Global Perspectives on Health Geography

Tomoki Nakaya
Yuri Ito *Editors*

The Atlas of Health Inequalities in Japan

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Global Perspectives on Health Geography

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Foreword

This *Atlas of Health Inequalities in Japan* accomplishes many intentions, and it is particularly novel because of the new and innovative visualization techniques used. First, patterns never seen before across the islands of Japan are revealed. Second, those patterns are seen to be changing in ways that should direct future research toward the greatest needs. Third, the true horror of the terrible 2011 Great East Japan Earthquake, one of the worst natural disasters in human history, is highlighted. Fourth, it illustrates for everyone how the use of advanced cartographic techniques enables us to see all these matters in ways not possible until relatively recently. Further, we can see that these issues of medical interest and inequality have never been visualized so comprehensively and thoroughly as in this atlas.

Traditional medical mapping hides, within tiny scattered specks of color, what is happening to the great majority of people living in cities. Traditional mapping draws the reader's attention toward large, sparsely populated areas, which may be of value when events in those areas are of the greatest interest. However, when studying people, and the geographic patterns of their health outcomes, traditional equal area map projections can completely distort the message to be received, leading the viewer to believe that something that is happening is important when it actually quite minor, and diverting their attention from what is really happening to most people. The use of equal population cartograms in this atlas of health inequalities ensures that each person in Japan is given equal representation on every map.

Not all inequalities are geographic. Early on in this atlas inequalities by occupation are investigated, revealing, for example, that the suicide rates of managers in Japan, below average until the late 1990s, rose during the first decade of the twenty-first century to become more frequent than among people working in other occupations or those people in professional occupations (Fig. 2.3).

Not all inequalities in health are best illustrated by studying mortality. The rise in the rate at which boys and girls in Japan are becoming overweight is shown, in this atlas, to be influenced by whether they have a sibling. It is often necessary to consider many factors at once, such as geographic area, gender, age, occupation, family structure, and all the many changes over time in such issues that can also influence our health. An atlas is the ideal way in which to do this, and this particular atlas is a brilliant example of how best to achieve such a set of considerations without overwhelming the reader.

This volume is also one of the first health atlases to be produced worldwide that does not shy away from explaining in detail complex measures such as the slope and relative indices of inequality. In this, it is reminiscent of the earlier, extremely methodical work of Peter Haggett, Mathew Smallman Raynor, Andrew Cliff, and Peter Gould, but here drawn using a very different perspective, especially suitable for a country so densely settled by so many people, and becoming increasingly more and more densely populated in a relatively small area of land.

The use of 3D perspectives and often the full range of color is especially striking. As one example, the maps of smoking show truly amazing geographic variation, both within cities and across the country, simultaneously (Fig. 3.31). The traditional mapping in detail within Osaka Prefecture is particularly stunning (Fig. 7.5).

Inequality is the key theme of this atlas. The rising geographic inequalities in mortality over time of men aged over 40 years, of boys and girls, and recently of most women of all ages is an especially worrying development (Fig. 7.2). The contribution of driving accidents to these changes suggests what may be occurring (Fig. 7.4). It is very possible that the latest worse inequality statistics are mainly a result of the deaths caused by the Great East Japan Earthquake. However, even before then, in many cases, geographic inequality in mortality in Japan was slowly increasing. As Japanese cities become ever more safe, people in rural areas may appear to suffer relatively more, as these people still rely upon their cars (one of the most dangerous of all human inventions).

After several decades of unprecedented low economic growth for Japan, an era that since 2008 that might well be beginning for many other countries, the messages of this atlas are of great importance to people all around our world. Japan is now often ahead of the curve, and so there is much to learn from this atlas for those living in countries where people have not yet managed to live so long on average. In Japan, geographic inequalities in deaths from the main causes—cancer, cerebrovascular disease, heart disease, pneumonia—are now rising, and especially so for cancers. Why is this? And could this be the future for many other parts of the affluent world in the years soon to come?

The editors and authors are to be greatly congratulated. To coordinate thirteen scholars from such a wide range of academic departments and universities is no easy task. To persuade a publisher to include so much complex material in one volume is also very difficult, and to cover so well, and so clearly and concisely, such a wide range of diseases, topics, other health-related material, and social and economic factors is a major achievement. The *Atlas of Health Inequalities in Japan* should be seen both as a model of great innovation that requires replication not now seen elsewhere and as a key resource for policy makers, researchers, and the general public in Japan, who want to know about the most important part of all our lives—our health—and how in aggregate this is changing.

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Preface

This atlas aims to visualise in detail the geographical disparities in the health of the Japanese population by focusing on the ‘lost decades’, the stagnation period of Japanese societies as Japan’s economic growth slowed down to the extent that it almost ceased. Towards the end of the 1990s the widening of income disparity became a focus of social concern in Japan, which was thought to be an egalitarian society with a poor sense of disparity with more than 80% of Japanese people regarding themselves as middle class. The widening trends of social and economic disparities, typified by income disparity, include the expansion of geographic disparities between major metropolitan areas such as Tokyo and peripheral local governments. This concern about geographic disparity has continued to grow and attract public interest. Such social disparities with geographic dimensions may contribute to the widening social disparities in health with geographic dimensions. This atlas was designed to provide the fundamental information to examine this issue.

In this book, we introduce cartograms to simultaneously express the distribution of population size and the regional differences in mortality rates, thereby effectively representing the health disparities across Japanese society. To our knowledge, this is the first cartogram-based health atlas in Japan. In addition, we provide various quantitative indicators of transitions in geographic socioeconomic inequalities of mortality using census-based area indicators during the target period. The attempt to identify social disparities in health through the cartographic technique with the inequality measures was inspired by previous exceptional collaborative works between geographers and epidemiologists, particularly those of Professor Danny Dorling and his colleagues.

We thank Mr. Shohei Nagata for his professional support in producing GIS-based maps. This collaborative research by geographers and epidemiologists was supported by the JSPS KAKENHI Grant-in-Aid for Scientific Research (B) Grant Number 15H02964 (Principal Investigator: Tomoki Nakaya), and Health Labour Sciences Research Grant (Principal Investigator: Yuri Ito).

Finally, we would like to express our gratitude to our families for their continuous support in our research activity.

Sendai, Miyagi, Japan — Tomoki Nakaya
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Abbreviations

ADI	Areal deprivation index
ASMR	Age-standardised mortality rate
ATL	Adult T-cell leukaemia
AYA	Adolescents and Young Adults
BYM model	Besag, York, and Mollié model
CMR	Crude mortality rate
CNP	Chlornitrofen
COPD	Chronic obstructive pulmonary disease
HBV	Hepatitis B Virus
HCC	Hepatocellular carcinoma
HCV	Hepatitis C Virus
HD	Heart disease
HPV	Human Papillomavirus
HTLV-1	Human T-lymphotropic virus type I
ICD	International Classification of Diseases
INLA	Integrated nested Laplace approximations
JAGES	Japan Gerontological Evaluation Study
JGSS	Japanese General Social Survey
LEB	Life expectancy at birth
OECD	Organisation for Economic Co-operation and Development
RII	Relative index of inequality
SEP	Socioeconomic position
SES	Socioeconomic status
SII	Slope index of inequality
SMR	Standardised mortality ratio
TB	Tuberculosis

List of Figures

List of Tables

1 Introduction

Tomoki Nakaya

This introduction explains the background of the health atlas project of Japan. After the bubble economy boom burst in the early 1990s, a long-lasting economic stagnation known as the lost decade(s) has deeply impacted Japan. Since the late 1990s, the widening income gap and rising poverty rates have become a shared social concern in society. These trends are thought to be associated with growing social inequality in health, even though the national insurance system covers most of the population. This health atlas project intends to provide a clear picture of Japanese health disparities from a geographic perspective by using a series of cartographic representations and quantitative measures of the health inequalities. Regarding the mapping technique conducted in the project, the concept of the cartogram with the example of life expectancy at birth (LEB) as of 2010 will be introduced; the cartogram may change our view on geographical health inequalities in Japan. Traditional thematic mapping of the indicator highlights the gap in LEB between two non-metropolitan parts, the northern and central parts of the main island, Honshu. Looking through the cartogram lens, another comparable gap in LEB emerges within metropolitan regions, affluent and healthy suburbs vs. unhealthy and more deprived inner-city areas, indicating socioeconomic inequality of longevity. This atlas project highlights geographically observable socioeconomic inequalities in health among about 1800 municipalities and their transitions in the two decades from 1995 to 2014.

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1.1 The Aim of This Health Atlas

Japan is one of the healthiest nations in the world. The life expectancy of Japanese men and women, as of 2017, is 80.5 and 86.8 years, respectively, and these numbers are still increasing. Between the 1920s and 1950s, the country experienced a rapid decline in mortality and changes to the composition of causes of death, from infectious diseases such as tuberculosis to chronic diseases such as cancer. There has been a sharp increase of life expectancy since then, reflecting the post-war rapid economic growth. At the same time, the country has often been perceived as one of the most egalitarian societies, as seen in “The Spirit Level” (Wilkinson and Pickett 2009), indicating that the egalitarian characteristics of Japanese society have contributed to the great epidemiological achievements of the country. Social services covering almost the entire population, including universal health insurance, compulsory primary education and social insurance system, may support the health of the general population as well as the regional equalisation of health in the country (Marmot and Smith 1989; Ikeda et al. 2011). The financial adjustment policy of the national government to assist local governmental revenue helped to reduce regional disparities in living standards and public health resources in the post-war period, contributing to the reduction of geographical disparities in health in Japan (Takano and Nakamura 2001). However, these views may mask the existence of various health inequalities that are often associated with socioeconomic geographical contexts within society.

This situation has been exacerbated by traditional mapping, which uses large areal units (e.g. nine regions or 47 prefectures) and ordinary map projections, in which large inequalities of health within metropolitan regions are easily underestimated because of their small areal sizes in the populous regions. Since three quarters of the total area of the Japanese islands is mountainous, large populations are generally concentrated in the limited areas of plains and basins

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surrounded by hilly ranges. The cartographical technique, population cartogram, can overcome this problem by enlarging areas of populated regions based on their population size. As the cartogram-based atlas has become popular in recent social atlas publications focusing on European countries (Ballas et al. 2014; Dorling 1995; Gleeson et al. 2010), it should also be suitable for mapping the social inequalities of health in Japanese society, with its mountainous geographical setting and large variation in local population densities.

This new atlas of Japan aims to present a series of maps showing the health of the contemporary Japanese population, i.e. detailed maps of health indicators, primarily mortality, in approximately 1800 municipalities using cartograms from the last two decades, 1995–2014. As well as the cartographic method using the concept of areal cartograms, Bayesian spatial smoothing is employed to gauge reliable mortality indices and to overcome problems caused by small-area-based data.

In addition, the atlas highlights geographical aspects of socioeconomic inequalities in health by comparing the mortality indicators with the distribution of deprivation indices in the country. Health inequalities mean systematic and unfair differences in health between populations segmented by socioeconomic position (SEP) in society (Braveman 2006). That is, more socioeconomically disadvantaged populations systematically experience worse health. As well as individual status, such as income or educational attainment, SEP has often been measured based on socioeconomic conditions of geographic residential areas to identify tendencies that populations living in more socioeconomically deprived areas are more likely to have worse heath levels. In this atlas, geographically measured indices of health inequalities from 1995 to 2014 are given for each mortality map. The results show how health inequalities have been shaped geographically over the two recent decades in one of the world's healthiest nations.

1.2 Cartogram: An Introductory Example

As introduced above, the cartographic technique conducted in the project and the resulting cartograms may alter our view of geographical health inequalities in Japan. Figure 1.1 demonstrates how the idea of the cartogram works. Figure 1.1a shows the 47 prefectures in Japan using an ordinary map projection, and Fig. 1.1b shows the distorted prefectures using the Gastner–Newman algorithm of the population density-equalising cartogram (Gastner and Newman 2004). The cartogram algorithm smoothly changes the geometry of regions to make their area size proportional to their regional population size. As a result, the area sizes of populated regions, such as Tokyo, Aichi, and Osaka Prefectures, the core regions of the three major metropolitan areas, are greatly enlarged in the population cartogram of Japan. In both maps in Fig. 1.1, the terrain was displayed by hill-shading. It illustrates that while the large part of the lands is mountainous as shown in the ordinary map (Fig. 1.1a), areas of plains with high population density becomes dominant by the cartographic transformation (Fig. 1.1b).

Using the cartogram, Fig. 1.2 shows the geographical distribution of life expectancy at birth (LEB) in approximately 1800 municipalities as of 2010. Figure 1.2a, b are maps of municipal LEB based on the ordinary map projection that is used for conventional maps for various purposes in daily life, such as teaching and navigating. The map image shows a clear contrast between the high mortality rate in the northern part of the biggest island, Honsyu, and the low mortality rate in the central mountainous areas of the same island. The two regions are both in non-metropolitan areas where municipalities are low in population density and large in area size. On the other hand, Fig. 1.2c, d show the same LEB distributions based on the population cartogram in which the area sizes of municipalities are geometrically distorted, in order to show area sizes as proportional to their population size. As aforementioned, the areas of municipalities in metropolitan areas are greatly enlarged to reflect their population size. The most obvious feature of these cartogram-based LEB maps is the magnitude of the health disparities within the metropolitan areas. For example, in the central part of the Tokyo metropolitan area, the suburbs extending westward from the centre of Tokyo are areas with long LEB (blue coloured), while the eastern and coastal areas of the Tokyo Bay are areas with shorter LEB (red coloured). These geographical disparities in health within metropolitan areas correspond well with differences in socioeconomic areas of residence, which are contrasted as *Yamanote* ('affluent uptowns') and *Shitamachi* ('old downtowns' becoming inner-city areas). We also identified similar geographical differences in the Osaka metropolitan areas, finding affluent suburbs with longer LEB and deprived inner-city areas with shorter LEB. See Chap. 2, Sect. 2.4 for the details of social areas in the Japanese metropolitan areas.

Noting that the area sizes on the cartogram correspond to the sizes of the regional populations, we understand that the total population size of the unhealthy (shorter LEB) regions coloured in orange or red within the metropolitan areas is almost equivalent to that of the northern part of the northern region of the main island. Similarly, the total population size of the healthy (longer LEB) regions coloured in blue within metropolitan areas is larger than that of the central region of Japan.

While traditional thematic mapping of the indicator highlights the gap in LEB between two non-metropolitan parts, when one looks through the cartogram lens, another comparable gap in LEB emerges within metropolitan areas,

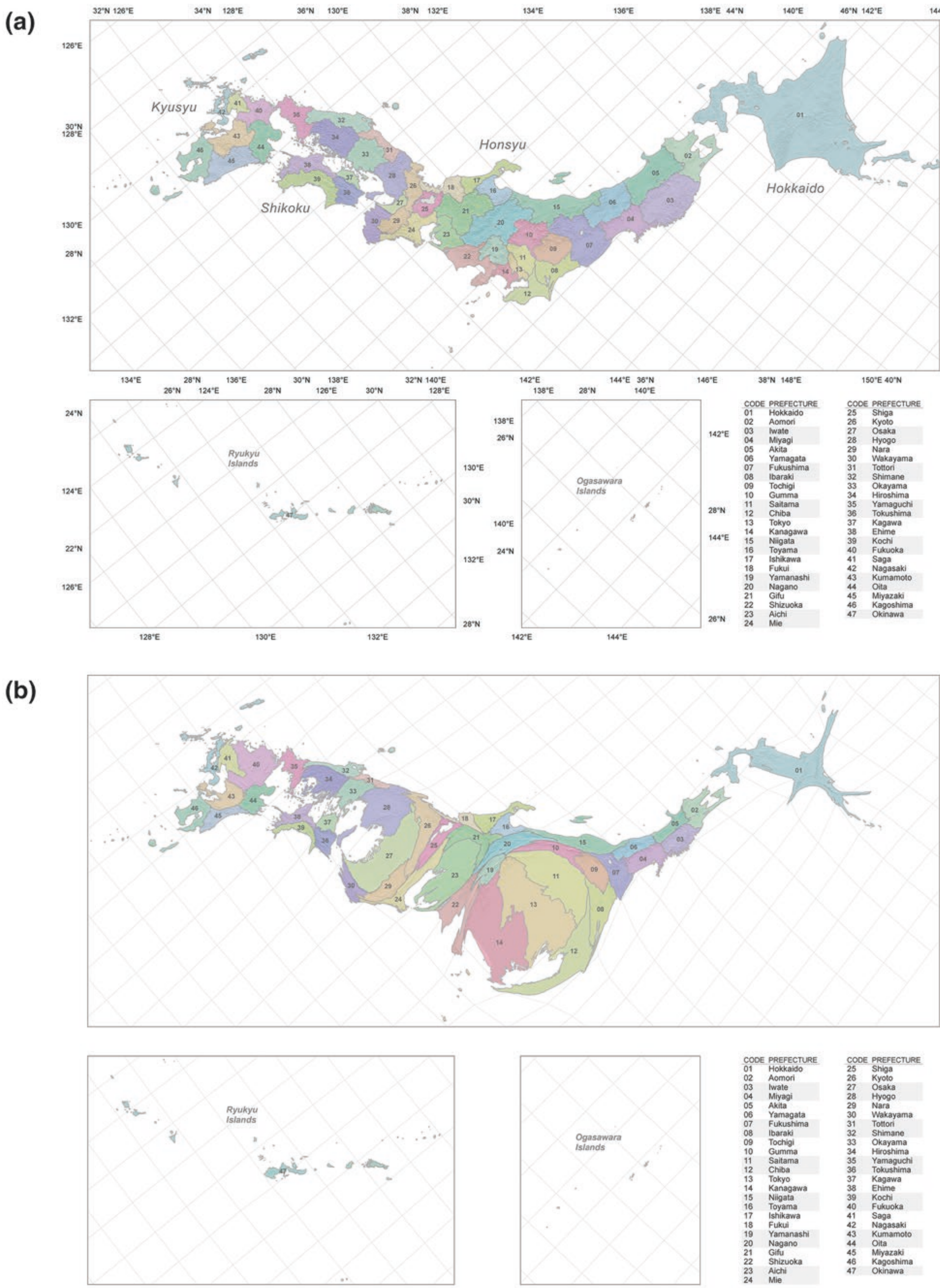

Fig. 1.1 Population cartogram of the 47 prefectures. (**a**) The prefectural map based on an ordinary map projection. (**b**) The prefectural map based on the density equalising cartogram using the population data as of 2010

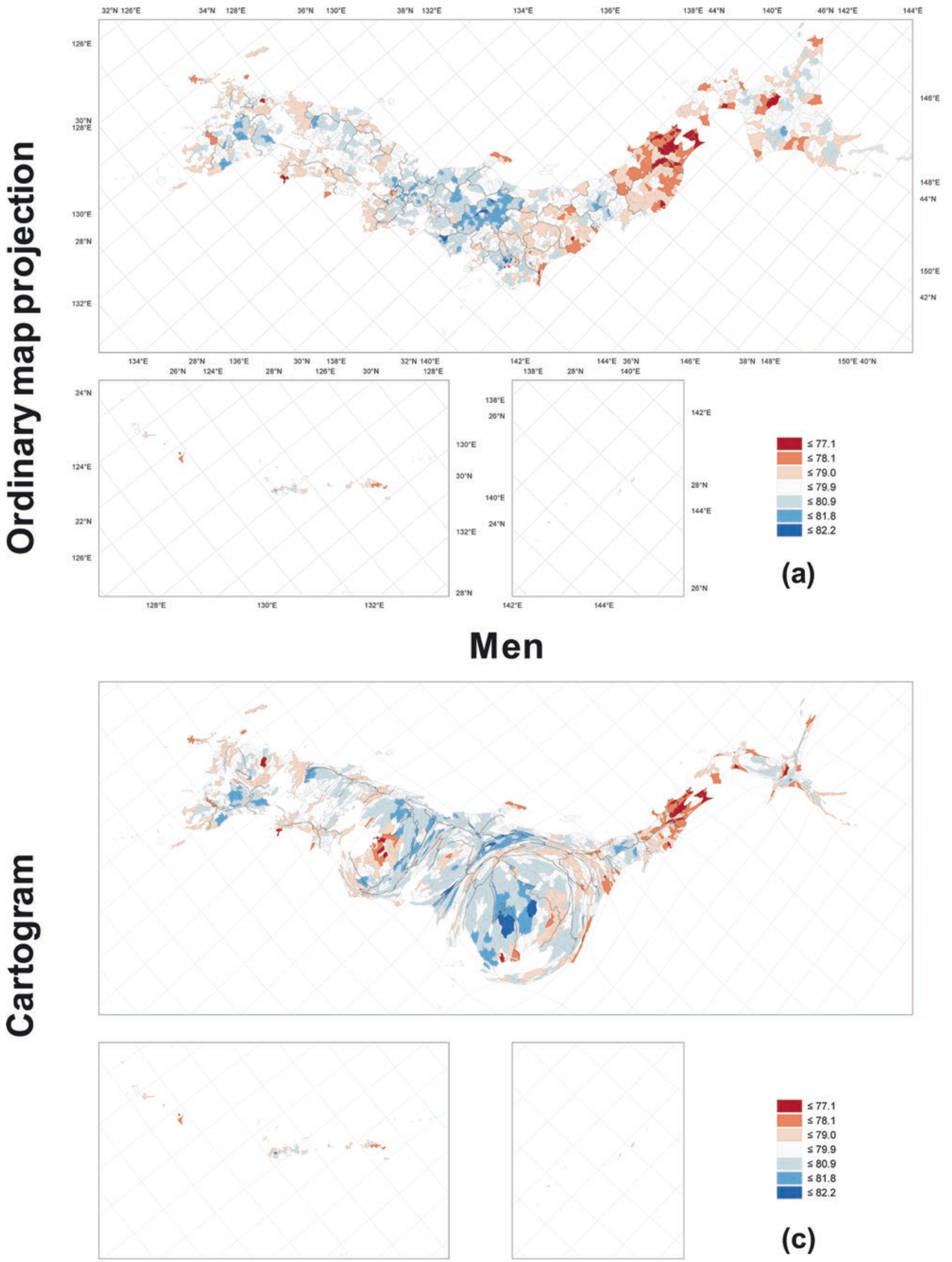

Fig. 1.2 Municipal life expectancy at birth as of 2010. (**a**) The distributional map for men based on an ordinary map projection. (**b**) The distributional map for women based on an ordinary map projection. (**c**) The distributional map for men based on the density equalising cartogram. (**d**) The distributional map for women based on the density equalising cartogram. Source: Municipal Life Table, 2010 (Ministry of Health, Labour and Welfare)

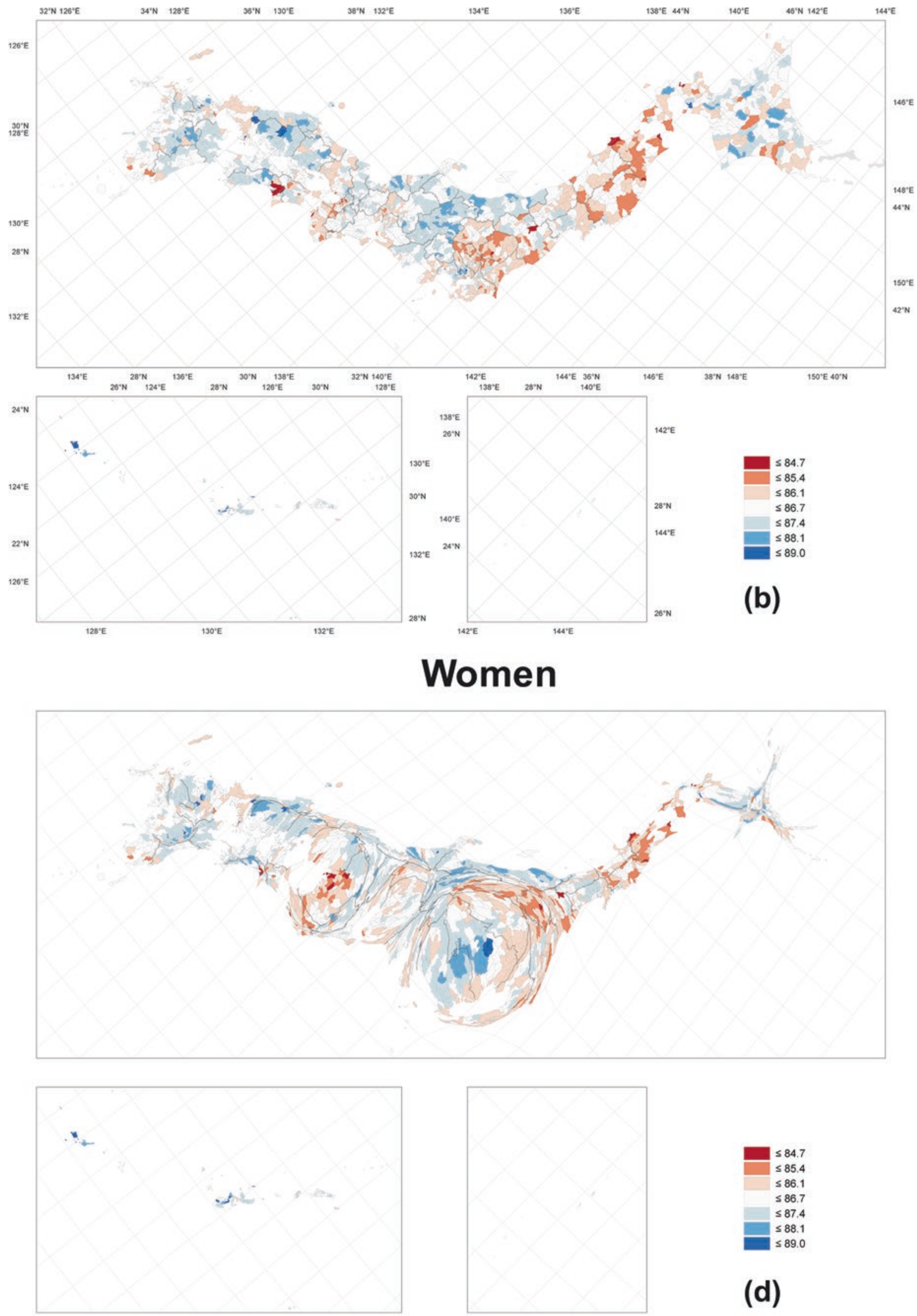

Fig. 1.2 (continued)

healthy suburbs and unhealthy inner-city areas. Longevity is simultaneously dependent on the region of residence and the residential zone within the region. To quantify the socioeconomic geographical inequalities in health, we use popular summary statistics including the relative and slope index of inequalities (Mackenbach and Kunst 1997). Since these inequality measures take into account population sizes compared to the entire national population to identify a relative socioeconomic position for each area, the population cartogram provides a more intuitive way to understand the degree of inequality with reference to these summary statistics. For example, even if summary statistics show significant inequality in health, such inequality could largely occur in metropolitan regions, making it difficult for map readers to understand the indicated health inequality using the conventional map based on an ordinary map projection.

