28)	2.54 (0.50)
India	28.30	530	low	9270	3.19 (0.40)	2.09 (0.37)	9534	52.51 (1.87)	18.50 (1.00)
Mali	29.46	320	low	3387	0.32 (0.13)	0.50 (0.21)	3494	24.71 (1.20)	4.23 (0.65)
Myanmar	29.56		low	5878	0.54 (0.15)	0.47 (0.15)	5886	48.02 (1.65)	14.75 (1.19)
Namibia	34.02	2010	lower middle	3938	1.22 (0.27)	3.13 (0.47)	3963	30.57 (1.93)	13.61 (1.16)
Pakistan	34.18	560	low	5988	2.68 (0.41)	4.48 (0.62)	6088	35.44 (1.55)	6.66 (0.62)
Zambia	34.92	360	low	3776	0.64 (0.26)	0.73 (0.26)	3797	26.39 (1.23)	7.55 (0.71)
Zimbabwe	35.06	760	low	3930	0.51 (0.23)	1.20 (0.30)	3985	28.90 (1.57)	4.37 (0.61)
Comoros	35.72	470	low	1738	0.67 (0.32)	0.82 (0.30)	1749	27.61 (2.19)	16.44 (1.49)
China	38.56	1270	lower middle	3960	0.93 (0.24)	1.20 (0.23)	3993	54.19 (1.45)	3.04 (0.50)
Mauritania	40.24	470	low	3481	1.81 (0.48)	2.75 (0.48)	3630	27.30 (1.85)	4.50 (0.71)
Senegal	41.20	520	low	2648	1.28 (0.35)	2.44 (0.54)	2711	22.08 (1.55)	2.11 (0.54)
Mauritius	42.52	4090	upper middle	3862	9.35 (0.79)	9.47 (0.79)	3887	41.39 (1.54)	3.15 (0.70)
Cote d'Ivoire	44.20	620	low	3023	2.05 (0.53)	1.66 (0.53)	3116	18.89 (1.22)	3.41 (0.67)
Bosnia & Herzegovina	44.70	1960	lower middle	1013	4.00 (1.13)	4.36 (1.13)	1026	49.95 (3.14)	33.33 (4.58)
Ghana	46.28	300	low	3886	1.21 (0.38)	1.04 (0.28)	3982	11.49 (0.87)	1.45 (0.35)

Country	Urbanicity 2003 (83)	GNI per capita 2003 (83)	Country income classification (131)	Diabetes prevalence (SE)			Current Smoking prevalence (SE)		
Guatemala	46.36	1950	lower middle	4691	1.72 (0.29)	4.07 (0.38)	4734	24.62 (1.04)	3.51 (0.35)
Slovenia	50.92	11990	high	581	3.07 (0.73)	3.63 (0.78)	585	31.73 (3.11)	22.20 (2.73)
Georgia	52.40	870	lower middle	2737	1.82 (0.30)	2.22 (0.42)	2745	59.02 (1.73)	6.39 (1.02)
Croatia	56.14	5480	upper middle	980	4.07 (0.78)	4.58 (0.71)	985	36.29 (2.80)	27.05 (3.16)
Slovakia	56.24	5010	upper middle	1775	8.63 (2.53)	5.39 (1.10)	1774	43.60 (4.48)	24.12 (2.52)
Portugal	56.32	12560	high						
Kazakhstan	56.90	1800	lower middle	4484	1.46 (0.45)	2.35 (0.40)	4494	49.69 (2.06)	8.97 (0.78)
Paraguay	57.22	1030	lower middle	5058	3.18 (0.46)	7.31 (0.59)	5113	42.25 (1.27)	14.17 (0.78)
Morocco	57.26	1500	lower middle	4469	2.77 (0.46)	6.56 (0.98)	4472	29.61 (1.77)	0.25 (0.11)
South Africa	58.34	2870	lower middle	2271	8.31 (1.28)	12.36 (1.19)	2323	39.28 (2.14)	13.02 (1.06)
Greece	58.92	16970	high						
Congo	59.44	710	low	2123	2.79 (0.90)	1.83 (0.80)	2172	18.36 (2.83)	1.79 (0.55)
Ireland	59.94	28550	high						
Philippines	61.02	1070	lower middle	9898	2.09 (0.25)	2.83 (0.31)	10074	56.46 (1.12)	13.20 (0.70)
Finland	61.10	27480	high						
Ecuador	61.80	1930	lower middle	4350	1.53 (0.60)	2.31 (0.36)	4065	28.93 (1.85)	7.42 (0.93)
Tunisia	64.54	2260	lower middle	5032	3.56 (0.44)	4.49 (0.48)	5050	51.04 (1.38)	2.51 (0.36)
Dominican Republic	65.04	1980	lower middle	4485	3.57 (0.66)	5.68 (0.64)	4503	17.98 (1.23)	13.23 (1.07)
Malaysia	65.10	3900	upper middle	5978	5.85 (0.57)	5.97 (0.57)	6002	51.46 (1.25)	2.81 (0.44)
Hungary	65.62	6590	upper middle	1417	5.59 (0.74)	7.75 (0.91)	1419	41.64 (2.22)	35.35 (2.19)
Austria	65.92	27150	high						
Turkey	66.26	2800	lower middle				11193	50.68 (1.11)	17.31 (0.74)
Italy	67.44	22170	high						
Ukraine	67.52	980	lower middle	2473	1.73 (0.39)	2.56 (0.42)	2488	55.38 (2.30)	13.71 (1.38)
Latvia	67.92	4450	upper middle	848	2.93 (0.84)	4.22 (0.86)	855	65.63 (3.24)	30.81 (2.63)
Estonia	69.22	5750	upper middle	1005	2.59 (1.10)	2.74 (0.62)	1010	57.68 (2.34)	27.44 (1.48)
Russian Federation	73.16	2590	lower middle	4352	0.85 (0.24)	2.58 (0.87)	4410	58.49 (2.61)	15.56 (1.57)
Czech Republic	73.70	7340	upper middle	918	8.21 (1.66)	6.83 (1.30)	929	39.98 (4.65)	27.11 (2.97)
Germany	75.16	25600	high						

Country	Urbanicity 2003 (83)	GNI per capita 2003 (83)	Country income classification (131)	Diabetes prevalence (SE)			Current Smoking prevalence (SE)		
Mexico	75.48	6370	upper middle	24062	4.64 (0.33)	5.84 (0.34)	38610	35.93 (0.65)	14.98 (0.49)
France	76.34	25290	high						
Spain	76.54	17560	high	6251	4.75 (0.37)	4.83 (0.37)	6275	41.25 (1.62)	31.73 (1.33)
Norway	76.88	44030	high						
United Arab Emirates	76.98	22540	high	1164	7.33 (1.28)	9.21 (1.70)	1175	27.13 (2.36)	3.31 (1.08)
Netherlands	78.84	28800	high						
Brazil	83.00	2950	lower middle	4957	5.19 (0.49)	6.90 (0.54)	5000	26.34 (1.08)	17.54 (0.94)
Luxembourg	83.40	41770	high						
Sweden	84.12	29520	high						
Denmark	85.40	33970	high						
Australia	87.80	22820	high						
United Kingdom	89.58	28510	high						
Israel	91.52	16910	high						
Uruguay	91.72	3860	upper middle	2970	4.25 (0.42)	4.06 (0.64)	2975	39.22 (1.50)	32.40 (3.07)
Belgium	97.16	26280	high						

Table 2.2 Regional summary measures of age-standardized mean and prevalence of BMI, obesity, diabetes, and current smoking by gender, World Health Surveys 2002-2003

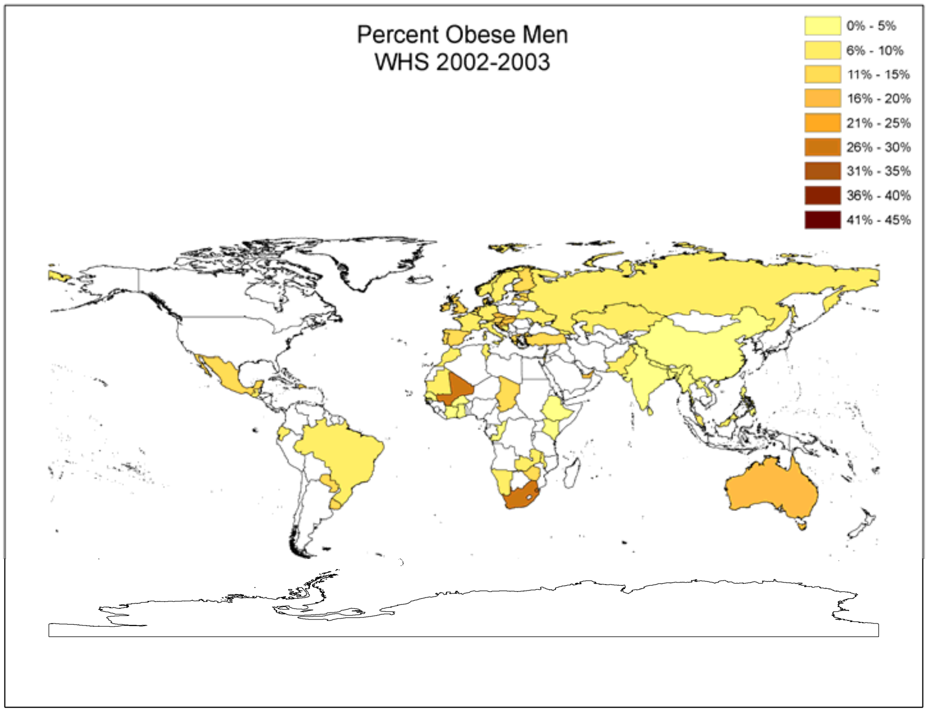
	BMI Mean kg/m^2 (range)		Obesity Prevalence (range)		Diabetes Prevalence (range)		Current smoking Prevalence (range)	
WHO Region	Men	Women	Men	Women	Men	Women	Men	Women
Africa (Burkina Faso, Chad, Comoros, Congo, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Mali, Mauritania, Mauritius, Namibia, Senegal, South Africa, Swaziland, Zambia, Zimbabwe)	24.27 (21.75-30.99)	24.42 (21.31-31.19)	8.83 (1.22-28.73)	13.21 (1.97-41.07)	2.38 (0.11-9.35)	2.73 (0.29-12.36)	24.41 (7.76-41.39)	6.06 (0.56-16.44)
Americas (Brazil, Dominican Republic, Ecuador, Guatemala, Mexico, Paraguay, Uruguay)	24.93 (24.05-25.56)	25.09 (24.18-26.23)	10.23 (7.31-11.86)	14.17 (10.62-17.71)	3.44 (1.53-5.19)	5.17 (2.31-7.31)	30.75 (17.98-42.25)	14.75 (3.51-32.4)
Eastern Mediterranean (Morocco, Pakistan, Tunisia, United Arab Emirates)	24.38 (23.47-26.34)	25.06 (23.95-26.62)	9.29 (5.37-18.90)	13.88 (10.13-17.77)	4.09 (2.68-7.33)	6.19 (4.48-9.21)	35.81 (27.13-51.04)	3.18 (0.25-6.66)
Europe (Austria, Belgium, Bosnia and Herzegovina, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Latvia, Luxembourg, Netherlands, Norway, Portugal, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Turkey, Ukraine, United Kingdom)	25.30 (23.45-26.76)	24.45 (22.65-25.42)	11.22 (5.23-19.57)	12.35 (5.56-18.17)	3.82 (0.85-8.63)	4.16 (2.22-7.75)	48.64 (31.73-65.63)	22.93 (6.39-35.35)
Southeast Asia (Bangladesh, India, Myanmar, Nepal, Sri Lanka)	20.90 (20.25-21.13)	21.08 (19.98-22.37)	1.51 (0.90-2.22)	3.06 (1.22-4.72)	2.85 (0.54-4.32)	1.99 (0.47-2.91)	50.61 (37.81-59.38)	19.48 (2.81-31.96)
Western Pacific (Australia, China, Lao People's Democratic Republic, Malaysia, Philippines, Viet Nam)	23.03 (20.20-26.51)	22.60 (19.86-25.30)	6.70 (0-18.67)	7.34 (0.54-16.90)	1.90 (0.038-5.85)	2.28 (0.68-5.97)	55.80 (50.41-66.50)	7.44 (2.54-15.62)

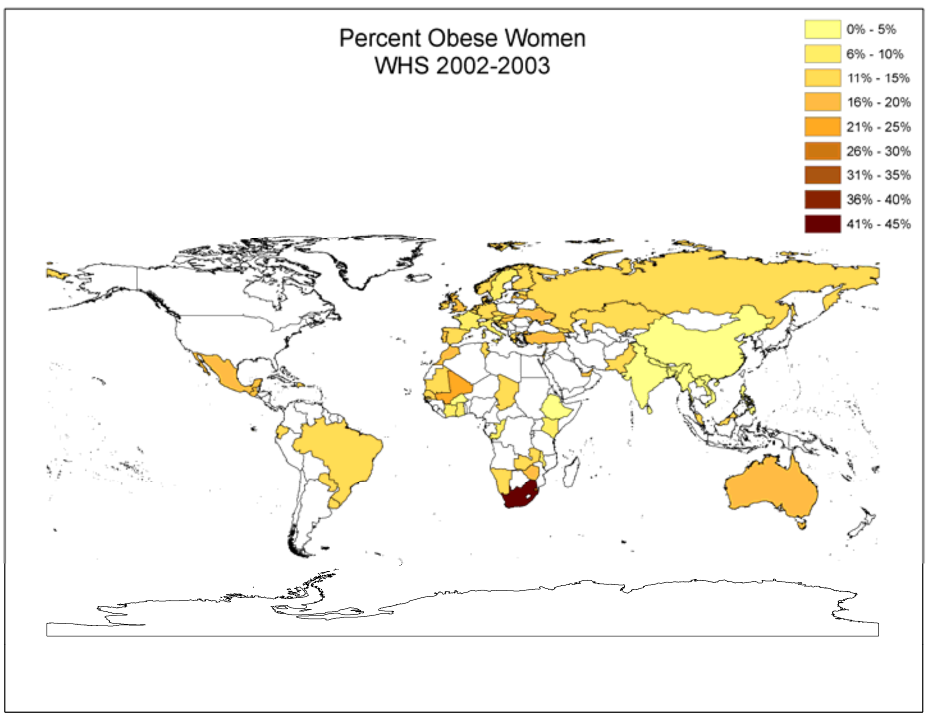
Table 2.3 Mean differences in BMI and odds ratios of obesity, diabetes, and smoking associated with country-level urbanicity, World Health Surveys 2002-2003

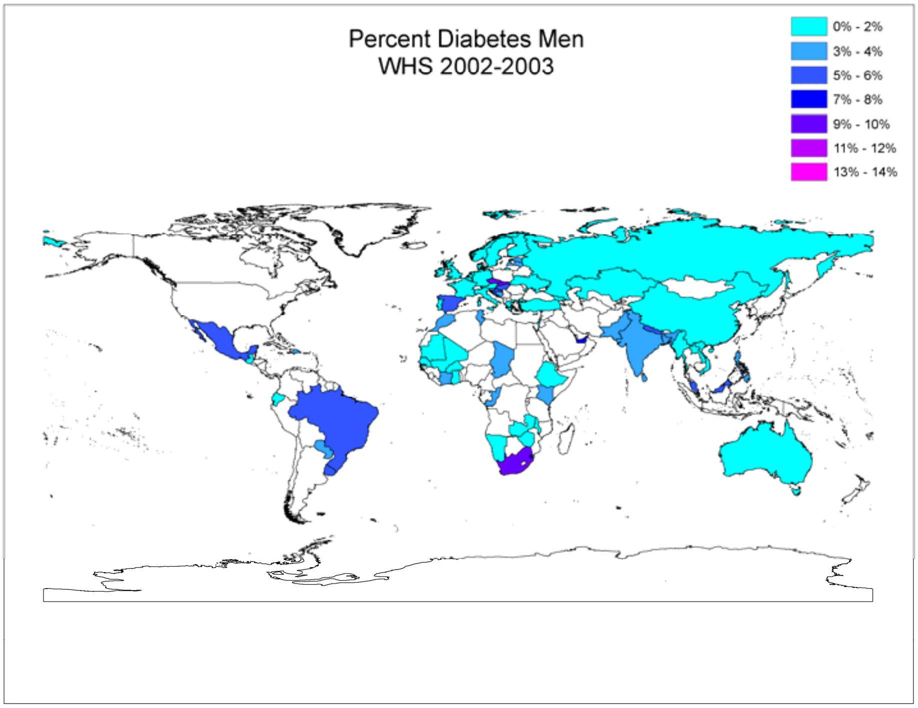
	BMI		Obesity		Diabetes		Smoking	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Men								
0-25% urban	0	0	1	1	1	1	1	1
25-50% urban	0.014 (-1.82, 1.85)	-0.12 (-1.96, 1.72)	0.89 (0.32, 2.52)	0.77 (0.29, 2.09)	0.94 (0.39, 2.24)	0.66 (0.30, 1.46)	1.21 (0.72, 2.03)	1.23 (0.67, 2.28)
50-75% urban	2.14 (0.58, 3.70)	1.39 (-0.16, 2.95)	2.45 (0.95, 6.29)	1.55 (0.62, 3.86)	1.98 (1.02, 3.83)	0.84 (0.40, 1.77)	1.72 (1.03, 2.87)	2.22 (1.24, 3.96)
75-100% urban	2.30 (0.72, 3.88)	1.34 (-0.29, 2.98)	2.50 (0.95, 6.56)	1.45 (0.55, 3.82)	3.10 (1.55, 6.24)	1.17 (0.56, 2.45)	1.44 (0.97, 2.15)	1.91 (1.19, 3.07)
P trend	<0.0001	0.0194	0.0003	0.0966	0.0006	0.5312	0.0186	0.0008
Global wealth decile		0.21 (0.13, 0.28)		1.16 (1.10, 1.23)		1.23 (1.12, 1.34)		0.98 (0.95, 1.01)
Education in years		-0.01 (-0.03, 0.02)		0.98 (0.97, 0.997)		0.99 (0.98, 1.01)		0.96 (0.95, 0.97)
Women								
0-25% urban	0	0	1	1	1	1	1	1
25-50% urban	-0.70 (-2.67, 1.27)	-0.94 (-3.01, 1.13)	0.71 (0.30, 1.69)	0.64 (0.26, 1.55)	1.41 (0.60, 3.31)	0.98 (0.49, 1.96)	1.28 (0.38, 4.29)	1.37 (0.44, 4.23)
50-75% urban	1.15 (-0.45, 2.76)	0.50 (-1.22, 2.21)	1.82 (0.84, 3.95)	1.35 (0.60, 3.03)	2.49 (1.20, 5.19)	1.38 (0.72, 2.64)	2.00 (0.87, 4.61)	2.17 (0.95, 4.92)
75-100% urban	0.77 (-0.87, 2.41)	-0.05 (-1.83, 1.73)	1.26 (0.59, 2.71)	0.87 (0.38, 1.99)	3.41 (1.50, 7.74)	1.54 (0.76, 3.11)	3.61 (1.40, 9.31)	3.82 (1.51, 9.67)
P trend	0.0182	0.3107	0.0447	0.6536	<0.0001	0.0661	0.0032	0.0022
Global wealth decile		0.24 (0.17, 0.32)		1.14 (1.09, 1.20)		1.25 (1.18, 1.33)		1.00 (0.93, 1.07)
Education in years		-0.06 (-0.09, -0.03)		0.97 (0.95, 0.98)		0.95 (0.93, 0.97)		0.98 (0.97, 1.00)

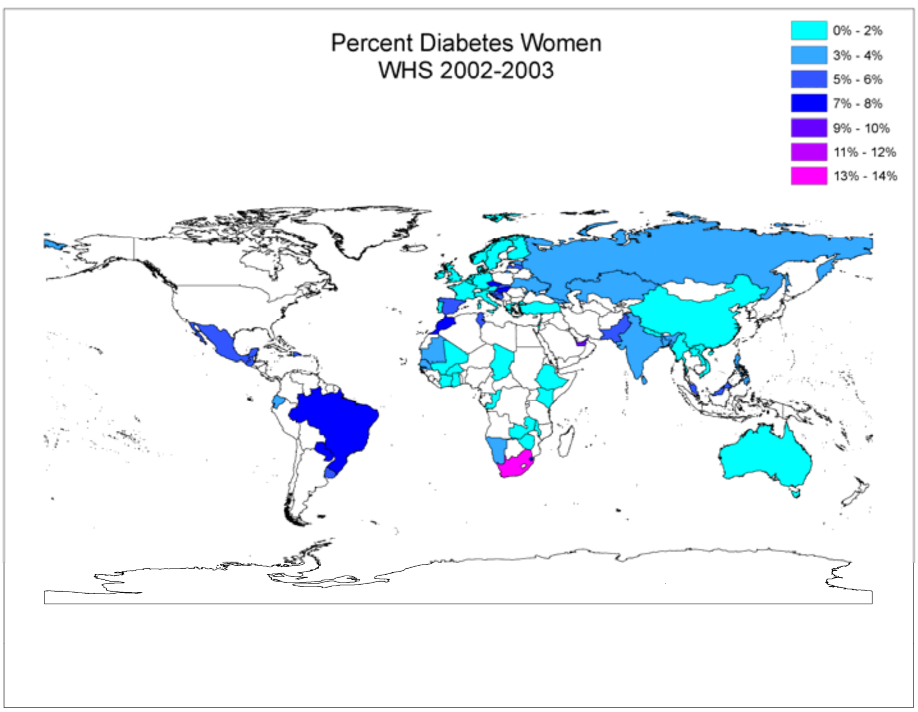
*Model 1 is adjusted for age. Model 2 is also adjusted for individual-level wealth and education.

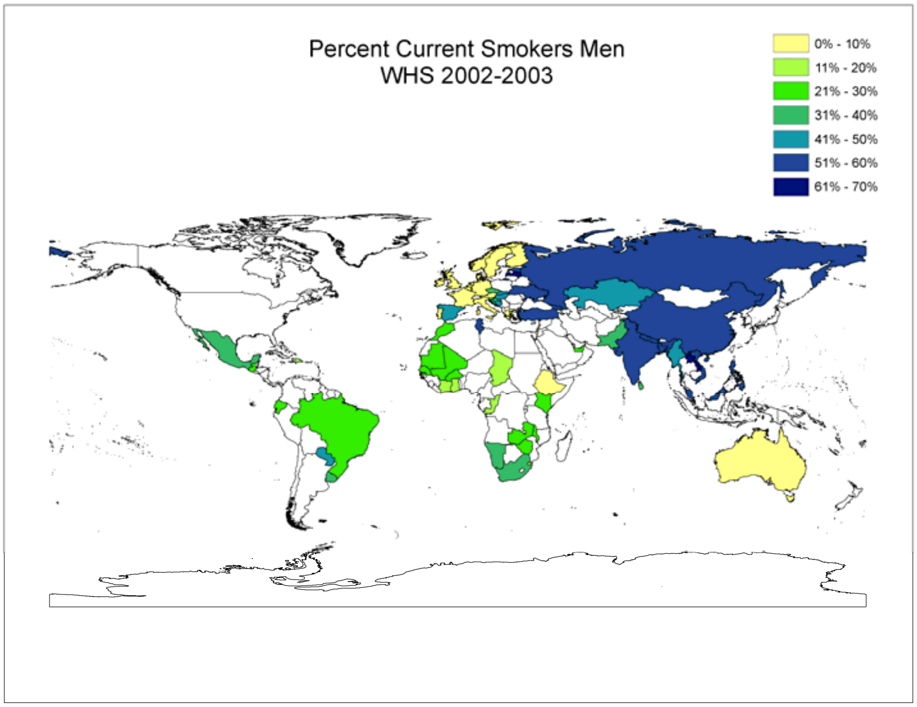
Figure 2.1 Maps of prevalence data for obesity, diabetes and current smoking, by gender, World Health Surveys 2002-2003






Percent Diabetes Men
WHS 2002-2003
0% - 2%
3% - 4%
5% - 6%
7% - 8%
9% - 10%
11% - 12%
13% - 14%


Percent Diabetes Women
WHS 2002-2003
0% - 2%
3% - 4%
5% - 6%
7% - 8%
9% - 10%
11% - 12%
13% - 14%


Percent Current Smokers Men
WHS 2002-2003
0% - 10%
11% - 20%
21% - 30%
31% - 40%
41% - 50%
51% - 60%
61% - 70%

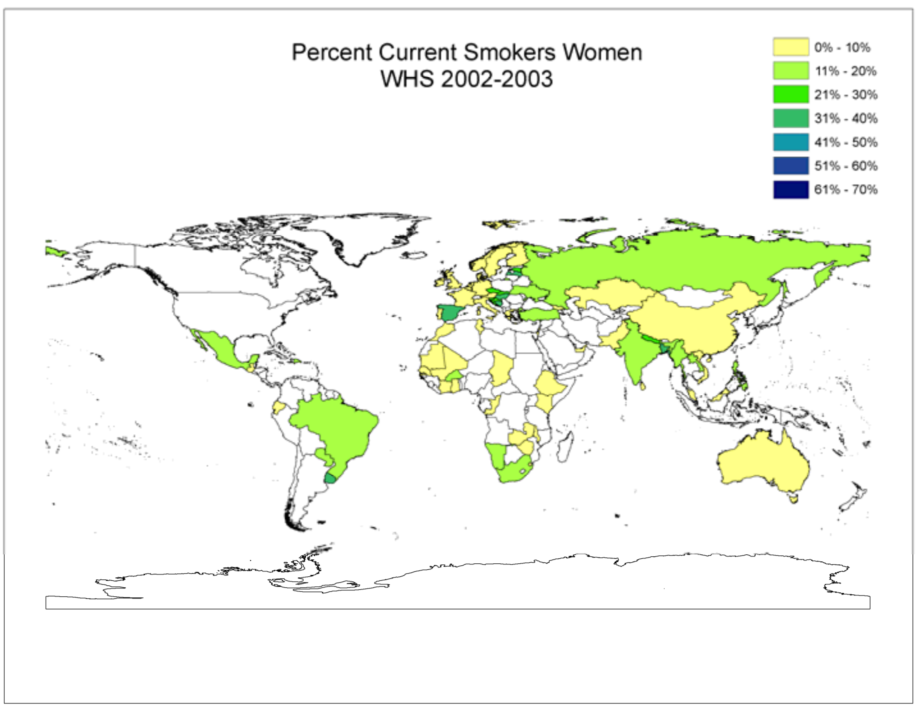
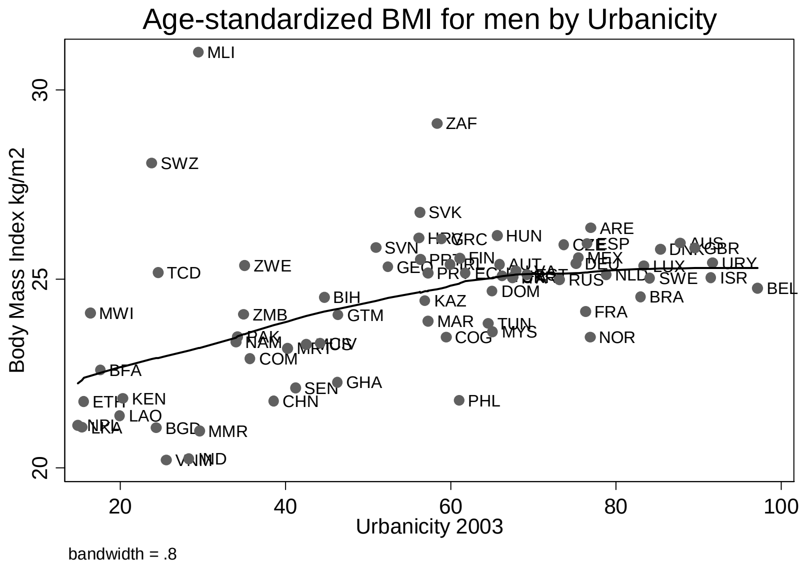
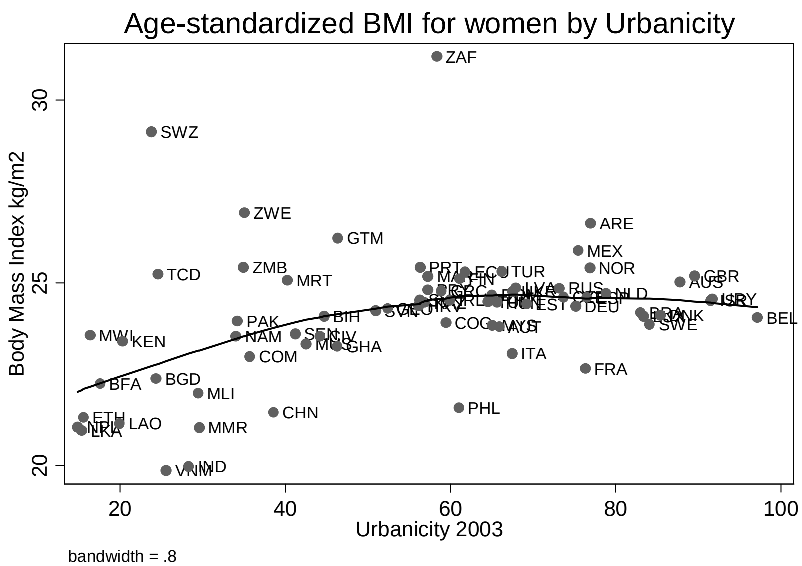
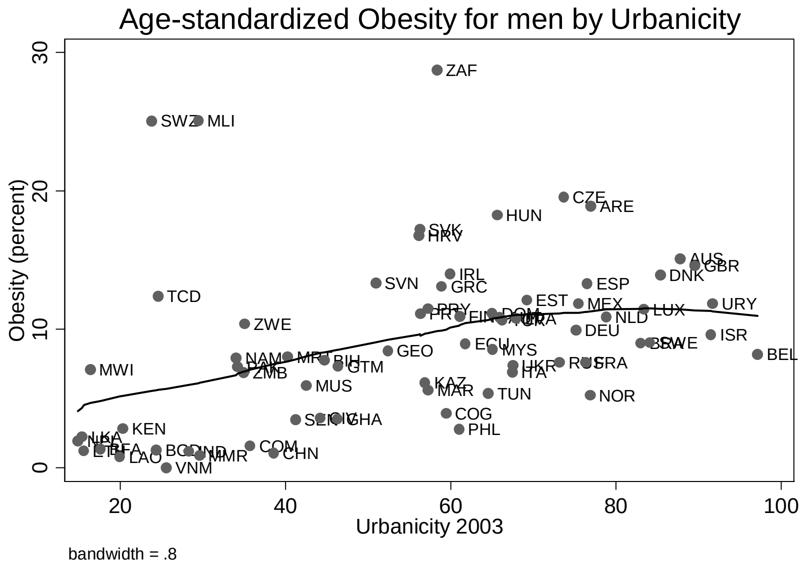
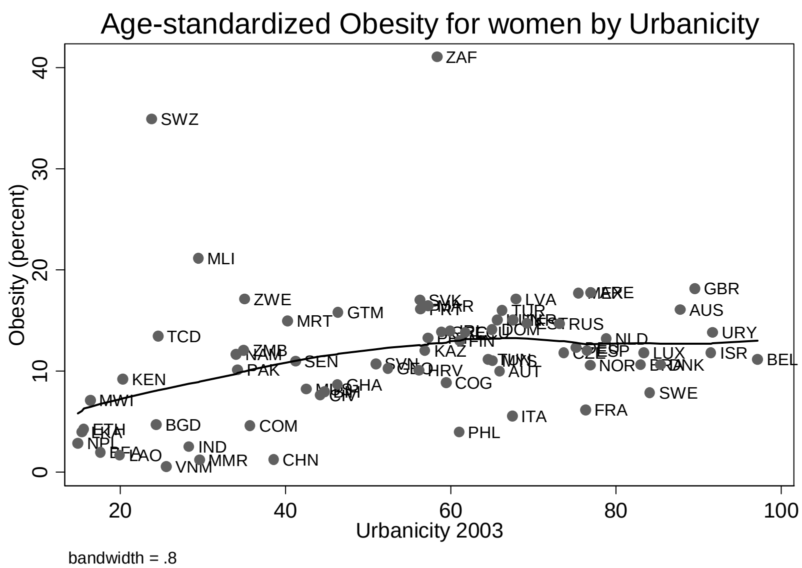

Percent Current Smokers Women
WHS 2002-2003
0% - 10%
11% - 20%
21% - 30%
31% - 40%
41% - 50%
51% - 60%
61% - 70%

Figure 2.2 Lowess smooths for relationship between urbanicity and BMI, obesity, diabetes and current smoking, by gender, World Health Surveys 2002-2003

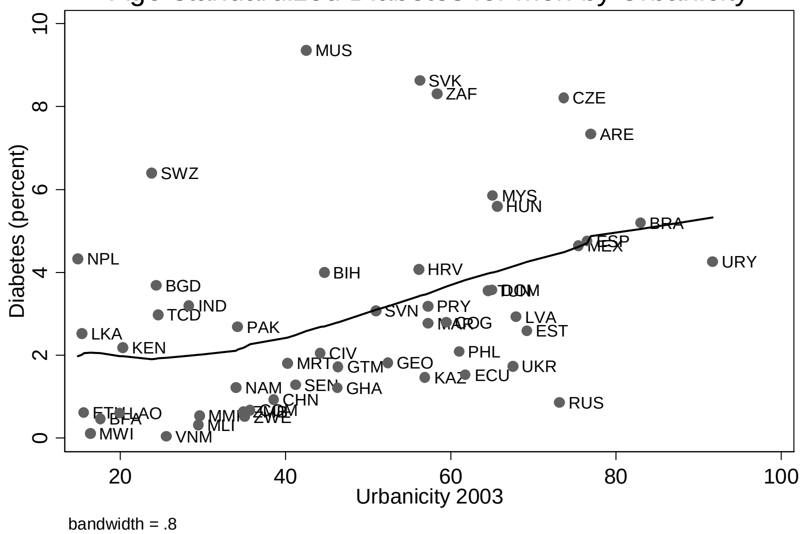




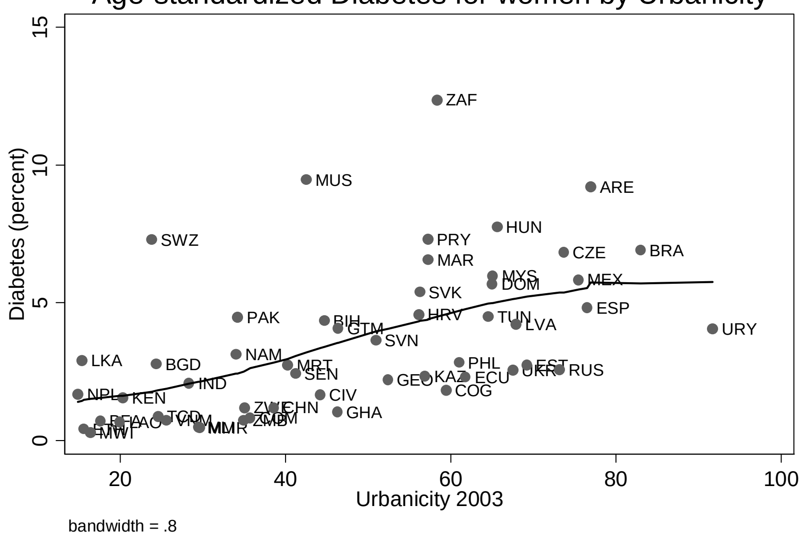

Age-standardized Obesity for men by Urbanicity
Obesity (percent)
0
10
20
30
20
40
60
80
100
Urbanicity 2003
ZAF
SWZ
MLI
CZE
ARE
HUN
SVK
HRV
AUS
GBR
DNK
IRL
GRC
SVN
ESP
TCD
EST
MEX
URY
LUX
NLD
ZWE
DEU
ISR
BEL
ECU
MYS
GEO
MWI
GTM
KAZ
MAR
TUN
NOR
MUS
COG
GHA
PHL
KEN
COM
CHN
LAO
VNM
MMR
bandwidth = .8


Age-standardized Obesity for women by Urbanicity
Obesity (percent)
0
10
20
30
40
20
40
60
80
100
Urbanicity 2003
ZAF
SWZ
MLI
GBR
AUS
ZWE
LVA
GTM
MRT
TUR
RUS
URY
TCD
NLD
ISR
BEL
KAZ
LUX
SEN
PAK
HRV
AUT
NOR
DNK
KEN
COG
GHA
SWE
MWI
FRA
ITA
BGD
COM
PHL
IND
LAO
VNM
MMR
CHN
bandwidth = .8

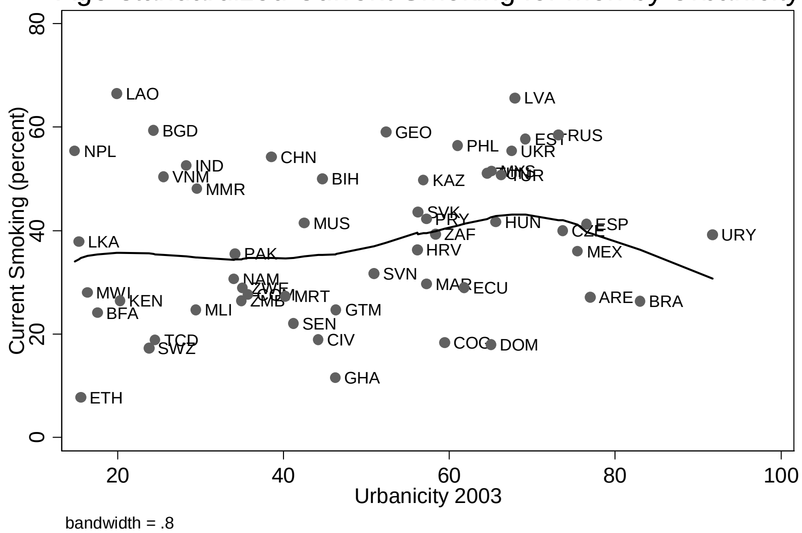
Age-standardized Diabetes for men by Urbanicity



Age-standardized Diabetes for women by Urbanicity



Age-standardized Current Smoking for men by Urbanicity



Age-standardized Current Smoking for women by Urbanicity

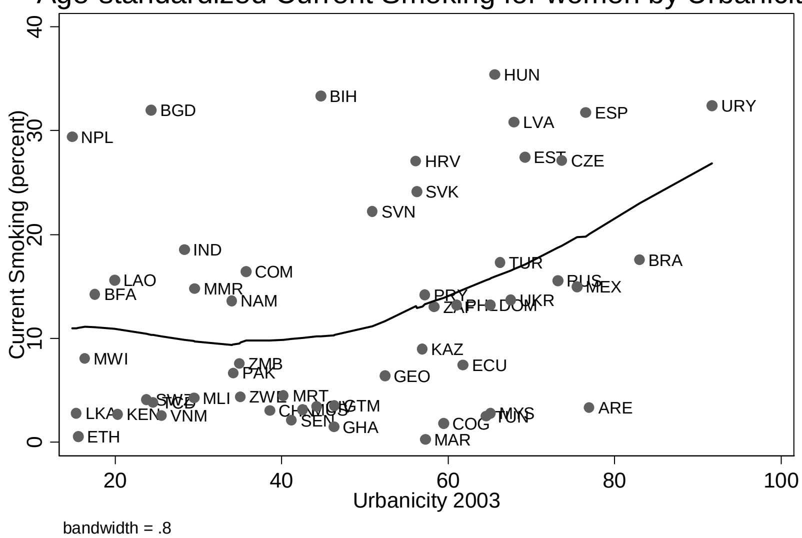
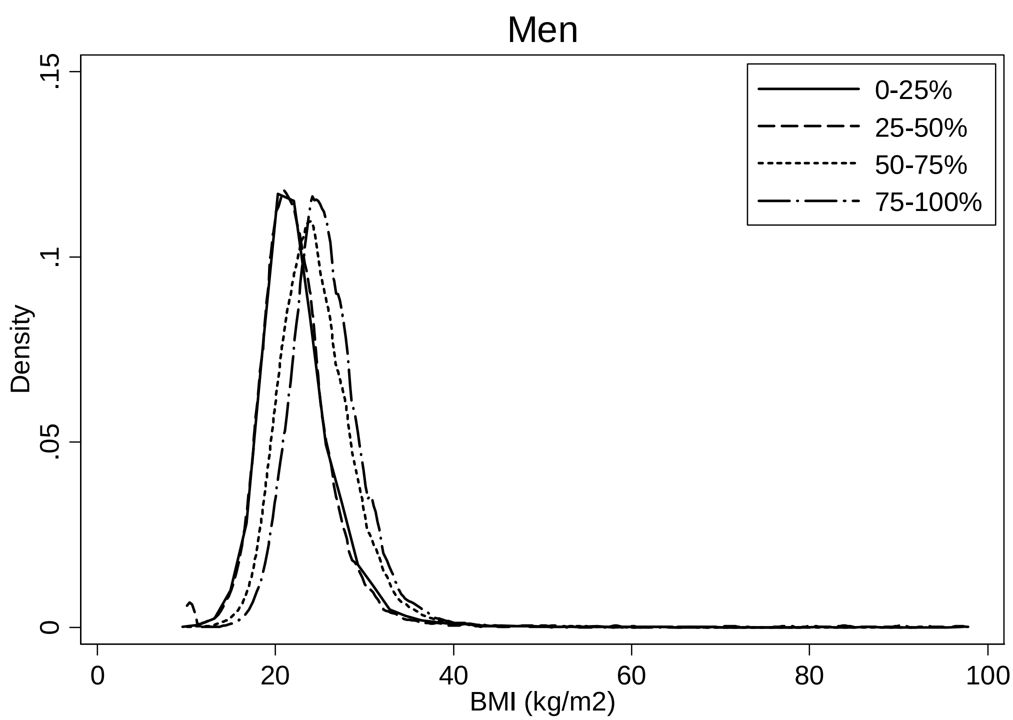
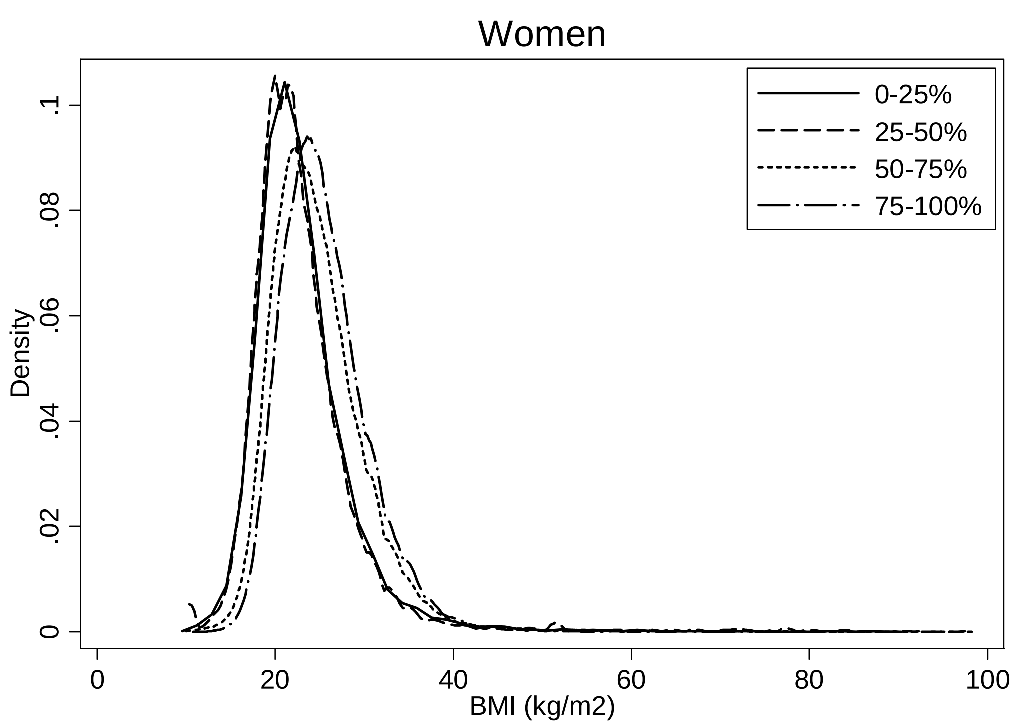


Figure 2.3 BMI population curves by four levels of urbanicity, World Health Surveys 2002-2003





Chapter 3 : Inequalities in BMI and smoking behavior in the World Health Surveys – evidence for a social transition in chronic disease risk

Introduction

Globally, chronic diseases are the primary cause of mortality, and the burden is projected to increase, especially in developing countries (2). Classic epidemiologic transition theory states that chronic diseases are the result of countries achieving a certain level of development whereby infectious diseases no longer predominate as a cause of morbidity and mortality (13). However, multiple forces are impacting and complicating the epidemiologic transition. Many low- and middle-income countries are faced with a double burden of infectious and chronic diseases (30). A number of processes are increasing the chronic disease burden globally. The global population is quickly ageing, and this is happening at a much faster pace in poor countries (31). In addition, a nutrition transition toward increased consumption of processed foods and higher intake of salt, sugar, and fat (37), and a physical activity transition toward more sedentary work and leisure activities (38) are impacting even the poorest countries. Due to these changes, the increasing chronic disease burden in low- and middle-income countries is outpacing past transitions in high-income countries (31). Health services in low- and middle-income countries, though, are still focused on infectious diseases and other acute care, and are ill-equipped to deal with chronic disease management (1).

In conjunction with the epidemiologic, demographic aging, nutrition, and physical activity transitions, a social transition of chronic disease risk is also occurring.

Historically within the U.S. and other high-income countries, chronic disease was once associated with affluence. Studies assessing social gradients in chronic disease risk between generations (41), and reviews of work over time (42), show a transition among men from a higher burden among those of higher socioeconomic position for past cohorts to a higher burden among those of lower socioeconomic position (SEP) for more recent cohorts. Researchers expect a reversal in the social gradient in poor countries to mirror what happened in high-income countries, such that the poor in all places will eventually bear the major burden of chronic disease. This social transition occurs because those of high SEP, who were early adopters of poor health behaviors, recognize more rapidly that their lifestyles are not conducive to a healthy life, and have the resources to change their behaviors and potentially their environments (10, 12).

The processes of globalization and urbanization are hastening the chronic disease epidemic, and are likely to affect the social transition as well. The globalization of food and tobacco processing and marketing has made these health-harming products more available, even in poor countries (48, 49, 50). Likewise, as the world quickly urbanizes, with, once again, most of the growth in low- and middle-income countries (7), residents around the globe have increased access to processed foods and tobacco products (39, 44). The nutrition and physical activity transitions, for instance, initially occur in more urban areas and are filtered down to rural areas over time (39, 40). It is likely that the social transition will also occur in urban areas followed by rural areas.

Even as low- and middle-income countries are experiencing an increased burden of chronic disease, most of the work on the socioeconomic patterning of chronic disease risk is in high-income countries. Despite a recent global focus on the social determinants of health (132), few studies have examined socioeconomic gradients in chronic disease risk within poor countries or between countries at different levels of development. This paper uses data from the WHO World Health Surveys (WHS). Using meta-analytic techniques, we investigated the heterogeneity in the socioeconomic patterning of two major risk factors of the global chronic disease epidemic – body mass index (BMI) and current smoking behavior – for the 70 countries that participated in the 2002-2003 WHS. We also examined whether country-specific cross-sectional associations of SEP with BMI and smoking were modified by country-level urbanicity. The hypothesis is that the socioeconomic patterning of BMI and smoking will differ according to the level of urbanicity within a country. Within the most urban countries, socioeconomic position (SEP) will be inversely associated with chronic disease risk factor prevalence; within countries with middle levels of urbanicity there will be no distinct socioeconomic patterning; within the least urban countries, SEP will be positively associated with chronic disease risk factor prevalence. We expect some variation according to gender and risk factor.

Methods

Data Sources

The main data source for this study is the World Health Organization World Health Surveys, which were conducted in 70 countries from 2002-2003. The purpose of WHS was to provide reliable, comparable information to policy-makers and to monitor health systems (80). Countries participating in WHS were required to use a probability sample, with either a single stage random sample or multiple stage cluster sample design; the sampling frame was intended to cover 100% of the eligible population in each country (i.e. all adults 18 years and older) (81). The target sample size for each country was between 1,000 and 10,000 (80) although it varied considerably across countries; these analyses are based on the 70 countries with information on relevant questions with sample sizes ranging from 585 (Slovenia) to 38610 (Mexico). A total of 273,585 participants were used in this analysis.

WHS employed several versions of the questionnaire depending on the relative wealth of the countries, so not all of the data was available in all countries. The questionnaires were standardized, and included household questionnaires for both low-income and high-income countries, as well as individual questionnaires. Surveys were conducted in person or over the phone, depending on the country.

We investigated two markers of chronic disease risk. BMI (measured in kg/m^2) was calculated from self-reported height and weight. Participants were classified as current smokers if they answered yes to the question “Do you currently smoke any tobacco products such as cigarettes, cigars, or pipes?” While BMI was available for all 70 countries, smoking status was only available for 53 countries. The 17 countries that did not have information on smoking status were all high-income countries with urbanicity levels ranging from 56% to 90%. BMI, although available in all 70 countries, had a high degree (>25%) of missingness in 18 countries. These countries were mostly low- and lower middle-income countries, with urbanicity ranging from 15% to 75%.

A measure of wealth was generated for each individual in each country using the same methodology across countries. The country-specific wealth measures were created by constructing a variable for each person, by country, that combined information on a number of predictors including asset ownership (e.g. bicycle, refrigerator), availability of services (e.g. electricity), housing characteristics (e.g. water source), and demographic information on the head of household (i.e. age, sex, education level). Thirteen assets were common to all countries, while high-income countries had 10 additional assets and low-income countries had 11 additional assets plus five extra country-specific assets. A random effects probit model approach was used to predict wealth for each person in each country. Initial wealth estimates were based on sociodemographic variables, and then adjusted in a second step based on the household assets, services, and housing characteristics. The random effect captured the systematic variation across households not explained by the sociodemographic predictors. The predicted wealth variable was categorized based on deciles in each country (84).

Education was defined as the total number of years of formal education completed. When data were available for level of education completed (i.e. no formal schooling, less than primary school, primary school completed, secondary school completed, high school (or equivalent) completed, college/pre-university/university completed, post graduate degree completed) but not the number of years, years of formal education completed was imputed using the mode of the years per category of education level by country. This information was available for all countries. Education was then modeled in units of standard deviation (SD).

Country-level urbanicity was defined as the percentage of the 2003 midyear population that lived in urban areas in each country as reported to the United Nations (83). The definition of urban areas was defined by each country individually. Countries were then categorized as 0-25%, 25-50%, 50-75%, and 75-100% urban for analyses.

Statistical Methods

Mean and SD for age and years of education, and mean BMI and prevalence of smoking with standard errors (SE) were calculated, by gender, for each risk factor using survey methods to take into account the complex survey design (including weights, sampling units, and strata) in each country as available. When SEs could not be calculated using the survey commands in Stata, due to insufficient numbers of sampling units in some of the strata for gender-stratified analyses, bootstrap procedures were used to obtain the standard errors using R software.

Ordinary least squares and logistic regression models were run, by country, to determine the relationship between BMI or current smoking, respectively, and SEP. All analyses were conducted separately for the two markers of socioeconomic position: wealth in deciles and education per SD. Each model was adjusted for age and stratified by gender. The complex survey design was again taken into account for all countries with information on weights, sampling units, and strata. Meta-analytic techniques were then used to assess the heterogeneity between countries in the relationships between BMI or smoking and SEP. Since substantial heterogeneity was present, forest plots were created using the random effects method to determine the overall estimate (133), although that combined estimate is of limited importance in this analysis. A test for homogeneity and the Der Simonian and Laird estimate of between-study (in this case, between countries) variance were calculated for each meta-analysis. Meta-regression was then conducted, by gender, using categories of urbanicity as the covariate in order to determine if the observed heterogeneity in each of the SEP-BMI and SEP-smoking estimates could be explained by this country-level factor. *P* values for trends were calculated using the continuous percent urban rather than the categories for maximum power. Percent decrease in the between-study variance was calculated to determine how much of the between-study variance was explained by urbanicity in the meta-regression. All analyses were conducted in Stata, except when standard errors of the SEP-BMI or SEP-smoking estimates were not available in some countries due stratification by gender, in which case the program R was used to obtain a bootstrap estimate of the standard error. Sensitivity analyses were conducted excluding countries with a high amount of missingness for BMI (<75% reporting) for the meta-analysis and meta-regression models.