In short, cartogram-based health mapping enables us to reveal and understand the importance of socioeconomic geographical inequalities in health, while accounting for variation in population size.

1.3 The Period from 1995 to 2014: The Lost Decades

The reason we focus on the period from 1995 to 2014 is the changes in the statistical system of mortality data and social background related to health inequality in Japan. In 1995, the death certificate was revised, introducing International Classification of Diseases (ICD) 10 for recording the causes of death in Japan. This revision caused an unnatural change to the recorded number of deaths by several major causes. For example, the number of deaths from heart disease discontinuously decreased in 1995 (see Chap. 2, Sect. 2.1 for the details). To avoid this death certificate classification problem, we decided to set the beginning of the health atlas project as 1995.

However, the year of 1995 also coincided with an important socioeconomic change to Japanese society. Historically, the rapid improvement of the health of the Japanese population has coincided with the rapid economic growth during the 1950s–1960s. However, the burst of the bubble economy at the beginning of the 1990s, the so-called lost decade(s), or lost two decades, which saw a long-lasting economic stagnation with low growth and deflation, has deeply impacted the society of Japan. In 1997 and 1998, there was a financial system crisis triggered by the collapse of major banks and security companies such as Yamaichi Securities. By the late 1990s to the early 2000s, the growing income gap and rising poverty rates had become a widely shared social concern in society, as several economists and sociologists had pointed out these issues (Sato 2000; Tachibanaki 1998, 2005). The year of 1995 closely preceded the widening inequality of the economic stagnation period, as well as the financial system crisis in Japan.

According to the statistics of the Organisation for Economic Co-operation and Development (OECD) (OECD 2019a), the Gini coefficient (the range is 0–1 and the higher the coefficient, the larger the income inequality) of disposable income with post taxes and transfers was 0.304 in 1985, increased to 0.323 in 1995 and 0.337 in 2000, though since then the values have become stable. It was 0.329 in 2006, 0.330 in 2012 and 0.339 in 2015. The relative poverty rate, defined as the percentage of people whose household disposable income after taxes and transfers is below 50% of the national median value, was 12.0% in 1985, increased to 13.7% in 1995, 15.3% in 2000, 16.1% in 2012 and 15.7% in 2015 which is well above the OECD average of around 11% (OECD 2019b).

A concern that has been raised is that these widening trends of inequality may cause a widening of social inequality in health, even though the egalitarian health system, such as the national insurance system, covers almost the entire population. Although the socioeconomic health inequalities in LEB at the 47-prefecture level had decreased substantially during the period from the 1960s to the early 1970s, such a regional equalisation trend has been obscured or turned to be in the phase of gradually widening, in line with the widening trends of socioeconomic disparities in society since the latter half of 1990s (Fukuda et al. 2007; Nomura et al. 2017).

In 2013, the national government began Health Japan 21 Secondary Term which is a 10-year national health promotion campaign with goals to prolong healthy life expectancy and reduce the social and geographical inequalities in the health of the population by improving individuals' lifestyle and social environments to support their health (National Institute of Health and Nutrition 2019; Ministry of Health, Labour and Welfare 2012). The national government set specific, nationwide targets to be assessed for the 10-year span, 2013–2022, of Health Japan 21 Secondary Term. While reduction in the difference in healthy life expectancy among 47 prefectures is included as one of specific target indicators, the way in which the socioeconomic inequalities in health will be assessed was not clarified in the national program. In addition, the national campaign encouraged prefectural and municipal governments to plan local health promotions based on the current geographic variations in health and lifestyles among municipalities. Thus, it will be valuable for both national and local governments to visualise and measure geographic inequalities in health at the municipality level.

The intention in developing the health atlas project is to provide clear pictures of geographic health disparities among about 1800 municipalities as fundamental resources to understand the geographical aspects of health inequalities and their transitions in the recent low-growth age of the society.

1.4 The Structure of This Atlas

The following chapter provides supplemental background information for understanding the context of Japanese society and population health. The chapter also explains the fundamental materials and methods used in the creation of this health atlas, including the Japanese area deprivation index, a composite indicator representing socioeconomic position (affluency–poverty dimension), to measure the degree of social inequality in health. The most important content of the second chapter is the explanation on how to read our cartographic and summary graphs of health inequalities used in later chapters.

Chapters 3–6 are composed of a series of maps with the same style format. Chapter 3 contains mortality maps of all causes of death, divided by sex and age groups. In this chapter, we provide information on sex–age differences in the compositions of major causes of death. Chapters 4–6 contain mortality maps of cancers by major cancer site, circulation diseases including cerebrovascular and cardiovascular diseases and other important major causes of death such as suicide and senility, respectively.

Chapter 7 provides a synthesis summarising the implications of the observed temporal trends of geographical health inequalities in the post-bubble economy period in Japan. The maps and health inequality indices revealed that area-based socioeconomic inequalities in mortality are widespread among Japanese society for various age groups and causes of death. Further, inequalities in mortality became larger during the two decades for many major causes of death, particularly cancer. While some aspects of inequalities in men of working age became smaller, inequalities among children and older adults have widened in both sexes. These trends can be related to the vulnerable populations that emerged during the economic stagnation periods in Japan.

The technical notes include supplementary information on the advanced techniques we used for this atlas, such as spatial smoothing with a hierarchical Bayesian model, and mathematical definition of income inequality measures.

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2 The Shape of Japan: Backgrounds, Materials and Methods

Tomoki Nakaya, Keisuke Fukui, Yuri Ito, Keiji Yano, Yuzuru Isoda, and Naoki Kondo

This chapter contains sections which provide background information about Japanese society and health including long-term transition of mortality, newly emergent socially vulnerable populations from the lost decades, the recent earthquake disaster whose impacts are readable in many mortality maps and social area formation in contemporary Japanese metropolitan areas. In addition, this chapter explains how to read the maps and graphs shown in later chapters. The materials and methods used to construct the health inequality atlas include the spatial unit for mapping, mortality indices with the data source and measurements of social inequalities in the mortality indices using areal deprivation index. Several analytical concepts such as the prismic cartogram, slope index of inequality and relative index of inequality are introduced.

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2.1 Background I: Long-Term Trends of Major Causes of Deaths

Tomoki Nakaya

Before presenting the contemporary mortality maps, the historical background of Japanese population health is briefly described here. Figure 2.1 shows the long-term trend in crude mortality rate by major cause of death, along with the total death for all causes. Looking at changes in the mortality rate by major cause of death, the mortality rates from infectious diseases such as tuberculosis, pneumonia and gastroenteritis were previously high before the World War II. The sudden increase in pneumonia mortality from 1918 to 1920 was due to the global pandemic of influenza. At those ages, the prefectures having large cities, such as Tokyo and Osaka, were characterised by low life expectancy at birth.

The Japanese society experienced a sharp decline in the mortality rate between the 1920s and 1960s along with the decrease of deaths from the major infectious diseases. Instead, the mortality rates of cancer and heart disease have greatly increased. Death from these chronic diseases including cerebrovascular disease which had been characterised by high mortality among Japanese population accounted for the majority of the total death in recent days. The progressive decline in mortality and changes in the composition of causes of death in this modernisation process have been observed in many societies. This was called epidemiological transition, and Japan was known as a representative case of the accelerated transition model by its rapid shift of mortality (Omran 2005). It should be noted that there are discontinuous changes in the mortality rate curves for cerebrovascular disease and heart disease in 1995 (Fig. 2.1), which are caused by the revision of Japanese death certificate criteria at the transition from ICD-9 to ICD-10 on that year.

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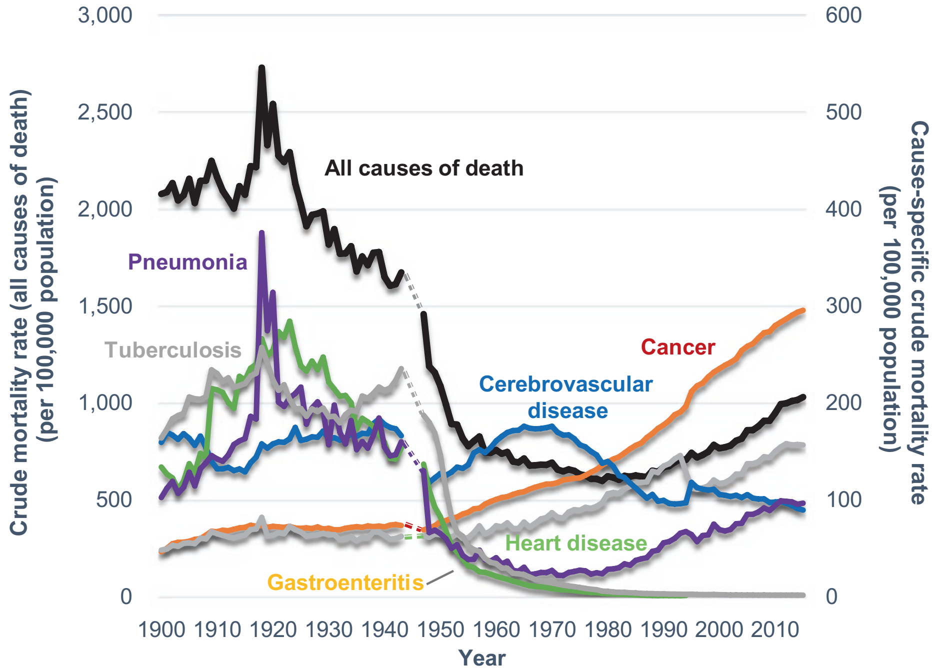


Fig. 2.1 The long-term transition of mortality by major causes of death in Japan. Source: Vital Statistics of Japan (the Ministry of Health, Labour and Welfare)

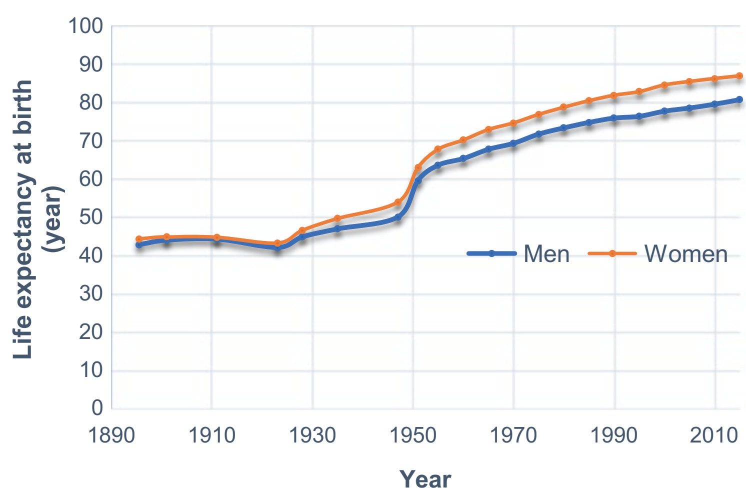


Fig. 2.2 The long-term transition of life expectancy at birth in Japan. Source: Complete Life Tables (the Ministry of Health, Labour and Welfare)

The rapid decline in the all-cause mortality rate and the drastic increase in average life expectancy in Japanese society (Fig. 2.2) were accompanied by the improvement of nutritional status, living environment and sanitary conditions as a result of economic developments particularly in the post-war period. In Japan, this caused a change in geographical pattern of health. During the rapid economic development age during 1960s to early 1970s, the health conditions for large cities have greatly improved, and the Tokyo metropolis/prefecture had enjoyed the first or second longest life expectancy at birth until 1975. An important achievement during the 1980s and 1990s is the reduction of cerebrovascular disease.

It was also thought that the Japanese egalitarian system of social services including a social insurance system, the universal health insurance (established in 1961) and the financial adjustment policy of the national government to assist local governmental revenue may contribute to the general improvement and regional equalisation of population health in entire Japan (Ikeda et al. 2011). Throughout the rapid economic development, the regional gaps of economic development and life expectancies had been reduced, but such a regional equalisation trend has been obscured since then at the prefectural level (Fukuda et al. 2007; Takano and Nakamura 2001).

2.2 Background II: Emergences of New Vulnerable Populations in the Lost Decades

Naoki Kondo

This section sketches emergent issues on vulnerable populations reflecting macrosocial changes and health inequality in the 1990s–2010s in Japan for interpreting the mortality maps and health inequality transitions shown in later chapters.

The 1990s was the period when globalisation started expanding. While it should have had both positive and negative effects, nations, organisations and citizens that could not adjust to the rapid social change suffered serious damage. In Japan, the period coincided with the beginning of the 'lost two decades'—lingering downturns of national economy triggered by the burst of 'bubble economy' at the beginning of the 1990s. Social epidemiologic evidence has shown the emergences of new vulnerable populations and their health issues, including a suicide epidemic among corporate managers, obesity among children with a single parent and disability among older adults caused by poverty and isolation.

Suicide Among Corporate Managers

Wada et al. (2012) suggest that the lingering economic recession since the 1990s led many male corporate managers to commit suicide, perhaps due to strong job strain and the sense of failed responsibility. In 1997, the Asian Financial Crisis started in Southeastern Asian nations. In Japan, multiple leading financial firms went bankrupt, leaving thousands of elite business persons unemployed. The crisis triggered a long-lasting suicide epidemic among the working ages. The suicide rate was 26.0 (per 1 million population) in 1997, and it spiked to 36.5 in 1998, when the biggest financial company in Japan at that time—Yamaichi Securities Co., Ltd.— went bankrupt. The suicide rate among working men hovered at the same level until the late 2010s. Longitudinal epidemiologic data, using the national death registry and population census data, show that, although before the crisis the mortality rate was lower for the two most privileged working groups (managers and professionals) compared to other occupational groups, their mortality, especially in terms of suicide, started to increase in the late 1990s (Fig. 2.3). We had indirect evidence that the strict career demands for managers might significantly increase in that time because the government eased labour regulations. This resulted in the emergence of unskilled workers in production lines, which, in turn, reduced the number of managers in the workforce between 1985 and 2005.

Child Poverty and Overweight Risk

Japan might not be an ideal place for children anymore. The relative poverty rate was 16.3% in Japan, which was higher than the average of the Organization for Economic Cooperation and Development (OECD) member states in 2015 (13.4%). The poverty rate for single-parent families was 50.8%, which was, again, the highest of the member states (OECD 2018). This could be due to many things, such as very cheap wages for precarious work and shortages in childcare services in Japan (Nohara 2018). Our trend analysis showed a potential link of the 2008 Global Financial Crisis and an increased obesity risk among children in low-income or single-parent households. Using a statistical technique to identify the point of trend change, we found that the expansion of income-related inequality in child obesity started in September 2008, when the Global Financial Crisis had just started (Ueda et al. 2015). We observed a similar phenomenon for single-parent families, regardless of the households' financial statuses (Fig. 2.4) (Shiba and Kondo 2019). Household financial burden due to the economic crisis and relevant anxiety might change parental childbearing behaviour, potentially resulting in increased health risks for their children.

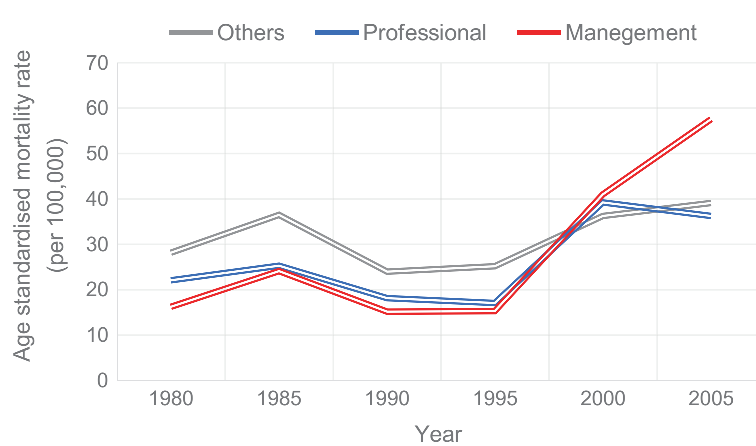


Fig. 2.3 Trends in suicide by occupation. Source: Wada et al. (2012), redrawn from the original data provided by the author

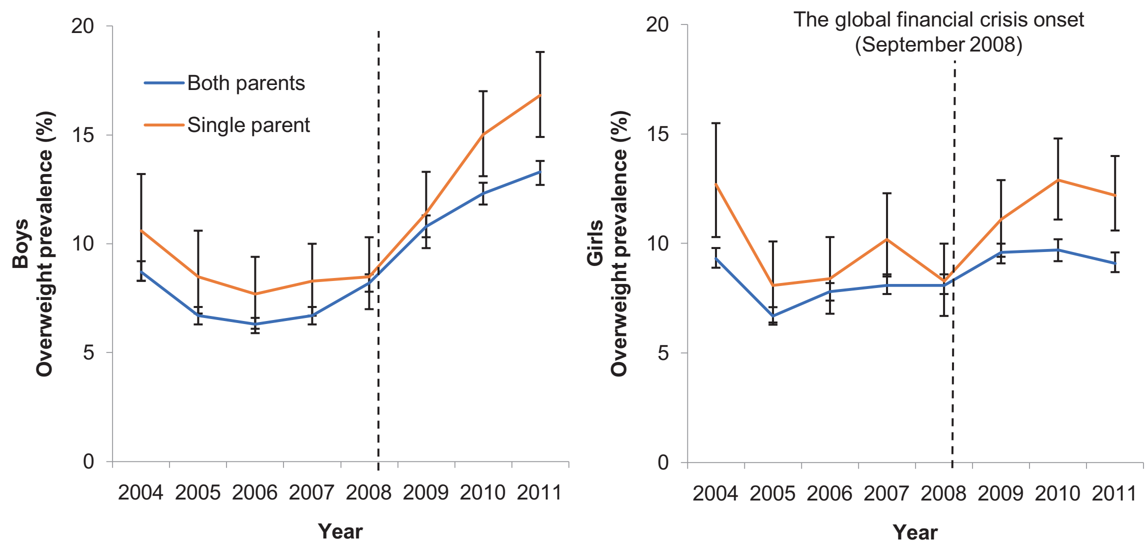


Fig. 2.4 Changes in % overweight among children in the cohort of Japanese Millennium Baby Panel Study. Source: Shiba and Kondo (2019), redrawn from the original data provided by the author

Poverty and Disability Risk Among Older Adults

Japanese society has the world's most rapidly ageing population. People aged 65 years or older accounted for 27.3% of the population in 2016. The government predicted that they could make up as much as one third of the population by 2036 (Cabinet Office of Japan 2018). Poverty risks are high among older adults, and the situation has not changed in the last three decades, especially among older women (Abe 2018). The poverty rates for older men and women were the highest among adults who were living alone. A number of large-scale longitudinal studies, including the Japan Gerontological Evaluation Study (JAGES) that has followed more than 100 thousand older adults over time, have suggested that poverty, isolation and weakened community ties were the key social determinants of mortality and functional disability (Kondo et al. 2019).

Officials have discussed policy reforms in not only healthcare but also labour, welfare and other macrosocial determinates of health, to amend these challenges. For example, there is an urgent call to establish novel systems to provide necessary cares for older adults, called Community-Based Integrated Care Systems, i.e., creating a good local governance across organisations and professionals in health and medical cares, long-term care and social welfare with locally suitable schemes by 2025 (Shibuya et al. 2018).

2.3 Background III: The Great East Japan Earthquake

Yuzuru Isoda

In many mortality maps shown in later chapters, the regionally raised mortalities caused by the Great East Japan Earthquake Disaster are observable. The disaster had been a tripartite disaster from earthquake, tsunami and nuclear contamination. A subduction zone earthquake of magnitude 9.0 Mw off the Pacific coast of northeast Japan occurred at 14:46 on Friday, 11 March 2011. The ground shook for 3 min causing building damages in the entire eastern Japan including Tokyo. Approximately 30 min after the earthquake, 10 m tsunami arrived to the coasts washing away housing and inundating the fields. The tsunami damaged the emergency power generators of the Fukushima Daiichi Nuclear Power Plant causing series of explosions in the subsequent days. Nuclear contamination spread mainly to the northwest of the plant due to wind direction during the major blast, causing displacement of 160,000 residents.

Human deaths of 19,689 were almost entirely due to tsunami, with the notable exception of Fujinuma Dam failure and the flood killing eight persons (Fire and Disaster Management Agency 2019). The deaths concentrate on coastal municipalities of Iwate, Miyagi and Fukushima Prefectures, and the figures all refer to these three prefectures. The largest deaths are found on Sanriku coast, a ria coast with saw tooth-like coastline stretching between Iwate and Miyagi. The coast is well known to be prone to tsunami disaster, facing the subduction zone and the ria coastline amplifying the tsunami waves.

The deaths are especially high at the very end of the ria inlets because population concentrate in such areas as flat lands are scarce along this coastline, and because the tsunami waves are most amplified in such areas (Fig. 2.5). Kadonowaki in Ishinomaki City, Shisiori in Kesennuma City and Yamada Town also had extensive post-tsunami fire caused by fuel spilled from oil tanks, cars and ships and inflammable debris. Tsunami to coastal plain facing Sendai Bay inundated 6 km inland from the coast.

While largest number of deaths are found in large cities, the highest rates of deaths are found elsewhere because large cities have expanded to higher grounds (Isoda 2011b). The highest death rates are in smaller towns of Onagawa, Rikuzentakata and Otsuchi, exceeding 5% (Fig. 2.5). The town centres of these towns were completely destroyed, but there are hills nearby and the people's evacuation behaviour seems to have lowered the death rates than what would be expected from the areal damage.

Death rates by age shows a clear pattern of low rates for children and high rates for aged population (Fig. 2.6). The rates are very similar between the sexes, and their age pattern is very similar across all coastal municipalities once adjusted for the levels (Isoda 2011a). The rates for school-aged children were particularly low because schools were built on higher ground or schools evacuated pupils well, and by fortune that the day was before the spring break and the time was before going home. Many of those who died in this age group died after being handed over to parents or have been absent in that day. The notable exception to this is the tragedy of Okawa Elementary School in which tsunami struck when pupils were gathered at school ground for head counts and the teachers were confused what to do next. The tsunami killed most of the pupils and the teachers. In Rikuzentakata City, Unosumai in Kamaishi City and Kitakami in Ishinomaki City, the tsunami destroyed evacuation centres killing those who succeeded in getting there, raising the death rates of adults than those expected from the age pattern.

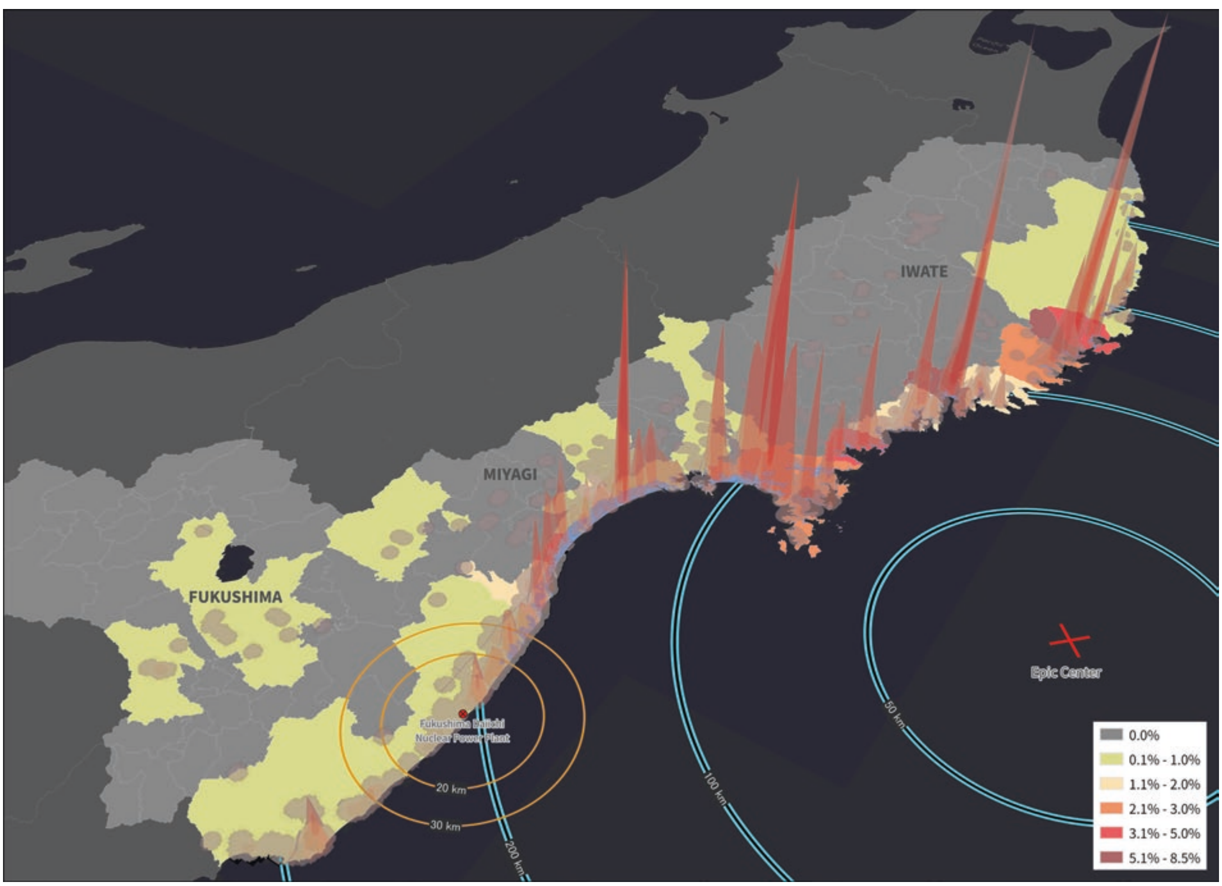


Fig. 2.5 Density of deaths and death rates by municipalities. Kernel densities (bi-weight kernel, search radius 2.5 km) of deaths of addresses matched at the *chocho-aza* level, not including missing persons. (Sources: Lists of Victims, Prefectural Police Offices of Iwate, Miyagi and Fukushima). Choropleth showing death and missing rates by municipality. (Sources: Damage Reports from Iwate, Miyagi and Fukushima Prefectures)

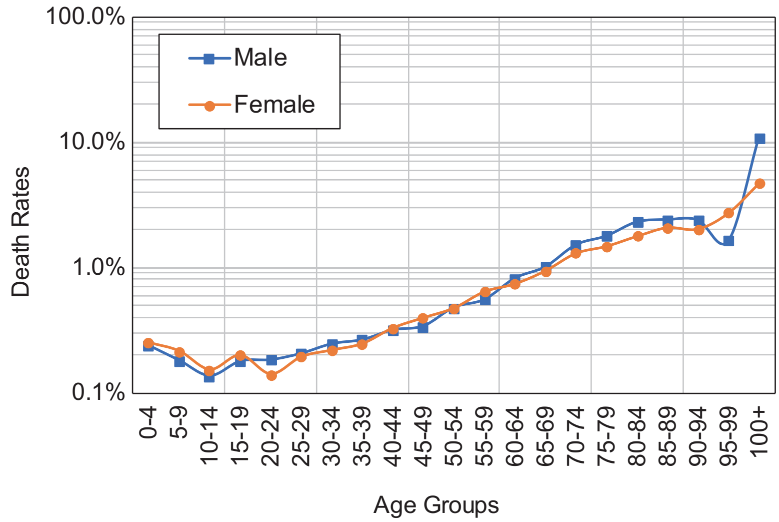


Fig. 2.6 Death rates by sex and age of coastal municipalities of the three prefectures based on the List of Victims and Census 2010, not including missing persons. Sources: Lists of Victims, Prefectural Police Offices of Iwate, Miyagi and Fukushima

Tsunami also hit many geriatric care facilities, killing the users and the staffs, raising the already high death rates of aged population even further in municipalities having such of those facilities. For such cases where large number of people died under supervision of an organisation or by a misleading evacuation plan, lawsuits have been filed, and the court largely found faults with the organisation or the local government (Isoda 2018).

2.4 Background IV: Social Areas of Japanese Metropolitan Areas

Keiji Yano

In this section, the residential structure of the three largest metropolitan areas of Japan is outlined briefly in order to help understanding residential patterns within Japanese large metropolitan areas. It is known that such socially structured residential patterns are associated with the regional variation of mortality in the metropolitan areas (Nakaya 2000).

Since 1920, the national population census of Japan has been conducted almost every 5 years. Census questionnaires are collected by nearly 50 household survey districts and then compiled in statistical tables by various spatial units, such as nationwide, prefecture, municipality and small areas including *chocho-aza* (small town blocks and settlements) and grid cells (Yano 2017). To present a finer spatial unit than municipality, the tertiary Grid Square Statistics (grid size of about 1 square km) and the Divided Grid Square Statistics (grid size of about 500 m by 500 m; hereafter called '500 m-grid') have been compiled since 1970 and 1975, respectively. In 1990, the Census Basic Unit Block, which is designed as a permanent fundamental census unit comprising approximately 20–30 households, was established. From the 1995 census, small area statistics based on *chocho-aza* have been compiled by subdividing municipalities into smaller units. In recent censuses from 2005, One-quarter Grid Square Statistics (grid size of about 250 m by 250 m) have become available.

The census data provides key information for understanding variations in residential characteristics in Japanese cities. Here, we will show social area maps using the 500 m-grid of census statistics for the three major metropolitan areas of Tokyo, Chukyo/Nagoya and Keihanshin/Kyoto-Osaka-Kobe that are composed of central cities and neighbouring municipalities. Following classic social area analysis and factorial ecology (Davies 1984), residential structure, spatial patterns of characteristics of residents, can be summarised in three basic dimensions: socioeconomic, family/urbanisation and ethnic status (Kurasawa and Asakawa 2004). The ratio of professional workers, household owners, and foreign nationals in the 2010 population census are considered representative variables of each status listed above.

Population Growth

Figure 2.7 illustrates population growth between 1995 and 2015 during the low growth period after the collapse of the bubble economy for the three major metropolitan areas. This population growth map is based on the 1 km-grid census statistics, because we do not have the national 500 m-grid data prior to 2000.

In 2015, the total population of Japan began to decline for the first time, but population growth has been observed in some parts of metropolitan areas, particularly around the metropolitan areas. Such urban growth was referred to as 'the population regression to city centres', reflecting the decrease in land prices due to a decreased demand for office space in those areas during the low growth period. There are many areas where a population increase greater than 1000

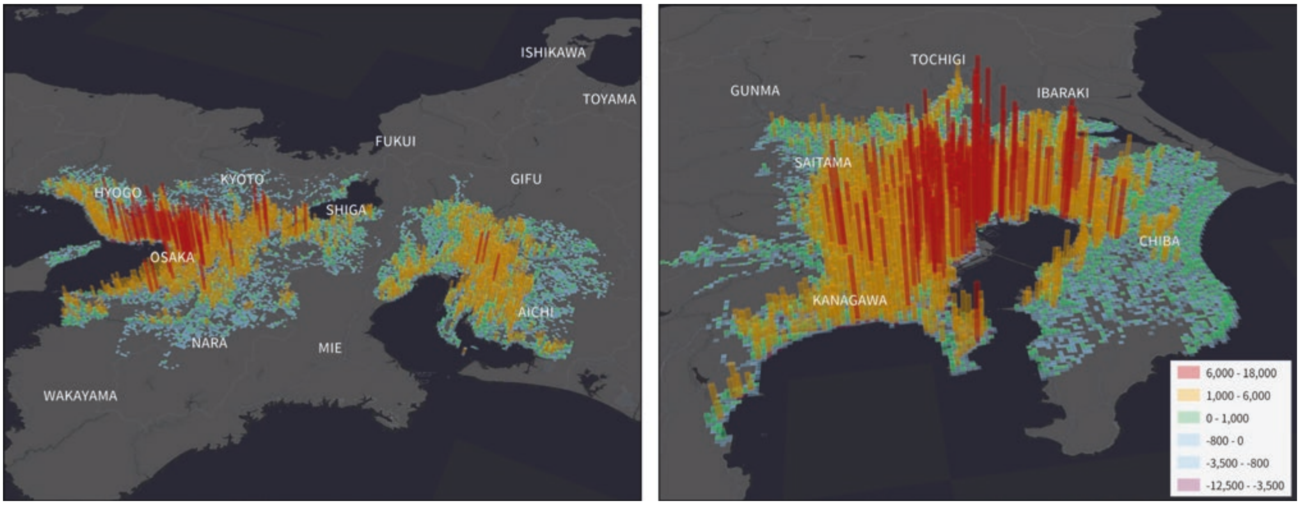


Fig. 2.7 Population growth in the metropolitan areas, between 1995 and 2015

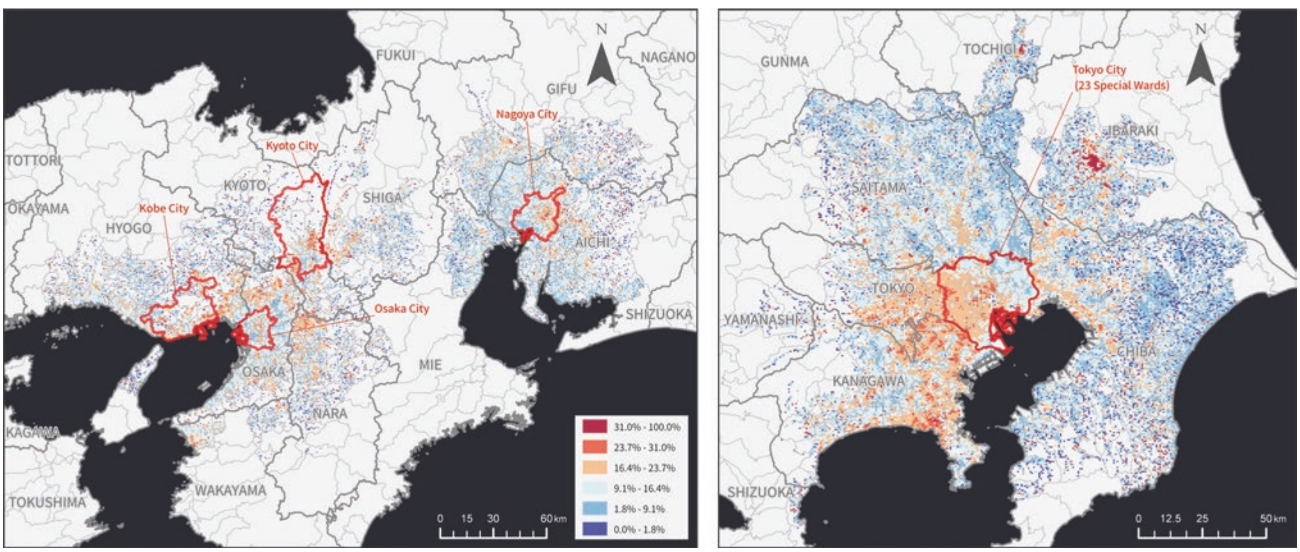


Fig. 2.8 Percentage of professional workers in the metropolitan areas, 2010

people is observed in newly constructed high-rise condominiums due to gentrification. The Keihanshin metropolitan area has seen significant population growth in the Hanshin area, the area between Osaka and Kobe Cities, due to recovery from the Great Hanshin-Awaji Earthquake that struck on 17 January 1995.

The baby boomer generation born in the 1940s changed the residential structure in the Tokyo metropolitan area. They moved from rural areas to the special wards in Tokyo City during the high economic growth period. They arrived as single people to seek employment, and eventually moved from the wards to the surrounding areas to purchase their own houses in the suburbs as they married and raised children (Watanabe 1978). As this generation has recently begun to retire, changes have occurred in the structure of suburban residential areas.

Socioeconomic Status

Figure 2.8 shows the distribution of percentage of professional workers. The spatial distribution of socioeconomic status is traditionally considered to be sectorally distributed from the city centre. In the Tokyo metropolitan area, we observe that the areas of high socioeconomic status are distributed in west and southwest of the city centre, such as the

Setagaya and Ota Wards, and Yokohama and Kawasaki Cities. Since the Edo Period (seventeenth century to mid-nineteenth century), areas on the western side of central Tokyo have been called *Yamanote* (uptown) at the eastern end of Musashino Plateau and *Shitamachi* (downtown) at the eastern part of the plateau below the cliff line. In terms of social status, *Yamanote* is dominated by white-collar residents, while *Shitamachi* is blue-collar.

In the Keihanshin/Kyoto-Osaka-Kobe metropolitan area, we observe that areas with a high socioeconomic status dominate in central Osaka City, reflecting the recent gentrification as well as in surrounding suburbs in northern Osaka Prefecture and the areas between Osaka and Kobe Cities in Hyogo Prefecture. Nara City and northeastern Kyoto City are also characterised by high socioeconomic status. In the Chukyo metropolitan area, eastern Nagoya City is dominated by areas with a high socioeconomic status.

Family Status

Figure 2.9 shows the distribution of percentage of owned houses. Familial status tends to increase concentrically from the centre of each metropolitan area, meaning that relatively large households that have a house tend to live in suburbs, while small households, such as single-member households, tend to live around the city centre. There is also a tendency for this status indicator to decrease along railways extending radially from the city centre and in local central cities, such as prefectural centres. In every metropolitan area, city centres tend to have low (30% or less) percentages of owned houses. However, in the periphery of metropolitan areas, the percentages tend to exceed 90%, indicating that long-distance commuters live there.

Ethnic Status

Figure 2.10 shows the distribution of percentage of foreign nationals. As ethic status classically exhibits a clustered spatial distribution, there are several concentrated areas with a high percentage of foreign nationals. In 2010, there were 1,648,037 foreigners living in Japan. Although the ratio was only about 1.3%, there are residential areas largely occupied by foreigners in the metropolitan areas.

In the Tokyo metropolitan area, such clusters are found in city centres, including Shinjyuku, Ikebukuro and Minato Wards in Tokyo City, and Chinatown in Yokohama City, as well as industrial areas in the northern Kanto region. In the Keihanshin metropolitan area, clusters with a high percentage of foreign nationals are found in Ikuno Ward in Osaka City, Chinatown and Nagata Ward in Kobe City, and Nishikujyo area in Kyoto City. In the Chukyo metropolitan area, residential districts with foreign nationals are found in the central part of Nagoya City, as well as Minokamo City (Ishikawa 2019).

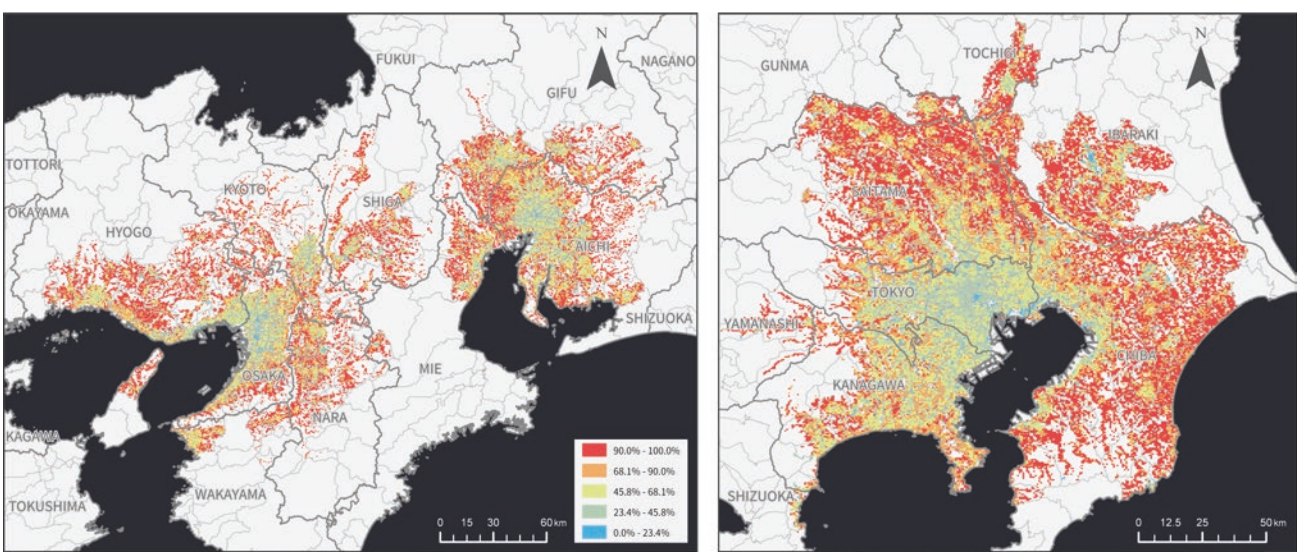


Fig. 2.9 Percentage of owned house in the metropolitan areas, 2010

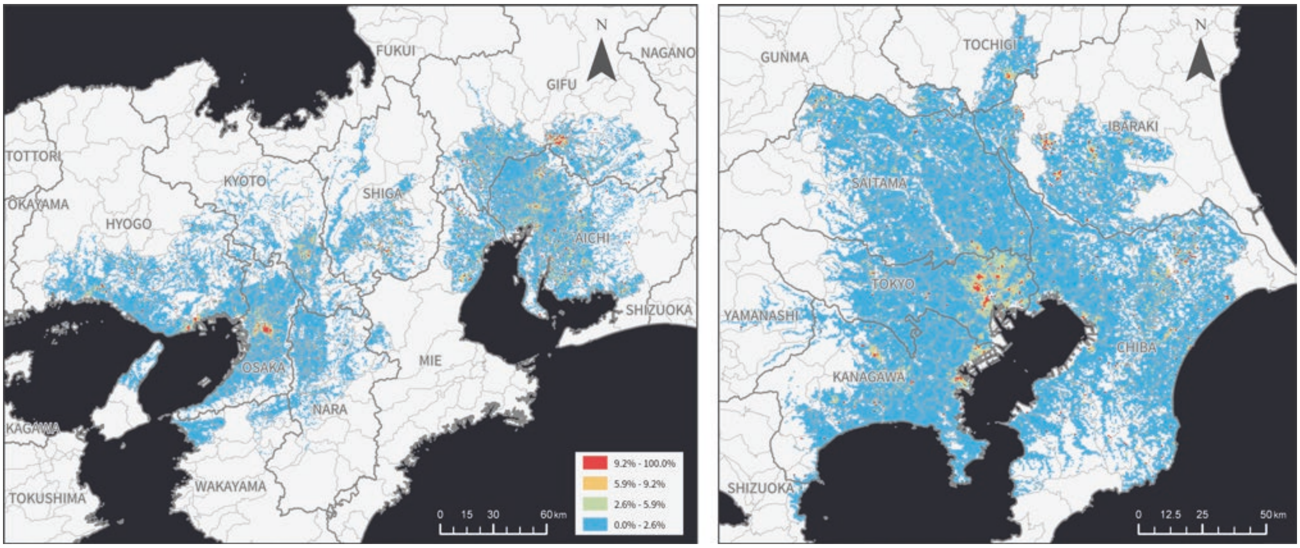


Fig. 2.10 Percentage of foreign nationals in the metropolitan areas, 2010

2.5 Material I: Spatial Unit of Maps

Tomoki Nakaya

Figure 2.11 illustrates the nine regions of Japan—Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kusyu and Okinawa—and major large cities (ordinance designated cities). Subregional names are occasionally mentioned, such as Hokuriku region, the Sea-of-Japan side of Chugoku region, Tokai region and the Pacific Ocean side of Chugoku region.

As introduced in Chap. 1, this atlas aims to visualise the health inequalities throughout Japan by using smaller area units (municipalities) for the mapping. A municipality, which includes *Shi* (City), *Ku* (Ward), *Cho/Machi* (Town) or *Son/Mura* (Village), is a fundamental local public agency responsible for obtaining basic statistics and implementing local policies. The central part of Tokyo (hereafter, called Tokyo City) consists of 23 special wards, each functionally equivalent to a city. Large cities designated by ordinance also comprise several administrative wards. These wards are considered municipalities for this atlas, although they are not actually municipalities but subordinate units of the cities. While the nine regions and 47 prefectures have remained stable over time, municipality numbers and borders have changed. In particular, during the first half of the 2000s, a large-scale municipal merger was implemented, resulting in a drastic decrease in small-sized municipalities. At the same time, recent ordinance-designated cities established administrative wards, resulting in an increase in municipalities as statistical units. The number of municipalities, including administrative wards of ordinance-designated cities, were 3376 and 1907 as of 31 December 1995 and 2014, respectively.

To enable consistent comparisons of health inequalities during different periods from 1995 to 2014, we define 1839 units mainly following the municipalities listed in the 2010 Population Census of Japan with some integration of the original municipalities. These municipalities are used for all of the maps we produced in the rest of this atlas. The index map of the 1839 municipalities with regional codes and the table having corresponding municipality names is available in the Appendix (Figs. A.1–2 and Table A.1).

We excluded several islands from the generated maps due to their zero populations during the period. Miyake-mura in Tokyo Prefecture was excluded due to the evacuation caused by a volcanic eruption in 2000. We included several municipalities in the evacuation zone in Fukushima Prefecture since the 2010 population census provided the regional population for calculating health indicators.