Results

Table 3.1 lists all countries that participated in WHS, in order of ascending percentage of the population living in urban areas, and includes percent urban and country income classification for each country, the percent male and age structure of the sample, and education, BMI, and smoking information by gender. The unweighted percent of men in each country's sample ranged from 33% (Netherlands, Latvia) to 57% (Cote d'Ivoire, Mali). In general, countries that are less urban and have a lower country income classification have a younger population structure and lower education levels than those that are more urban and have a higher level of country income classification. Mean age ranged from 33 years (Kenya) to 51 years (Denmark, Greece, Russian Federation). Education levels were generally higher for men than women, except in a few, mostly higher income countries (Denmark, Dominican Republic, Estonia, Finland, Ireland, Latvia, Norway, Philippines, Sweden, Uruguay). Mean education was lowest in Burkina Faso for men and women (1.7 and 0.8 years, respectively) and highest in Belgium for both genders (14.1 years for men and 13.5 years for women).

Mean BMI was lowest in Viet Nam for both men and women (20.3 and 19.8 kg/m^2, respectively). Mali had the highest BMI among men (32.7 kg/m^2), whereas South Africa had the highest BMI among women (30.9 kg/m^2). The lowest prevalence of current smoking was in Ethiopia for men (7.3%) and Morocco for women (0.3%). Current smoking prevalence was highest in Lao People's Democratic Republic for men (66.2%) and Bosnia and Herzegovina for women (34.2%). Several countries, mostly in Eastern Europe and the Eastern Mediterranean Region, had a large difference in prevalence between men and women; Georgia had the largest difference (60.3% for men and 6.2% for women).

Figures 3.1 and 3.2 display the forest plots from the meta-analysis of differences in mean BMI per country-specific decile of wealth for men and women, respectively. Countries were sorted from the top down in ascending order of percent urban. Men generally showed a positive association between wealth and BMI, such that men with more wealth had a higher BMI. This relationship was strongest in the least urban countries; in countries with the highest urbanicity, there was a null association between wealth and BMI. Women in the least urban countries again showed a positive relationship between wealth and BMI, but this relationship transitioned to an inverse relationship with increasing urbanicity, such that at the highest levels of urbanicity women with higher wealth had a lower mean BMI. Figures 3.3 and 3.4 show the forest plots of the mean differences in BMI per SD increase in education for men and women, respectively. In men the relationship between education and BMI was analogous to that observed for wealth, except that at the highest levels of urbanicity there wan an inverse association between education and BMI rather than the null relationship seen with wealth. Major exceptions to this trend were Mexico and Brazil, two countries with high urbanicity in which men with higher education had higher mean BMI; a similar pattern was observed for wealth in these two countries. Women again followed a social transition from a positive relationship between education and BMI to an inverse relationship with education and BMI with increasing urbanicity as they did with wealth. Only Mexico showed an important difference depending on the SEP marker: women with higher wealth had higher BMI, but women with higher education had lower BMI.

Figures 3.5 and 3.6 show the forest plots of odds ratios of current versus not current smoking associated with a one decile increase in wealth for men and women, respectively. Again, countries were sorted in order of increasing urbanicity from top to bottom. Regardless of urbanicity, men generally had an inverse association between wealth and smoking, such that those with higher wealth had a lower odds of current smoking. Exceptions to this trend were Mauritania, Georgia and Mexico, which all had statistically significant positive associations between wealth and smoking. For women, the results were more mixed. In the least urban countries, with the exception of Chad, women with higher wealth had a lower odds of current smoking. Countries with around 50% of their population living in urban areas had more positive associations between wealth and smoking, whereas the most urban countries were split between positive and negative associations. Turkey, Ukraine, Mexico, Spain and the United Arab Emirates had more positive associations, while other Eastern European (e.g. Latvia) and Latin American countries (e.g. Brazil) had negative associations. Figures 3.7 and 3.8 show the relationship between education and smoking for men and women, respectively. Trends were again similar to those observed for wealth. Overall, men with higher education had a lower odds of current smoking. The same countries that tended toward positive associations in the wealth analyses did so in the education analyses, but none were statistically significant. Women with higher education had a lower odds of current smoking at low levels of urbanicity, as they did with wealth. Again, this relationship trended towards more positive associations starting just below 50% urban.

Tests for homogeneity for the eight meta-analyses are shown in Table 3.2. For all analyses, the test for homogeneity had a p-value <0.20, the traditional cutoff, leading one to reject the null hypothesis that there is no heterogeneity in the associations between the countries. The between-country variance was greater for women than men in each analysis. It ranged from 0.005 to 0.081 for men, and from 0.016 to 0.246 for women. Since heterogeneity was present in all of the meta-analyses, we also ran meta-regressions for each relationship to determine whether the heterogeneity could be explained by the country-level factor of urbanicity (Table 3.3). The regression coefficients shown in Table 3.3 represent the estimated change in the mean difference (BMI) or log odds ratio (smoking) associated with a unit increase in SEP indicator for different categories of urbanicity, with the least urban category (0-25%) as the reference category. In both men and women the mean difference in BMI associated with a unit increase in wealth or education became less positive or more strongly negative with increasing urbanicity. The trends were stronger for women than men, and urbanicity explained a substantial (27-48%) proportion of the between-country variance in the SEP regression coefficients in women but did not explain any of the variance in men. In men there was no association between country-level urbanicity and differences in the relationship between SEP and smoking. In contrast, women showed a trend by which the association of wealth or education with the log odds of smoking became less negative or more positive as urbanicity increased. Urbanicity explained a substantial proportion of the variance of the country-specific regression estimates in women (33-43%), but explained little or none of the variance in men.

Discussion

Overall, these analyses show that the socioeconomic patterning of BMI and smoking varies greatly by country-level urbanicity. In less urban countries, women display a positive socioeconomic gradient with BMI, such that those of high SEP have a higher BMI than those with low SEP. There is evidence for a social transition with increasing urbanicity such that women in the most urban countries have an inverse relationship where women of high SEP have a lower BMI than those of low SEP. Men show a similar trend with BMI, except that they convert to a null relationship between wealth and BMI in countries at high levels of urbanicity. For smoking, men with higher SEP have a lower odds of smoking regardless of country-level urbanicity. The pattern for women's smoking behavior is less straightforward. In the least urban countries, they have an inverse socioeconomic gradient. This relationship is attenuated with increasing urbanicity, with some countries drifting toward a positive gradient, especially for those with about half of their populations living in urban areas. Taken as a whole, countries seem to be transitioning to a concentration of worse BMI among those of lower SEP with increasing urbanicity, especially for women. It appears that globally, smoking is already concentrated among those of lower SEP, especially for men. In women, however, greater urbanicity is associated with greater smoking in the higher SEP groups.

The striking evidence for a social transition of BMI globally is consistent with two recent reviews of socioeconomic status and obesity. The first, a review of literature from developing countries only, found that women showed a transition from positive associations to negative associations from low-income to lower middle- and upper middle-income countries. Men, on the other hand, transitioned from more positive associations to more null associations with increasing level of development (65). The second review, a comprehensive review of literature from countries at all levels of development, found that the patterns of the associations varied by gender and depended on level of development of the country. The general trend was from more positive associations (i.e. those of higher SEP had higher levels of obesity) to more negative associations (i.e. those of lower SEP had higher levels of obesity) for women but more null associations for men, when shifting from countries with a low Human Development Index (HDI) to middle- and high-HDI countries (57).

The poorest, least urban countries (mainly in Asia and the Pacific, and sub-Saharan Africa) are also those countries that have the most problems with food security, where calories are more scarce and food intake among many parts of the population do not meet the minimum dietary energy requirement (134). The wealthier and more educated in these countries may be more likely to have access to sufficient calories, which could help explain the positive socioeconomic gradients for BMI for both genders in the least urban countries. The social transition toward inverse socioeconomic gradients can be interpreted within the light of globalization. Calories are becoming increasingly more plentiful and cheaper on a global scale, but they are also less nutritious, with more fat and sugar (37). The availability of many of these products, and the associated physical and nutrition transitions, occur in urban areas first (39, 40). This phenomenon is fueling the global obesity epidemic. However, it is also impacting the socioeconomic gradient of BMI and obesity in countries, and areas within countries, that have access to these products. Diets rich in energy-dense foods (high in fats and sugars) are inexpensive in many middle- and high-income countries, and are consumed by people of lower socioeconomic status (135). This is due to a number of factors, including a lack of access to healthy food outlets in poorer neighborhoods (136, 137).

The gender differences we found in the socioeconomic gradients for women and men were also consistent with the recent global review of socioeconomic status and obesity: while women in the highest urbanicity countries had an inverse gradient regardless of SEP marker, men had a null association between BMI and wealth, but more inverse relationships between BMI and education. That women have stronger and more consistently inverse associations at the highest levels of urbanicity is potentially related to gender roles regarding body image. In societies of high-income countries, repeated studies have found that men are generally more satisfied with their body size than women, who consider smaller body sizes to be more desirable (138). There is also evidence that women of higher socioeconomic status may be particularly sensitive to body image (139). This could lead toward an increased attention to diet and physical activity for women of higher SEP in the more urban and developed countries, which contributes to the inverse socioeconomic gradients that are nearly ubiquitous for women in countries at the highest level of urbanicity in our study, particularly when using education as the marker of SEP. Another possible source of gender differences is discrimination based on weight. Research has shown bias in educational achievement and employment settings (140), and so there may be selection into lower SEP for heavier people due to fewer opportunities to advance. This pattern, and subsequent downward social mobility, appears to be particularly prominent for women (141). These cultural norms, mainly associated with Western societies, are likely transmitted through the processes of globalization, contributing to the reversal of socioeconomic gradients for women as countries become more urbanized and exposed to these norms.

The tobacco epidemic is a more mature epidemic globally in comparison to obesity, and has been described in terms of four stages (130, 142). In the first stage, smoking prevalence is low and concentrated mostly among men, and there is no real increase in smoking-related disease. The second stage is characterized by smoking prevalence of men reaching above 50%, an increase in smoking prevalence for women, and higher smoking-related disease rates among men. In stage three, the smoking prevalence among men begins to decrease, although the deaths attributable to smoking continue to increase; prevalence of smoking and smoking-related diseases increase among women. The fourth stage is characterized by decreases in smoking prevalence for men and women, and in smoking-related diseases for men, but smoking-related death rates continue to increase in women. Many countries in sub-Saharan Africa, which have yet to participate fully in the global tobacco economy, are considered to be in the first stage. Asian, Latin American and North African countries are in the second stage, when tobacco control is not fully realized. Eastern and Southern Europe are in the third stage, and Northern and Western Europe, the U.S., Australia and Canada are in the fourth stage. Along with the stages, one could consider a social transition as well. Since men have been smoking longer globally, the social transition from a concentration of smoking among those of higher social class to those of lower social class could have occurred earlier in men than women. Since women have not been smoking as long, due in part to previous restrictions on the behavior of women in many parts of the world, their participation in the social transition may be delayed, with a different pattern depending on the cultural liberalization of treatment of women. This is likely reinforced by inequalities for women in the distribution of economic resources in the various countries, with women of higher social status likely having differential access to funds to buy tobacco products.

Our analyses on tobacco use also showed evidence for a social transition, and gender differences therein. Men, who were the earliest and are still the heaviest smokers, show a predominance of smoking among those of lower SEP globally, regardless of country-level factors or SEP marker. However, there is some heterogeneity in the socioeconomic patterning of smoking among men. Even though most countries showed strong inverse associations between SEP and smoking, several countries in sub-Saharan Africa (as well as some in Eastern Europe and Latin America) have null or positive associations, representing a lag in their social transition likely related to their presence in the earlier stages of the tobacco epidemic.

Women, who have only recently begun to smoke en masse, have a wider range of relationships between SEP and tobacco use. In countries with around 50% urban populations, women had mostly no socioeconomic gradient of smoking. At higher levels of urbanicity, however, there was more heterogeneity, with positive, null and inverse relationships, depending on the country. These results make sense in the context of the social transition of tobacco use. Whereas men in more urban countries showed a clear inverse socioeconomic gradient with smoking, women showed more null results overall and much more heterogeneity, perhaps representing a lag in the social transition. There are many potential reasons for this. Women's prevalence of smoking increases with country-level urbanicity, as shown in Chapter 2. This is likely related to increased liberalization of women's behavior in general. Women's tobacco use in many middle-income countries may represent a signal of autonomy and equality with men, just as it did a generation ago in the U.S. and other Western countries (51, 52, 143). It is also affected by more intense marketing of women by the tobacco industry and advertising that suggests smoking as a method of weight control, among other messages (144). More prevalent smoking behavior, in turn, likely affects the social gradient. In countries where women's smoking was previously seen as socially aberrant, but is now more widely accepted, women from all social classes are likely to smoke. As health messages and tobacco control policies emerge, the social transition will likely take full effect for women as well, such that smoking becomes concentrated among the lower social classes, just as it has with men globally and with women in many high-income countries (145, 146) (few of which are represented in these analyses). Age differences in socioeconomic gradients in smoking among women, historically in high-income countries and currently in middle-income countries (145, 146), also support evidence of the social transition; older cohorts show more positive and null associations between SEP and smoking while younger cohorts show more inverse socioeconomic gradients.

An interesting finding is the presence of an inverse socioeconomic gradient among women in the least urban countries such that those of lower SEP had higher odds of smoking. This result was not expected given the context of the stages of the tobacco epidemic and the stages of the social transition for men overall and for women in the more urban countries. There are several possible explanations for this. It is possible that women in the least urban countries are smoking more traditional forms of tobacco, which may be more common among those of lower SEP (147, 148, 149). Another possibility is that some of the countries have a longer history of tobacco industry influence, and now see a concentration of those addicted to tobacco among the poor, who in turn stay poor due to the expense of tobacco use (150). A third possibility is that, in some countries, smuggling (often sanctioned by the tobacco industry) contributes to control over the market and pricing of tobacco (151), which can lead to cheaper tobacco products more accessible to those of lower SEP.

This study has a number of limitations. Our analyses were limited to the countries that participated in WHS. Although the countries represented all regions of the world, and covered a large spectrum in terms of urbanicity and development, the analyses may not completely capture the full range of patterns seen globally. This may be particularly true of our tobacco results, since few of the high-income countries included the tobacco questions into their surveys. For instance, since many of the higher-urbanicity countries were middle-income countries, this might explain why we do not see overall inverse socioeconomic gradients for women with smoking. Middle-income countries, with poorer tobacco control policies and less time participating in the global marketplace, are likely to lag in the social transition of tobacco use. If more high-income countries had included the tobacco questions in their surveys, we may have seen a completed social transition for smoking among women at higher urbanicity. In addition, we studied the heterogeneity in the social patterning of BMI and smoking by country-level urbanicity only. While urbanicity has been shown to be associated with the nutrition and physical activity transitions and changing population structures, especially in low- and middle-income countries, other country-level factors may also play a large role, including cultural norms or economic development. However, percent urban and gross national index (GNI) per capita, at least, were highly correlated in this sample (Spearman correlation = 0.83), and it may be difficult to tease apart the impact of urbanization and development in this context. Another limitation is that all data were self-reported. Self-reported height and weight, in particular, could be subject to measurement error, which may be differential according to SEP and country-level urbanicity. For instance, in the least urban countries, those of lowest SEP may not know their height and weight. In fact, we had high levels of missingness for BMI in some countries. Eighteen of the 70 countries had less than 75% reporting for BMI. In order to investigate this missingness, we compared the age, gender, education, and wealth levels of those with and without data for BMI in each country. Most of the countries with high levels of missing data were low- or lower middle-income countries, and the majority (10/18) had populations with less than 50% living in urban areas. In general, those with missing BMI data had lower levels of wealth and education, were older, and had a greater proportion of female participants compared to those with BMI data. Since the analyses were gender-stratified and age-adjusted, the main concern is regarding the differences in SEP. However, in sensitivity analyses excluding the countries that had statistically different mean SEP levels between persons with and without data, the meta-analysis and meta-regression results were qualitatively the same, and the interpretation of the social transition for men and women did not change.

Conclusions

This study demonstrates the complicated picture of the social patterning of two major drivers of chronic disease risk globally – BMI and smoking. The analyses suggest a social transition from a concentration of higher BMI among those more affluent in society to the poorest members of society with increasing country-level urbanicity, especially among women. We also found a clear concentration of smoking among the poorest members of society, regardless of country-level urbanicity for men, and among the least urban countries for women. These results highlight the need to consider health disparities in addition to the increasing population-level burden of chronic diseases, particularly in developing countries, where chronic disease burden are becoming increasingly concentrated among the poor. Public health policy would benefit from additional attention to the social transition of chronic disease risk.

Table 3.1 Country-specific economic development and urbanicity indicators, education, and age-standardized mean BMI and prevalence of current smoking by gender, World Health Surveys 2002-2003

Country	Urbanicity 2003 (83)	Country income classification 2003 (131)	Percent Male (not weighted)	Age Mean (SD)	Education in years Mean (SD)			BMI (kg/m^2) Mean (SD)			Current Smoking Prevalence (SE)		
					N	Men	Women	N	Men	Women	N	Men	Women
Nepal	14.84	low	42.6	37.0 (15.3)	8686	5.4 (4.4)	2.3 (4.2)	3189	21.11 (3.29)	20.98 (4.25)	8681	54.07 (1.21)	27.84 (0.95)
Sri Lanka	15.34	lower middle	46.6	40.5 (16.1)	6698	9.1 (3.6)	9.1 (4.4)	5709	21.17 (3.75)	21.06 (5.34)	6589	39.74 (1.50)	2.84 (0.53)
Ethiopia	15.56	low	48.4	35.5 (15.0)	4934	4.4 (4.6)	2.4 (4.0)	972	21.41 (2.73)	21.48 (3.86)	4921	7.29 (0.95)	0.56 (0.18)
Malawi	16.36	low	41.7	35.8 (15.5)	5297	6.2 (4.0)	4.3 (4.5)	5207	24.10 (4.95)	23.46 (4.90)	5271	25.62 (1.29)	6.10 (0.78)
Burkina Faso	17.58	low	47.1	34.6 (14.9)	4821	1.7 (3.8)	0.8 (2.7)	1729	22.64 (2.74)	22.46 (2.99)	4809	24.25 (1.63)	11.38 (1.59)
Lao People's Democratic Republic	19.92	low	46.9	36.8 (15.2)	4887	5.2 (4.1)	3.5 (3.9)	4874	21.42 (2.70)	21.19 (3.37)	4883	66.20 (1.38)	15.57 (1.40)
Kenya	20.30	low	42.3	33.4 (13.6)	4345	9.6 (3.4)	8.3 (4.5)	4229	21.78 (3.24)	23.35 (4.81)	4337	27.23 (2.40)	1.97 (0.58)
Swaziland	23.78	lower middle	45.9	35.8 (15.8)	3060	7.0 (4.8)	6.5 (4.5)	1857	27.84 (7.51)	28.82 (9.30)	2058	15.12 (1.76)	3.28 (0.77)
Bangladesh	24.34	low	46.5	36.3 (14.6)	5550	5.0 (4.5)	3.4 (4.2)	864	21.10 (3.33)	21.97 (5.21)	5526	59.90 (1.27)	28.36 (1.44)
Chad	24.54	low	47.2	35.8 (14.9)	4635	3.0 (4.5)	1.0 (2.8)	3569	25.15 (7.82)	25.21 (7.86)	4589	18.70 (1.66)	3.60 (0.93)
Viet Nam	25.56	low	45.0	38.4 (16.1)	3491	8.4 (3.5)	7.5 (4.2)	3475	20.25 (2.05)	19.81 (2.52)	3487	51.13 (2.60)	2.51 (0.50)
India	28.30	low	48.5	38.4 (16.0)	9678	6.3 (5.1)	3.1 (4.6)	9132	20.30 (3.30)	20.00 (4.52)	9538	51.61 (2.52)	18.17 (0.97)
Mali	29.46	low	57.2	34.2 (15.2)	4132	2.7 (4.7)	1.6 (3.1)	1067	32.72 (26.94)	22.85 (17.78)	3873	24.86 (1.25)	2.98 (0.47)
Myanmar	29.56	low	43.3	38.4 (15.5)	5886	6.7 (4.0)	6.1 (4.8)	5886	20.99 (2.55)	21.04 (3.26)	5886	48.87 (1.64)	13.75 (1.18)
Namibia	34.02	lower middle	40.6	37.0 (16.0)	4236	7.3 (4.9)	7.1 (5.5)	3794	23.25 (5.24)	23.46 (6.46)	3963	28.45 (1.76)	12.54 (1.09)
Pakistan	34.18	low	55.9	36.6 (15.1)	6103	5.1 (5.5)	2.3 (4.0)	3239	23.58 (0.21)	23.99 (0.30)	6091	33.75 (1.57)	6.34 (0.61)
Zambia	34.92	low	45.2	35.2 (15.5)	3810	7.3 (3.7)	5.5 (4.2)	2289	23.90 (7.87)	25.46 (12.12)	3806	23.64 (1.18)	5.86 (0.69)
Zimbabwe	35.06	low	36.4	35.2 (16.2)	4061	8.9 (3.2)	7.4 (4.5)	2609	25.18 (7.75)	26.93 (12.54)	3992	26.33 (1.49)	3.07 (0.46)
Comoros	35.72	low	44.7	40.7 (17.7)	1758	4.8 (5.1)	2.8 (4.6)	1725	22.87 (3.12)	22.90 (4.11)	1749	27.89 (2.32)	17.32 (1.59)
China	38.56	lower middle	48.9	45.1 (15.9)	3993	7.9 (4.0)	6.8 (4.5)	3984	22.03 (3.23)	21.71 (3.22)	3993	57.50 (1.25)	3.48 (0.57)
Mauritania	40.24	low	38.9	35.8 (14.9)	3705	4.7 (4.8)	2.8 (4.6)	3066	22.99 (5.21)	25.20 (8.08)	3632	29.85 (1.98)	4.74 (0.75)
Senegal	41.20	low	52.0	35.3 (14.0)	2963	4.4 (5.2)	2.6 (4.2)	1567	22.08 (4.22)	23.50 (5.47)	2724	24.18 (1.70)	1.88 (0.45)
Mauritius	42.52	upper middle	48.2	40.6 (15.8)	3888	9.1 (3.8)	8.0 (4.4)	2520	23.46 (4.68)	23.31 (5.11)	3887	42.68 (1.54)	2.87 (0.53)
Cote d'Ivoire	44.20	low	57.2	34.7 (14.4)	3165	6.7 (5.8)	4.2 (5.2)	2864	23.19 (4.37)	23.50 (5.02)	3121	20.75 (1.36)	3.14 (0.52)

Country	Urbanicity 2003 (83)	Country income classification 2003 (131)	Percent Male (not weighted)	Age Mean (SD)	Education in years Mean (SD)			BMI (kg/m^2) Mean (SD)			Current Smoking Prevalence (SE)		
Bosnia & Herzegovina	44.70	lower middle	42.2	44.0 (16.2)	1028	10.7 (3.2)	8.6 (4.9)	1022	24.99 (3.17)	24.50 (3.95)	1026	54.25 (3.61)	34.19 (5.10)
Ghana	46.28	low	45.1	36.1 (15.1)	3929	7.5 (4.8)	5.3 (5.1)	3680	22.28 (4.46)	23.24 (5.22)	3902	10.01 (0.80)	1.33 (0.32)
Guatemala	46.36	lower middle	38.4	40.0 (16.4)	4768	4.9 (5.3)	4.0 (4.8)	3281	24.24 (5.10)	26.23 (8.23)	4752	24.63 (1.01)	3.55 (0.34)
Slovenia	50.92	high	46.3	47.3 (18.1)	585	11.8 (3.0)	11.3 (3.4)	571	26.16 (3.73)	24.91 (4.41)	585	28.78 (2.76)	19.43 (2.24)
Georgia	52.40	lower middle	42.3	45.2 (17.9)	2749	12.5 (3.0)	12.1 (3.6)	2738	25.46 (3.54)	24.79 (4.59)	2745	60.29 (1.45)	6.20 (1.02)
Croatia	56.14	upper middle	40.5	49.5 (16.7)	990	11.1 (3.3)	10.2 (4.1)	980	26.47 (3.96)	25.64 (4.66)	985	31.61 (2.57)	22.94 (2.12)
Slovakia	56.24	upper middle	38.5	44.3 (17.0)	1795	13.4 (2.9)	12.8 (3.0)	1770	27.08 (4.36)	25.35 (5.25)	1780	41.07 (4.60)	23.17 (2.79)
Portugal	56.32	high	38.0	46.1 (18.3)	1030	7.8 (4.1)	6.7 (5.1)	896	25.76 (3.28)	25.74 (5.34)			
Kazakhstan	56.90	lower middle	34.3	41.4 (15.4)	4496	13.1 (2.5)	12.9 (3.3)	4116	24.74 (3.11)	24.92 (5.29)	4495	52.26 (2.11)	9.62 (0.97)
Paraguay	57.22	lower middle	45.8	37.1 (15.3)	5131	8.1 (4.4)	8.1 (5.1)	4668	25.18 (5.23)	24.64 (6.38)	5113	41.59 (1.28)	13.30 (0.76)
Morocco	57.26	lower middle	41.5	37.7 (15.2)	4472	6.6 (5.8)	3.1 (5.1)	1929	23.43 (0.35)	25.14 (0.31)	4472	32.35 (2.18)	0.34 (0.17)
South Africa	58.34	lower middle	47.4	37.4 (15.2)	2351	8.5 (5.6)	8.4 (5.5)	1585	28.65 (10.68)	30.88 (12.12)	2330	39.35 (2.16)	12.27 (1.09)
Greece	58.92	high	50.0	51.1 (18.7)	1000	10.0 (4.5)	9.4 (4.5)	961	26.56 (3.65)	25.86 (4.80)			
Congo	59.44	low	46.8	35.3 (14.2)	2480	8.2 (5.5)	7.0 (4.8)	2197	23.30 (3.42)	23.80 (4.50)	2174	16.53 (2.14)	1.78 (0.56)
Ireland	59.94	high	45.3	43.5 (18.1)	1006	12.1 (2.9)	12.6 (3.2)	909	25.50 (4.24)	24.91 (5.01)			
Philippines	61.02	lower middle	46.3	37.2 (15.1)	10075	8.6 (3.6)	8.9 (3.8)	8184	21.84 (3.42)	21.59 (4.33)	10070	57.82 (1.11)	12.45 (0.65)
Finland	61.10	high	44.6	48.2 (17.9)	1013	11.9 (3.7)	12.0 (4.1)	1004	26.04 (3.90)	25.62 (4.74)			
Ecuador	61.80	lower middle	44.2	38.3 (16.1)	4605	8.5 (4.3)	8.2 (4.9)	4051	25.22 (6.51)	25.32 (7.78)	4068	28.72 (1.87)	6.93 (0.85)
Tunisia	64.54	lower middle	46.2	38.6 (16.0)	5068	8.9 (5.3)	6.2 (6.1)	4227	23.84 (4.03)	24.38 (4.56)	5050	53.01 (1.42)	2.22 (0.33)
Dominican Republic	65.04	lower middle	46.4	38.5 (15.5)	4533	7.6 (4.8)	7.9 (5.2)	3119	24.82 (4.38)	24.60 (5.42)	4503	17.29 (1.18)	12.55 (1.00)
Malaysia	65.10	upper middle	44.3	38.8 (15.1)	6035	9.2 (3.8)	8.3 (5.0)	5016	23.70 (5.09)	23.86 (7.11)	6003	53.29 (1.22)	2.62 (0.39)
Hungary	65.62	upper middle	41.7	46.5 (18.1)	1419	12.6 (3.4)	11.4 (3.9)	1401	26.57 (4.47)	25.47 (5.38)	1419	42.90 (2.15)	31.40 (1.97)
Austria	65.92	high	37.6	45.1 (16.2)	1055	11.0 (2.7)	10.7 (2.8)	948	25.90 (3.81)	24.30 (4.19)			
Turkey	66.26	lower middle	42.8	38.8 (15.7)	11217	7.7 (3.9)	5.4 (4.5)	8166	25.10 (4.45)	24.99 (6.14)	11193	52.74 (1.09)	18.72 (0.80)
Italy	67.44	high	42.6	48.3 (18.2)	1000	11.9 (4.5)	10.5 (5.1)	958	25.31 (3.33)	23.97 (4.05)			
Ukraine	67.52	lower middle	35.2	46.1 (17.9)	2498	12.2 (2.8)	12.0 (3.9)	1570	25.38 (3.23)	25.78 (5.42)	2488	54.09 (2.27)	10.34 (1.14)
Latvia	67.92	upper middle	33.4	46.5 (18.6)	855	11.5 (2.7)	11.8 (3.7)	734	25.41 (3.16)	25.97 (5.68)	855	64.37 (3.28)	24.15 (2.01)
Estonia	69.22	upper middle	36.3	47.1 (18.0)	1011	11.6 (2.9)	12.1 (3.6)	1000	25.57 (3.65)	25.60 (5.43)	1011	56.66 (2.51)	25.03 (1.42)
Russian Federation	73.16	lower middle	36.0	51.4 (17.9)	4421	12.0 (3.5)	11.5 (3.8)	3503	25.34 (3.66)	26.11 (5.04)	4412	56.74 (2.64)	11.35 (1.19)