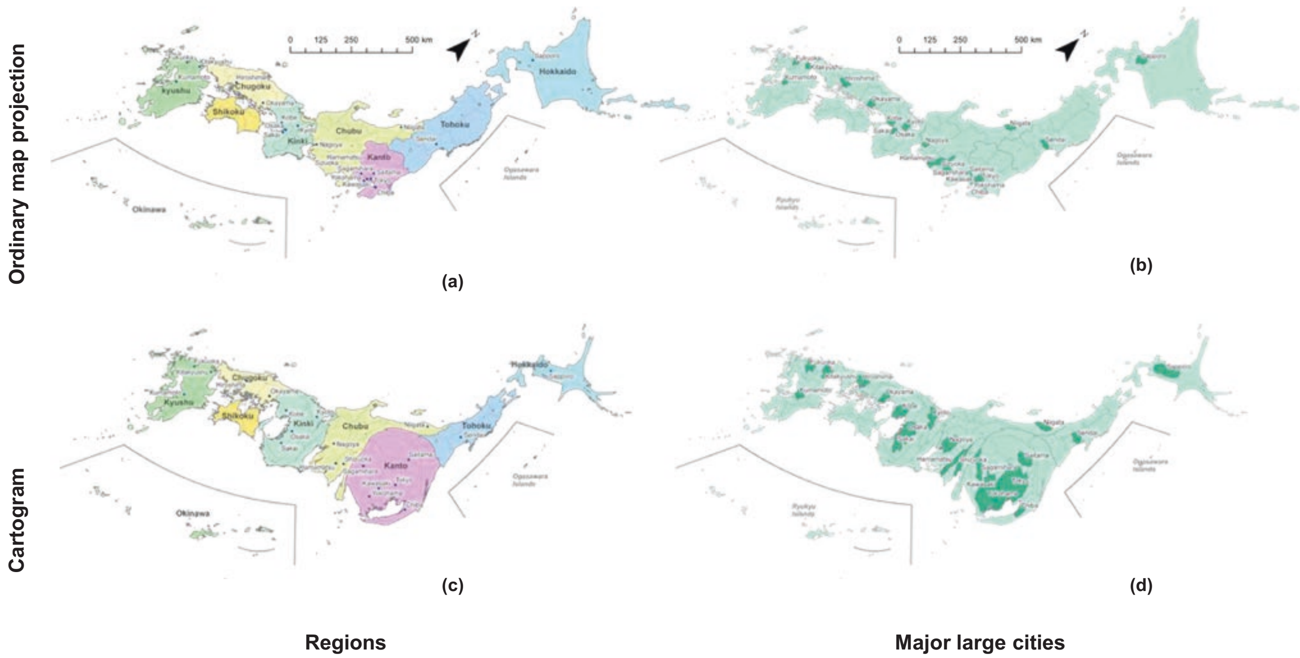


Fig. 2.11 Nine regions of Japan and major cities of Japan (ordinance-designated cities). (**a**) Nine regions (ordinary map projection). (**b**) Ordinance-designated cities (ordinary map projection). (**c**) Nine regions (cartogram). (**d**) Ordinance-designated cities (cartogram)

2.6 Material II: Mortality Indices

Tomoki Nakaya

Mortality-related indicators are mainly used for measuring age or cause of specific health inequalities throughout this atlas. Although life expectancy at birth introduced in Chap. 1 is a useful summary indicator of the overall health level of a local population, mortality rates are more intuitive, and it is computationally easier to process the data, such as by spatial smoothing using statistical models.

The simplest mortality rate is crude mortality rate (CMR):

$$\mathrm{CMR}_i = \frac{(\text{The observed number of deaths in unit } i)}{(\text{The total size of population in unit } i)}$$

where the unit i can represent a region, demographic group or observation period. We often report crude mortality rate as the number of deaths per 100,000 people.

It is easy to calculate CMR for different groups, areas, periods or causes of death. If i is an age group, CMR is simply called age-specific mortality. Since mortality rate is strongly determined by age, direct and indirect methods to compute age-adjusted/standardised mortality indices are commonly used for regional and temporal comparisons. Although CMR is not used for mapping, the mortality measure is used for determining the ranks of the leading causes of deaths.

Age-standardised mortality rate (ASMR) based on the direct method is defined as a weighted average of age-specific mortality:

$$\mathrm{ASMR}_i = \sum_k \left\{ (\text{age specific mortality of } k \text{ in unit } i) \times (k\text{th weight in the standard population}) \right\}$$

where k is an age group and the kth weight is the population proportion of age group k in the standard population, which are fixed among regions or periods in comparisons. The scale of ASMR is also often expressed as the number of deaths per 100,000 population. It is useful for comparing the absolute mortality difference among regions and periods after adjusting for age effects. Using the 1985 population in Japan as the standard, we employ ASMR to compare mortality over periods and area groups introduced later.

Standardised mortality ratio (SMR) based on the indirect method is another popular age-adjusted index:

$$\mathrm{SMR}_i = \frac{(\text{The observed number of deaths in unit } i)}{(\text{The expected number of deaths in unit } i)} \times 100$$

The expected number of deaths are calculated by the sum of the product of the unit i's actual population size of age group k and the reference age-specific mortality for age group k.

We provide the reference age-specific mortality by national population for each period and use this value to map age group or cause-specific mortality by municipality. SMR values are intuitive for understanding relative levels of mortality over regions. An SMR value of 100 means that the risk of death within the unit is equivalent to the national average. SMR values of 120 and 80 indicate that risk of death is 20% elevated and reduced, respectively. If the number of deaths in a local population is low, which is likely to occur in small areas, such as rural municipalities, the computed SMR can be statistically unstable and unreliable. To overcome this problem, we compute municipality SMRs for 5-year periods: 1995–1999, 2000–2004, 2005–2009 and 2010–2014. Further, Bayesian spatial smoothing is applied to the data sets, and the geographically smoothed SMR values are mapped (see details in technical note T1).

To calculate the mortality indices, the number of deaths is obtained from the Vital Statistics of Japan from 1995 to 2014. The sex and 5-year age-specific population sizes of municipalities are available for census years, which are conducted every 5 years: 1995, 2000, 2005, and 2010. Linear interpolation of the annual population data for each municipality was performed using the census statistics (see details in technical note T2). The categories of major causes of deaths mainly follows the Selected List of Causes of Death for Japan, but added several important cancer sites to the list (Table 2.1).

Table 2.1 List of causes of death for the atlas with the number of deaths in 1995–2014

Disease name	ICD10	Men		Women	
		Number of deaths	%	Number of deaths	%
All causes of death		**11,516,606**	**100**	**9,985,561**	**100.0**
Cancer					
Cancer (all sites)	C00–C97	3,867,055	33.6	2,561,992	25.7
Oesophageal cancer	C15	184,021	1.6	34,007	0.3
Stomach cancer	C16	651,756	5.7	349,974	3.5
Colorectal cancer	C18–C20	437,268	3.8	364,779	3.7
Liver and intrahepatic bile ducts cancer	C22	451,870	3.9	212,674	2.1
Gallbladder and other biliary tract cancer	C23–C24	153,986	1.3	173,484	1.7
Pancreatic cancer	C25	245,843	2.1	216,775	2.2
Trachea, bronchus and lung cancer	C33–C34	882,105	7.7	334,840	3.4
Malignant mesothelioma	C45	15,004	0.1	4118	0.0
Breast cancer	C50	–	–	212,584	2.1
Cervical cancer	C53	–	–	49,853	0.5
Uterine corpus cancer	C54	–	–	29,948	0.3
Ovarian cancer	C56	–	–	87,844	0.9
Prostate cancer	C61	176,836	1.5	–	–
Malignant lymphoma	C81–85, C96	101,304	0.9	76,200	0.8
Leukaemia	C91–C95	86,037	0.7	59,749	0.6
Circulatory diseases					
Heart disease (excluding hypertensive diseases)	I01–I02.0, I05–I09, I20–I25, I27, I30–I52	1,624,102	14.1	1,761,041	17.6
Acute myocardial infarction	I21	493,020	4.3	409,493	4.1
Other ischaemic heart diseases	I20, I22–I25	322,106	2.8	264,678	2.7
Cardiac arrhythmias and conduction disorders	I44–I49	200,876	1.7	205,702	2.1
Heart failure	I50	447,331	3.9	661,730	6.6
Cerebrovascular disease	I60–I69	1,247,797	10.8	1,359,081	13.6
Subarachnoid haemorrhage	I600–I609, I690	108,019	0.9	177,263	1.8
Intracerebral haemorrhage	I610–I619, I691	357,433	3.1	297,952	3.0
Cerebral infarction	I630–I639, I693	745,335	6.5	837,305	8.4
Hypertensive diseases	I10–I15	37,789	0.3	61,371	0.6
Aortic aneurysm and dissection	I71	125,741	1.1	99,463	1.0
Diabetes mellitus	E10–E14	140,979	1.2	128,869	1.3
Liver diseases	K70–K77	217,783	1.9	107,590	1.1
Renal failure	N17–N19	190,537	1.7	217,328	2.2
Other major causes of death					
Tuberculosis	A15–A19	31,967	0.3	15,912	0.2
Pneumonia	J12–J18	1,081,815	9.4	940,183	9.4
Chronic obstructive pulmonary disease	J41–J44	217,294	1.9	68,349	0.7
Asthma	J45–J46	35,639	0.3	35,821	0.4
Senility	R54	175,851	1.5	510,185	5.1
Accidents	V01–X59	237,043	2.1	122,401	1.2
Transport accidents	V01–V99	142,622	1.2	62,268	0.6
Suicide	X60–X84	402,868	3.5	167,815	1.7

It should be noted that mortality-related indices based on the Vital Statistics of Japan for mapping and measuring health inequalities in this atlas were originally compiled by the authors of this project, resulting that the numbers were not always corresponding to those in the official reports of the Vital Statistics of Japan.

2.7 Method I: Cartographic Representation

Tomoki Nakaya

The same style of cartographic representation will be used for various municipal SMRs in later chapters. To demonstrate the style, we first introduce the set of municipal SMR maps for all causes of deaths for men during the period from 2010 to 2014 (see Fig. 2.12). Each figure consists of three differently shaped maps using the same municipal SMRs: a 2D map based on an ordinary map projection, 2D map based on a population cartogram and 3D prismic map based on the same population cartogram (prismic cartogram).

The 2D maps are similar to the ones used to display life expectancy that were introduced in Chap. 1. One of the 2D maps is drawn by using the azimuthal equidistant projection centred on Tokyo City (hereafter called “ordinary map projection”). The other 2D map is drawn by using the Gastner–Newman algorithm to produce a density-equalising cartogram (Gastner and Newman 2004). The municipality area size is distorted to be proportional to the municipality’s regional population size. It should be noted that the municipality’s total expected number of deaths during the period from 2010 to 2014 is used as the regional population size. Strictly speaking, the population size and age structure influencing the expected number of deaths are different over the study periods. However, we use the same population indicator for all study periods, because the changes during the 20-year period do not affect any visual impression.

In the SMR map based on ‘3D Prismic cartogram’ in Fig. 2.12, each municipality is represented as a prism whose horizontal shape is the same as the 2D cartogram using its regional population size. The vertical height is proportional to SMR of 80, meaning that zero height corresponds to the SMR value of 80. The prismic map enables intuitive understanding of the regional fluctuations of SMR levels, especially for areas with extremely high SMRs (‘peaks’).

Moreover, this prismic cartogram of SMR highlights the absolute size of excess/avoidable deaths by municipal prism volumes (Nakaya 2010). Imagine an area in which SMR is higher than 80. Here, the excess death is defined as the difference of the observed number of deaths in the area from the

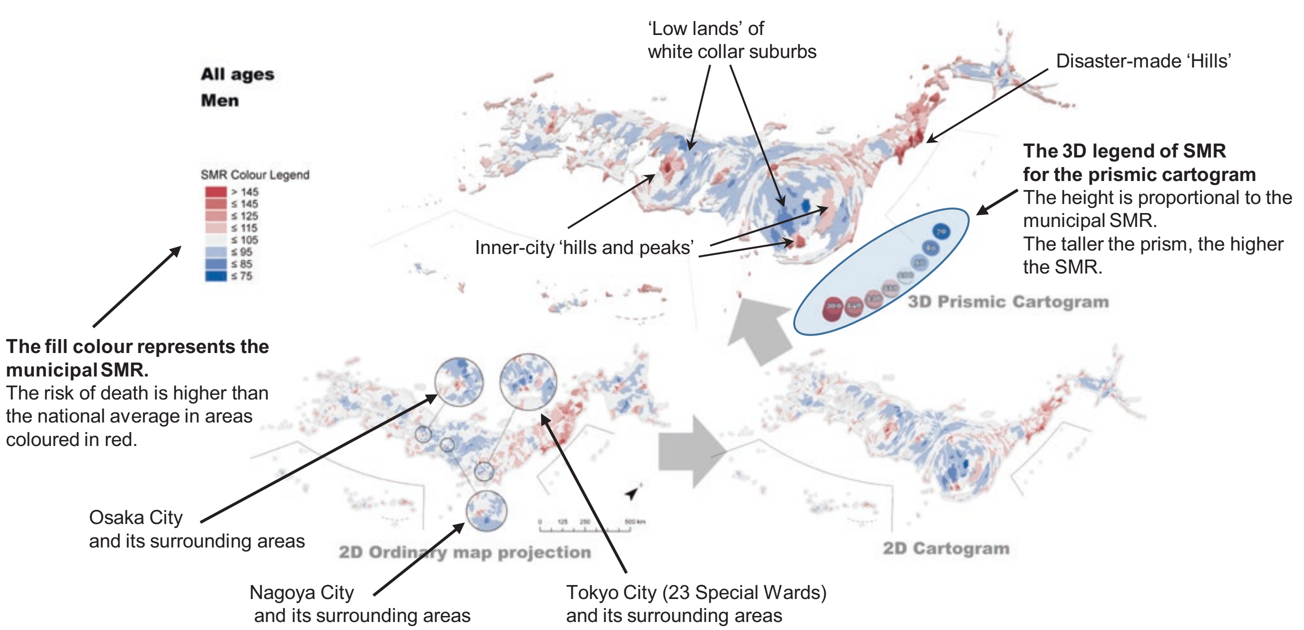


Fig. 2.12 An example of SMR maps (all causes of death for men, 2010–2014)

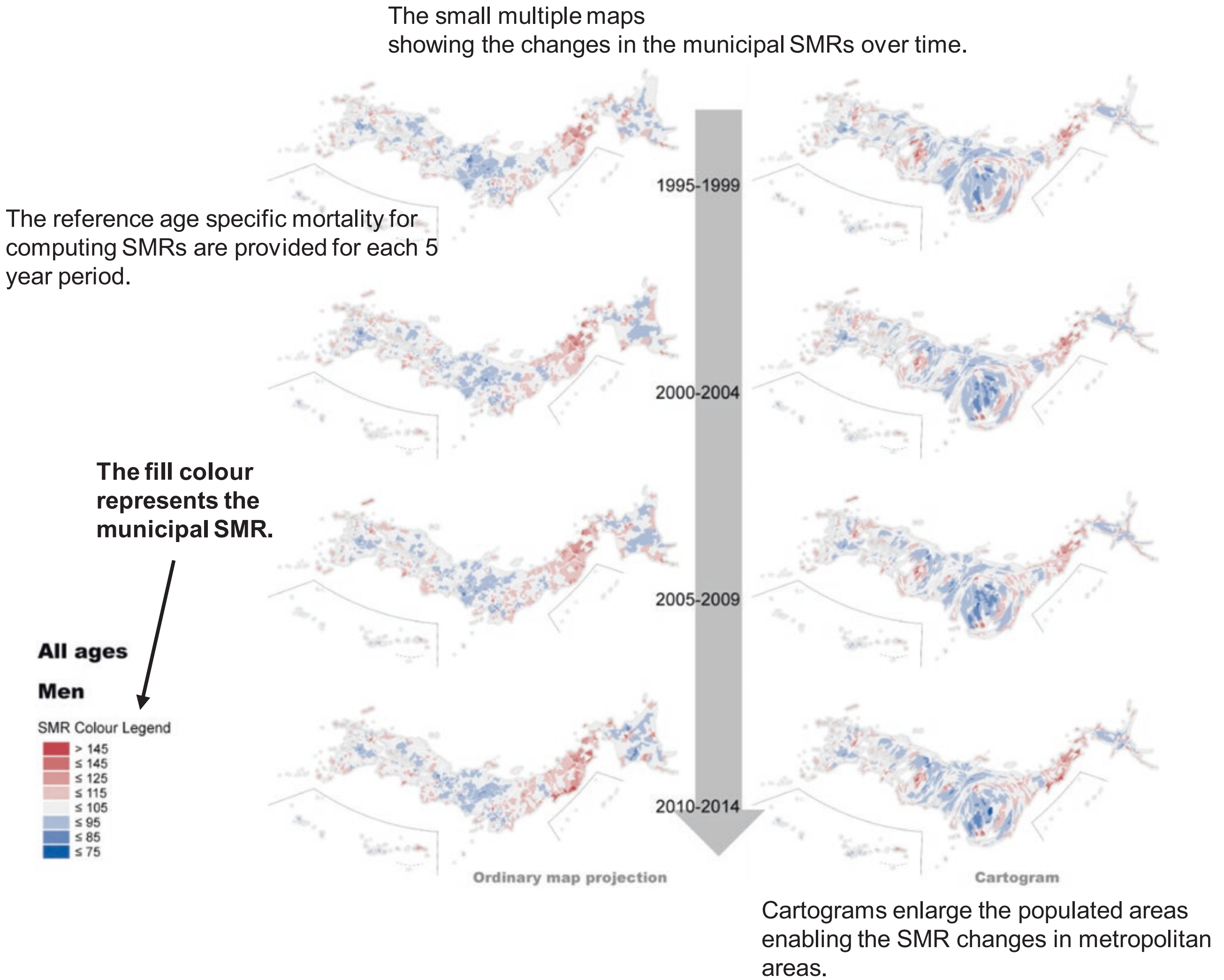


Fig. 2.13 An example of small multiple maps showing the SMR transitions (all causes of death for men)

estimated number of deaths in the same area assuming that the regional SMR is changed to be the reference level 80. The volume of prisms that appear as 'mountains or hills' represents the number of excess deaths compared with a municipal SMR value of 80. The relationship is expressed by the following equation:

$$\begin{aligned}\text{Prismic volume} &= \text{Area size} \times \text{Height}\\ &= \text{Population size}\left(\text{expected number of deaths}\right) \times \left(\text{SMR gap from 80}\right)\\ &= \text{Number of excess deaths}\end{aligned}$$

As a result, the prismic cartogram provides another view of regional mortality variation. While large agglomerations of excess deaths are shown as 'hills and peaks', the concentrations of healthy populations with low SMRs are shown as 'lowlands'. In the example of prsimic cartogram, we can observe high-volume hills corresponding to inner-city areas in metropolitan areas and disaster-affected coastal parts of the Tohoku region and low-lying lands in metropolitan suburbs occupied by residents with high socioeconomic status.

In addition, multiple small 2D maps based on the ordinary map projection and cartogram will be used to visualise temporal transitions of SMRs for the four 5-year periods (1995–1999, 2000–2004, 2005–2009 and 2010–2014) in later chapters, as exemplified in Fig. 2.13. All of the cartographic illustrations are generated by ArcGIS Pro (ESRI Inc.) and Adobe Illustrator CC (Adobe Systems Inc.).

2.8 Method II: Areal Deprivation Index and Socioeconomic Position

Tomoki Nakaya

As discussed in Chap. 1, geographical knowledge of regional socioeconomic conditions is necessary to interpret whether SMR variations reflect regional socioeconomic disparities. Further, to quantify socioeconomic inequalities/disparities in the municipal SMR distribution, it is desirable to use a measure that provides a relative socioeconomic position (SEP) for every municipality in the country. An areal deprivation index (ADI), a composite index of selected census variables, is introduced as the appropriate measure to achieve this goal. Various types of ADI have been proposed as geographic social indicators to reflect the composition of people in need of support under low living conditions among residents in certain areas (Senior 2002).

The ADI used for this study is defined as the weighted sum of eight census variables (Nakaya et al. 2014):

$$\begin{aligned}\mathrm{ADI}_i = k \times \{&2.99 \times (\text{proportion of old couple households})_i + 7.57 \times (\text{proportion of old single households})_i + 17.4 \times (\text{proportion of single-mother households})_i + \\ &2.22 \times (\text{proportion of rented houses})_i + 4.03 \times (\text{proportion of sales and service workers})_i + 6.05 \times (\text{proportion of agricultural workers})_i + 5.38 \times (\text{proportion of blue-collar workers})_i + 18.3 \times (\text{unemployment rate})_i\},\end{aligned}$$

where i is an area index and k is a positive constant. Irrespective of the value of k, we can assign the relative position of the municipality according to the relative values of the municipal ADI. The larger the ADI value, the more deprived the area. The deprived areas with high ADI in the metropolitan areas are roughly corresponding to residential areas having low scores of socioeconomic and family status introduced in Sect. 2.4 in this chapter.

We compute the municipal ADI as the average value of the indices with $k = 1$ using the four census datasets from 1995, 2000, 2005 and 2010. Thus, the municipal ADI-based SEP is the same over the study period. The municipal ADIs were weighted to the population size and sorted, then the relative SEP of the whole Japanese population was estimated as 0 to 1, from least deprived SEP to most deprived. For example, when a municipality has 0.3 SEP, it means that 30% of the entire population is more deprived than the municipality. Figure 2.14 shows the distribution of the municipal ADI-based SEP by ADI quintile groups. The first quintile (Q1) and the fifth quintile (Q5) are the least and most deprived groups of municipalities, respectively. Each quintile group has almost the same population size.

The weights of the ADI on the eight census-based variables in the above equation were determined by a micro data analysis of 'poverty households' by following the Breadline Britain deprivation index proposed by Gordon (1995). The large weights in the above ADI equation indicate that those census variables were most likely associated with poverty. Only significant coefficients from the logistic regression at the 5% level were used for the weighting (see technical note T3 for more details).

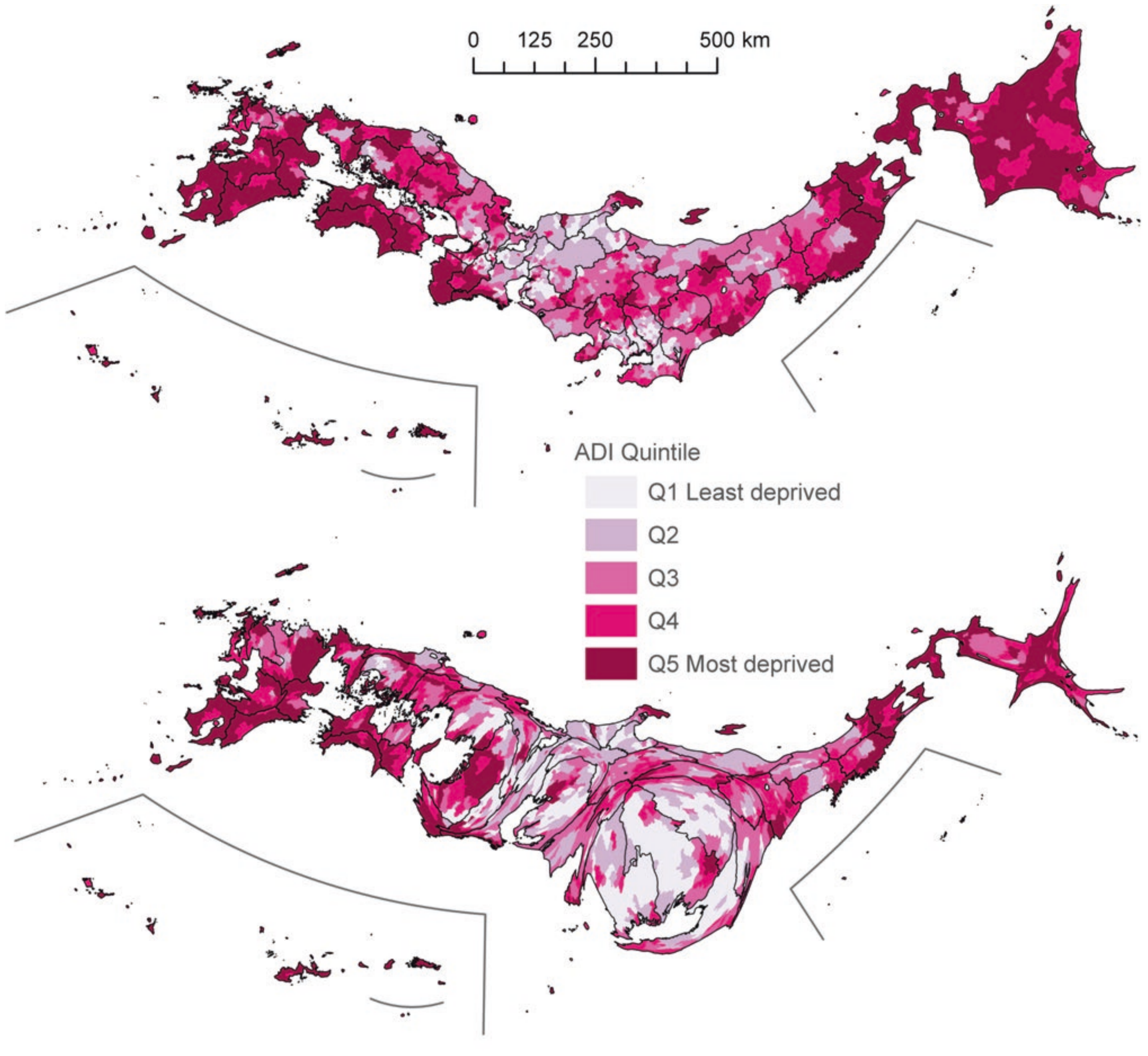


Fig. 2.14 Distribution of the quintile groups of the area deprivation index

2.9 Method III: Measure of Socioeconomic Inequalities Using Areal Deprivation Index: Slope Index of Inequality and Relative Index of Inequality

Keisuke Fukui and Yuri Ito

The measure of socioeconomic inequalities in all-cause mortality and cause-specific mortality was analysed by calculating ASMR by quintiles of the deprivation index and the more sophisticated summary indices of inequality, 'relative index of inequality' (RII) and 'slope index of inequality' (SII). While RII represents the magnitude of relative inequality, SII quantifies the magnitude of absolute inequality between the top and bottom of the ADI-based SEP distribution. Each index was obtained by the estimator of a regression, which quantifies the association between the health outcome and socioeconomic variables. The advantage of RII and SII is that they not only compare two extreme groups (e.g. most vs. least deprived quintile), but consider full information about the association between the socioeconomic position and health outcome. Figure 2.15 illustrates the concept of the regression model for RII and SII. The square points are the observations of each municipality, and the solid line represents the fitted regression line. RII and SII are obtained as the relative ratio and absolute difference of the standard mortality rate between the most deprived and least deprived on this fitted value in the regression model, respectively.

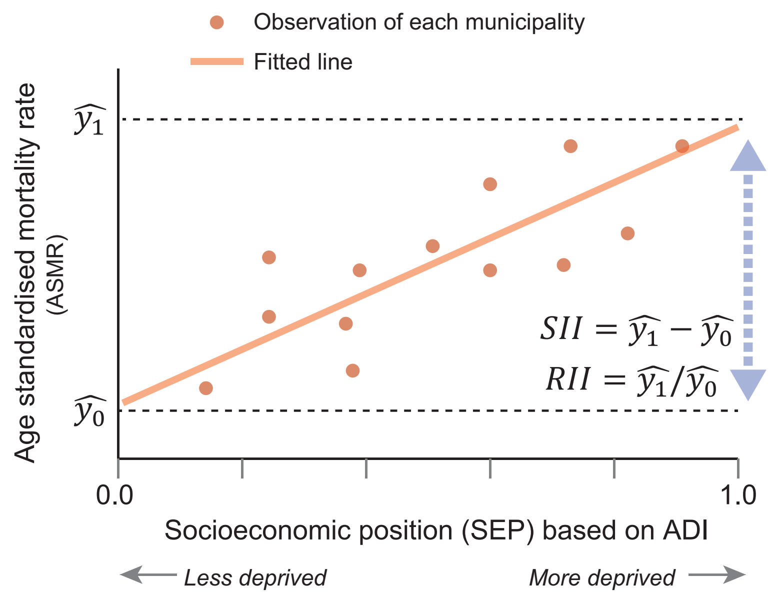


Fig. 2.15 The hypothetical regression for calculating the relative index of inequality and slope index of inequality

To calculate the RII and SII, the area deprivation index was converted to a fractional rank variable ranging from 0 (least deprived) to 1 (most deprived), which was an independent variable in the regression model. RII represents the rate ratio of mortality for those who live in the most deprived area to that in the least deprived area. In other words, they compare the mortality risk at the very bottom to that at the very top of the regional socioeconomic distribution while taking into account all data through the regression-based method. For example, if RII = 2.0, people living in the most deprived area are estimated as twice as likely to die compared with those living in the least deprived area. SII represents the absolute rate difference in terms of ASMR in this atlas. For example, if SII = 200, the ASMR of the most deprived area is estimated as 200 deaths (per 100,000 persons) more than that of the least deprived area.

Strictly speaking, we use a Poisson regression for computing RII rather than a conventional regression model and then estimate SII in terms of ASMR. Calculation details are shown in technical note T4.

2.10 Method IV: Graphs of the Transitions in Mortality and Indices of Health Inequalities

Yuri Ito

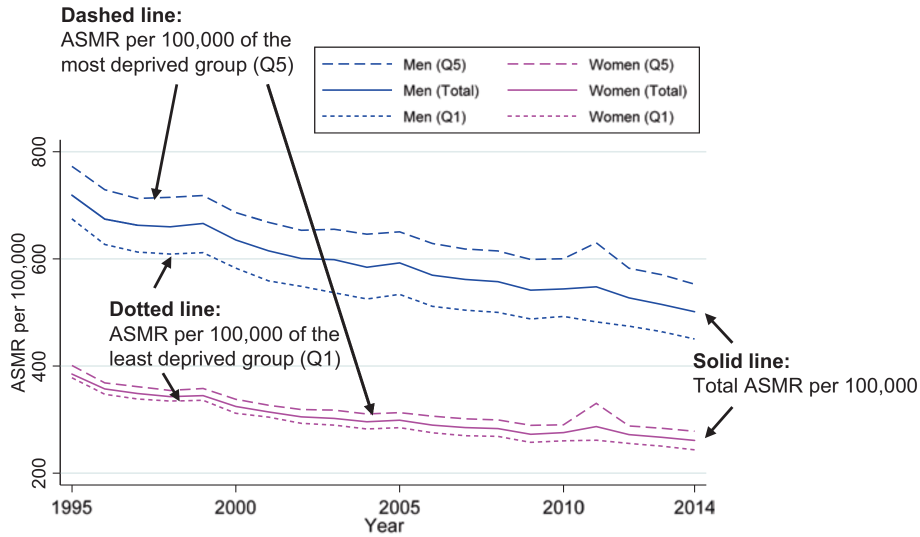
In Chaps. 3–6, a series of graphs follows the maps and shows the inequalities in each cause of death or age group in case of all-cause mortality. In this section, we explain how to interpret these graphs.

The first graph (Fig. 2.16) shows annual trends in total ASMR of the cause of death (solid line: blue for men, magenta for women). It shows the least deprived group (first quintile of ADI: Q1, dotted line) and the most deprived group (fifth quintile of ADI: Q5, dashed line). From this figure, the annual trends in total ASMR, Q1 and Q5 become clear. For example, we can observe changes before and after the earthquake disaster and the economic crisis. However, these trends become unstable when the number of deaths is small.

The second graph (Fig. 2.17) shows ASMR by ADI quintile. From this figure, we can judge whether a socioeconomic gradient exists in the ASMR of the cause of death. Some causes of death show a non-linear gradient, such as J-shape or U-shape which cannot be detected through the model-based indices of RII and SII.

The third graph (Fig. 2.18) shows trends in the sophisticated indices of inequalities based on both absolute and relative aspects. The SII indicates the direct impact of inequalities on population death in Japan. However, the SII will be influenced by whether the cause of death is common or rare, the relative index is therefore also important to show trends in the inequalities in ASMR. In the SII figure, the reference line SII = 0 means that there are no inequalities. Negative SII means an inverse socioeconomic gradient, that is a higher ASMR in the least deprived group than in the most deprived group. RII = 1 indicates no relative inequalities. A RII of more than 1, e.g. 1.25, shows that the ASMR is 25% higher in the most deprived group than the least deprived group.

Fig. 2.16 An example graph showing annual transition in the ASMR (all-cause deaths) from 1995 to 2014



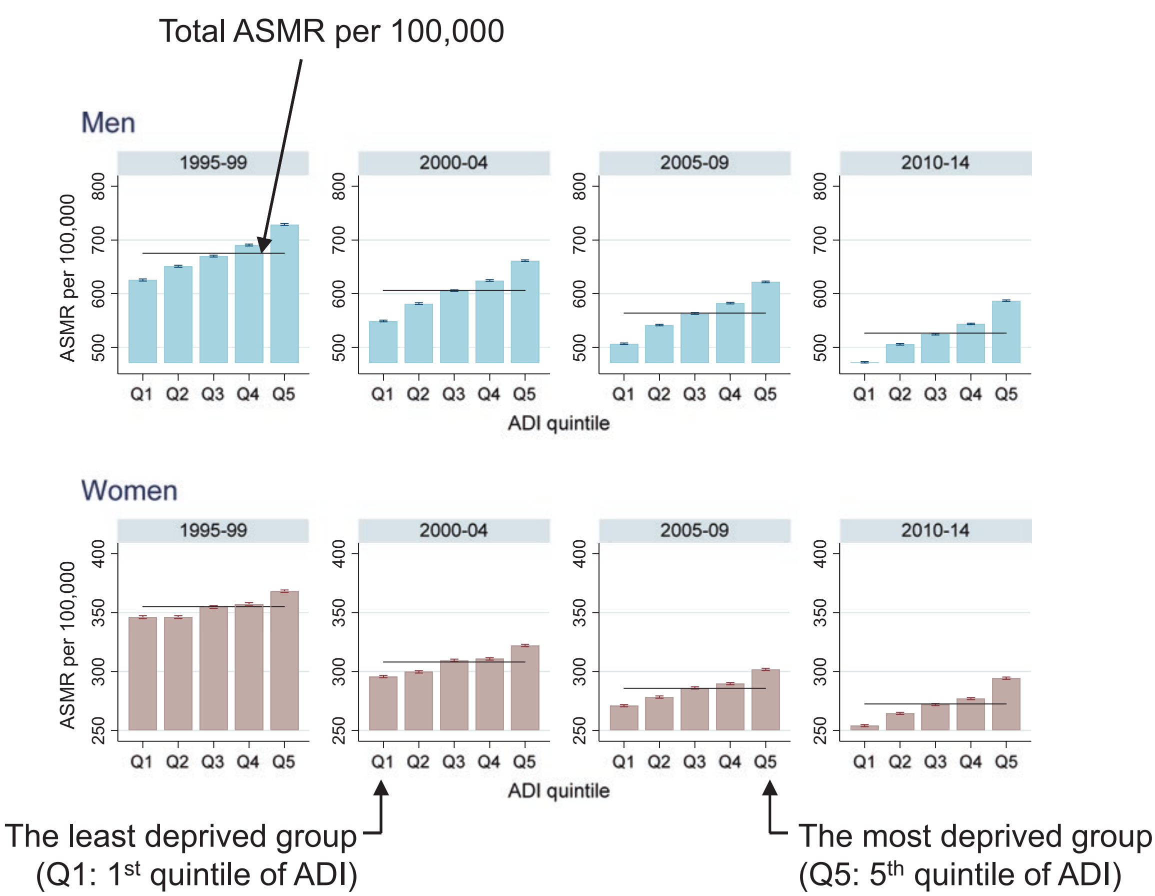


Fig. 2.17 An example graph showing the transition in the ASMR distribution (all-cause deaths) by ADI quintile (top: men, bottom: women)

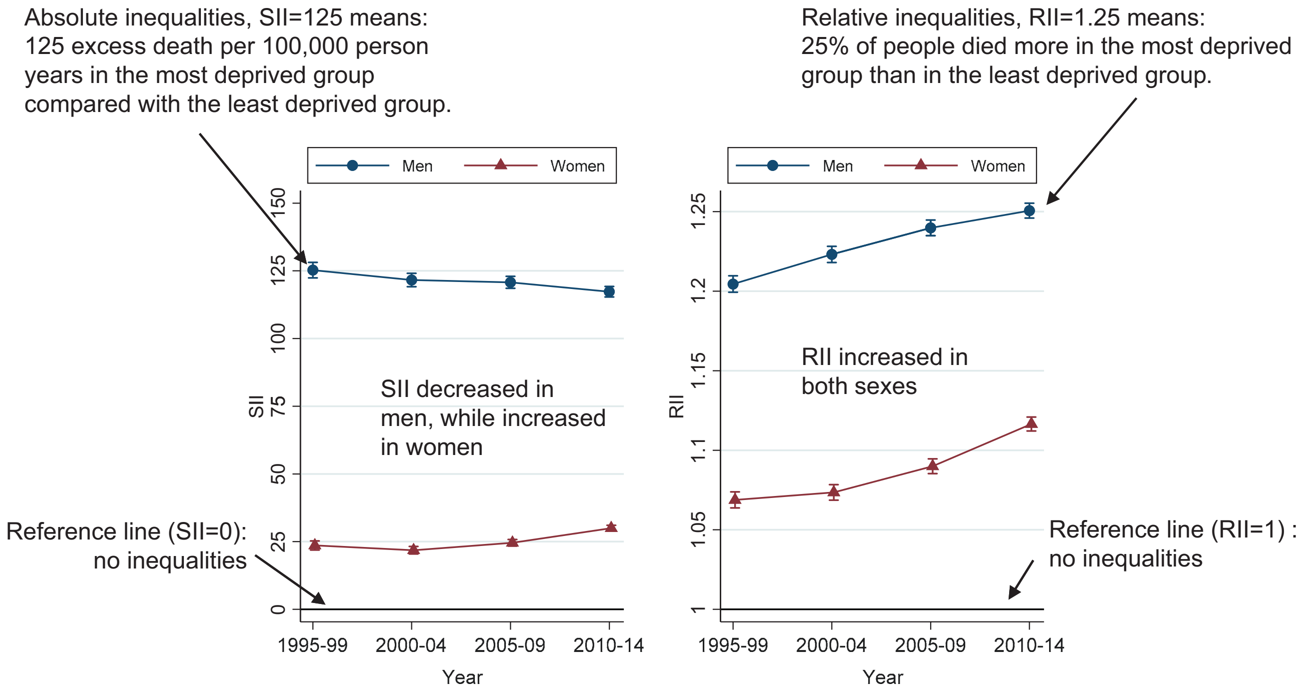


Fig. 2.18 An example graph showing the transition in SII and RII of all-cause deaths from 1995 to 2014 by 5-year period (left: SII, right: RII)

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3 Deaths Across Life Courses

Tomoki Nakaya, Yuri Ito, and Kazumasa Hanaoka

This chapter provides maps showing the geographical inequalities in causes of deaths by five age groups (0–14, 15–39, 40–64, 65–74, and 75+ years old) from 1995 to 2014 in Japan. Areas with higher standard mortality ratios (SMRs) are found in several non-metropolitan areas, particularly in the Tohoku region, while cartogram-based SMR maps highlight socioeconomic residential disparities within metropolitan areas. The social inequalities measured by the areal deprivation index are generally high among working age groups (15–39 and 40–64 years old) and their transitions indicate that the inequalities among those age groups are stable. The social inequalities of older adult groups (65–74 and 75+ years old), however, were relatively small but steadily rising between the years of 1995 and 2014. The tsunami caused by the Great East Japan Earthquake in 2011 created a sudden increase of mortality across different age groups. The older adults were more likely to die than the younger population in tsunami-affected areas. However, the SMR maps show that relative increases in SMR due to the tsunami were larger among younger populations with generally low mortality even before the disaster. Since the tsunami-affected areas are relatively deprived of countryside, the disaster resulted in an increase of socioeconomic inequalities in terms of mortality in Japan.

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3.1 All Causes of Death (All Ages): Where Are People More Likely to Die?

Tomoki Nakaya

Overview

The maps of all-cause death SMRs (Fig. 3.1) are quite similar to those of life expectancy shown in Chap. 1 in that they both describe the geographical disparity in Japanese health and well-being in terms of mortality. As introduced in Chap. 1 in the context of life expectancy maps, the SMR maps based on the ordinary projection give a strong impression regarding large geographical clusters of unhealthy areas with high mortality ratios in the northern part of the Tohoku region (or, in the case of women, even in the peripheral parts of the Kanto region) and another cluster of healthy areas with low mortality ratios in the mountainous areas of the Chubu region. Both clusters are outside major metropolitan areas.

On the other hand, according to the SMR distribution map using the cartogram, both the unhealthy large-sized population with the high mortality ratio and the healthy large-sized population with the low mortality ratio live in major metropolitan areas. The local populations characterized by high SMRs are commonly observed in inner-city areas of the metropolitan areas, shown as red-coloured 'peaks' in the prismic cartogram maps. The size of the unhealthy population in the metropolitan area is almost identical to that of the high SMR area in the northern part of the Tohoku region. Further, other local population groups with low SMRs are more common in suburban residential areas within the metropolitan areas, shown as blue-coloured 'low-lands'. Their total size is larger than that of local populations with low SMRs in mountainous central regions. The cartogram revealed the health divide according to residential zones in the metropolitan areas and

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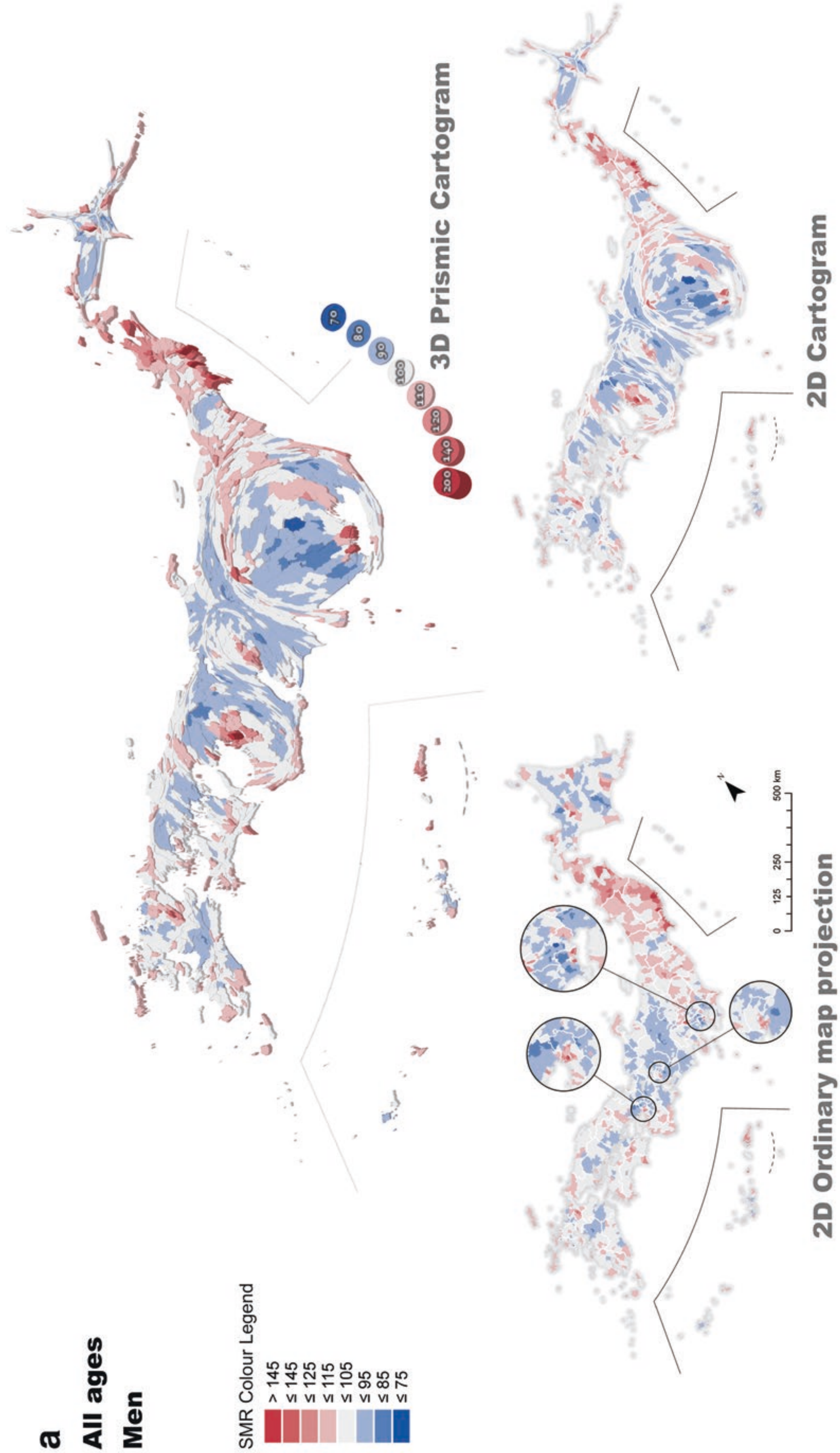

a
All ages
Men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0
125
250
500 km
N

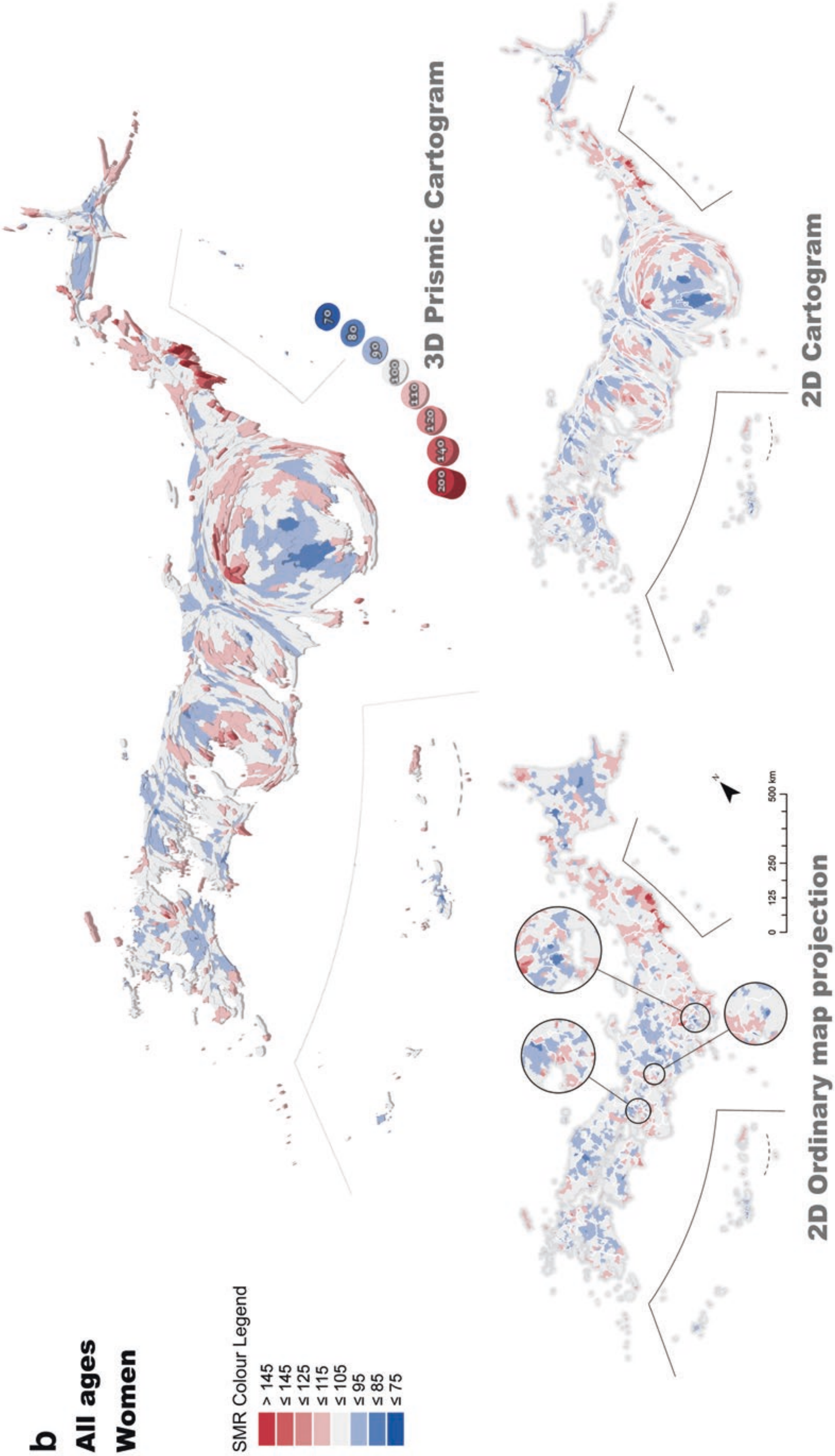


Fig. 3.1 SMR distribution of all causes of death (all ages), 2010–2014. (**a**) Men. (**b**) Women