Country	Urbanicity 2003 (83)	Country income classification 2003 (131)	Percent Male (not weighted)	Age Mean (SD)	Education in years Mean (SD)			BMI (kg/m^2) Mean (SD)			Current Smoking Prevalence (SE)		
Czech Republic	73.70	upper middle	44.8	45.8 (17.9)	934	12.8 (2.7)	11.9 (2.7)	913	26.51 (0.39)	25.49 (0.37)	929	38.96 (3.84)	25.19 (2.87)
Germany	75.16	high	40.4	50.4 (17.7)	1258	10.9 (3.0)	10.8 (3.1)	1180	26.14 (3.84)	25.26 (5.19)			
Mexico	75.48	upper middle	42.3	38.3 (16.0)	38610	8.0 (4.7)	7.4 (5.2)	23427	25.51 (3.76)	25.85 (5.05)	38610	36.19 (0.65)	15.21 (0.50)
France	76.34	high	40.1	47.4 (18.6)	1000	13.5 (4.1)	12.5 (4.6)	944	24.61 (3.30)	23.36 (4.48)			
Spain	76.54	high	41.2	46.8 (18.4)	6275	10.2 (5.0)	9.5 (5.6)	6077	26.26 (3.37)	25.24 (4.86)	6275	40.45 (1.37)	27.19 (1.08)
Norway	76.88	high	49.6	47.3 (18.2)	971	12.1 (4.2)	12.2 (4.1)	959	23.91 (4.43)	25.58 (3.48)			
United Arab Emirates	76.98	high	52.3	37.6 (11.7)	1179	12.9 (4.2)	10.9 (7.6)	1141	26.79 (4.03)	26.26 (7.82)	1175	32.40 (3.02)	3.08 (0.80)
Netherlands	78.84	high	32.5	43.6 (18.4)	1091	13.6 (3.4)	12.6 (3.5)	1085	24.94 (3.73)	24.98 (4.42)			
Brazil	83.00	lower middle	43.8	39.2 (15.9)	5000	7.2 (4.7)	7.0 (5.0)	4446	24.57 (3.90)	24.22 (4.96)	5000	27.02 (1.14)	18.10 (0.92)
Luxembourg	83.40	high	48.9	46.0 (17.3)	700	12.6 (4.2)	11.4 (3.7)	692	25.81 (4.32)	24.71 (5.21)			
Sweden	84.12	high	41.6	48.8 (18.0)	1000	11.7 (3.1)	12.3 (3.7)	975	25.63 (3.48)	24.47 (4.33)			
Denmark	85.40	high	47.4	50.8 (17.0)	1002	11.6 (4.1)	11.7 (3.9)	974	26.30 (4.16)	24.40 (4.51)			
Australia	87.80	high	41.7	46.5 (16.5)	1754	13.5 (3.6)	12.9 (3.5)	1451	26.33 (4.41)	25.67 (5.54)			
United Kingdom	89.58	high	36.8	50.3 (19.4)	1200	12.0 (3.3)	12.0 (2.9)	1060	26.17 (5.17)	25.68 (5.61)			
Israel	91.52	high	42.9	43.0 (17.8)	1225	13.0 (3.7)	13.0 (4.0)	1182	25.17 (4.30)	24.82 (5.47)			
Uruguay	91.72	upper middle	48.6	45.0 (18.5)	2977	10.0 (4.4)	10.6 (4.6)	2966	25.66 (4.18)	24.96 (4.87)	2975	38.89 (1.26)	28.43 (1.98)
Belgium	97.16	high	43.6	45.2 (17.3)	1012	14.1 (3.7)	13.5 (3.7)	956	25.21 (4.47)	24.49 (4.91)			

Table 3.2 Tests for homogeneity and between-country variances from meta-analyses, World Health Surveys 2002-2003

		BMI and wealth	BMI and education	Smoking and wealth	Smoking and education
Men					
	Test for homogeneity	$P < 0.0005$	$P < 0.0005$	$P < 0.0005$	$P < 0.0005$
	Between-country variance	0.008	0.081	0.005	0.043
Women					
	Test for homogeneity	$P < 0.0005$	$P < 0.0005$	$P < 0.0005$	$P < 0.0005$
	Between-country variance	0.026	0.245	0.017	0.20

Table 3.3 Change in the mean difference (BMI) or log odds ratio (smoking) associated with a unit increase in SEP indicator by urbanicity, World Health Surveys 2002-2003

	BMI and wealth	BMI and education	Smoking and wealth	Smoking and education
Men				
constant[a]	0.14	0.27	-0.09	-0.24
0-25% urban	0	0	0	0
25-50% urban	0.01 (-0.08, 0.10)	-0.07 (-0.33, 0.19)	0.02 (-0.03, 0.08)	0.01 (-0.17, 0.19)
50-75% urban	-0.03 (-0.11, 0.05)	-0.15 (-0.39, 0.09)	0.00 (-0.05, 0.06)	-0.08 (-0.26, 0.09)
75-100% urban	-0.09 (-0.18, 0.003)	-0.45 (-0.71, -0.18)	0.01 (-0.06, 0.09)	0.03 (-0.22, 0.27)
P trend	0.034	0.001	0.734	0.440
Percent decrease in between-country variance	(0.008 - 0.009) / 0.008 = -12.5%	(0.081 - 0.0817) / 0.081 = -0.9%	(0.005 - 0.0045) / 0.005 = 10.0%	(0.043 - 0.0477) / 0.043 = -10.9%
Women				
constant[a]	0.25	0.53	-0.13	-0.74
0-25% urban	0	0	0	0
25-50% urban	-0.10 (-0.22, 0.03)	-0.37 (-0.70, -0.03)	0.08 (-0.01, 0.17)	0.49 (0.20, 0.78)
50-75% urban	-0.24 (-0.35, -0.12)	-0.91 (-1.22, -0.60)	0.11 (0.03, 0.20)	0.66 (0.38, 0.94)
75-100% urban	-0.36 (-0.49, -0.23)	-1.11 (-1.44, -0.77)	0.16 (0.03, 0.28)	0.82 (0.43, 1.21)
P trend	<0.0005	<0.0005	0.003	<0.0005
Percent decrease in between-country variance	(0.026 - 0.0192) / 0.026 = 26.2%	(0.245 - 0.1287) / 0.245 = 47.5%	(0.017 - 0.0108) / 0.017 = 36.4%	(0.20- 0.1126) / 0.20 = 43.7%

[a]Mean difference in BMI associated with unit increase in SEP marker in the reference category and log odds ratio for smoking associated with unit increase in SEP marker in the reference category.

Figure 3.1 Forest plot of mean difference in BMI per decile increase in wealth for men sorted by increasing level of urbanicity, World Health Surveys 2002-2003

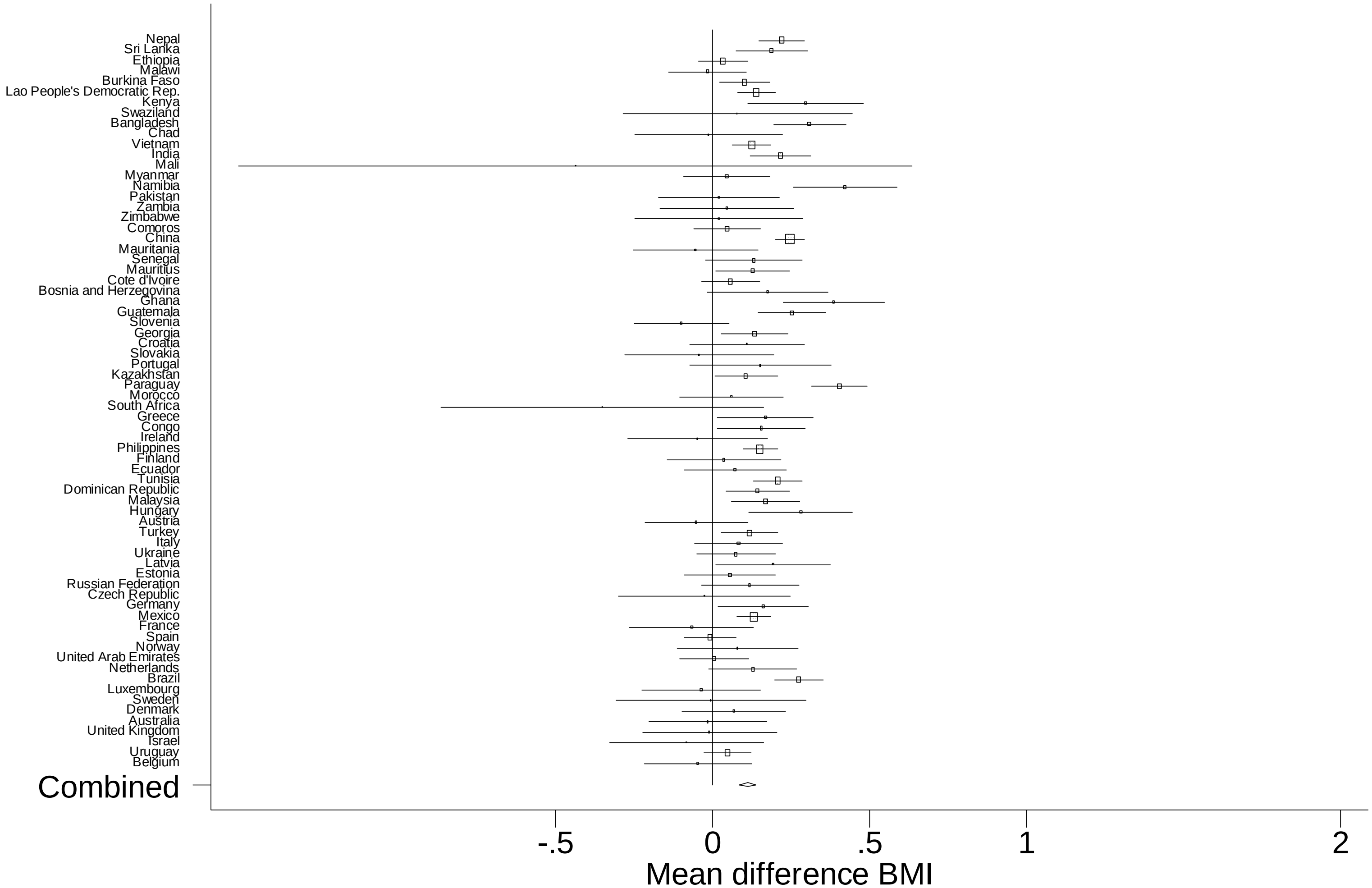


Figure 3.2 Forest plot of mean difference in BMI per decile increase in wealth for women sorted by increasing level of urbanicity, World Health Surveys 2002-2003

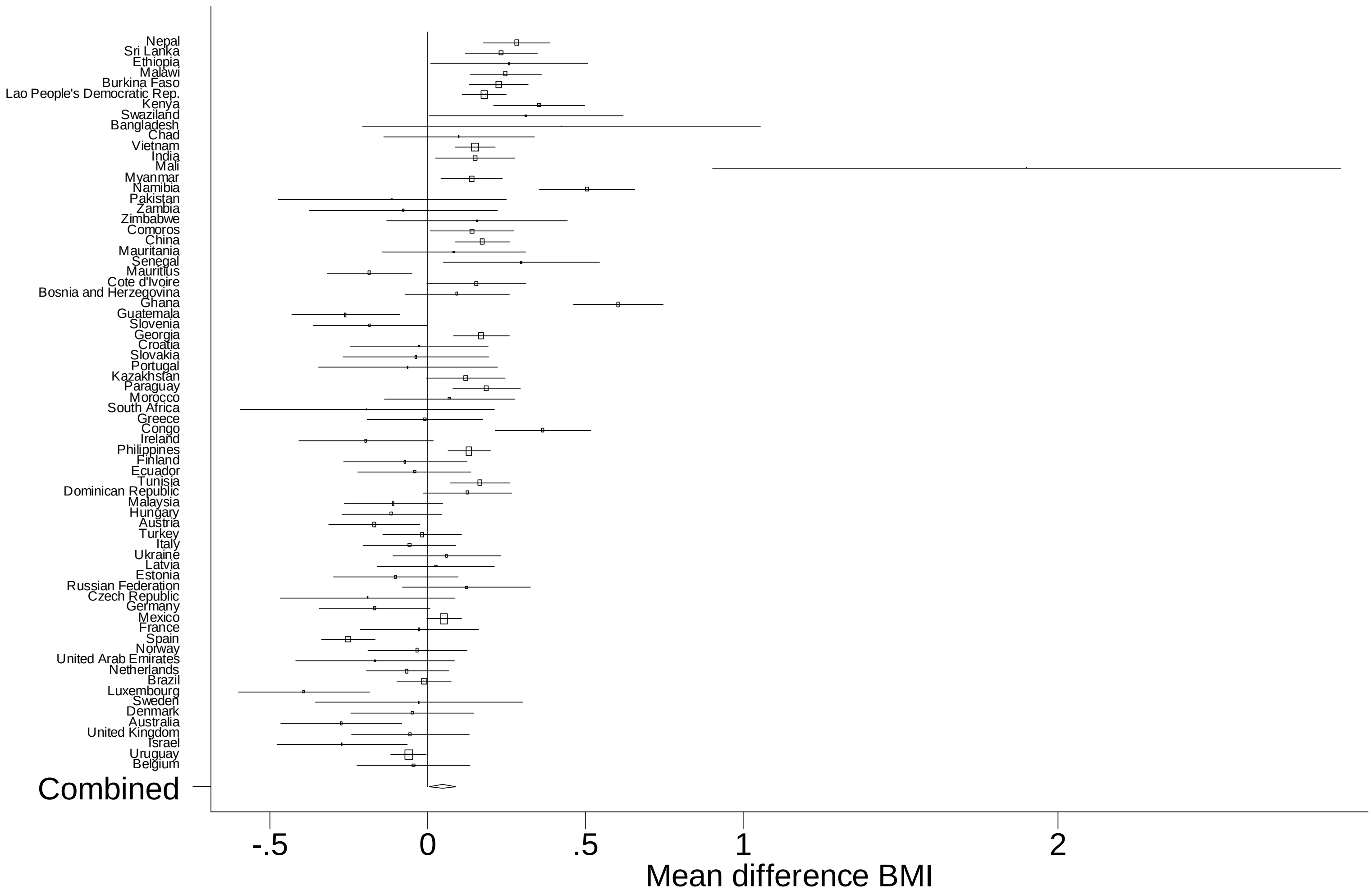


Figure 3.3 Forest plot of mean difference in BMI per SD increase in education for men sorted by increasing level of urbanicity, World Health Surveys 2002-2003

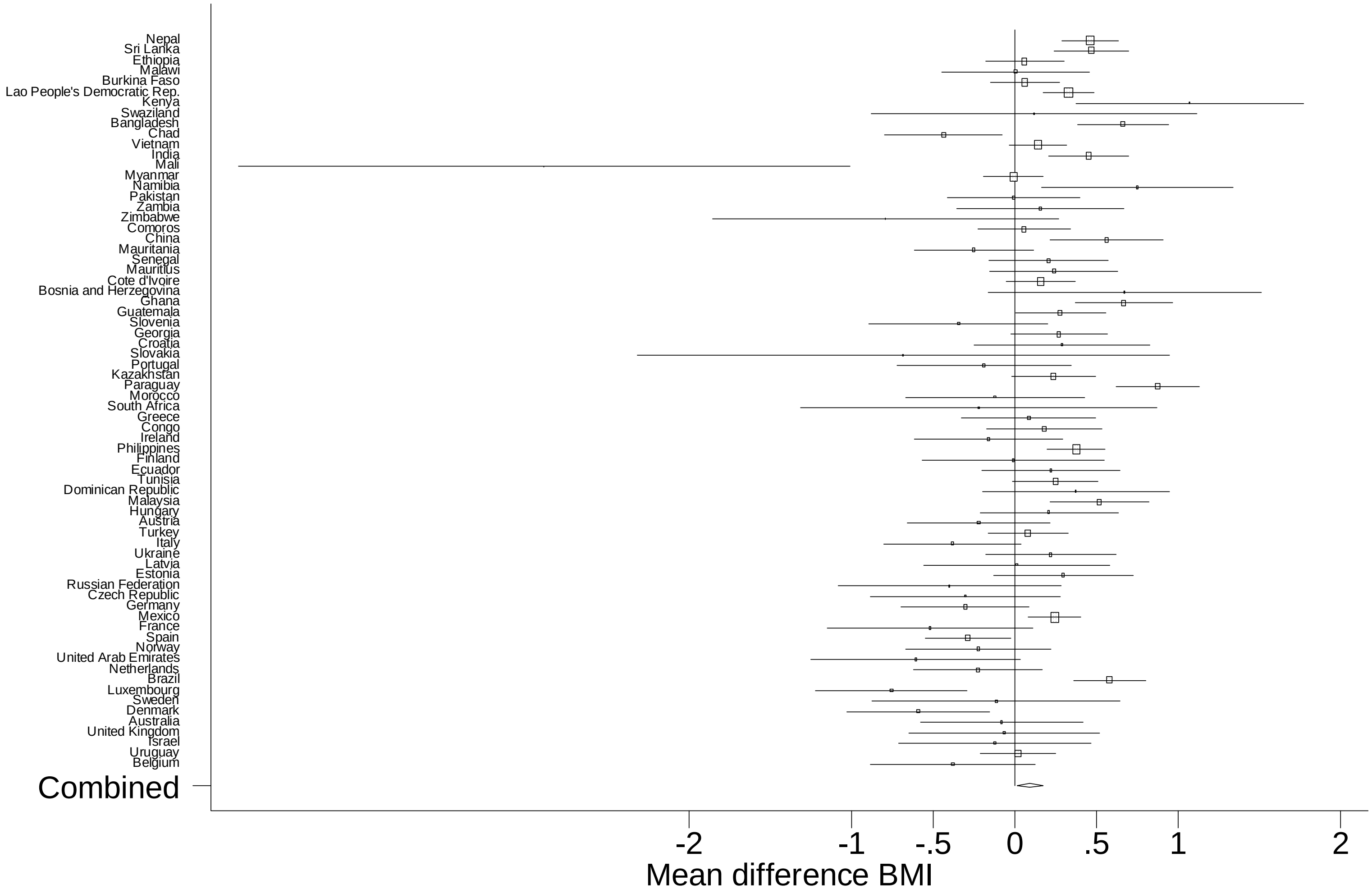


Figure 3.4 Forest plot of mean difference in BMI per SD increase in education for women sorted by increasing level of urbanicity, World Health Surveys 2002-2003

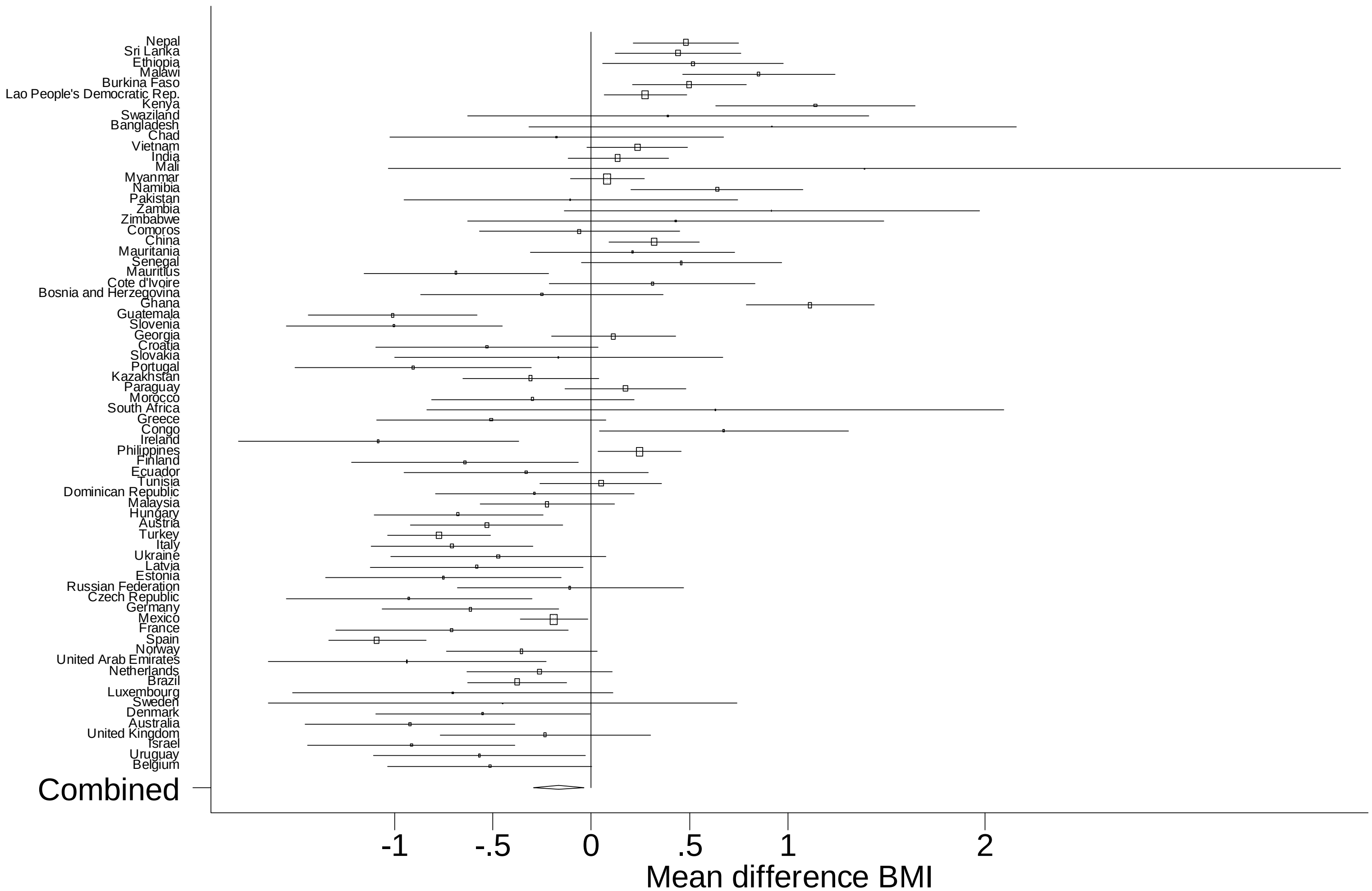


Figure 3.5 Forest plot of odds ratio of current versus not current smoking associated with a one decile increase in wealth for men sorted by increasing level of urbanicity, World Health Surveys 2002-2003