Table 3.1 Leading causes of deaths for all age groups from 2010 to 2014 by 5-year period

	1995–1999		2000–2004		2005–2009		2010–2014	
Rank	Cause of death	%	Cause of death	%	Cause of death	%	Cause of death	%
Men								
1	Cancer	33.2	Cancer	34.3	Cancer	34.0	Cancer	32.9
2	Heart diseases	14.1	Heart diseases	14.0	Heart diseases	14.2	Heart diseases	14.1
3	Cerebrovascular disease	13.2	Cerebrovascular disease	11.6	Cerebrovascular disease	10.3	Pneumonia	10.0
4	Pneumonia	8.5	Pneumonia	8.9	Pneumonia	9.9	Cerebrovascular disease	8.9
5	Suicide	3.5	Suicide	4.0	Suicide	3.7	Suicide	2.9
6	Accident	2.7	Accident	2.2	Chronic obstructive pulmonary disease	1.9	Senility	2.2
7	Liver diseases	2.2	Liver diseases	2.0	Liver diseases	1.8	Chronic obstructive pulmonary disease	2.0
8	Chronic obstructive pulmonary disease	1.8	Chronic obstructive pulmonary disease	1.8	Accident	1.7	Kidney failure	1.8
9	Kidney failure	1.5	Kidney failure	1.6	Kidney failure	1.7	Accident	1.7
10	Diabetes	1.3	Diabetes	1.2	Senility	1.3	Liver diseases	1.6
Women								
1	Cancer	25.7	Cancer	26.8	Cancer	25.9	Cancer	24.5
2	Cerebrovascular disease	17.4	Heart diseases	17.5	Heart diseases	18.1	Heart diseases	17.7
3	Heart diseases	17.2	Cerebrovascular disease	15.2	Cerebrovascular disease	12.8	Cerebrovascular disease	10.4
4	Pneumonia	8.9	Pneumonia	9.2	Pneumonia	10.0	Pneumonia	9.5
5	Senility	3.6	Senility	3.7	Senility	4.6	Senility	7.7
6	Kidney failure	2.1	Kidney failure	2.2	Kidney failure	2.3	Kidney failure	2.2
7	Suicide	1.9	Suicide	1.9	Suicide	1.7	Suicide	1.4
8	Accident	1.6	Diabetes	1.3	Diabetes	1.3	Aortic aneurysm and dissociation	1.3
9	Diabetes	1.5	Accident	1.2	Aortic aneurysm and dissociation	1.1	Accident	1.2
10	Liver diseases	1.2	Liver diseases	1.1	Liver diseases	1.1	Diabetes	1.1
Both sexes								
1	Cancer	29.8	Cancer	30.9	Cancer	30.2	Cancer	28.9
2	Heart diseases	15.5	Heart diseases	15.6	Heart diseases	16.0	Heart diseases	15.8
3	Cerebrovascular disease	15.1	Cerebrovascular disease	13.2	Cerebrovascular disease	11.5	Pneumonia	9.8
4	Pneumonia	8.7	Pneumonia	9.1	Pneumonia	9.9	Cerebrovascular disease	9.6
5	Suicide	2.8	Suicide	3.1	Senility	2.9	Senility	4.8
6	Senility	2.3	Senility	2.3	Suicide	2.7	Suicide	2.2
7	Accident	2.2	Kidney failure	1.8	Kidney failure	2.0	Kidney failure	2.0
8	Kidney failure	1.8	Accident	1.8	Liver diseases	1.5	Accident	1.5
9	Liver diseases	1.8	Liver diseases	1.6	Accident	1.4	Chronic obstructive pulmonary disease	1.3
10	Diabetes	1.4	Chronic obstructive pulmonary disease	1.3	Chronic obstructive pulmonary disease	1.3	Liver diseases	1.3

identified the importance of it in terms of the proportion of the national population that they occupy. See Chap. 2, Sect. 2.4 for the social area formation inside the metropolitan areas.

We can also recognise red-coloured hills of high SMR along the Pacific Ocean side of Tohoku region in the prismic cartogram map, 2010–2014, caused by the Great East Japan Earthquake in 2011 (see Chap. 2, Sect. 2.3 for the details).

Table 3.1 summarises the leading causes of deaths for the study periods.

Transitions and Socioeconomic Disparities

The temporal multiples of SMR distributional maps show small changes of local SMR values over the entire country (Fig. 3.2). Thus, it is difficult to identify meaningful changes of the SMR distributions between 1995 and 2014. It is clear, however, that the variation of SMRs is consistently larger for men than for women during the period.

Except for the temporary impact in 2011, age-adjusted mortality rates (ASMR) for both sexes have continued to

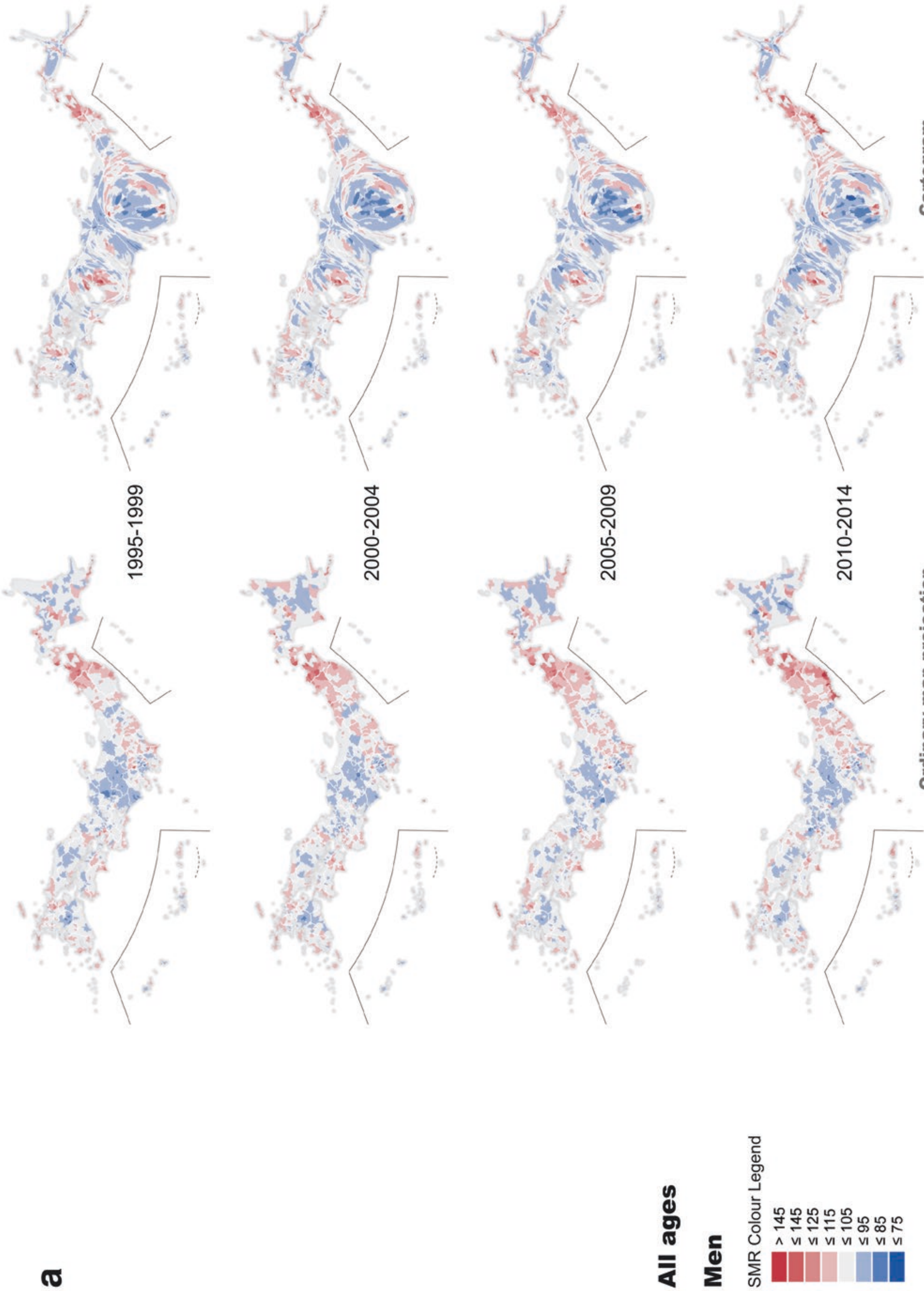


Fig. 3.2 Transition of SMR distribution of all causes of death (all ages) from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

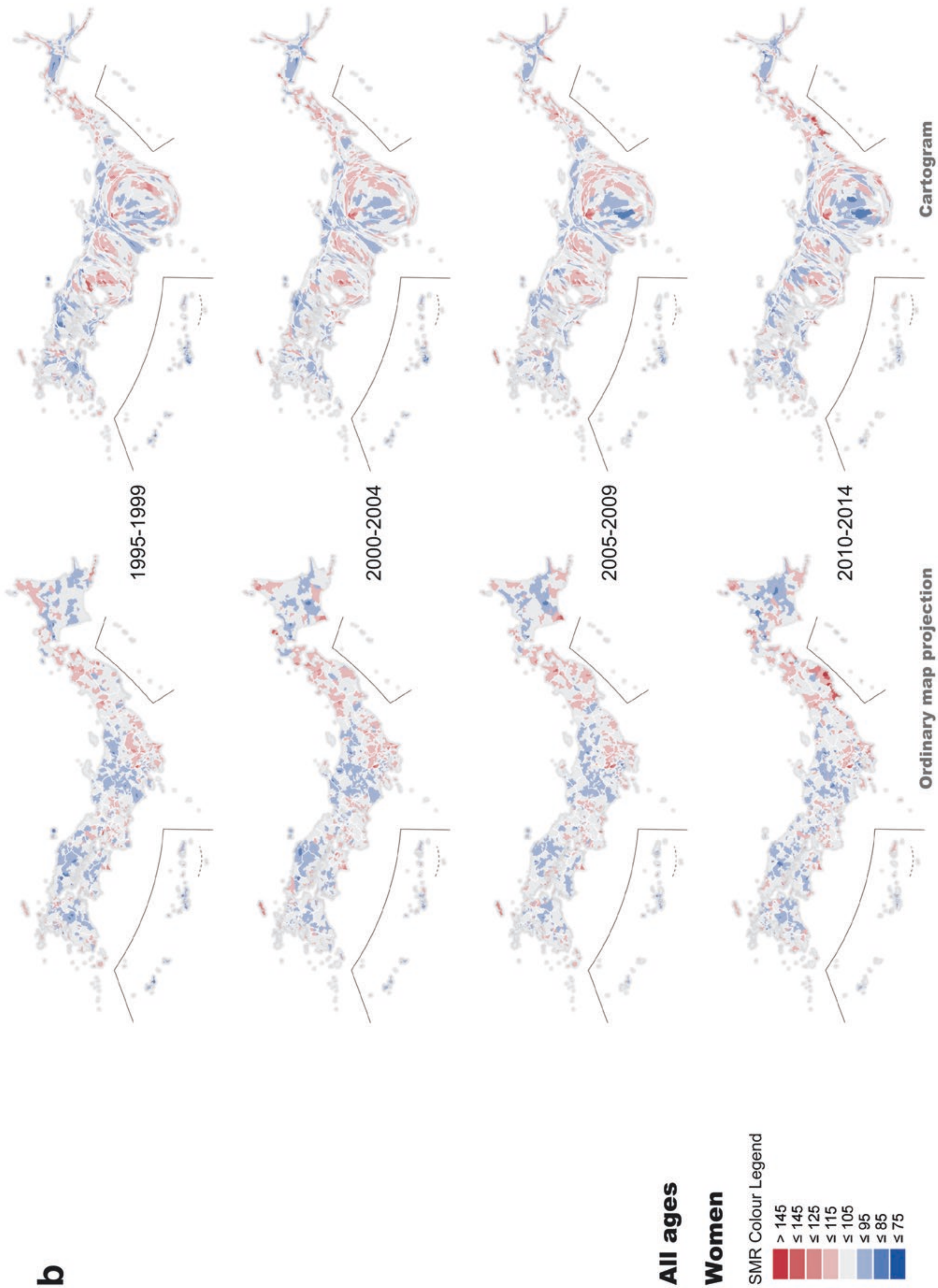


Fig. 3.2 (continued)

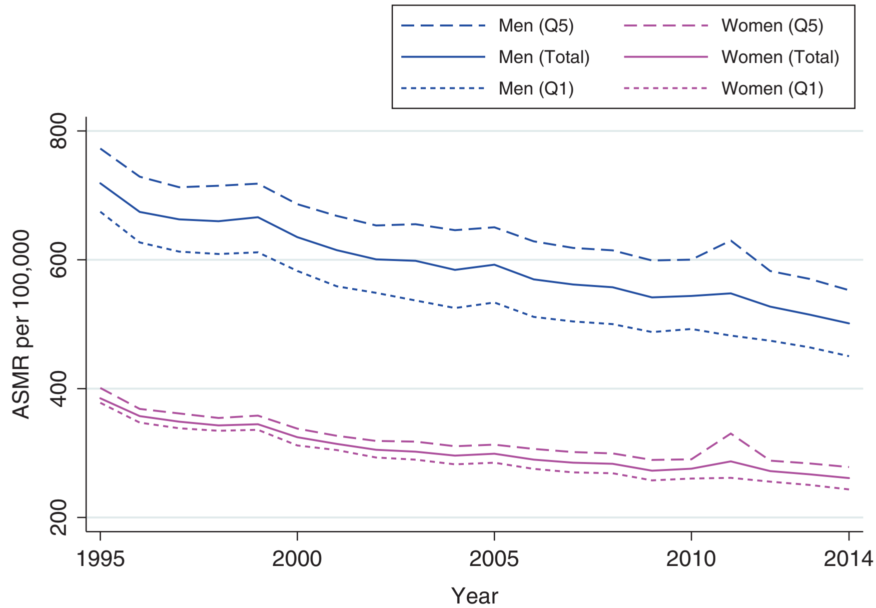


Fig. 3.3 Annual transition in the ASMR of all causes of death (all ages) from 1995 to 2014

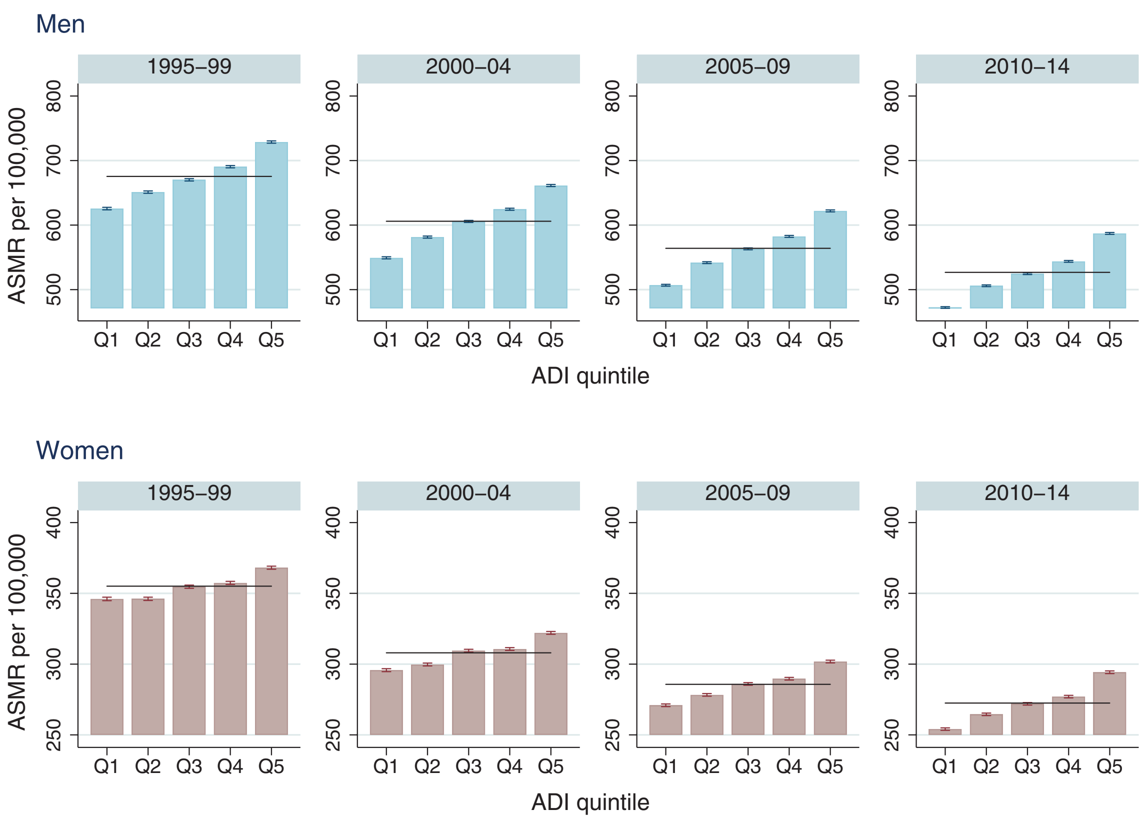


Fig. 3.4 The transition in the ASMR distribution of all causes of death (all ages) by ADI quintile (top: men, bottom: women)

decline over the 20-year period from 2010 to 2014 (Fig. 3.3). The most of distribution of ASMR by ADI Quintile shows a clear socioeconomic gradient in ASMR for both sexes (Fig. 3.4). The trends of the slope index of inequality (SII) indicate that the absolute socioeconomic inequalities in ASMR have levelled off, with a slight decrease for men and a slight increase for women (Fig. 3.5). Trends in the relative index of inequalities (RII) show that the relative socioeconomic inequalities in ASMR have also been steadily growing (Fig. 3.5).

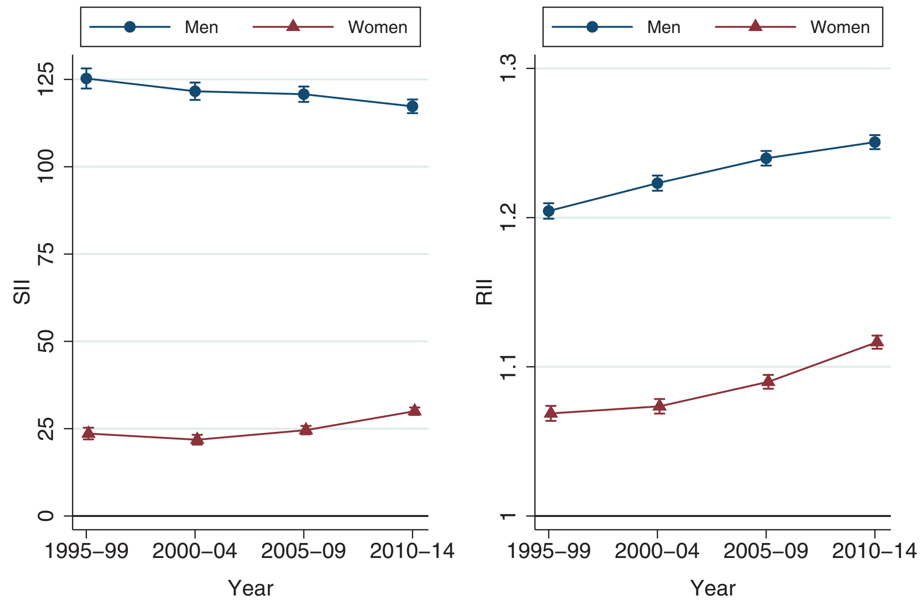


Fig. 3.5 Transition in SII and RII of all causes of death (all ages) from 1995 to 2014 by 5-year period (left: SII, right: RII)

3.2 All Causes of Death (0–14 Years Old): High-Rise Peaks Caused by the Tsunami Disaster

Tomoki Nakaya

Overview

One fourth of the deaths in this age group (children) can be attributed to genetic problems (Table 3.2). The second leading cause of death is 'pathogenesis occurred during perinatal period', including infection and disordered conditions originating before birth. Accidental deaths are the third leading cause of death for this age group. On the prismic cartogram map of 2010–2014 (Fig. 3.6), high-rise peaks signifying high SMRs were observed in the Pacific coast area of the Tohoku region, indicating the serious impact of the Great East Japan Earthquake. At the time of the earthquake, the mortality rate of the older adults was higher, but the rate of increase in the mortality rate due to the earthquake was higher for children. The SMR maps in the period from 1995 to 1999 show another temporal increase of SMR that occurred in Kobe City in Hyogo Prefecture, reflecting another earthquake disaster of the Great Hanshin-Awaji Earthquake in 1995. On the prismic cartogram map of 2010–2014, there are other high SMR areas in several rural regions outside of the major metropolitan areas. While we cannot identify extremely high SMRs in inner-city areas, we can determine that large populations living in metropolitan suburbs are generally characterised by low SMRs, represented by blue-coloured areas.

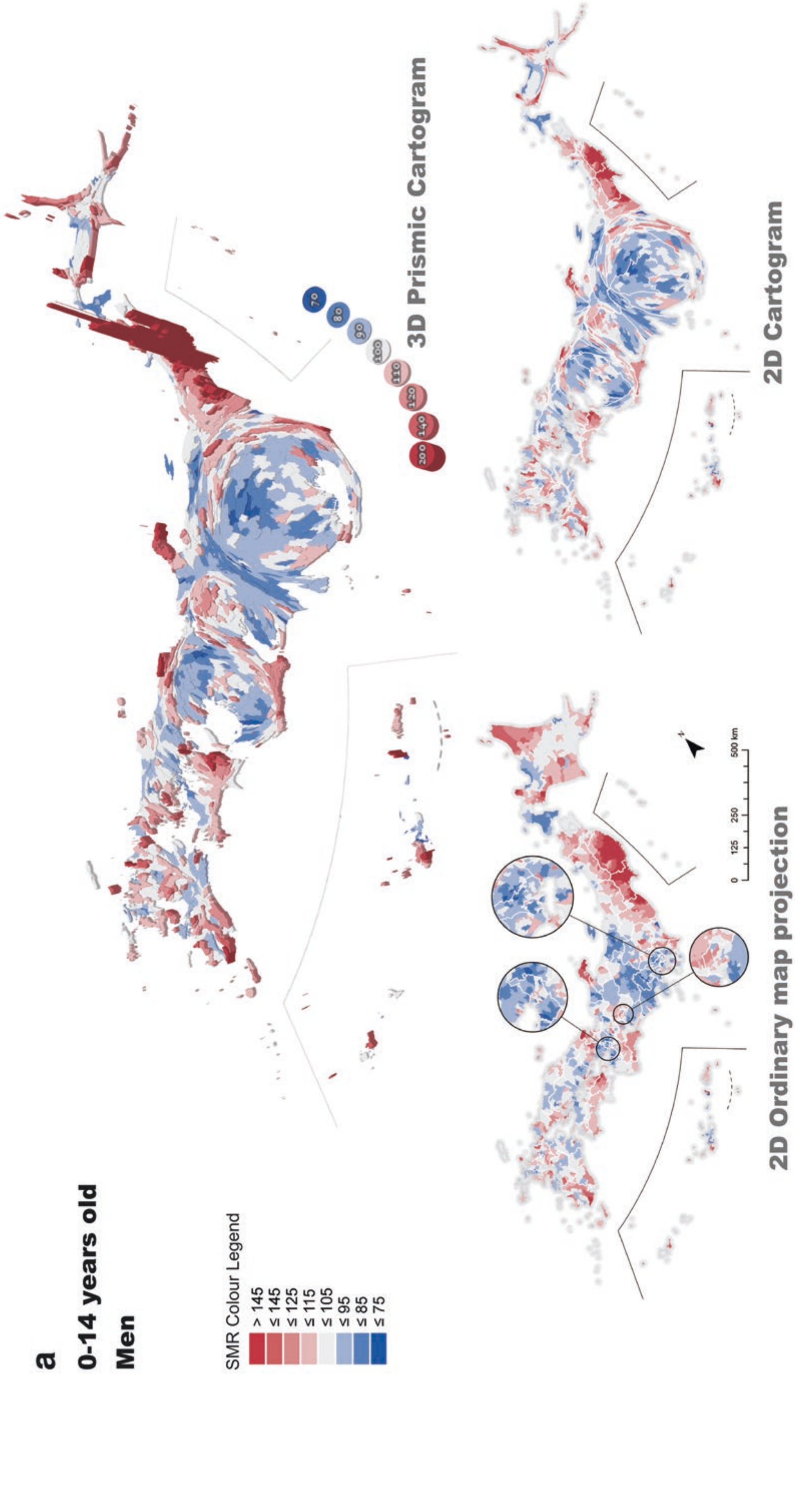
Transitions and Socioeconomic Disparities

Regional differences in SMR have been small in the periods without earthquake disasters (Fig. 3.7), because of the overall low mortality rate of this age group (Fig. 3.8). Especially, in the latter half of the 2000s, the regional difference in SMRs for women is quite small. All of the SMRs are in the middle range, 95–105. Conversely, in 2010–2014, a period impacted by the earthquake, regional differences in SMR are more clearly depicted than in other years due to increased overall mortality. Despite these temporal fluctuations in SMR ranges, the lower SMRs are frequently found in metropolitan suburbs, indicating that affluent residential areas tend to have lower mortality than the metropolitan areas.