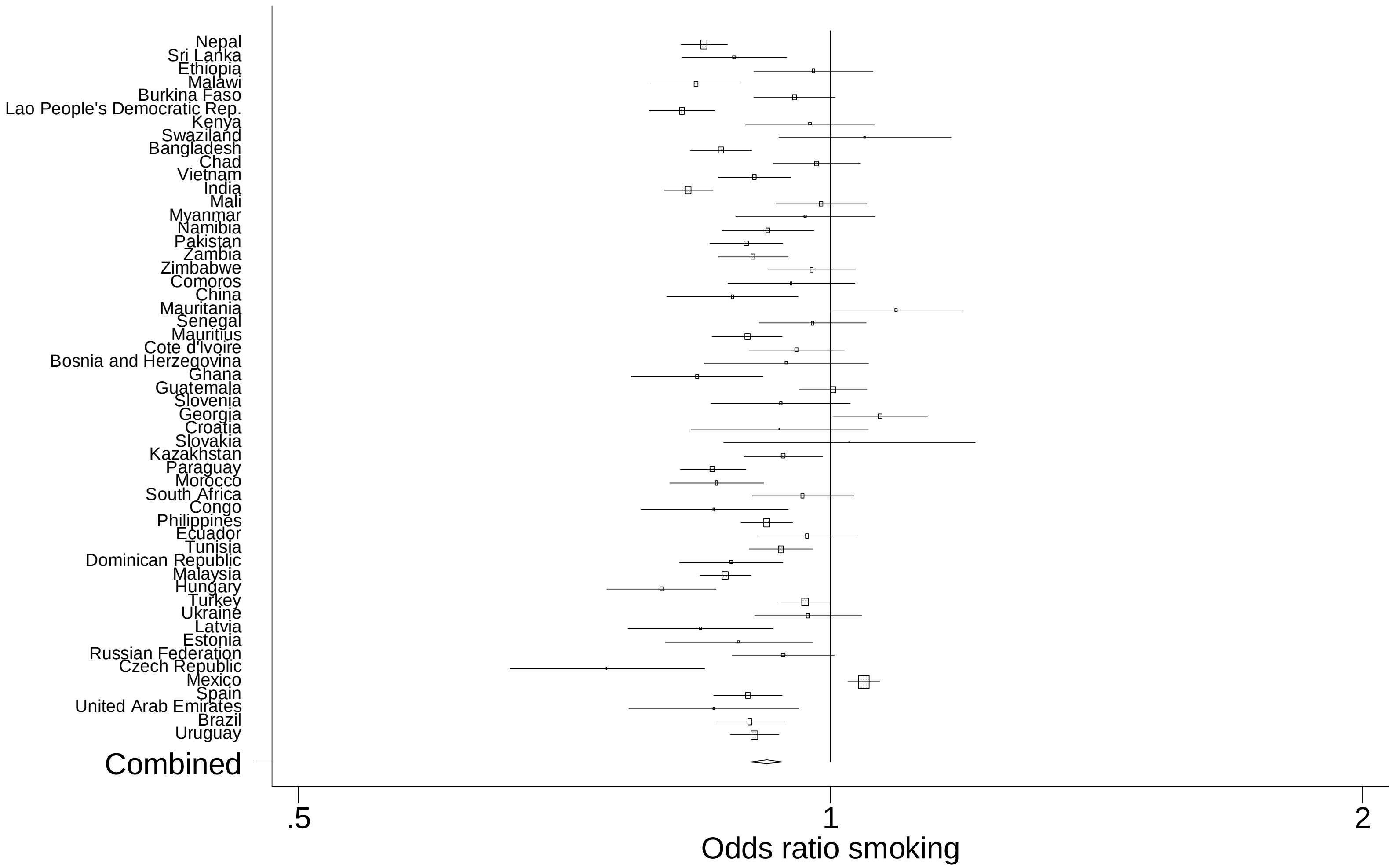


Figure 3.6 Forest plot of odds ratio of current versus not current smoking associated with a one decile increase in wealth for women sorted by increasing level of urbanicity, World Health Surveys 2002-2003

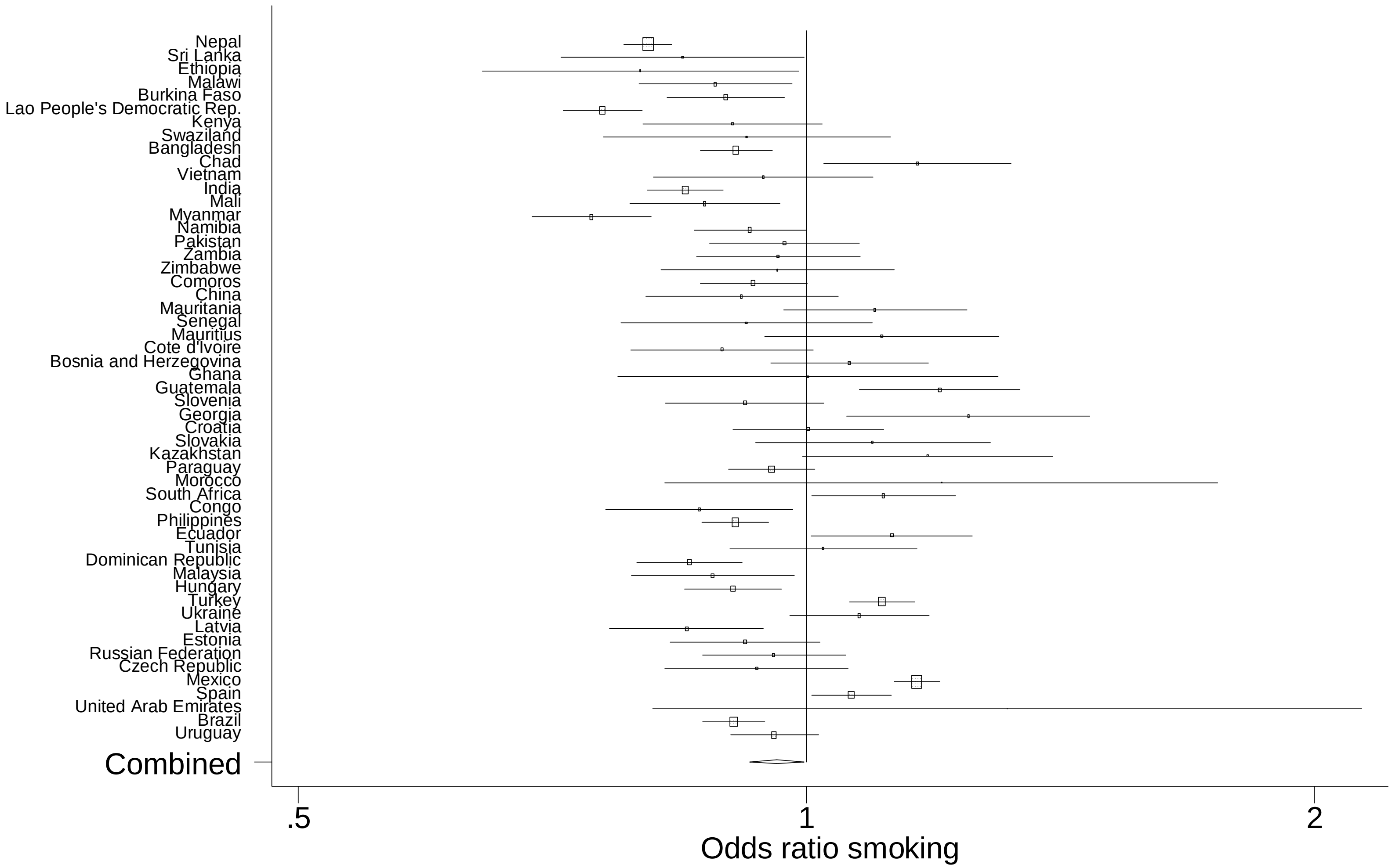


Figure 3.7 Forest plot of odds ratio of current versus not current smoking associated with a one SD increase in education for men sorted by increasing level of urbanicity, World Health Surveys 2002-2003

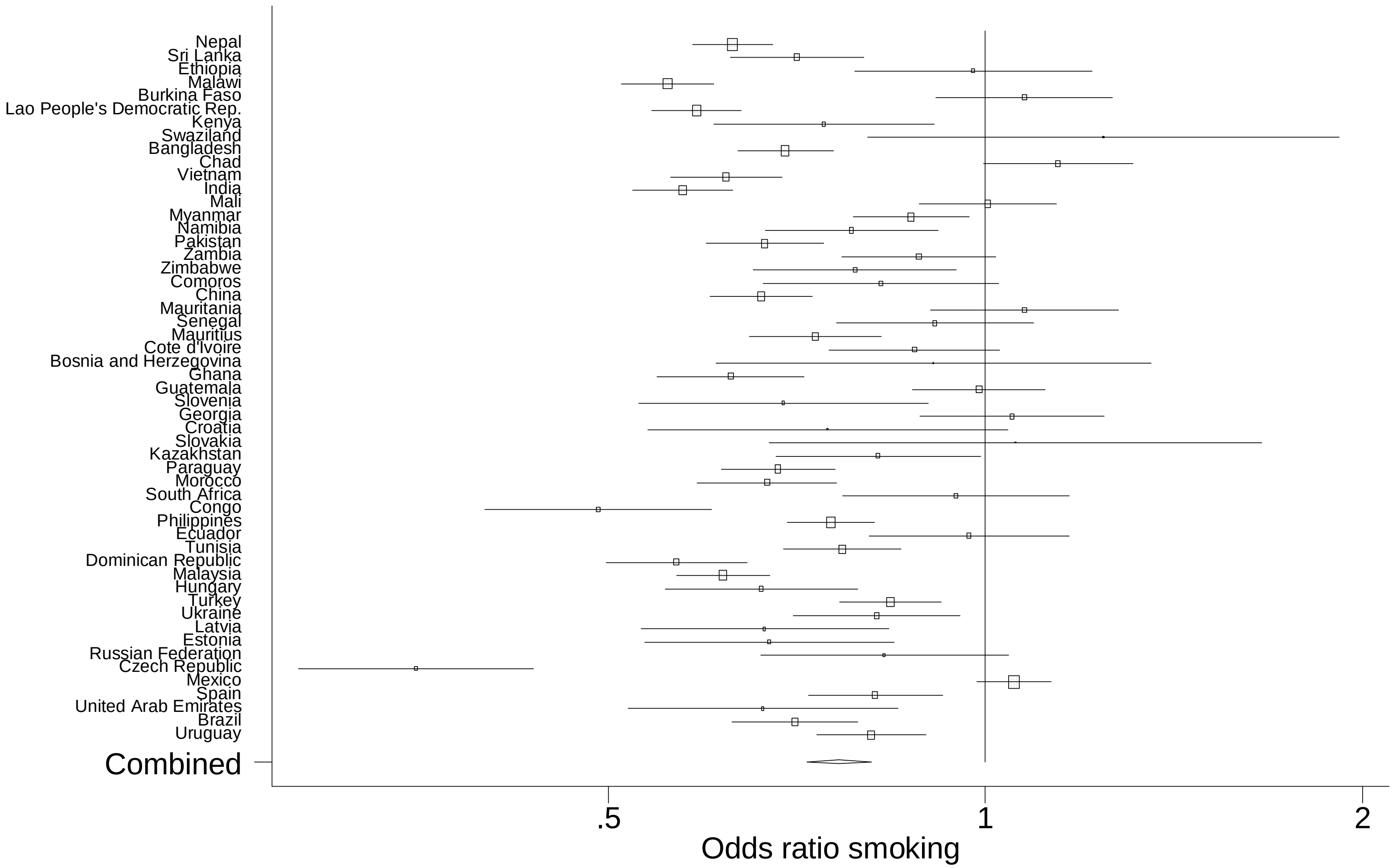
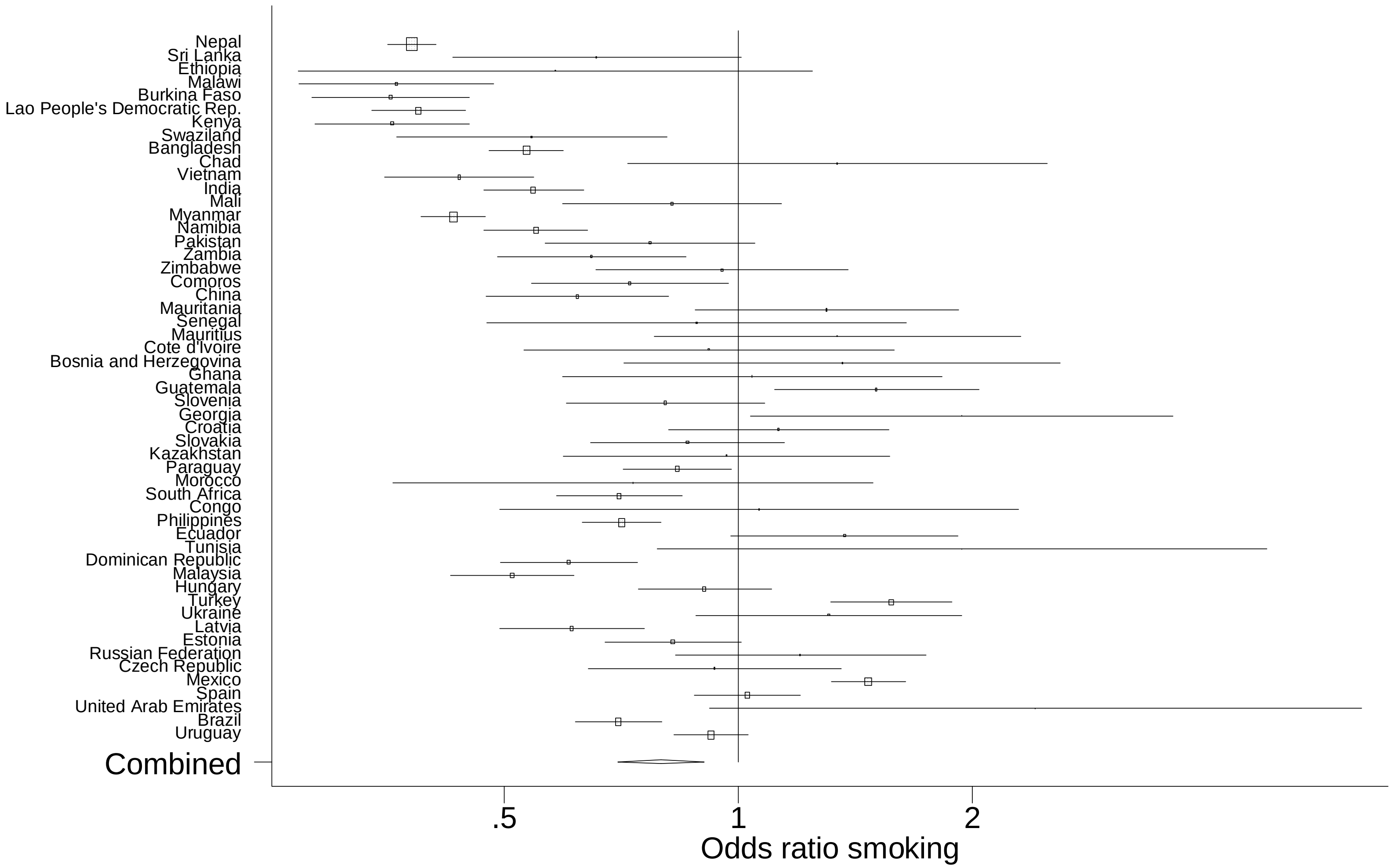


Figure 3.8 Forest plot of odds ratio of current versus not current smoking associated with a one SD increase in education for women sorted by increasing level of urbanicity, World Health Surveys 2002-2003



Chapter 4 : Socioeconomic gradients in chronic disease risk factors in middle income countries: evidence of effect modification by urbanicity in Argentina

Introduction

Deaths from non-communicable chronic diseases are on the rise globally, and are projected to account for 69% of all deaths by 2030 (2). Nearly 80% of these deaths already occur in low- and middle-income countries (9). Also troubling is that deaths from chronic diseases usually occur at younger ages in developing compared to developed countries (35, 36).

Although the classic epidemiologic transition theory states that as countries become more developed, the disease burden shifts from mostly infectious diseases to mostly chronic diseases (13), many developing countries are experiencing a “double burden” of communicable and non-communicable diseases (30). Demographic shifts are part of the driving force behind this phenomenon. The global population at a whole is aging, but developing countries are aging at a faster rate than developed countries (31). In addition, there have been changes in the types of diets and activity levels in developing countries, causing a “nutrition transition” in which people in poorer nations are consuming more fats and sugars, and more processed food (37) as well as a “physical activity transition” by which populations become more sedentary (38, 39, 40).

A number of macroeconomic and social processes have contributed to these transitions. Trade liberalization and foreign investment have contributed to changes in tobacco and agricultural production, and the processing and distribution of energy-dense foods and tobacco products globally (48, 49, 50). Urbanization is also a major influence on chronic disease risk. As of 2008, more than half of the world's population was living in urban areas. The urban population is expected to continue growing over the next two decades, and most of the increase will occur in developing countries (7). Rapid urbanization is associated with a change in diets to those with more fat, sugar and sodium and increased access to tobacco products (39, 44). The types of jobs available in urban areas are often more sedentary than those in rural areas, causing changes in physical activity levels. Likewise, changes in leisure-time activities and the different types transportation available (e.g. buses, cars) result in more sedentary lifestyles (10, 11, 32). In addition, urbanization increases the participation of women in the labor force, which subsequently changes the amount of money households have as well as time available for food preparation (45). Not surprisingly, then, those living in urban areas in most developing countries have higher levels of chronic disease risk factors such as overweight, hypertension, and diabetes compared to their rural counterparts (9).

The increasing burden of chronic diseases does not affect all people equally (53). Although those of higher socioeconomic position are usually the early adopters of lifestyles associated with greater risk for chronic diseases, they are also the first to respond to health messages and are able to change their behavior and environment to decrease their risk. Thus social gradients in chronic disease risk factors may change over time. Most research on the social gradients of chronic disease risk has occurred in high-income countries where numerous studies have shown inverse socioeconomic gradients for chronic diseases such as cardiovascular disease (42). While few studies have examined this trend in developing countries, there is evidence that despite an initial greater risk among those with higher SEP, some countries have already transitioned to a pattern in which the poor carry the greater burden of chronic disease risk (35). These trends are related to country-level income. For instance, a recent review of the social patterning of obesity found that the proportion of positive associations between SEP and obesity decreased and the proportion of negative associations increased as country income increased (57).

Very few studies have examined how the transition in the social patterning occurs within developing countries. Identifying factors associated with the social patterning may help better understand the determinants of inequities in chronic disease. It may also assist efforts to prevent chronic diseases through the development of more appropriate or targeted interventions. Using data from a nationally representative survey, we investigated the social patterning of several chronic disease risk factors (BMI, high blood pressure, diabetes, physical activity, diet, and smoking) in the middle-income country of Argentina. We also examined how this social patterning varied according to the provincial-level indicator of urbanicity.

Methods

Data Sources

The main data source for this study was the 2005 National Survey of Risk Factors for Non-communicable Diseases conducted by the Argentine government (152). It was the first survey of its kind in Argentina. The study employed a four-stage probabilistic sample design with agglomerations of at least 5,000 inhabitants sampled at the first stage, censal radios (with an average of 300 housing units) or clusters of censal radios sampled at the second stage, housing units sampled at the third stage, and an individual 18 years or older randomly sampled from all households within each housing unit at the fourth stage. The sample represented 96% of adults living in urban areas (with at least 5,000 inhabitants). According to the 2001 census, Argentina had a population of 36.3 million people and 89% of them live in urban areas (defined as areas with at least 2000 people) (153). A total of 41392 people participated in the survey, from all 23 provinces in addition to the city of Buenos Aires. The response rate was 87% (154).

Trained interviewers visited the sampled households. Study participants answered questions about their height, weight, blood pressure status, diabetes status, diet, physical activity and tobacco use, in addition to questions about their socioeconomic position and the status of the household they reside in. Body mass index (BMI; measured in kg/m^2) was calculated from self-reported weight and height. Obesity was defined as having a BMI of ≥ 30 kg/m^2. Participants were classified as having high blood pressure or diabetes if they reported they had ever been diagnosed with the condition by a health professional. Diet was assessed by questions on the frequency of fruit and vegetable intake: "How many days in the last week, in your house or outside of your house, did you eat or drink …fruit (not including fruit juice)? …vegetables?" Participants were considered to have high intake of fruits and vegetables if they reported eating fruits and vegetables at least five days/week. Physical activity level was determined based on the questions: "In the last week, how many days did you participate in intense physical activity/moderate physical activity/walking, lasting at least 10 min"? and "Time of intense physical activity/moderate physical activity/walking in minutes." Based on responses to these questions, physical activity was defined as low if the person did not meet the following criteria: at least three days/week of intense activity for 20 min/day, or at least five days/week of moderate activity, or walked at least 30 min/day, or at least five days of any combination of activity yielding at least 600 MET-minutes per week. A MET was defined as the caloric consumption of a person while at complete rest (1 kcal/kg/h). A current smoker was defined as someone who smokes all or some days, and who has smoked at least 100 cigarettes in his/her lifetime.

Socioeconomic position was measured using education. Self-reported education level included categories for no school, incomplete primary, complete primary, incomplete secondary, complete secondary, incomplete tertiary or university education, and complete tertiary or university or more. Education level was treated as an ordinal variable.

There are 23 provinces in addition to the autonomous city of Buenos Aires in Argentina, ranging in population size from 101,079 (Tierra del Fuego) to 13.8 million (province of Buenos Aires) in 2001 (153). The provincial-level indicator of urbanicity was taken from the 2001 census (153). Urbanicity is measured as the percent of households living in urban areas, defined as areas with at least 2000 people, by province. Each person in the sample is given the value for their province (or city of Buenos Aires).

Statistical Methods

All analyses were adjusted for age and stratified by sex due to the variation in social gradients by sex for some risk factors (57, 155) and the differential way in which women experience economic development and its health consequences (156). Regression analyses included survey weights to account for the complex sampling design.

Generalized estimating equations (87) were used to account for the clustering at the provincial level. Two regression models were run for each risk factor (BMI, high blood pressure, diabetes, low physical activity, eating fruit and vegetables, and current smoking) separately. The first model looked at the mutually-adjusted main effects of education and urbanicity, and the second model introduced interaction terms between education and urbanicity. Predicted means (BMI) and probabilities (high blood pressure, diabetes, low physical activity, eating fruits and vegetables, and smoking) were calculated based on the models with interaction terms. The predicted values were calculated for various levels of urbanicity (mean, ±1 standard deviation (SD), ±2 SD) and education (10th, 25th, 50th, 75th, 90th percentiles) in order to graphically display the interactions. Age was given its mean value when calculating the predicted values.

Results

Table 4.1 displays selected characteristics, by sex, for the Argentina-wide sample. Of the 41392 participants, 57% were women. The sample included a mean of 1725 people per province (SD 391). Women were slightly older than men, and had similar education levels but lower monthly household income. Education and income were positively, though not highly, correlated (Spearman correlation=0.46). Men reported higher mean BMI and had higher levels of obesity (17% versus 15% for women). However, more women (39%) reported being diagnosed with high blood pressure compared to men (32%). Men and women reported being diagnosed with diabetes at the same frequency (12%). Women reported low physical activity more often than men (47% versus 42%), but women ate fruits and vegetables at least five days a week more often than men (35% versus 25%). Men had a higher prevalence of current smoking than women (37% versus 25%). Mean province-level urbanicity (percent of households living in urban areas) was 85% with a range of 66% to 100%.

Associations of education and province-level urbanicity (adjusted for each other, in addition to age) with the risk factors are shown in Table 4.2 for men and women. For men, higher education was associated with lower odds of high blood pressure, diabetes, and smoking, greater odds of low physical activity, and greater odds of eating fruit and vegetable. For women, higher education was associated with lower mean BMI, lower odds of high blood pressure and diabetes, and higher odds of eating fruits and vegetables. In men, greater levels of urbanicity were associated with higher odds of low physical activity, and lower odds of eating fruits and vegetables. In women, greater levels of urbanicity were associated with lower odds of high blood pressure and higher odds of smoking. However, there was evidence of important interaction between province-level urbanicity and education: of the 12 interactions between urbanicity and education tested, nine (five in men and four in women) were statistically significant. More specifically, in men there were statistically significant interactions between urbanicity and education for all risk factors except low physical activity (which was marginally statistically significant α=0.10). For women, there were statistically significant interactions between urbanicity and education for BMI, diabetes, low physical activity, and smoking.

Figures 4.1 and 4.2 show predicted risk factor levels for varying levels of urbanicity and education. Among men living in less urban areas, higher education was either unassociated with the risk factors or was associated with adverse risk factor profiles, with the exception of smoking (Figure 4.1). In contrast, in more urban areas, higher education was usually associated with better risk profiles. For example, as urbanicity increased, the social gradient changed from those of highest education level having the highest BMI to those of lowest education level having the highest mean BMI. Similar patterns were observed for high blood pressure. For diabetes no social gradient was observed in areas of low urbanicity, whereas an inverse gradient emerged in areas of high urbanicity. Higher education was associated with less physical activity across both urban and rural areas, with the gradient also appearing to be slightly stronger at higher urbanicity, although the interaction between urbanicity and education was only marginally statistically significant (*P*=0.12) The probability of eating fruits and vegetables increased with education in all areas; however, in contrast to the other risk factors examined, this gradient was stronger in less urban than in more urban areas. Current smoking, however, was inversely associated with education regardless of level of urbanicity, although the gradient was steeper in less urban areas.

Heterogeneity by urbanicity of the social patterning of cardiovascular risk factors for women is shown in Figure 4.2. In general, women showed inverse gradients regardless of level of urbanicity, with the exception again of smoking. Similar to men, results for BMI and diabetes showed stronger inverse associations with education in more urban than in less urban areas (P for interaction <0.05 for both outcomes). The social patterning of hypertension and eating fruits and vegetables (with more education being associated with better profiles) was not substantially modified by urbanicity. In contrast to the other risk factors in women, greater education was associated with greater probability of low physical activity and current smoking in more urban areas whereas the opposite pattern in observed in more rural areas.

The varying social patterning by urbanicity described above also implies that the relationship between urbanicity and chronic disease risk factors varies by level of education. In men, greater urbanicity was associated with lower BMI and lower prevalence of hypertension and diabetes at high levels of education but no association or the opposite association was observed at low levels of education. In contrast, greater urbanicity was associated with lower probability of fruit and vegetable intake at high levels of education but the effect weakened at low levels of education. Higher urbanicity was also associated with lower probability of smoking, although only at lower levels of education. In women, findings for BMI and diabetes were very similar to those in men: at high education levels urbanicity was associated with lower levels of BMI and diabetes whereas the opposite effects or no effect was observed at low levels of education. Higher urbanicity was associated with lower probability of low physical activity but differences are greater at lower than at higher education levels. For smoking, higher urbanicity was associated with higher probability of current smoking but differences were greater at higher than at lower education levels.

Discussion

This study demonstrates the complexity of the social gradients in several major chronic disease risk factors, and how urbanicity affects these gradients in a middle-income country in Latin America. Overall, our results showed that the social patterning of risk factors was modified by urbanicity, such that for many of the risk factors examined the inverse social patterning (i.e. lower risk factor levels in the more advantaged groups) became stronger or only emerged in more urban settings. This effect modification was stronger in men than in women. Exceptions to this general pattern included eating fruits and vegetables in men and low physical activity in women, and smoking in both genders. All of these risk factors showed stronger inverse social patterning in less urban than in more urban areas: in men, the inverse association of education with eating fruits and vegetables and smoking was stronger in less urban than in more urban areas; in women higher education was associated with lower probability of low physical activity and smoking in less urban areas but the opposite was observed in more urban areas.

Our results also showed that the associations of urbanicity with risk factors were not homogeneous across social groups. For example, in both men and women, greater urbanicity had beneficial effects on BMI and diabetes for persons of higher education but no effect or the opposite effect (worse risk factor levels in more urbanized areas) was observed for persons of low education. A similar pattern was observed for hypertension in men. Greater urbancity also had beneficial effects on smoking among men, but only at lower education levels. In men, greater urbanicity had unfavorable effects on probability of fruit and vegetable intake, but only among the more educated. In women, greater urbanicity had unfavorable effects on physical activity and smoking, but this was more pronounced in the less educated for physical activity and in the more educated for smoking.

Few studies have investigated heterogeneity in social patterning of chronic disease risk by urbanicity or other development indicators within developing countries. Most of these studies used an urban/rural dichotomy as their marker, and none used a country-wide, population-based study. Two studies in China investigated the interaction between urbanicity and social patterns of risk. One study found that higher SEP was associated with lower physical activity levels in both urban and rural areas (43), while another of older adults found that higher SEP was associated with less chronic health conditions (including hypertension among others) in rural areas, but more chronic health conditions in urban areas (157). In Bangladesh, the prevalence of diabetes by social class did not differ according to urbanicity (158). These studies may indicate an earlier stage of the social transition of chronic disease risk. The results could differ in Latin America, where economic conditions and urbanization are different. A study of older adults in Mexico found an inverse association between education and obesity in urban areas, but a positive gradient in less urban areas; however, income was associated with an increase in obesity throughout the country. In addition, there was evidence of effect modification by gender: the education/obesity relationship was negative for women but positive for men in urban areas. In the same study, higher income was positively associated with smoking in urban areas, wealth was inversely associated with smoking in rural areas, and there was no association with education (76). In Brazil, results were more mixed. For men, there was a positive social gradient for obesity with income in more developed and less developed areas, but a slight inverse gradient with education in more developed areas and no gradient with education in less developed areas. Women in less developed areas had a positive gradient for obesity with income and a negative relationship with education, while those in more developed areas only education had an inverse association with education (159). The patterns from the two studies in Latin America are generally consistent with our findings, which show consistent inverse social gradients for women regardless of level of urbanicity, and increasingly inverse associations for men with increasing urbanicity for most risk factors.

Our results also showed that differences in risk factors associated with urbanicity differed depending on the risk factor and were also heterogeneous across social groups. We observed that urbanicity was actually associated with better risk factor profiles for BMI and diabetes in men and women at higher levels of education, but no effect (or the opposite effect) was observed at lower levels of education. In the case of hypertension, greater urbanicity was associated with lower prevalence for all education levels in women, but only in the more educated in men. In men, eating fruit and vegetables was less prevalent in more urbanized areas with differences being especially pronounced in the more educated. For men, low levels of physical activity were consistently more prevalent in urban areas compared to rural areas. In contrast, in women, having a low level of physical activity was more common in more rural areas, with differences being more pronounced in the less educated. Smoking was less common in urban areas, but only at lower education levels for men, whereas smoking was more common in urban areas for women regardless of education level, although the relationship was most prominent at higher education.

In general, the association of low socioeconomic position with adverse risk factor profiles emerges or becomes stronger as urbanization increases, as those of high socioeconomic position recognize the detrimental health effects of certain behaviors and use their resources and power to change their behavior and environment. Thus, inverse social gradients emerge first in urban areas. Just as increased chronic disease risk filters from urban to rural areas as countries develop, the inverse social patterning emerges in urban areas and subsequently extends to rural areas. Although high income countries have generally already gone through this transition, many middle-income countries are in the midst of it.

As we have shown, in this context, the effects of urbanicity on chronic disease risk varies by SEP. For example, urbanicity had favorable effects on BMI, hypertension, and diabetes for higher SEP groups, but adverse effects were observed for some of these risk factors in low SEP groups. This may be because higher SEP groups are able to benefit from greater resources and better access to care associated with urbanization. However, this pattern was not present for all risk factors: in men, living in more urban areas was associated with less consumption of fruits and vegetables, with this effect being stronger in high SEP groups, possibly because of changes in diet associated with urbanization in working-age men. Only with physical activity among men can we unequivocally say that urbanicity is associated with a less physical activity regardless of SEP. This makes sense given that occupations are typically more sedentary in urban areas. The opposite result for women, whereby women in less urban areas were less physically active, with the differences most pronounced at low SEP, may indicate an increase in leisure time or work activity associated with urban living. Taken together these findings illustrate the complex way in which urbanization and social circumstances interact to shape chronic disease risk.

Smoking showed much different patterns compared to the other risk factors, although the findings were consistent with the global trends we found in chapters 3 and 4 of this dissertation. For instance, among men urbanicity alone had only a marginal effect on smoking, but there were socioeconomic gradients regardless of level of urbanicity, just as was found in the WHS when looking across countries. However, in Argentina we found that, when investigating the interaction between urbanicity and SEP, higher urbanicity was associated with less smoking, but only among the less educated. For women, smoking patterns in Argentina were again similar to global patterns: women in more urban areas have higher probability of smoking, and the socioeconomic gradient depends on the level of urbanicity. Comparable to the global findings using WHS, women in less urban areas have an inverse socioeconomic gradient with smoking, which becomes positive at higher urbanicity. Since men are typically the earliest and heaviest smokers in any society, it is not surprising that they are the first to transition to inverse socioeconomic patterns. The results for women are consistent with a shorter epidemic of tobacco, and their usage is likely related to a number of factors, including increased liberalization of women's behavior, particularly in urban areas, and a potential signal of autonomy and equality with men, just as it was a generation ago in the U.S. and other Western countries (51, 52, 143). Women's smoking behavior is also likely affected by more intense marketing of women by the tobacco industry and advertising that suggests smoking as a method of weight control, among other messages (144). There may also be other important factors influencing the socioeconomic gradient; we examine one of these, cohort/time differences, in the next chapter.

These findings offer some insight into how the processes of globalization affect health, but many other areas have yet to be investigated. Are these patterns in Argentina typical of middle-income countries globally, or perhaps just in Latin America? Does the rate of urbanization and economic development exacerbate social inequalities in chronic disease risk? What country-level policies reduce both the overall burden as well as the inequalities in chronic disease risk factors? Are there ways that countries can simultaneously participate in globalization and reduce chronic disease burden and inequalities in chronic disease risk?

There are several limitations to this study. The use of self-reported data undoubtedly introduces measurement error. For example, since people of lower SEP or those living in more rural provinces may have more limited access to medical care, the prevalence of hypertension and diabetes may be underestimated for these groups (160). Another limitation is that, due to the cross-sectional and single point in time nature of the data, we were unable to determine if the trends we see are recent manifestations of development, or characteristics of longer-term differences between various areas of the country. Our study reports the social patterning according to only one marker of SEP – education. Additional analyses, not reported here, investigated the associations by household income; patterns were similar. The urbanicity indicator we investigated may be a proxy for a variety of social and economic changes associated with urbanization. Urbanicity and two economic indicators (median household income by province, derived from the survey data, and a marker of provincial-level economic activity per capita) were highly correlated making it difficult to distinguish between their effects (Spearman correlation coefficient=0.78 and 0.73, respectively). In sensitivity analyses using median household income by province, the results were similar. In addition, the survey itself was designed to target people living in areas of 5000 people or more, so our results are not generalizable to people living in less populated areas. Nearly 90% of the population of Argentina lives in areas of 2000 people or more as of 2001, making the survey approximately representative of the country. However, studies on countries with a greater variability in levels of urbanization could lead to different results.

Conclusions

Our study is among the first to examine heterogeneity in the social patterning of risk factors by geographic areas and level of urbanicity within a middle-income country using a nationally-representative sample. Our results show inverse social gradients for women for most risk factors regardless of level of urbanicity, and emerging inverse gradients for men with increasing levels of urbanicity. Since middle-income countries are by definition in transition and often quite heterogeneous, they provide an ideal setting in which to investigate modifiers of the social patterning. As the world becomes more urban, with most of the growth occurring in developing countries, it is likely that we will see an increasing burden of chronic disease risk among the poor. In Argentina, this transition appears to happen first among women given that inverse social patterns were consistent regardless of urbanicity, whereas men displayed positive or no social gradients in less urban areas, transitioning to inverse social gradients with chronic disease risk in more urban areas.

Table 4.1 Selected characteristics of the sample by gender, Argentina 2005

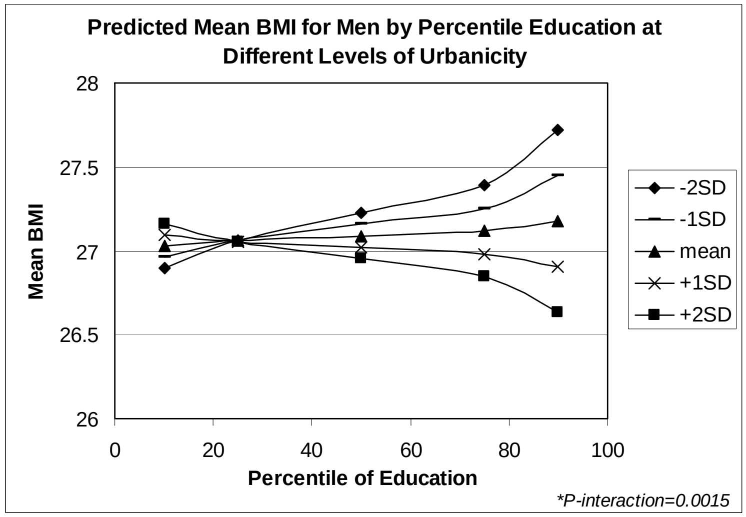
Variable	Men	Women
N	17827	23565
Age in years; Mean±SD (range)	42.7±17.1 (18-97)	44.8±18.0 (18-98)
Education; N (%)		
No school	289 (1.6)	558 (2.4)
Primary incomplete	2048 (11.5)	2924 (12.4)
Primary complete	4198 (23.6)	5474 (23.3)
Secondary incomplete	3360 (18.9)	3544 (15.1)
Secondary complete	3563 (20.0)	4535 (19.3)
Tertiary or university incomplete	2303 (12.9)	2946 (12.5)
Tertiary or university complete or more	2033 (11.4)	3560 (15.1)
Monthly household income (in pesos); Mean±SD (range)	920.7±863.9 (0-5500)	815.7±774.3 (0-5500)
BMI (kg/m^2); Mean±SD (range)	26.4±4.3 (10.6-76.1)	25.0±5.1 (12.4-94.9)
	(N=16913)	*(N=21033)*
Obesity (BMI ≥ 30); %	17.0	14.9
	(N=16913)	*(N=21033)*
High blood pressure (diagnosed at least once); %	32.3	39.1
	(N=14765)	*(N=21962)*
Diabetes (diagnosis); %	12.3	12.3
	(N=11278)	*(N=17970)*
Physical activity level; N (%)		
Low	7360 (41.8)	10937 (47.0)
Moderate	7400 (42.0)	10822 (46.5)
Intense	2850 (16.2)	1535 (6.6)
Eat fruits and vegetables at least 5 days/week; %	25.3	35.0
Current smoker; %	37.3	25.3
	(N=17773)	*(N=23495)*
Percent of households in province living	84.5±8.3 (66.1-100.0)	84.6±8.2 (66.1-100.0)
in urban areas	84.4	84.4
Mean±SD (range)	79.5-89.2	79.5-89.2
Median		
25th-75th percentile		

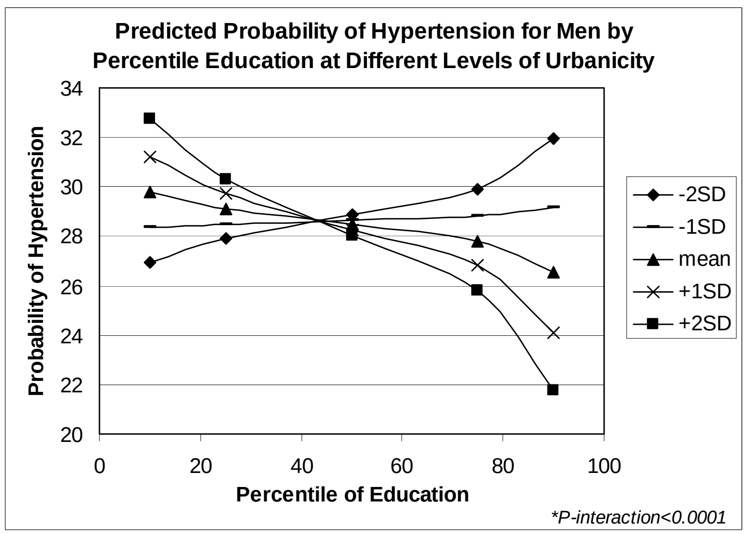
Table 4.2 Main effects and P for interaction models for adjusted mean differences in BMI and odds ratios of high blood pressure, diabetes, fruit and vegetable intake, and low physical activity according to education and urbanicity, by gender, Argentina 2005

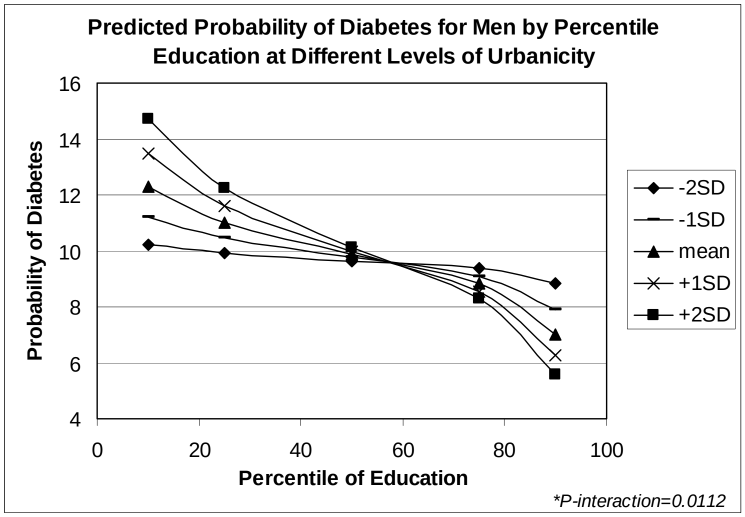
		BMI, mean difference (95% CI) (*N*=15600 men; *N*=19473 women)	High blood pressure, OR (95% CI) (*N*=13574 men; *N*=20296 women)	Diabetes, OR (95% CI) (*N*= 10288 men; *N*=16555 women)	Low physical activity level, OR (95% CI) (*N*=16227 men; *N*=21530 women)	Eat fruits and vegetables, OR (95% CI) (*N*=16405 men; *N*=21764 women)	Current smoking, OR (95% CI) (*N*= 17740 men; *N*=23472 women)
Men	Education	-0.02 (-0.07, 0.03)	0.94 (0.90, 0.98)	0.85 (0.82, 0.88)	1.06 (1.04, 1.08)	1.20 (1.17, 1.24)	0.88 (0.85, 0.90)
	Urbanicity (centered, per SD)	-0.09 (-0.19, 0.01)	0.98 (0.92, 1.05)	1.01 (0.93, 1.10)	1.19 (1.03, 1.38)	0.92 (0.87, 0.97)	0.96 (0.92, 0.996)
	P for interaction	*P*=0.0015	*P*<0.0001	*P*=0.0112	*P*=0.1210	*P*=0.0055	*P*=0.0655
Women	Education	-0.48 (-0.56, -0.41)	0.86 (0.84, 0.89)	0.80 (0.78, 0.82)	1.02 (0.96, 1.08)	1.27 (1.22, 1.31)	1.01 (0.998, 1.04)
	Urbanicity (centered, per SD)	0.07 (-0.10, 0.25)	0.94 (0.90, 0.98)	0.98 (0.90, 1.08)	0.85 (0.69, 1.05)	1.02 (0.89, 1.17)	1.07 (1.01, 1.14)
	P for interaction	*P*=0.0167	*P*=0.4705	*P*=0.0149	*P*=0.0024	*P*=0.5618	*P*=0.0112

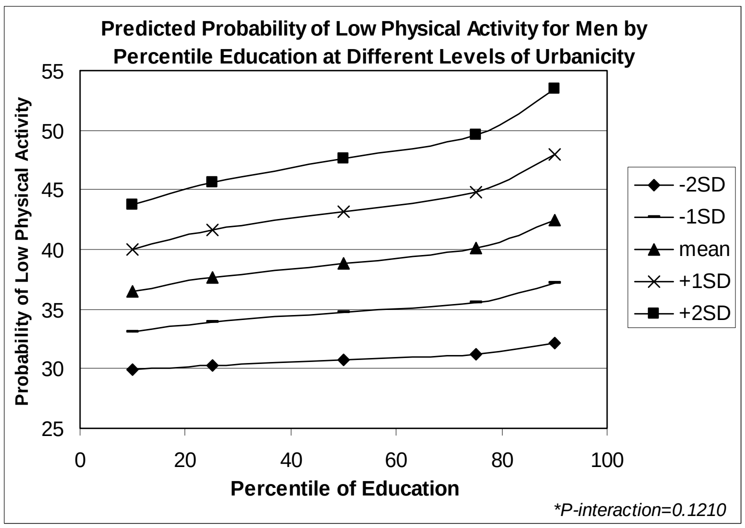
*All models adjusted for age; BMI also adjusted for age-squared.

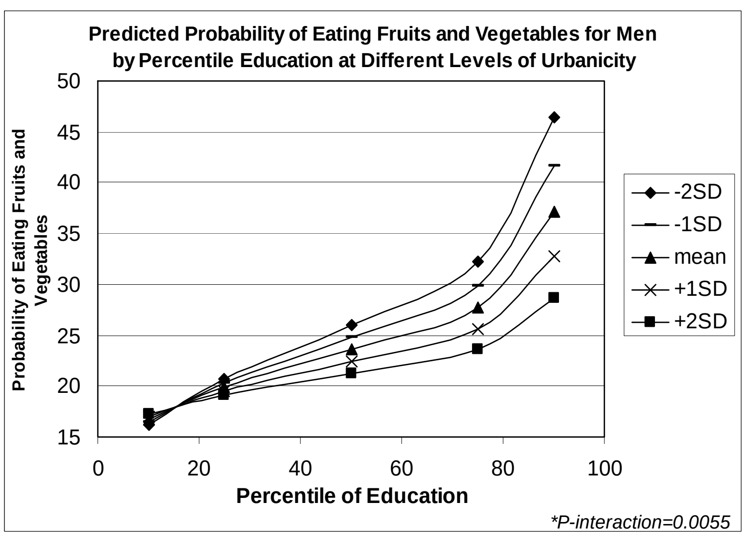
Figure 4.1 Predicted mean BMI and probability of hypertension, diabetes, low physical activity, and eating fruits and vegetables by education according to different levels of urbanicity for men, Argentina 2005






Predicted Probability of Diabetes for Men by Percentile Education at Different Levels of Urbanicity
Probability of Diabetes
16
14
12
10
8
6
4
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.0112


Predicted Probability of Low Physical Activity for Men by Percentile Education at Different Levels of Urbanicity
Probability of Low Physical Activity
55
50
45
40
35
30
25
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.1210


Predicted Probability of Eating Fruits and Vegetables for Men by Percentile Education at Different Levels of Urbanicity
Probability of Eating Fruits and Vegetables
50
45
40
35
30
25
20
15
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.0055

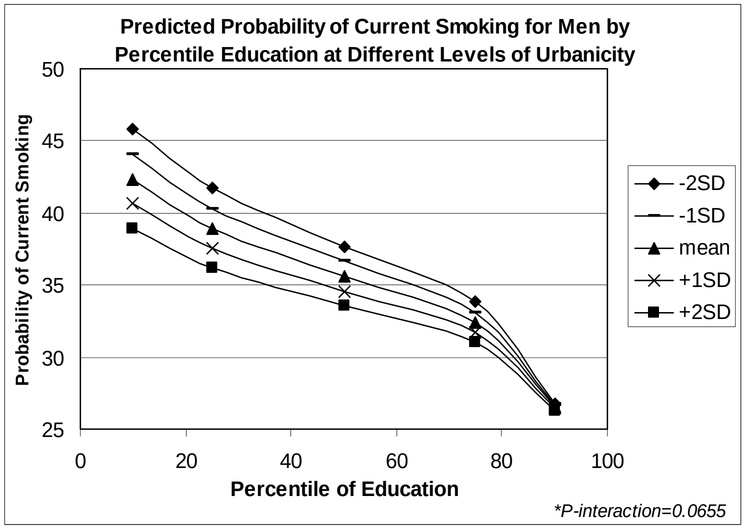
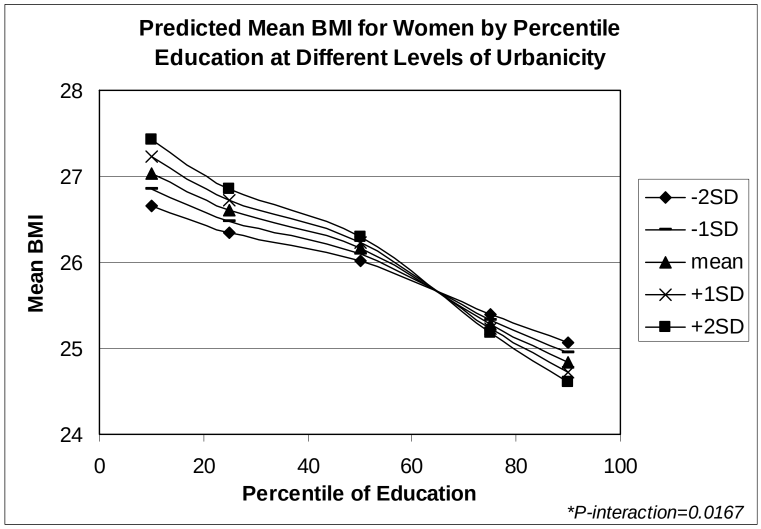
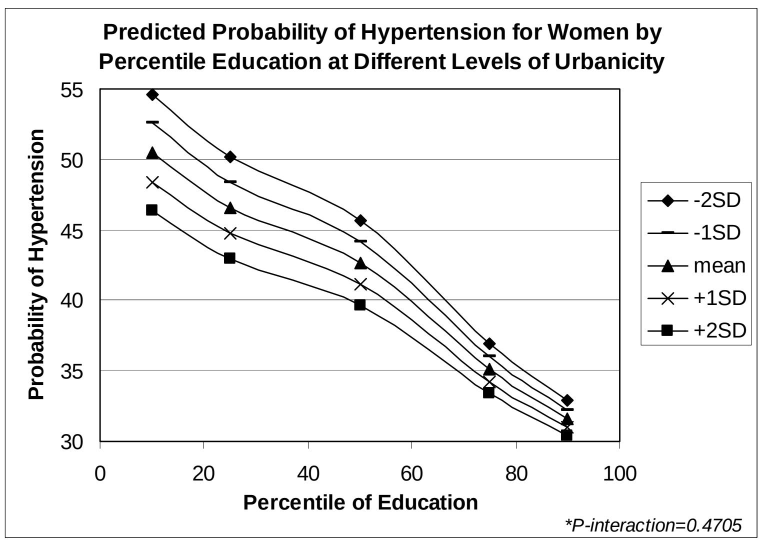
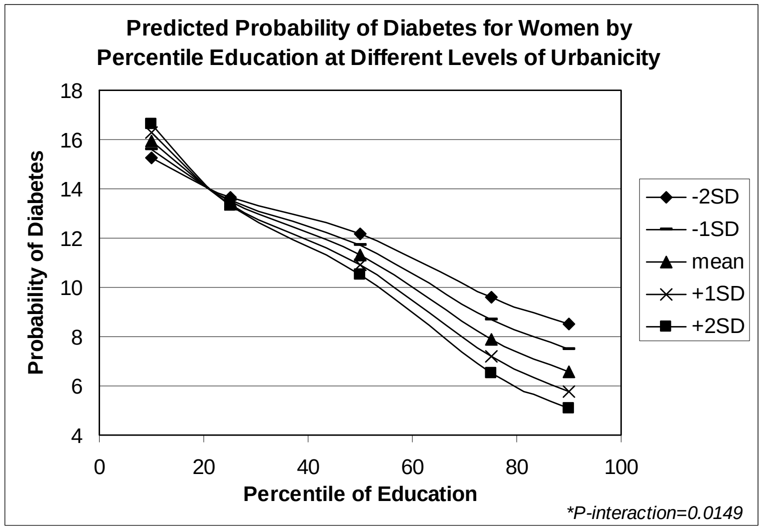
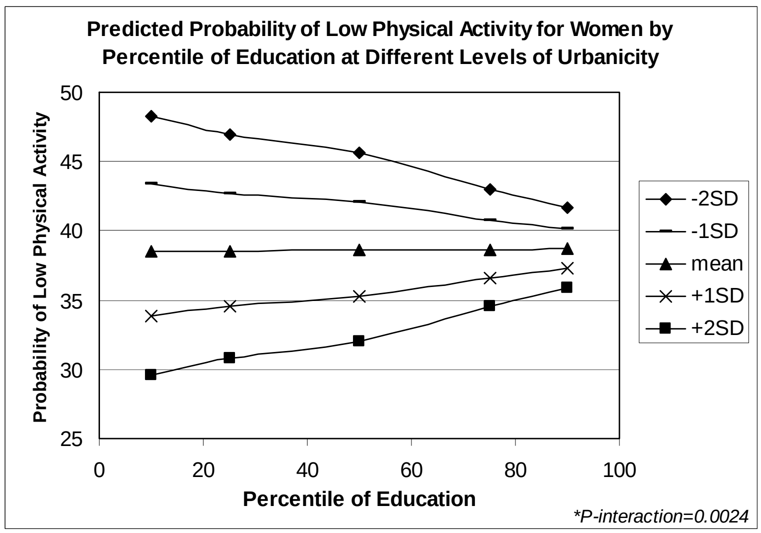

Predicted Probability of Current Smoking for Men by
Percentile Education at Different Levels of Urbanicity
Probability of Current Smoking
50
45
40
35
30
25
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.0655

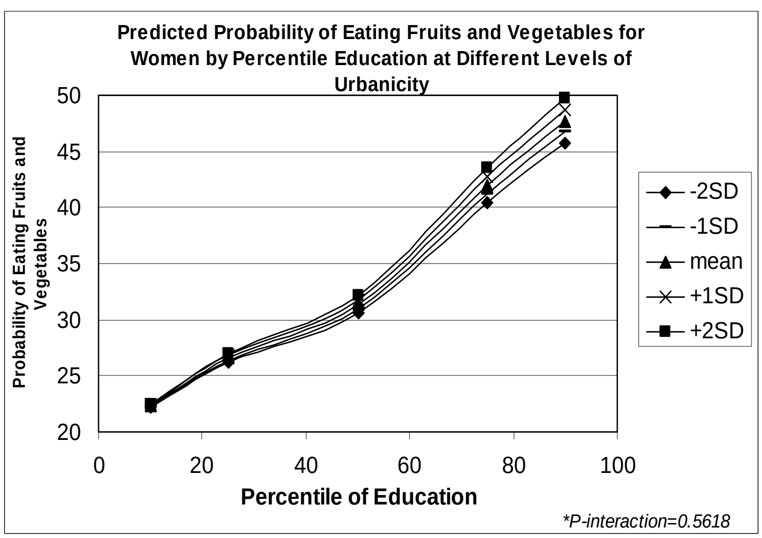
Figure 4.2 Predicted mean BMI and probability of hypertension, diabetes, low physical activity, and eating fruits and vegetables by education according to different levels of urbanicity for women, Argentina 2005

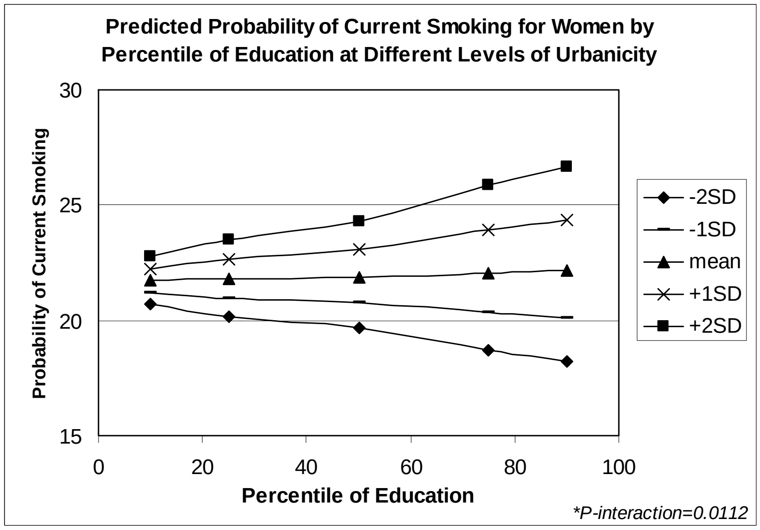





Predicted Probability of Diabetes for Women by Percentile Education at Different Levels of Urbanicity
Probability of Diabetes
18
16
14
12
10
8
6
4
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.0149


Predicted Probability of Low Physical Activity for Women by Percentile of Education at Different Levels of Urbanicity
Probability of Low Physical Activity
50
45
40
35
30
25
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.0024


Predicted Probability of Eating Fruits and Vegetables for Women by Percentile Education at Different Levels of Urbanicity
Probability of Eating Fruits and Vegetables
50
45
40
35
30
25
20
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.5618



Predicted Probability of Current Smoking for Women by
Percentile of Education at Different Levels of Urbanicity
Probability of Current Smoking
30
25
20
15
0
20
40
60
80
100
Percentile of Education
-2SD
-1SD
mean
+1SD
+2SD
*P-interaction=0.0112

Chapter 5 : Socioeconomic patterning in tobacco use in Argentina – traits of an epidemic

Introduction

Tobacco is the number one preventable cause of death worldwide, killing one in ten adults (2, 161). It is projected that by 2030, 80% of all tobacco deaths will occur in developing countries (2). The global public health community has begun to make tobacco control a priority, by passing the World Health Organization Framework Convention on Tobacco Control [FCTC] in 2003 (162) and through increased research and policy attention (163). Despite progress, developing countries are experiencing an increasing burden of the tobacco epidemic.