The age-standardised mortality rate (ASMR) for children is highest in deprived community groups (Q5) for both sexes between 1995 and 2014 (Fig. 3.9). Due to the low number of deaths, the socioeconomic inequality indices (SII and RII) have large confidence intervals, indicating statistical uncertainty (Fig. 3.10). However, most of these indices do indicate the existence of socioeconomic inequality of child mortality. These inequalities could be related to poor access to medical services for both pregnancy and child care and the presence of child poverty. The association of child death and their social environment, such as the issue of child abuse in community poverty (Farrell et al. 2017), needs further consideration in the context of Japan.

Table 3.2 Leading causes of deaths for 0–14 years old from 2010 to 2014 by 5-year period

	1995–1999		2000–2004		2005–2009		2010–2014	
Rank	Cause of death	%	Cause of death	%	Cause of death	%	Cause of death	%
Men								
1	Congenital malformation, deformity and chromosomal abnormality	22.3	Congenital malformation, deformity and chromosomal abnormality	24.0	Congenital malformation, deformity and chromosomal abnormality	23.1	Congenital malformation, deformity and chromosomal abnormality	22.1
2	Pathogenesis occurred during perinatal period	16.6	Pathogenesis occurred during perinatal period	16.5	Pathogenesis occurred during perinatal period	15.5	Pathogenesis occurred during perinatal period	13.8
3	Accident	9.0	Accident	7.8	Cancer	6.8	Accident	7.9
4	Sudden infant death syndrome	6.2	Cancer	5.9	Accident	6.3	Cancer	7.2
5	Cancer	6.2	Sudden infant death syndrome	5.0	Heart diseases	4.3	Heart diseases	3.8
6	Heart diseases	4.0	Heart diseases	4.7	Sudden infant death syndrome	3.8	Sudden infant death syndrome	3.5
7	Pneumonia	3.3	Pneumonia	3.0	Pneumonia	2.9	Pneumonia	3.1
8	Sepsis	1.6	Sepsis	1.8	Other neoplasms	1.9	Suicide	2.3
9	Other neoplasms	1.4	Other neoplasms	1.6	Sepsis	1.8	Sepsis	1.9
10	Murder	1.2	Murder	1.4	Murder	1.5	Other neoplasms	1.6
Women								
1	Congenital malformation, deformity and chromosomal abnormality	27.0	Congenital malformation, deformity and chromosomal abnormality	28.6	Congenital malformation, deformity and chromosomal abnormality	26.9	Congenital malformation, deformity and chromosomal abnormality	26.9
2	Pathogenesis occurred during perinatal period	16.7	Pathogenesis occurred during perinatal period	17.0	Pathogenesis occurred during perinatal period	16.7	Pathogenesis occurred during perinatal period	14.2
3	Accident	6.8	Cancer	6.2	Cancer	6.7	Accident	7.5
4	Cancer	5.9	Accident	6.0	Accident	4.7	Cancer	7.1
5	Sudden infant death syndrome	5.8	Heart diseases	5.0	Heart diseases	4.5	Heart diseases	3.9
6	Heart diseases	4.2	Sudden infant death syndrome	4.4	Pneumonia	3.2	Pneumonia	3.3
7	Pneumonia	3.5	Pneumonia	2.8	Sudden infant death syndrome	3.1	Sudden infant death syndrome	3.1
8	Sepsis	1.7	Other neoplasms	2.0	Sepsis	2.1	Sepsis	2.2
9	Other neoplasms	1.7	Murder	1.7	Other neoplasms	2.1	Other neoplasms	2.1
10	Murder	1.4	Sepsis	1.6	Murder	1.4	Suicide	1.4
Both sexes								
1	Congenital malformation, deformity and chromosomal abnormality	24.3	Congenital malformation, deformity and chromosomal abnormality	26.0	Congenital malformation, deformity and chromosomal abnormality	24.8	Congenital malformation, deformity and chromosomal abnormality	24.3
2	Pathogenesis occurred during perinatal period	16.6	Pathogenesis occurred during perinatal period	16.7	Pathogenesis occurred during perinatal period	16.0	Pathogenesis occurred during perinatal period	14.0
3	Accident	8.1	Accident	7.0	Cancer	6.7	Accident	7.7
4	Cancer	6.0	Cancer	6.0	Accident	5.6	Cancer	7.2
5	Sudden infant death syndrome	6.0	Heart diseases	4.8	Heart diseases	4.4	Heart diseases	3.9
6	Heart diseases	4.1	Sudden infant death syndrome	4.8	Sudden infant death syndrome	3.5	Sudden infant death syndrome	3.3
7	Pneumonia	3.4	Pneumonia	2.9	Pneumonia	3.0	Pneumonia	3.2
8	Sepsis	1.6	Other neoplasms	1.8	Other neoplasms	2.0	Sepsis	2.1
9	Other neoplasms	1.5	Sepsis	1.7	Sepsis	1.9	Suicide	1.9
10	Murder	1.3	Murder	1.5	Murder	1.5	Other neoplasms	1.8



a
0-14 years old
Men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0
125
250
500 km
N

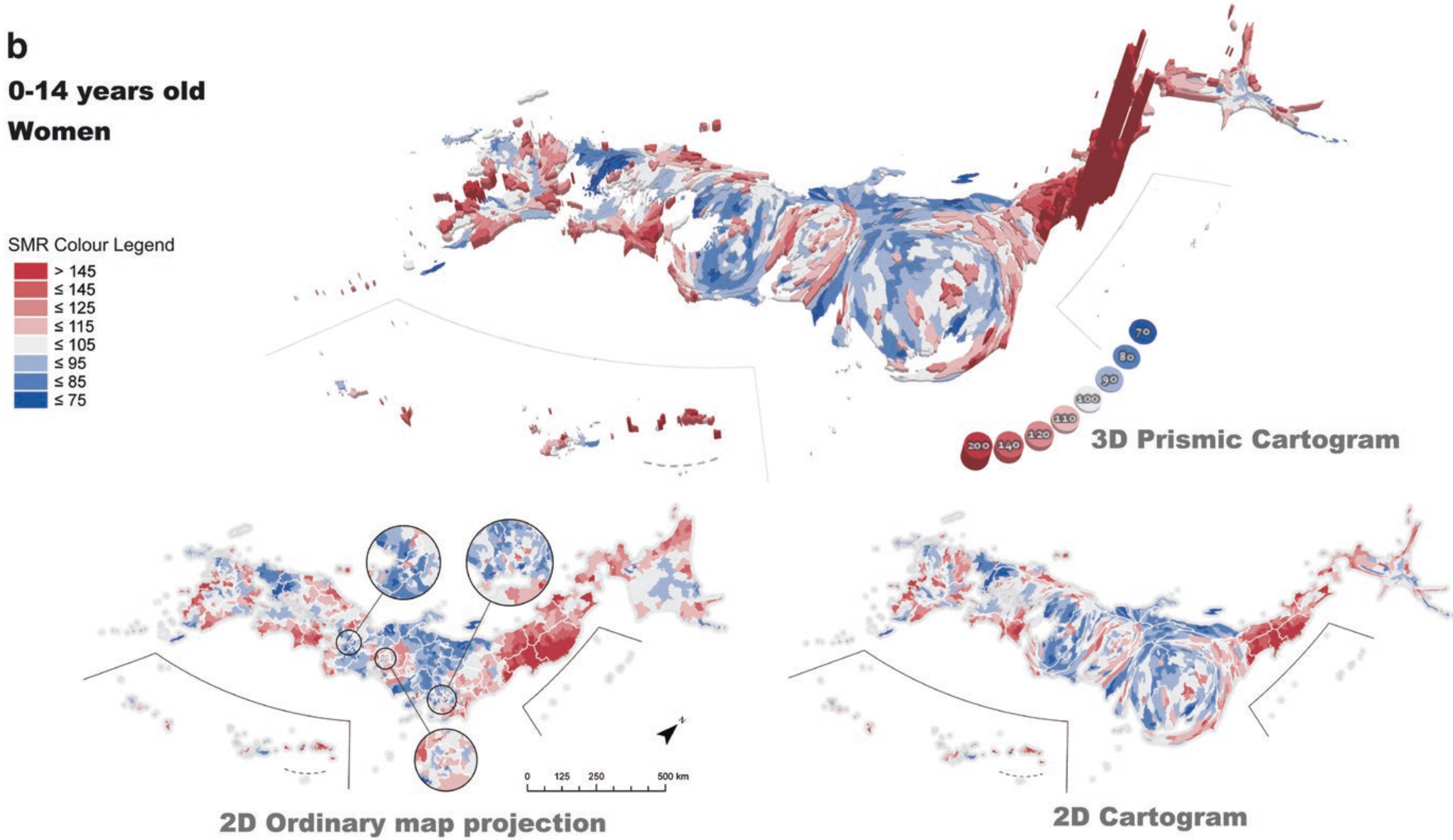
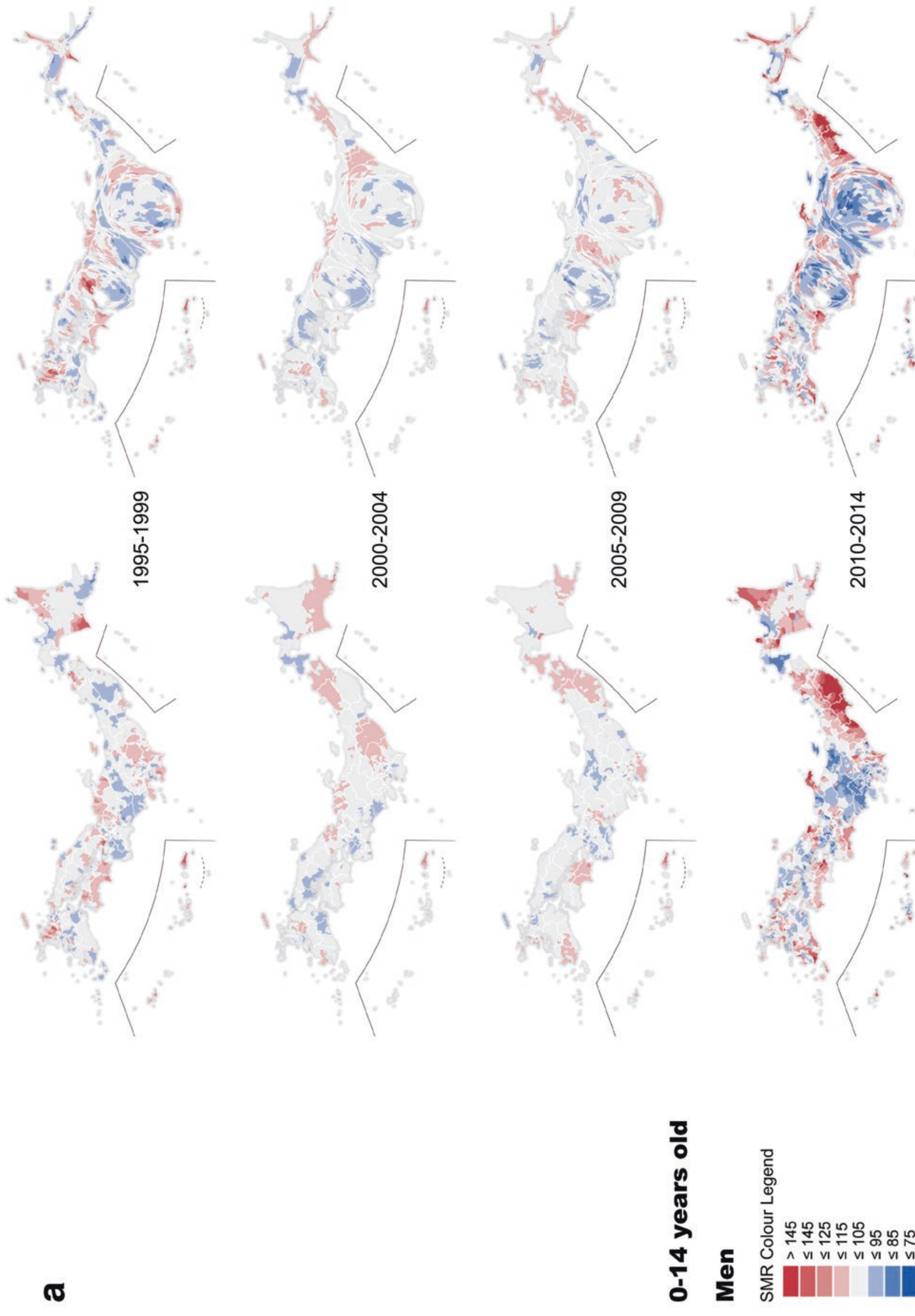


Fig. 3.6 SMR distribution of all causes of death (0–14 years old), 2010–2014. (**a**) Men. (**b**) Women


a
0-14 years old
Men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

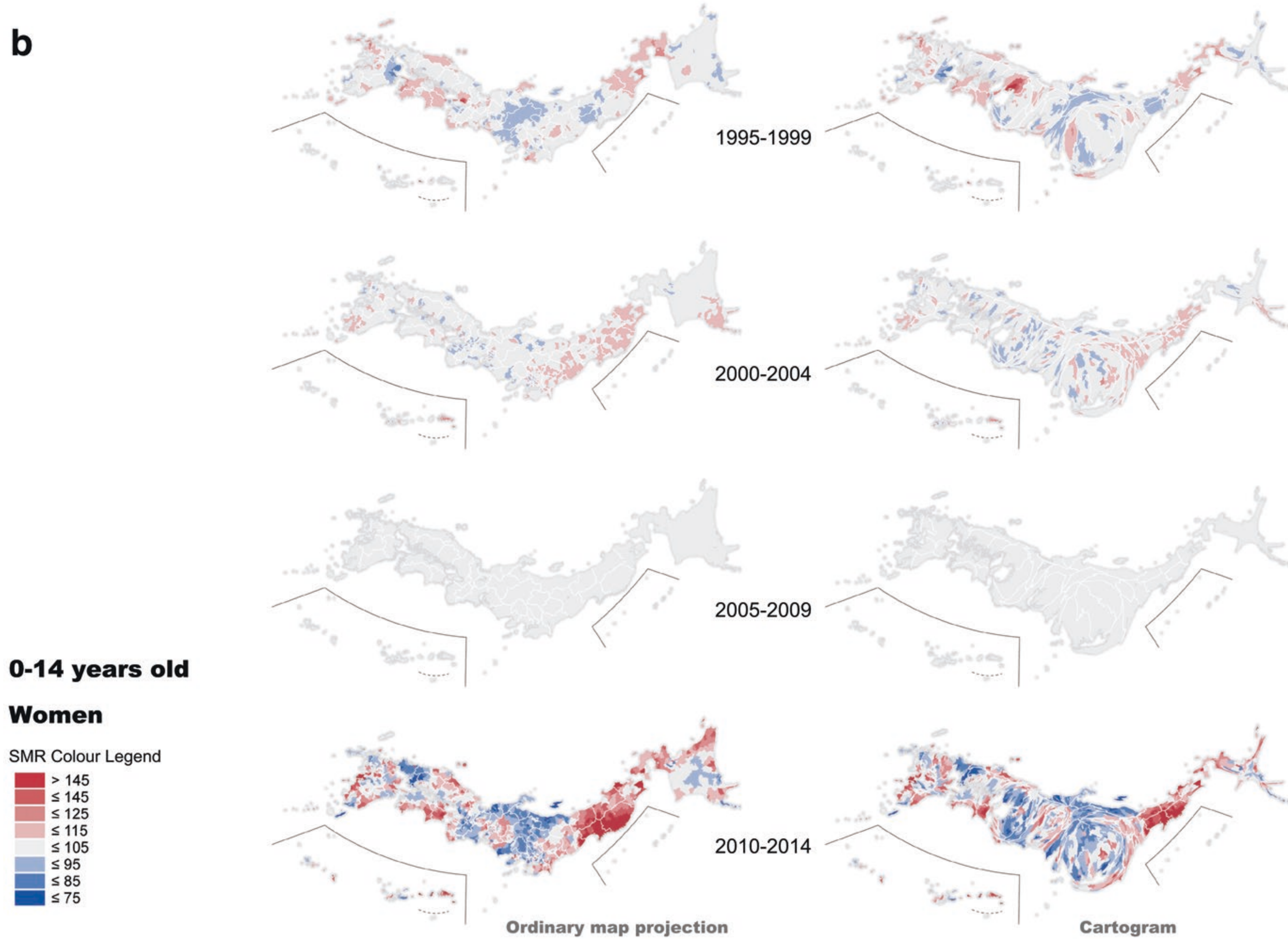


Fig. 3.7 Transition of SMR distribution of all causes of death (0–14 years old) from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

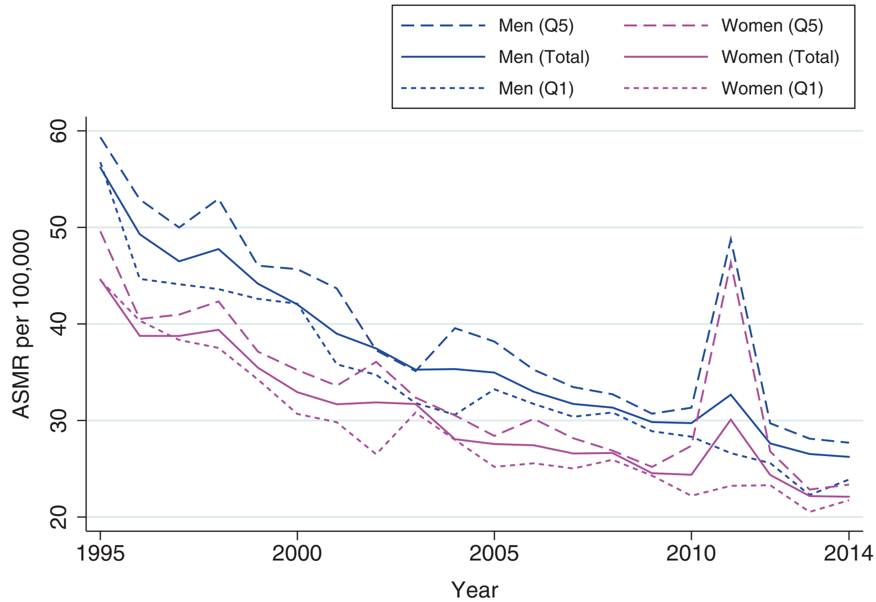


Fig. 3.8 Annual transition in the ASMR of all causes of death (0–14 years old) from 1995 to 2014

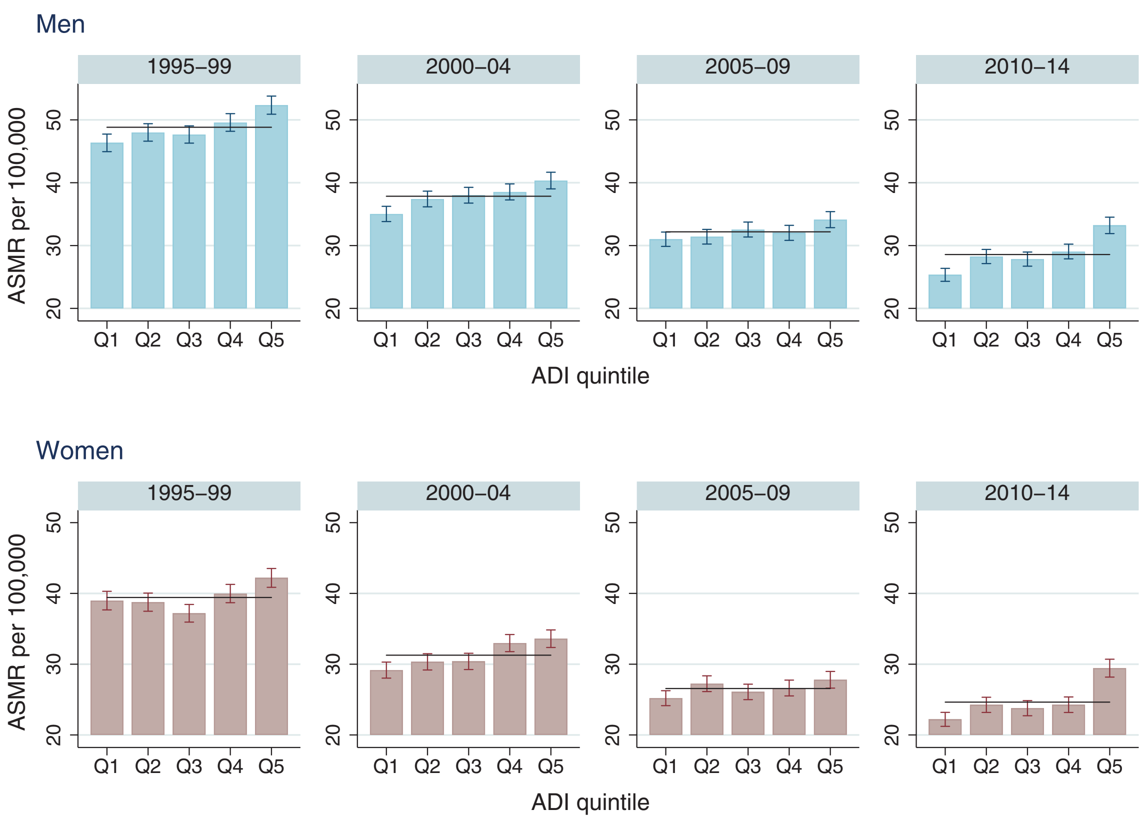


Fig. 3.9 The transition in the ASMR distribution of all causes of death (0–14 years old) by ADI quintile (top: men, bottom: women)

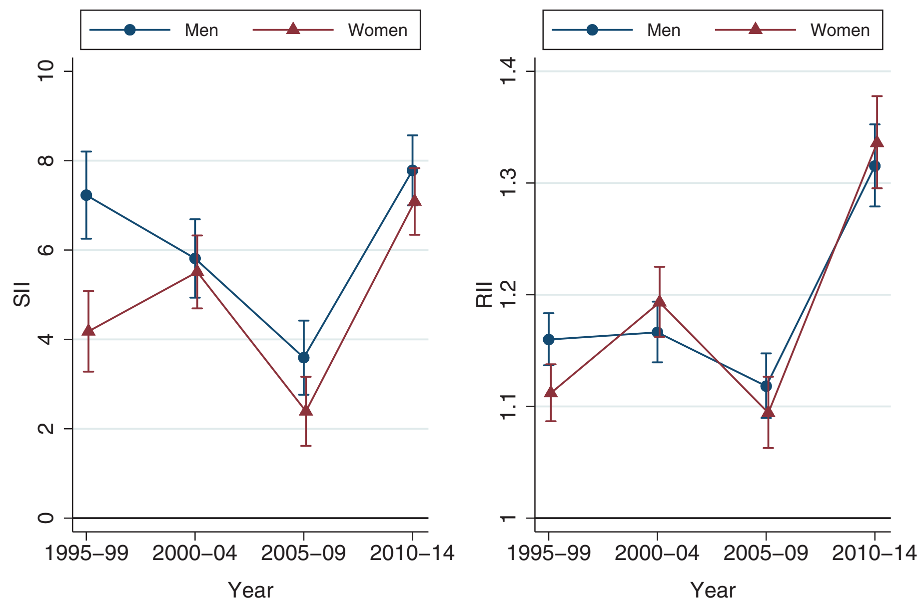


Fig. 3.10 Transition in SII and RII of all causes of death (0–14 years old) from 1995 to 2014 by 5-year period (left: SII, right: RII)

3.3 All Causes of Death (15–39 Years Old): Large Socioeconomic Inequalities of Small Deaths of Adolescents and Young Adults

Tomoki Nakaya

Overview

This age group is often called Adolescents and Young Adults (AYA). It includes the early stage of working age though most of junior high school graduates are enrolled in high schools (usually from 16 to 18 years old), and over 70% of high school graduates are enrolled in higher education including university, technology collages, and specialized schools (Higher Education Bureau 2012). Suicide was consistently the leading cause of death in this age group (Table 3.3). Cancer and accidents follow as the second and third leading causes of death. The proportions of suicide to all AYA deaths have been increasing for both sexes, reaching 41.4% for men and 32.2% for women in the period from 2010 to 2014.