Latin America is in the second stage of the tobacco epidemic, in which smoking rates among men and women continue to increase, and mortality due to smoking is also on the rise (130, 164). In 1995, the Latin America and Caribbean region had the third highest smoking prevalence for men (39%) and highest for women (22%) (165). In 2000, an estimated 15% of all male deaths and 6% of all female deaths at ages 30 years and over in the Region of the Americas B (which includes much of Latin America) were attributable to smoking (161). For women, this proportion is the largest among developing regions (166). Several countries in Latin America are among the leading tobacco producers in the world, and production in the region increased 29.5% between 1995-2000 (167). In addition, the transnational tobacco industry has made a concerted effort to undermine tobacco control in Latin America (168, 169, 170). Accusations against the industry include that is has ignored the science on secondhand smoke, employed ineffective “youth smoking prevention” campaigns to boost its public image, promoted smuggling, and influenced government officials to weaken tobacco control (169, 171).

Argentina is a middle-income country in the Southern Cone of Latin America. It is one of only a few countries in the world that has signed but failed to ratify the FCTC (172). Tobacco production is a major economic activity in the country, with 70% of the tobacco leaf grown exported (173). The tobacco industry is a strong force in Argentina, targeting youth through marketing (174, 175), preventing litigation (176), and working to prevent tobacco control legislation (173, 177, 178).

Social factors such as age, gender, socioeconomic position and ethnicity drive the adoption (42) and cessation (179) of smoking in populations in high-income countries, but few studies have examined the socioeconomic patterning of smoking in developing countries. Socioeconomic disparities in smoking behavior are predictive of future disparities in chronic diseases. To better understand social patterns in smoking behavior among adults in Argentina, we analyzed data from a nationally representative survey conducted in 2005. We investigated 1) the socioeconomic patterning of current, former, and never smoking status and intensity of smoking behavior; 2) whether socioeconomic gradients in smoking status and intensity varied by age or gender; and 3) the socioeconomic patterning of smokers’ readiness for smoking cessation.

Methods

Data Source

Data were taken from the 2005 National Survey of Risk Factors for Non-communicable Diseases conducted by the Argentine government. The study employed a four-stage probabilistic sample design with agglomerations of at least 5000 inhabitants sampled at the first stage, censal radios (with an average of 300 housing units) or clusters of censal radios sampled at the second stage, housing units sampled at the third stage, and an individual 18 years or older randomly sampled from all households within each housing unit at the fourth stage. The sample represents 96% of adults living in urban areas (with at least 5000 inhabitants). According to the 2001 census, Argentina has a population of 36.3 million people, with 89% of them living in urban areas (defined as areas with at least 2000 people) (153). A total of 41,392 people participated in the survey, from all 23 provinces in addition to the city of Buenos Aires. The response rate was 87% (154).

Trained interviewers visited the sampled households. Study participants answered questions about their tobacco use and other behavioral risk factors, in addition to questions about demographics, socioeconomic position (SEP), and household characteristics. A current smoker was defined as someone who smokes all or some days, and who has smoked at least 100 cigarettes in his/her lifetime. A former smoker was someone who has smoked at least 100 cigarettes in his/her lifetime, but does not currently smoke. A never smoker was someone who has never smoked at all, or has smoked less than 100 cigarettes in his/her lifetime. The number of cigarettes smoked per day was determined based on responses to the question, "During the last 30 days, on average, how many cigarettes did you smoke per day?" The survey also asked a series of questions that allow categorization of respondents into the Prochaska stages of change. The Prochaska stages of change is a theoretical model that represents a series of steps related to a person's attempt to change a health-related behavior (180). As applied to smoking in this study, precontemplation is the first step, in which the person has not considered stopping smoking, or thinks they might stop in more than six months. Contemplation represents the step in which the person hopes to stop smoking within one to six months. The Preparation stage is characterized by the person hoping to stop smoking within a month or less. Action is the stage when the person has stopped smoking, but smoked for the last time within the last six months. In the Maintenance step, the former smoker has not smoked for seven months or more. The Never Smoker stage represents people who have never smoked in their lives, or if they have, they have smoked less than 100 cigarettes in their lifetime.

Socioeconomic position was measured using individual education and monthly household income. Self-reported individual education level included categories for no school, incomplete primary, complete primary, incomplete secondary, complete secondary, incomplete tertiary or university education, and complete tertiary or university or more. Education level was treated as an ordinal variable. Monthly household income in pesos was reported in categories with ranges of no income, 1-100, 101-200, …, 1001-1250, …, 2001-3000, .., 5001 or more. In order to create a continuous variable we assigned each person the midpoint of the category as their monthly income.

Statistical Methods

All analyses were stratified by gender. Survey weights were used to account for the complex sampling design. Socioeconomic patterning by education and income were investigated separately.

Multinomial logistic regression was used to determine the socioeconomic patterning of smoking status and readiness for cessation. Smoking status was modeled as three levels: current smoking, former smoking, and never smoking. Smokers' readiness for cessation, based on the stages of change model, was also modeled as three levels: action stage, contemplation/preparation stage, and precontemplation stage (reference group). The contemplation and preparation stages were combined for this analysis since both stages represent a hope to stop in the near future. Ordinary least squares regression was used to investigate the socioeconomic patterning of smoking intensity, as measured by the number of cigarettes smoked per day among current smokers. Log transformation of the number of cigarettes resulted in qualitatively similar results, so the more easily interpretable metric was reported.

For each dependent variable (smoking status, cigarette consumption, and smokers' readiness for cessation), we ran two regression models for each SEP variable. In the first model we adjusted only for age, and in the second model we included an interaction term between each SEP variable and age. Due to evidence of important heterogeneity in the socioeconomic patterning of almost all smoking outcomes by age in both men and women, we report odds ratios associated with SEP for categorical smoking outcomes stratified by age. For cigarette consumption, we estimated predicted mean number of cigarettes smoked per day for the 10th, 25th, 50th, 75th, and 90th percentiles of education, stratified by age.

Results

Selected characteristics of the sample, stratified by gender, are reported in Table 5.1. Women reported lower monthly household income than men, but men and women had similar education levels. Education and income were positively, though not highly, correlated (Spearman correlation=0.46). Smoking prevalence was high for both genders, with 37% of men and 25% of women classified as current smokers and 21% of men and 12% of women as former smokers. Among smokers, women began smoking at slightly older ages than men (19 versus 17 years old). Men smoked more cigarettes per day than women (means of 12 and 9, respectively). The stages of change results indicate that many current smokers are in the precontemplation stage of change (30% in men and 21% in women). People in this stage do not see quitting as necessary and do not plan to quit within the next six months. Although a substantial percentage of men and women are former (maintenance stage) or never smokers, very few smokers plan to quit within one to six months (contemplation stage) or one month or less (preparation stage), and a small percentage have quit within the past six months (action stage).

Table 5.2 displays the gender-stratified multinomial logistic regression results for smoking status, with never smokers as the reference group. Older age was associated with lower odds of current smoking and higher odds of former smoking versus never smoking for both men and women. Associations of age with the odds of being a former smoker were substantially stronger in men than in women (OR of being former vs. never smoker =1.48, 95% CI 1.44-1.52 for men and OR=1.05, 95% CI 1.02-1.07 for women in education-adjusted model). Higher SEP was associated with lower odds of current smoking in men, but showed no association with former smoking (OR=0.80, 95% CI 0.77-0.83 for education for current versus never smoking). In contrast, higher SEP was associated with greater odds of current and former smoking in women (OR=1.09, 95% CI 1.06-1.13 for education for current versus never smoking).

Further analyses revealed evidence of important effect modification of the socioeconomic patterning by age for both genders (P for interaction <0.0001 in men and women for education for current and former versus never smoking). For men, higher education was associated with lower odds of smoking (both current and former versus never) across all age groups except former smoking in men aged 50-64 years (Figure 5.1). The inverse association of education with smoking was stronger among younger men than older men (OR=0.57, 95% CI 0.51-0.63 and OR=0.92, 95% CI 0.85-1.00 for current versus never smoking for ages 18-24 and 50-64 years, respectively). Among women, higher education was associated with higher odds of current and former smoking compared to never smoking in older age groups; in contrast, in younger age groups, women with higher education had lower odds of current smoking (OR=0.86, 95% CI 0.78-0.96 and OR=1.51, 95% CI 1.41-1.62 for current versus never smoking for ages 18-24 and 50-64 years, respectively). The qualitative patterns and statistical significance of the results for income were similar, but the magnitude of the associations was smaller.

Table 5.3 presents the regression results for intensity of smoking, measured as cigarettes smoked per day among current smokers. Older age was associated with greater cigarette consumption for men and women. Education showed no association with consumption for men or women, but higher income was associated with greater consumption for both genders (mean difference=0.30, 95% CI 0.13-0.45 for men and mean difference=0.57, 95% CI 0.44-0.70 for women in income model). There was evidence of heterogeneity in the SEP results by age, especially with education. For both men and women at younger ages, higher education had either no association or was associated with fewer cigarettes smoked per day (Figure 5.2). However at older ages (especially in those ages 50 and older) higher education was associated with more cigarettes smoked per day. These differences were more pronounced for women than men.

Table 5.4 displays the multinomial logistic regression results for the stages of change variables. For men, older age and higher SEP were associated with an increased odds of being in the action stage (i.e. quit smoking within the past six months) compared to the precontemplation stage (i.e. do not see quitting as necessary, or do not plan to quit within the next six months). For women, higher education was associated with increased odds of being in the action stage compared to the precontemplation stage, although associations were much weaker than those observed for men, and no patterns were observed by income (OR=1.59, 95% CI 1.43-1.77 for men and OR=1.11, 95% CI 1.00-1.23 for women in education model). Action was not consistently patterned by age in women (if anything, greater age was associated with lower odds of action). Being in the contemplation or preparation stage was not consistently or strongly associated with age or SEP in either gender when compared to the precontemplation stage.

Both men and women again showed important heterogeneity by age in the socioeconomic patterning of the action (though not contemplation/preparation) versus precontemplation stages (Figure 5.3). Higher education was associated with higher odds of being in the action stage versus precontemplation stage for men regardless of age group, though the association was stronger at older ages (OR=2.51, 95% 2.00-3.16 for ages 50-64 years). For women, higher education was also associated with higher odds of being in the action stage compared to the precontemplation stage, but only in younger age groups; there was no association for older women.

Discussion

Our analyses of this nationally representative sample from Argentina showed evidence of social inequalities in smoking-related outcomes, and also suggested that stronger associations of low socioeconomic position with adverse smoking behavior are emerging in younger cohorts. Higher education and income were associated with less smoking for men in all age groups, regardless of the marker used, although the results were most pronounced for men at younger ages. For women, higher education and income were associated with more smoking in older age groups, but less smoking in younger age groups. The number of cigarettes smoked was also generally positively associated with education in older age groups but less strongly so, or even inversely patterned, in younger age groups, although this interaction was not observed for income. These findings suggest that the socioeconomic patterning of smoking is changing with successive birth cohorts in Argentina, and increasingly concentrated among those with lower socioeconomic position. This pattern is particularly pronounced in women, among whom smoking has clearly shifted from those of higher to those of lower socioeconomic position.

Few studies have investigated the epidemiology of smoking in Argentina. The prevalence of current smoking was reported to be 40% for men and 23% for women in

1992 (164), with similar estimates (38% for men and 24% for women) in 2001 (181). We found a weighted prevalence of current smoking of 35% for men and 25% for women in 2005, suggesting a slight decrease in prevalence for men but little change or potentially slight increase for women. Within the city of Buenos Aires, better education was associated with less current smoking for men, but more current smoking for women; these results were not adjusted for age (182). A study using data from a 2001 national household survey in Argentina found that higher education was associated with less current smoking for men but more current smoking for women, with opposite trends for former smoking (181). These national results are generally consistent with our findings of stronger inverse social patterning in men than women overall. Our study adds to these findings by revealing stronger inverse associations of SEP with smoking in men in the younger cohorts, and important differences in the social gradient by age in women, with positive associations of higher SEP with smoking in older women, but an inverse patterning emerging in the younger cohorts. These results suggest that smoking is increasingly concentrated in the lower SEP groups, especially among younger cohorts.

Globally, few studies have comprehensively investigated the socioeconomic patterning of smoking in other middle- and low-income countries. Work in Asia and Africa generally shows that higher SEP is associated with less current smoking (69, 183, 184), except in rural areas in Pakistan and India where there was no socioeconomic patterning (69, 185). In Latin America, a study of adults 60 years and older in seven cities in Latin America and the Caribbean in 1999-2000, higher education was associated with less current smoking for men and showed no gradient for women in the overall sample (182). A study of Chilean adults showed no association between current smoking and

SEP (186), while among older Mexicans higher SEP was associated with more current smoking in urban areas but less current smoking in less urban areas (76). Together with this other work our results highlight the changing nature of the socioeconomic patterning of smoking and the concentration of smoking in the lower socioeconomic groups as the smoking epidemic evolves in middle- and low-income countries. The concentration of smoking in low SEP groups is especially worrisome because of the many socio-environmental factors that promote and sustain smoking in these groups (such as psychosocial stress, advertising, and accessibility of tobacco). These factors make it especially challenging to reduce smoking rates.

Our study also examined the prevalence and socioeconomic patterning of readiness to quit among smokers, according to the Prochaska stages of change model. Stage differences are predictive of a person's attempt to stop smoking, and their success in smoking cessation (187). We found that the vast majority of current smokers are in the first stage of change, or precontemplation, when smokers have not considered stopping their smoking behavior, or think they might stop in more than six months. Being a recent quitter was positively associated with education in both genders, although this relation was substantially stronger in men than in women. There was also some evidence that education was more related to quitting in younger women than in older women, which is consistent with the inverse socioeconomic gradient in smoking generally observed in younger women. These results highlight the importance of targeting messages regarding quitting, as well as offering support for quitting for persons of lower socioeconomic position. Although prevention is paramount, research in the US has shown that smoking prevalence will not decrease without also increasing cessation (188). Public health messages must include options for quitting, and support to access these options. A potential barrier to cessation is that although nicotine replacement therapies are increasingly available in Latin America, their costs are high compared to cigarettes (167). This is likely to enhance and reinforce socioeconomic gradients.

The FCTC has encouraged governments to enact a wide range of policies to decrease smoking. In a simulation model of tobacco control policies in Argentina, researchers found that the largest reductions in smoking prevalence and premature death due to smoking came from employing multiple policies simultaneously, although large tax increases could also cause large reductions on their own (189). Some of the most common population-based interventions to reduce smoking include clean air laws to restrict smoking in workplaces and public areas, restricting smoking in schools, preventing cigarette sales to minors, health warnings on tobacco products, prohibit tobacco advertising, and increase tobacco prices through taxation. Of these interventions, however, the only one that consistently affects socioeconomic classes differentially is the last: increasing the prices on tobacco products is more effective in reducing smoking in lower-income adults and those in manual occupations (190).

The Argentina tobacco control movement has seen some progress in recent years. For instance, the city of Buenos Aires and several provincial governments have passed clean indoor air laws (191). However, some of these laws are weak, with allowances for separate smoking areas in restaurants of a large enough size, and enforcement is spotty (192). The Argentine government, as well as governments in other countries facing the complex obstacle of the tobacco epidemic, will benefit from implementing a wide range of policy options. However, it would be helpful to also keep in mind how policies might affect the socioeconomic gradients in smoking behavior. For instance, large tax increases on tobacco products would potentially reduce smoking behavior overall while also working to decrease the relative burden of smoking among those of lower socioeconomic position. This is consistent with our results that higher income is associated with more cigarettes smoked per day.

This study has several limitations. Due to its cross-sectional nature we are not able to determine if the differences in the socioeconomic patterning of smoking that we see according to age groups represent more of an age or a true cohort effect. Although the survey is a large, national, population-based survey, it does not include people who live in areas with less than 5000 people. However, this is a small segment of the population, since 89% of Argentina's population live in urban areas (defined as areas with at least 2000 people) according to the 2001 census (153).

Conclusions

In this study we found an increasing concentration of smoking among those of lower SEP, especially among younger age cohorts. Very few studies in developing countries have investigated the socioeconomic patterning of smoking. While those of higher education and income levels may be the first to adopt unhealthy behaviors such as smoking in low- and middle-income countries, they are also more likely to have the resources to change their behavior and environment. Those of lower socioeconomic position may not have access to health promotion messages, and may not be able to afford products such as nicotine replacement therapy to help combat their addiction, making quitting more difficult among these groups. A growing concentration of smoking in persons of lower socioeconomic position is likely to result in increased disparities in chronic diseases unless appropriate interventions are undertaken.

Table 5.1 Selected characteristics of the sample by gender, Argentina 2005

Variable	Men	Women
N	17827	23565
Age in years; Mean±SD (range)	42.7±17.1 (18-97)	44.8±18.0 (18-98)
Education; N (%)		
No school	289 (1.6)	558 (2.4)
Primary incomplete	2048 (11.5)	2924 (12.4)
Primary complete	4198 (23.6)	5474 (23.3)
Secondary incomplete	3360 (18.9)	3544 (15.1)
Secondary complete	3563 (20.0)	4535 (19.3)
Tertiary or university incomplete	2303 (12.9)	2946 (12.5)
Tertiary or university complete or more	2033 (11.4)	3560 (15.1)
Monthly household income (in pesos); Mean±SD (range)	920.7±863.9 (0-5500)	815.7±774.3 (0-5500)
Current smokers; N (%)	6638 (37.2)	5955 (25.2)
Former smokers; N (%)	3832 (21.5)	2954 (12.5)
Never smokers; N (%)	7303 (41.0)	14586 (61.9)
Age in years when smoked for first time; Mean±SD (range)	16.7±3.5 (9-33)	18.6±5.5 (11-46)
Cigarettes per day during past 30 days; Mean±SD (range)	11.7±10.7 (1-90)	8.9±8.8 (1-90)
Prochaska Stages of Change; N (%)		
Precontemplation	5421 (30.4)	4889 (20.7)
Contemplation	685 (3.8)	530 (2.2)
Preparation	532 (3.0)	536 (2.3)
Action	438 (2.5)	410 (1.7)
Maintenance	3394 (19.0)	2544 (10.8)
Never smoker	7303 (41.0)	14586 (61.9)

Table 5.2 Adjusted odds ratios (95% CIs) of current versus never smokers and former versus never smokers according to age and socioeconomic characteristics for men and women, Argentina 2005

		Current versus never smoker	Former versus never smoker
Men	Age (centered, per 10 y)	0.88 (0.86, 0.90)	1.48 (1.44, 1.52)
	Education (per SD)	0.80 (0.77, 0.83)	0.99 (0.95, 1.03)
	P for interaction term	*P*<0.0001	*P*<0.0001
	Age (centered, per 10 y)	0.89 (0.87, 0.91)	1.45 (1.41, 1.48)
	Income (per 500 pesos)	0.91 (0.89, 0.93)	1.01 (0.99, 1.03)
	P for interaction term	*P*=0.7014	*P*=0.0270
Women	Age (centered, per 10 y)	0.78 (0.76, 0.79)	1.05 (1.02, 1.07)
	Education (per SD)	1.09 (1.06, 1.13)	1.29 (1.24, 1.34)
	P for interaction term	*P*<0.0001	*P*<0.0001
	Age (centered, per 10 y)	0.78 (0.76, 0.79)	1.02 (0.99, 1.04)
	Income (per 500 pesos)	1.06 (1.04, 1.08)	1.15 (1.13, 1.18)
	P for interaction term	*P*<0.0001	*P*<0.0001

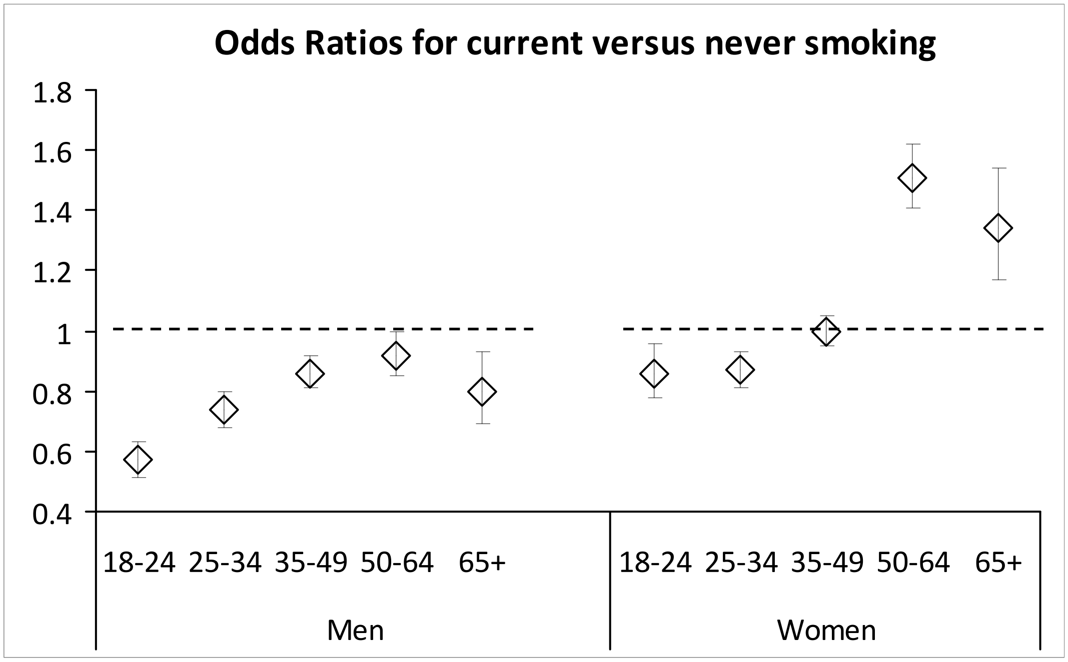
Table 5.3 Adjusted mean differences (95% CI) in cigarettes smoked per day by gender, Argentina 2005

		Cigarettes smoked per day
Men	Age (centered, per 10 y)	1.20 (1.02, 1.38)
	Education (per SD)	-0.11 (-0.42, 0.20)
	P for interaction term	*P*<0.0001
	Age (centered, per 10 y)	1.19 (1.01, 1.38)
	Income (per 500 pesos)	0.30 (0.13, 0.45)
	P for interaction term	*P*=0.0383
Women	Age (centered, per 10 y)	0.67 (0.52, 0.82)
	Education	0.17 (-0.05, 0.38)
	P for interaction term	*P*<0.0001
	Age (centered, per 10 y)	0.63 (0.47, 0.79)
	Income (per 500 pesos)	0.57 (0.44, 0.70)
	P for interaction term	*P*=0.4944

Table 5.4 Socioeconomic patterning of first four stages of Prochaska stages of change by gender, Argentina 2005

		Action versus Precontemplation	Contemplation and Preparation versus Precontemplation
Men	Age (centered, per 10 y)	1.22 (1.14, 1.31)	0.95 (0.91, 1.00)
	Education (per SD)	1.59 (1.43, 1.77)	1.09 (1.01, 1.18)
	P for interaction term	*P*=0.0978	*P*=0.8546
	Age (centered, per 10 y)	1.14 (1.07, 1.22)	0.94 (0.90, 0.99)
	Income (per 500 pesos)	1.17 (1.12, 1.22)	0.99 (0.95, 1.03)
	P for interaction term	*P*=0.0045	*P*=0.6091
Women	Age (centered, per 10 y)	0.97 (0.90, 1.04)	1.01 (0.96,1.07)
	Education (per SD)	1.11 (1.00, 1.23)	0.88 (0.82, 0.95)
	P for interaction term	*P*<0.0001	*P*=0.8012
	Age (centered, per 10 y)	0.92 (0.85, 0.99)	0.99 (0.94, 1.05)
	Income (per 500 pesos)	1.03 (0.97, 1.10)	0.97 (0.92, 1.01)
	P for interaction term	*P*=0.1035	*P*=0.5128

Figure 5.1 Odds ratios and 95% CI of current and former smoking versus never smoking associated with a 1 SD increase in education, by age and gender, Argentina 2005



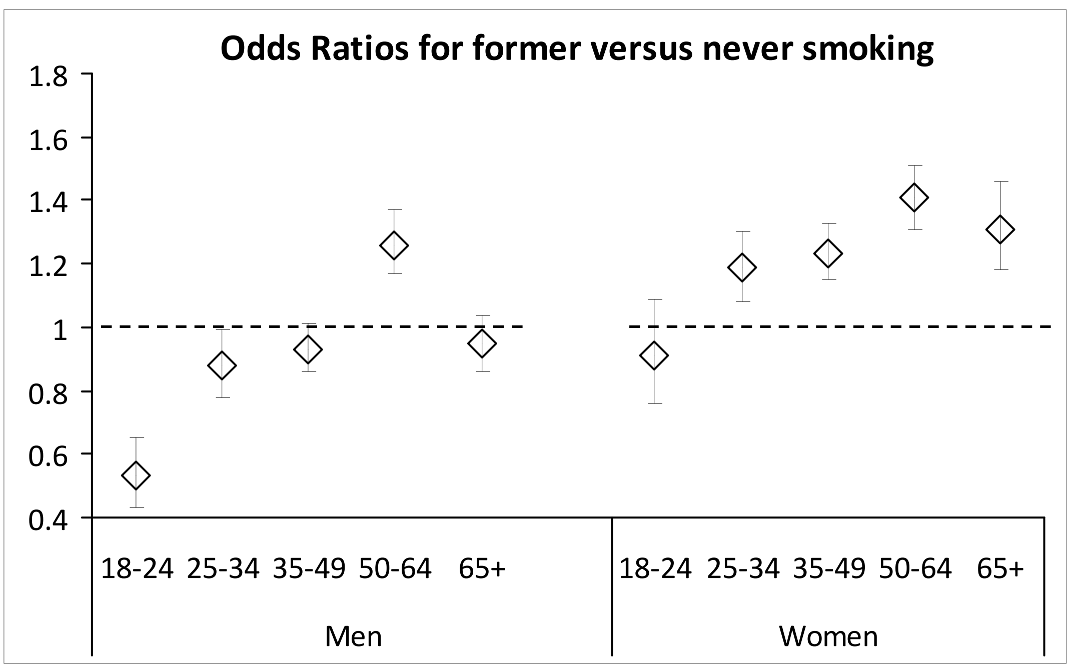
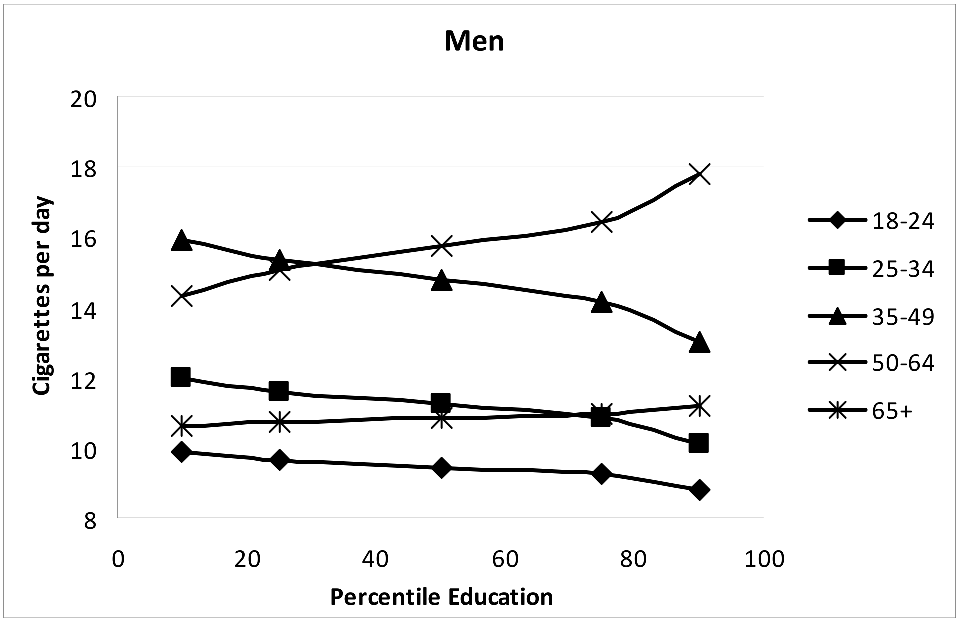


Figure 5.2 Predicted mean cigarettes smoked per day by education and age for men and women, Argentina 2005



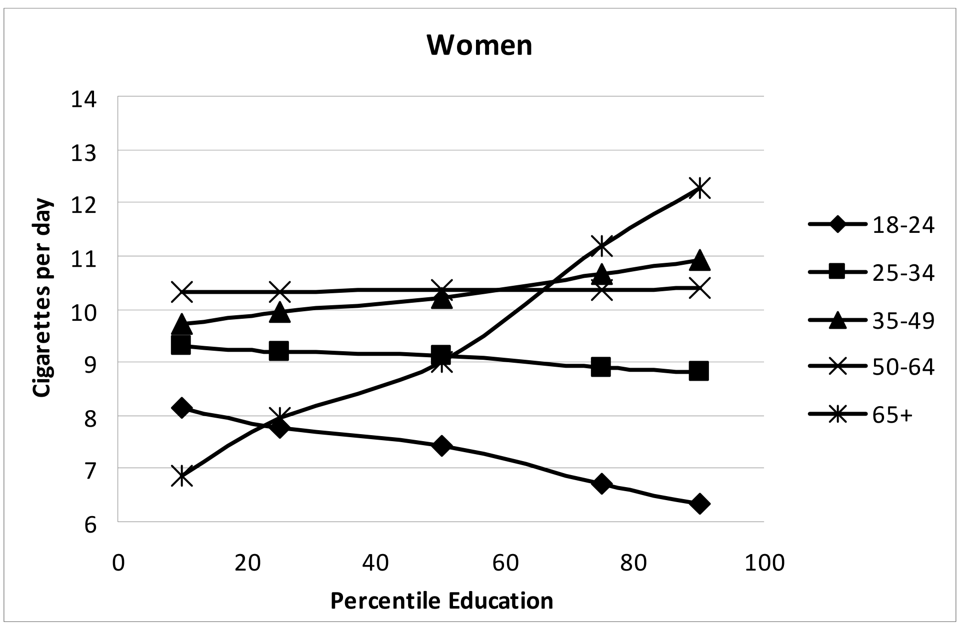
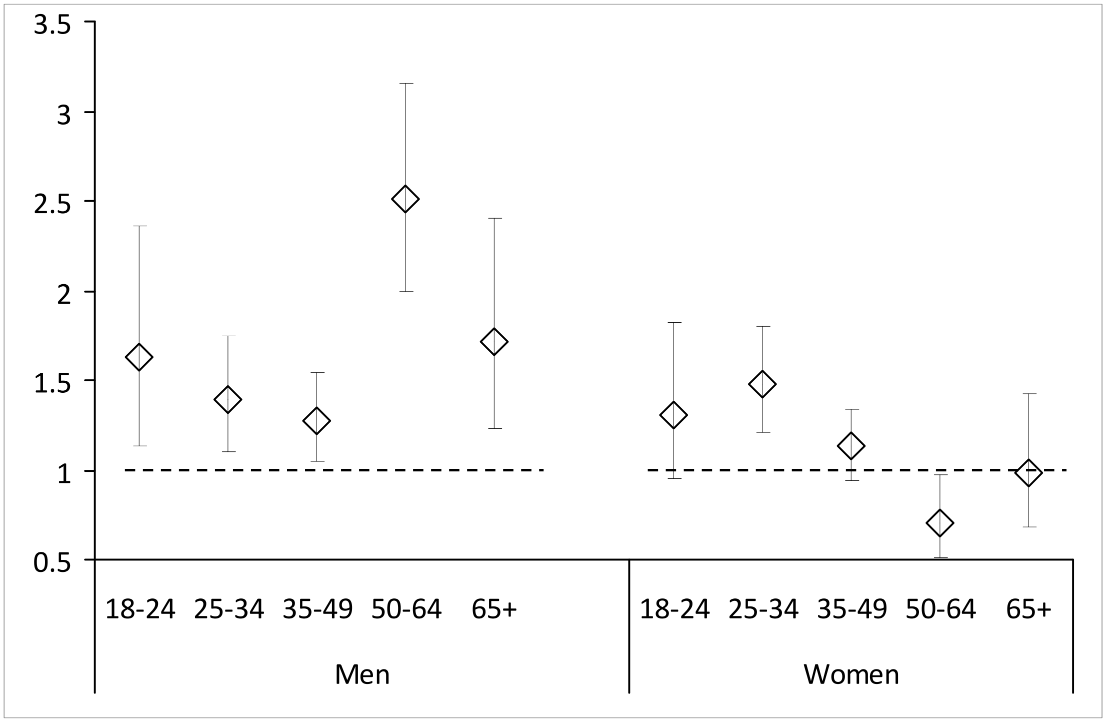


Figure 5.3 Odds ratios and 95% CI of action versus precontemplation stage associated with a 1 SD increase in education, by age and gender, Argentina 2005



Chapter 6 : Conclusions and Future Directions

Summary of Findings from Chapters 2-5

As a whole, this dissertation highlights a trend, globally and within countries, toward increasing burden of chronic disease risk among those of lower socioeconomic position. This social transition is documented both between countries (Chapters 2 and 3) and within one middle-income country, Argentina (Chapters 4 and 5). The epidemiologic and social transitions of chronic disease risk are complicated phenomena that vary geographically, over time, between genders, and between cohorts within countries. The transitions also vary depending on the specific chronic disease risk factor investigated. Smoking and obesity, two of the largest drivers of chronic disease risk globally, show much different patterns. Understanding the specific epidemics can help public health policy makers and practioners implement the most meaningful recommendations.

Chapter 2, the cross-national study using the World Health Survey data, examined the differences in population-level chronic disease risk prevalence between countries. In general, the prevalence of chronic disease risk factors was higher in countries with higher levels of urbanicity, with variation depending on gender and the specific risk factor. The ecologic loess analyses showed that BMI, obesity and diabetes are higher at higher levels of urbanicity for men and women, although BMI and obesity level off between 60-70% urban, whereas diabetes does not. The population curves of BMI, though, showed a distinct shift toward higher BMI in countries with at least 50% urban compared to those with less than 50% urban for both men and women. For men, there was little association between urbanicity and prevalence of smoking, except for higher prevalence around 60-80% urban. However, for women, there was a distinct rise in the prevalence of smoking with higher urbanicity, starting at about 50% urban.

In examining the contextual relationship between country-level urbanicity and the risk factors, we found similar results to the ecologic analyses with regards to BMI, obesity, and diabetes for men and women before adjusting for individual-level SEP. After adjustment, the trends of higher BMI and obesity were attenuated, particularly for women, as was diabetes, particularly for men. For smoking, both before and after adjustment for individual-level SEP, higher smoking was associated with higher urbanicity. This relationship was stronger and increased in a more monotonic fashion among women, whereas for men the peak of smoking was in the 50-75% urban areas compared to 0-25% urban areas.

Overall, results from Chapter 2 showed that although there is a concentration of risk factors among those living in the most urban countries, this may be changing. BMI, obesity and diabetes are clearly concentrated among the most urban, but the obesity epidemic (which fuels diabetes), is a younger epidemic globally than smoking. Tobacco use among men, who began smoking before women in most parts of the world, was not strongly related to country-level urbanicity. For women, smoking was higher with higher country-level urbanicity. This could represent a shift in the tobacco epidemic, where men's smoking behavior is similar regardless of country-level factors but women's behavior lags behind. It is also possible that the obesity epidemic will follow the same route, where eventually all populations have similar, and high, levels of obesity without public health intervention.

Chapter 3 also used the WHS data to investigate the within-country socioeconomic patterning of BMI and smoking, and to see whether these country-specific patterns could be explained by country-level factors in a global context. The analyses showed that the socioeconomic patterning of BMI and smoking varied greatly by country-level urbanicity. In less urban countries, women displayed a positive socioeconomic gradient with BMI, such that those of high SEP had a higher BMI than those with low SEP. There was evidence for a social transition with increasing urbanicity such that women in the most urban countries had an inverse relationship where women of high SEP had a lower BMI than those of low SEP. Men showed a similar trend with BMI, except that they converted to more of a null relationship between wealth and BMI in countries at high levels of urbanicity rather than an inverse socioeconomic relationship. For smoking, men with higher SEP had a lower odds of smoking regardless of country-level urbanicity. The pattern for women's smoking behavior was less straightforward. In the least urban countries, they had an inverse socioeconomic gradient. This relationship was attenuated with increasing urbanicity, with some countries drifting toward a positive gradient, especially for those with about half of their populations living in urban areas. Taken as a whole, countries seem to transition to a concentration of worse BMI among those of lower SEP at higher levels of urbanicity, especially for women. It appears that globally, smoking is already concentrated among those of lower SEP, especially for men.

In addition to finding variation in the social patterning of chronic disease risk across countries, this dissertation also found differences regionally (Chapter 4) and over time (Chapter 5) within one middle-income country in transition, Argentina. Chapter 4 examined the socioeconomic patterning of several risk factors depending on provincial-level urbanicity within Argentina, which did not participate in WHS. Again the study demonstrated overall trends, with a great deal of complexity in the socioeconomic gradients of several major chronic disease risk factors, and how urbanicity affected the gradients. The results showed that the socioeconomic patterning of risk factors was modified by urbanicity, such that for many of the risk factors examined the inverse patterning (i.e. lower risk factor levels in the more advantaged groups) became stronger or only emerged in more urban settings. This effect modification was stronger in men than in women. Two exceptions to this general pattern were eating fruits and vegetables in men and low physical activity in women. Both of these risk factors showed stronger inverse social patterning in less urban than in more urban areas: in men, the inverse association of education with eating fruits and vegetables was stronger in less urban than in more urban areas; in women higher education was associated with lower probability of low physical activity in less urban areas but the opposite was observed in more urban areas. The results also showed that the associations of urbanicity with risk factors were not homogeneous across social groups. For example, in both men and women, greater urbanicity had beneficial effects on BMI and diabetes for persons of higher education but no effect or the opposite effect (worse risk factor levels in more urbanized areas) was observed for persons of low education. A similar pattern was observed for hypertension in men. In men, greater urbanicity had unfavorable effects on probability of fruit and vegetable but only among the more educated. In women, greater urbanicity had unfavorable effects on physical activity but this was more pronounced in the less educated.

Chapter 5 analyzed the use of tobacco in Argentina in more depth. The analyses showed evidence of social inequalities in tobacco use, and suggested that stronger associations of low socioeconomic position with adverse smoking behavior were emerging in younger cohorts. Higher education and income were associated with less smoking for men in all age groups, regardless of the marker used, although the results were most pronounced for men at younger ages. For women, higher education and income were associated with more smoking in older age groups, but less smoking in younger age groups. The number of cigarettes smoked was also generally positively associated with education in older age groups but less strongly so, or even inversely patterned, in younger age groups, although this interaction was not observed for income. These findings suggest that the socioeconomic patterning of smoking is changing with successive birth cohorts in Argentina, and increasingly concentrated among those with lower socioeconomic position. This pattern is particularly pronounced in women, among whom smoking has clearly shifted from those of higher to those of lower socioeconomic position.

Study Limitations

Cross-sectional data

This dissertation used population-based datasets from 71 countries, but all data were cross-sectional in nature. Ideally, in order to study the transition of prevalence and socioeconomic patterning of chronic disease risk, we would like to look across time for many countries. However, comparable, cross-national datasets with population-representative data are not readily available. In fact, WHS represents one of the first efforts to have data that are comparable across countries on a wide range of health indicators in order to provide reliable, comparable information to policy-makers and to monitor health systems (80). Since these surveys were only conducted once – between 2002 to 2003 – the analyses are limited by the data. Likewise, the Argentina dataset represents the first time in that country's history that a chronic disease risk factor survey was employed, in 2005. A second survey was in the field in 2009, which will enable public health researchers to examine changes in trends over time within Argentina. Some risk factors have been investigated in more depth, and cross-national datasets are available for data collected in a comparable manner. For instance the Global Adult Tobacco Survey, started in 2007 by the Centers for Disease Control and Prevention (193), is another cross-national study of population-based data. However, once again, these data were only collected at one point in time to date. As global surveillance of chronic disease risk improves, researchers will have greater opportunity to investigate these trends over time.

Generalizability and representativeness of countries

The dissertation analyses were also limited by the countries for which data were available. Chapters 2 and 3 included data from the 70 countries that participated in the WHS, but it is not clear if this is a representative sample of all countries in the world. Although there were countries from all levels of development (low-, lower middle-, upper middle- and high-income), from all of the WHO regions, and from a wide range of levels of urbanicity, this does not preclude that there were some areas in the world that were not adequately represented, and that may have very different patterns of chronic disease risk. For instance, although six countries from the WHO Western Pacific Region participated in WHS, none of them were the island nations of the South Pacific, which experience quite different interactions with the global community than the Philippines or Malaysia, as an example. In addition, only BMI and obesity had data from all 70 countries. Diabetes and smoking data were only available for 52 and 53 countries, respectively. Many of the high-income countries did not include these questions in their surveys, and so those results may not fully capture the range of experiences for those two risk factors. Likewise, the results of the in-depth studies of Argentina may be unique to that country, and may not represent the experiences of other Southern Cone, Latin American or middle-income countries.

Self-reported measures

Another limitation of the research presented here is that all of these data were self-reported. Both the WHS and Argentina surveys, though validated and conducted with trained interviewers, relied on the respondents for all individual-level data. This likely introduces measurement error. For example, people in poorer countries, in less urban areas within those countries, and of lower socioeconomic position may have more limited access to medical care, and the prevalence of hypertension and diabetes may be underestimated for these groups (160). In addition, these same populations may not know their height or weight, due to few measuring tools in their parts of the world, and may not accurately report these measures, leading to a miscalculation of BMI and obesity. These factors could also explain some of the large degree of missingness for BMI in several countries in the WHS. In turn, the missingness could be impacting the prevalence and social patternings within the countries. For instance, since those with missing data were more likely to be older, female, and of lower SEP, mean BMI and the prevalence of obesity in the least urban countries could be overestimated, particularly for women, given the positive socioeconomic patterns we see in these countries.

Individual-level measures socioeconomic position

In the WHS studies we used individual-level education and household wealth as markers of socioeconomic position, and in Argentina we used education and household income. These measurements are meant to capture different aspects of socioeconomic position, which encompasses the "social and economic factors that influence what position(s) individuals and groups hold within the structure of society" (194). Social epidemiologists emphasize the importance of relating different markers of SEP to specific mechanisms that may influence particular health outcomes (195). However, our measurements of education, income and wealth were treated in general as more generic measures which may not adequately represent relevant social stratification for all of the populations in the studies. For instance, although the wealth markers in the WHS were designed to allow for cross-national comparisons, they may not adequately capture the range of situations within and between countries. The measure included asset ownership (e.g. bicycle, refrigerator), availability of services (e.g. electricity), housing characteristics (e.g. water source), and demographic information on the head of household (84), but there could have been other markers that were more salient in specific communities. We also focus more on general patterns than specific hypotheses relating particular SEP measures to the specific chronic disease risk markers. On the one hand, the similar results that we found regardless of SEP measure indicate a certain robustness in the patterns within and between countries. However, it also the general patterning also fails to identify specific mechanisms that may be happening, for instance, within a particular country or region when multiple markers do not give the same patterning.

In addition, due to large gender differences in the access to education and wealth, especially in poorer countries, other markers may be more appropriate for women. The same could be true for the markers used in Argentina – education and household income. Perhaps a wealth measure would have more appropriately described the variation between the households in the different regions of the countries.

Another issue of comparability between countries arises with the use of education modeled per standard deviation by country and then used in the meta-analysis to make comparisons across countries. Since the distributions of education are so different across the 70 countries represented in the WHS data, this may not be a fair comparison and it may be inappropriate to compare the point estimates when they are in effect on different scales (196). Although the standard deviation of education does not appear to be related to urbanicity (results not shown), SD ranges between 2.5 and 5.8 for men, and 2.7 and 7.6 for women (with means of 4.1 and 4.3 for men and women, respectively). Thus, education modeled per standard deviation may not be the best way to compare education across countries. We might consider scaling education by four years (the mean of the SD distribution), or creating an ordinal variable related to levels of education, such as no education, grade school, middle school, high school, and advanced education. However, the ordinal variable may create problems in making comparisons across countries due to poor representation in the lowest-income countries in the higher education levels. In addition, although the point estimates should not perhaps be compared across countries, there may be fewer problems comparing the direction of association (197), which was the focus of the meta-analysis. The meta-regression, however, would be more susceptible to the SD issues. Since the meta-analysis and meta-regression results using wealth as the measure of SEP rather than education provided similar interpretation, though, the results may not be sensitive to the particular modeling of education.

Urbanicity

Urbanicity was used throughout this dissertation as a proxy for a variety of social and economic changes associated with urbanization. Again, due to limitations with the cross-sectional nature of the data, the analyses were unable to look at the how the process of urbanization itself influences chronic disease risk. The speed of urbanization is most rapid in the developing world, so the static measure of urbanicity is unlikely to fully capture the impact of these changes. In addition, other markers of globalization, including economic development and the liberalization of trade policies, are impacting chronic disease risk and were not investigated here. However, economic development and urbanicity, for instance, were highly correlated, making it difficult to tease apart their contributions. In the WHS studies, GNI per capita and percent urban were high correlated (Spearman correlation = 0.83). The same was true for provincial-level urbanicity and two economic indicators (median household income by province, derived from the survey data, and a marker of provincial-level economic activity per capita) in the Argentina study (Spearman correlation coefficient=0.78 and 0.73, respectively). In sensitivity analyses, results did not differ much when a marker of economic development was used in lieu of urbanicity, highlighting that the difficulty in isolating independent parts of the processes of globalization.

Public Health, Policy and Research Implications

These dissertation findings offer some insight into how the processes of globalization affect health and how social conditions as fundamental causes of disease affect advanced stages of the epidemiologic transition. Differences in chronic disease risk both between and within countries reveal a complex pattern. Although the analyses presented here provide evidence for a social transition of chronic disease risk toward an increased burden among those of lowest socioeconomic position, many factors influence the transition. The specific risk factor, geographic location, gender issues, and urbanicity all contribute to the variability in chronic disease risk that is being influenced by the complicated processes of globalization.

These studies focus on the social transition across varying levels of urbanicity, and how that transition differs for women and men. However, many other areas have yet to be investigated. Are these patterns seen in the cross-national studies representative of the global situation, or specific to the 70 countries that participated in WHS? Do the diabetes and smoking results differ when a substantial number of high-income countries are included in the analyses? Does the rate of urbanization and economic development exacerbate social inequalities in chronic disease risk? What country-level policies reduce both the overall burden as well as the inequalities in chronic disease risk factors? Are there ways that countries can simultaneously participate in globalization and reduce chronic disease burden and inequalities in chronic disease risk?

With the rapid pace of urbanization, low- and middle-income countries are increasingly susceptible to enormous health and economic consequences due to the increase in chronic disease burden (36). Health systems in these countries are poorly equipped to deal with the epidemic of chronic diseases (1). Population-level interventions, such as implementing tobacco control policies and salt reduction, must be considered in addition to improvements in individual-level treatments to avert greater consequences from chronic diseases in low- and middle-income countries (127, 128, 129). However, it is clear from the analyses that policies that address socioeconomic inequalities in chronic disease risk are also paramount.

Although population-level policies focused on the obesity epidemic are relatively new and unproven (e.g. banning trans fats, urban planning intiatives), the tobacco control movement has had success with policies affecting both population-level and social inequalities. Effective population-based interventions to reduce smoking include clean air laws to restrict smoking in workplaces and public areas, restricting smoking in schools, preventing cigarette sales to minors, placing health warnings on tobacco products, prohibiting tobacco advertising, and increasing tobacco prices through taxation (163). Of these, however, only price increases consistently affect socioeconomic classes differentially (190). Countries that have yet to implement aggressive tobacco control measures, as well as all places concerned with the obesity epidemic, can learn from these findings. Perhaps taxing high fructose corn syrup, for instance, could contribute to a reduction in the inequalities in BMI, especially in the most urbanized countries. In fact, there is evidence, at least in the U.S., of increased price elasticity (i.e. decrease in demand or amount purchased) for many food items, especially food eaten away from home (including fast food and restaurant meals), soft drinks, juice, and meat; there is little evidence, though, that the elasticity is different by social class (198). However, even if reduction in calories can be achieved by such options, an increase in physical activity must also occur. Changing the environment offers promise, but also great challenge due to the expense of employing these interventions. Rapidly urbanizing countries could take note, though, and incorporate green spaces, public transportation, and mixed-use communities into urban planning initiatives now to prevent chronic disease in the future. In doing so, however, it is critical that inequalities in access to these public goods also be taken into account, lest the trend of increasing disparities accelerate.

While health policies and interventions to reduce disparities in chronic disease risk are critical to the public health agenda, it is paramount that we remember the underlying causes of these inequities. If social conditions are, truly, a "fundamental cause of disease" (63), a shift to increased burden of chronic disease risk among the poor as countries become more urban and more developed is only the latest example of health disparities. These dissertation findings indicate that as countries process through the epidemiologic transition, an additional stage in the theory, or even a reformulation of the theory based on this evidence and the critiques mentioned in Chapter 1, may be necessary. Health behaviors (e.g. smoking, diet, and physical activity) and biomedical risk factors (e.g. BMI, hypertension, and diabetes) affecting the transition to a predominance of chronic disease risk also undergo a risk and subsequent social transition. Those of lower socioeconomic position seem to process more slowly through the various stages of the epidemiologic transition, resulting in increased burden among the poor despite country-level movement toward less chronic disease risk and advanced aging patterns. Providing equal access to education and employment, in addition to social policies that address wealth and income distribution, should be priorities for all countries regardless of level of development in order to eliminate or avoid inequalities as countries progress through the increasingly complex conceptualization of the epidemiologic transition.

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