However, on the prismic cartogram SMR map in the period from 2010 to 2014 (Fig. 3.11), as in the case with children, the data highlight the serious impact of accidental deaths on the Pacific coast in the Tohoku region caused by the Great East Japan Earthquake in 2011. The SMRs of AYA are generally high in rural parts, particularly for men, possibly reflecting higher chances of death due to traffic accidents in those areas. We also can observe large blue-coloured basins in the metropolitan areas on the prismic cartogram maps, indicating that SMRs of AYA are substantially low in metropolitan areas (except for several inner-city areas), particularly for women.

Transitions and Socioeconomic Disparities

While the transitions in the SMR distribution were generally unchanged (Fig. 3.12), the ASMR of AYA slightly decreased (except for 2011) between 1995 and 2014 (Fig. 3.13). Despite the low ASMR, there were consistently clear socioeconomic inequalities regarding AYA mortality, as shown in the graph of ASMRs by ADI quintile (Fig. 3.14). In every period, the highest and lowest ASMRs are observed for the most and least deprived group of municipalities.

Both the absolute and relative socioeconomic inequalities of AYA mortality, shown by SII and RII, exhibit relatively stable transitions (Fig. 3.15). Although the statistical uncertainty of RII is large because of the low number of deaths, it is important to note that the RII of AYA, around 1.5 for males and 1.3 for females in the latest period from 2010 to 2014, is the largest as compared to the other age groups.

Table 3.3 Leading causes of deaths for 15–39 years old from 2010 to 2014 by 5-year period

	1995–1999		2000–2004		2005–2009		2010–2014	
Rank	Cause of death	%	Cause of death	%	Cause of death	%	Cause of death	%
Men								
1	Suicide	26.0	Suicide	32.6	Suicide	39.2	Suicide	41.4
2	Accident	23.3	Accident	18.6	Accident	13.0	Accident	11.6
3	Cancer	12.1	Cancer	10.9	Cancer	10.7	Cancer	10.6
4	Heart diseases	9.3	Heart diseases	10.0	Heart diseases	9.5	Heart diseases	8.8
5	Cerebrovascular disease	4.0	Cerebrovascular disease	3.8	Cerebrovascular disease	4.1	Cerebrovascular disease	3.7
6	Liver diseases	1.8	Liver diseases	1.8	Liver diseases	1.5	Liver diseases	1.5
7	Pneumonia	1.4	Pneumonia	1.1	Pneumonia	1.1	Pneumonia	1.2
8	Other neoplasms	1.2	Other neoplasms	1.1	Other neoplasms	1.0	Other neoplasms	0.9
9	Asthma	1.1	Murder	0.7	Congenital malformation, deformity and chromosomal abnormality	0.7	Congenital malformation, deformity and chromosomal abnormality	0.8
10	Congenital malformation, deformity and chromosomal abnormality	0.8	Congenital malformation, deformity and chromosomal abnormality	0.7	Diabetes	0.6	Aortic aneurysm and dissociation	0.6
Women								
1	Cancer	27.8	Suicide	27.1	Suicide	32.4	Suicide	32.2
2	Suicide	22.4	Cancer	26.9	Cancer	25.1	Cancer	25.7
3	Accident	12.9	Accident	9.6	Accident	7.0	Accident	8.6
4	Heart diseases	6.0	Heart diseases	6.5	Heart diseases	6.0	Heart diseases	5.0
5	Cerebrovascular disease	4.2	Cerebrovascular disease	4.0	Cerebrovascular disease	3.9	Cerebrovascular disease	3.6
6	Pneumonia	1.8	Pneumonia	1.6	Liver diseases	1.5	Pneumonia	1.4
7	Other neoplasms	1.5	Other neoplasms	1.5	Pneumonia	1.5	Liver diseases	1.3
8	Diseases of the musculoskeletal system and connective tissue	1.3	Liver diseases	1.2	Other neoplasms	1.4	Other neoplasms	1.2
9	Congenital malformation, deformity and chromosomal abnormality	1.1	Congenital malformation, deformity and chromosomal abnormality	1.0	Congenital malformation, deformity and chromosomal abnormality	1.1	Congenital malformation, deformity and chromosomal abnormality	1.0
10	Liver diseases	1.1	Murder	1.0	Murder	0.8	Diseases of the musculoskeletal system and connective tissue	0.6
Both sexes								
1	Suicide	24.8	Suicide	30.8	Suicide	36.9	Suicide	38.3
2	Accident	20.0	Cancer	16.0	Cancer	15.5	Cancer	15.7
3	Cancer	17.2	Accident	15.7	Accident	11.0	Accident	10.6
4	Heart diseases	8.3	Heart diseases	8.9	Heart diseases	8.3	Heart diseases	7.5
5	Cerebrovascular disease	4.1	Cerebrovascular disease	3.9	Cerebrovascular disease	4.0	Cerebrovascular disease	3.7
6	Liver diseases	1.6	Liver diseases	1.6	Liver diseases	1.5	Liver diseases	1.4
7	Pneumonia	1.5	Pneumonia	1.3	Pneumonia	1.2	Pneumonia	1.3
8	Other neoplasms	1.3	Other neoplasms	1.2	Other neoplasms	1.1	Other neoplasms	1.0
9	Asthma	1.1	Murder	0.8	Congenital malformation, deformity and chromosomal abnormality	0.8	Congenital malformation, deformity and chromosomal abnormality	0.9
10	Congenital malformation, deformity and chromosomal abnormality	0.9	Congenital malformation, deformity and chromosomal abnormality	0.8	Murder	0.6	Diabetes	0.5

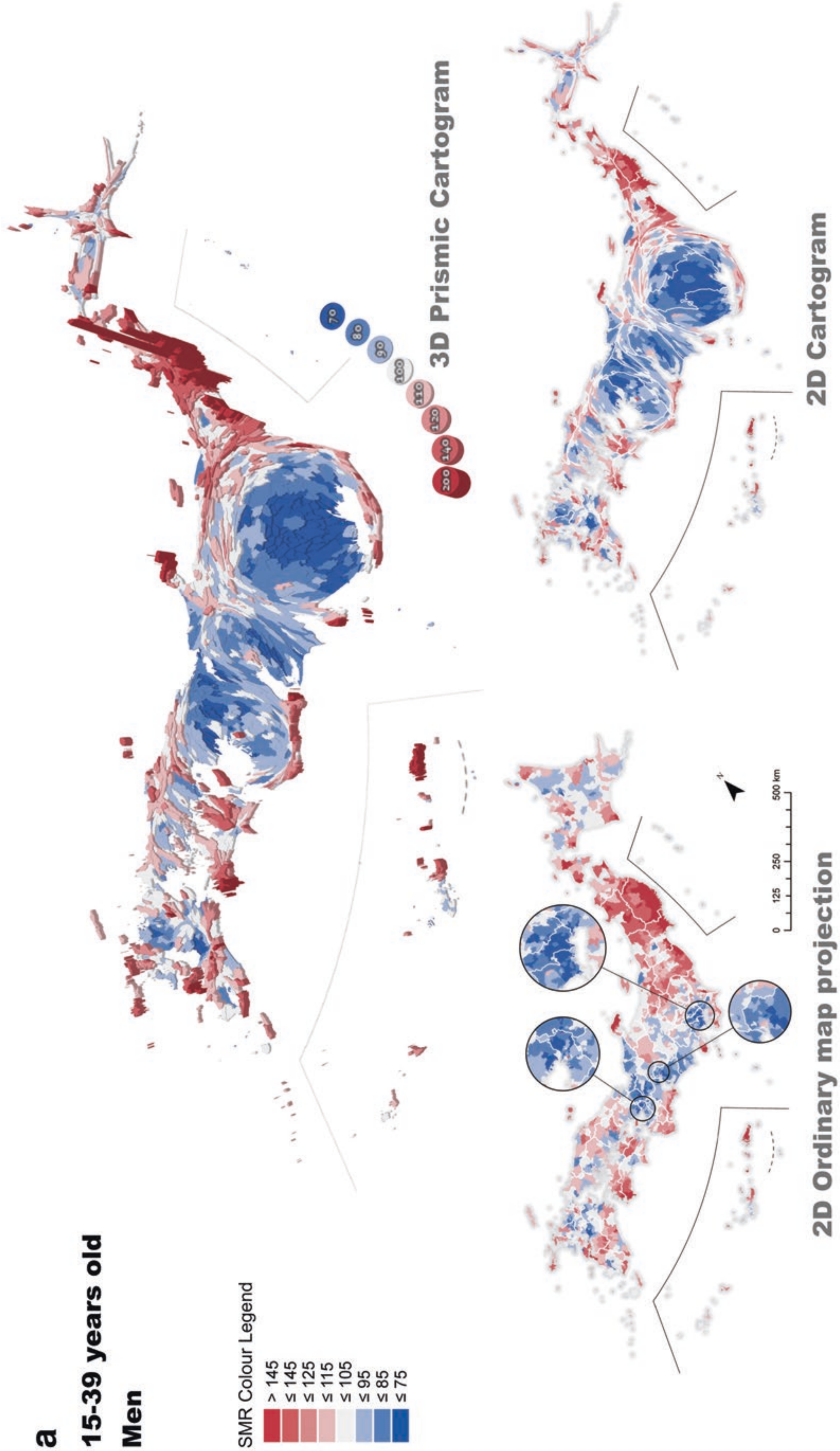


Fig. 3.11 SMR distribution of all causes of death (15–39 years old), 2010–2014. (**a**) Men. (**b**) Women

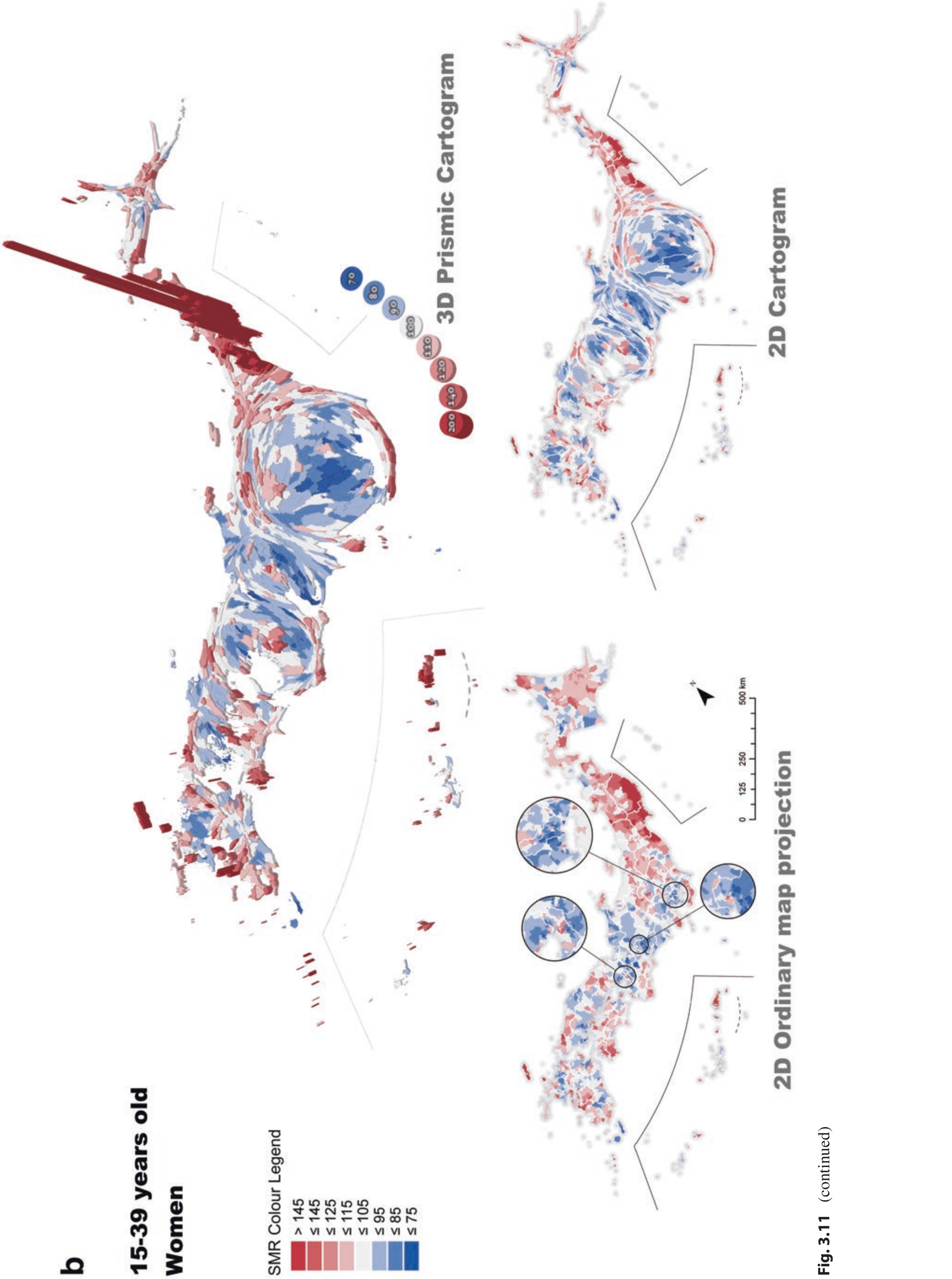


Fig. 3.11 (continued)

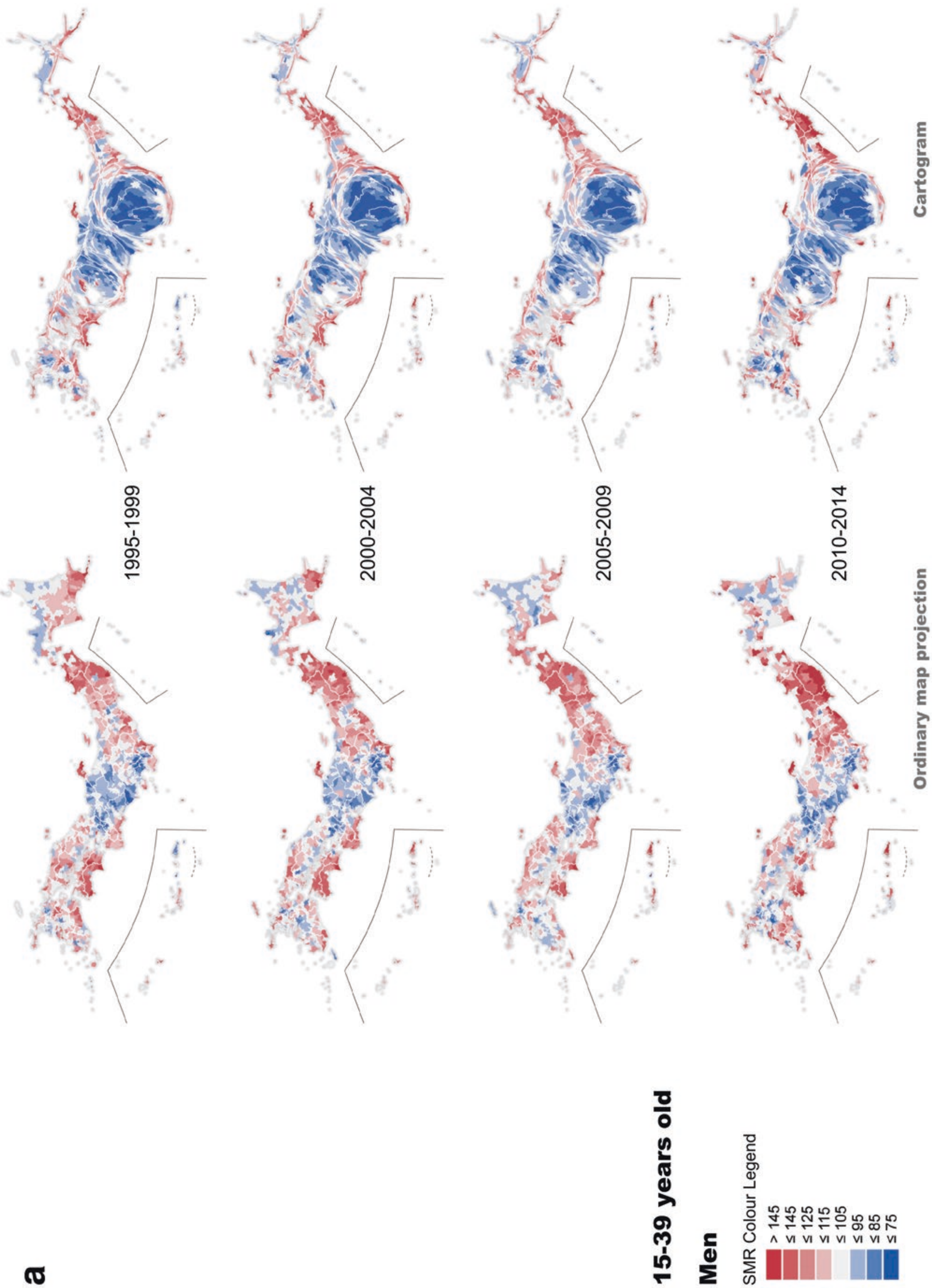


Fig. 3.12 Transition of SMR distribution of all causes of death (15–39 years old) from 1995 to 2014 by 5-year period. **(a)** Men. **(b)** Women

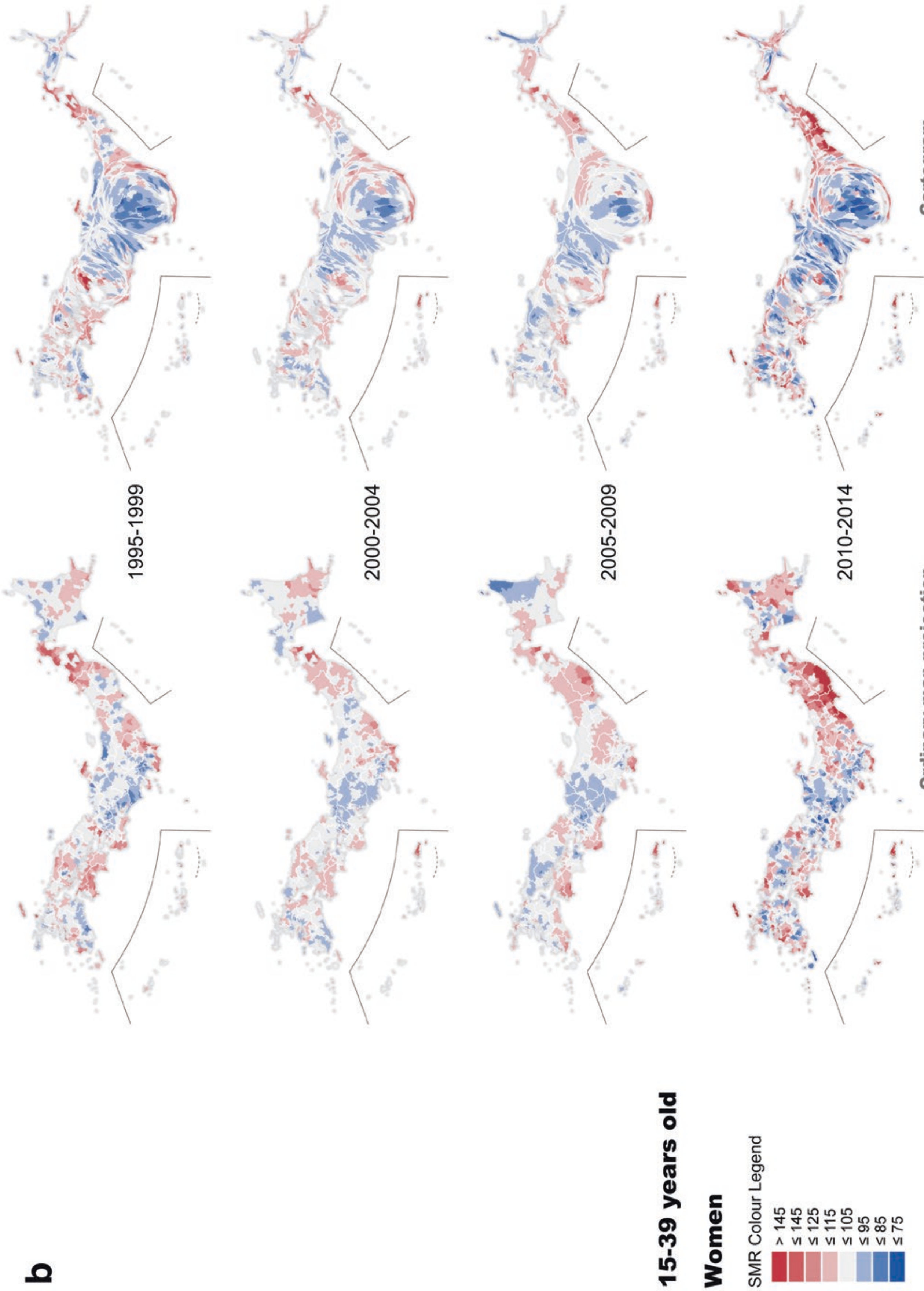


Fig. 3.12 (continued)

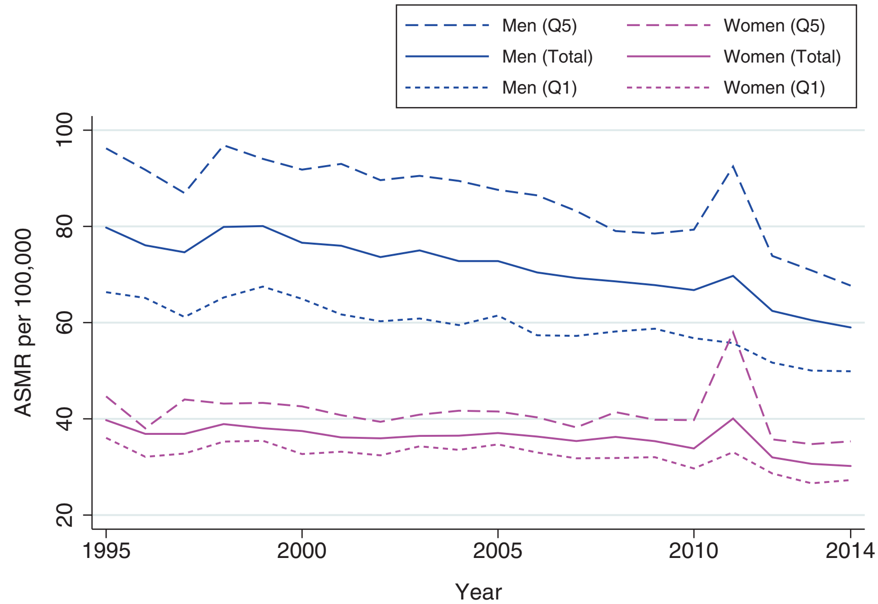


Fig. 3.13 Annual transition in the ASMR of all causes of death (15–39 years old) from 1995 to 2014

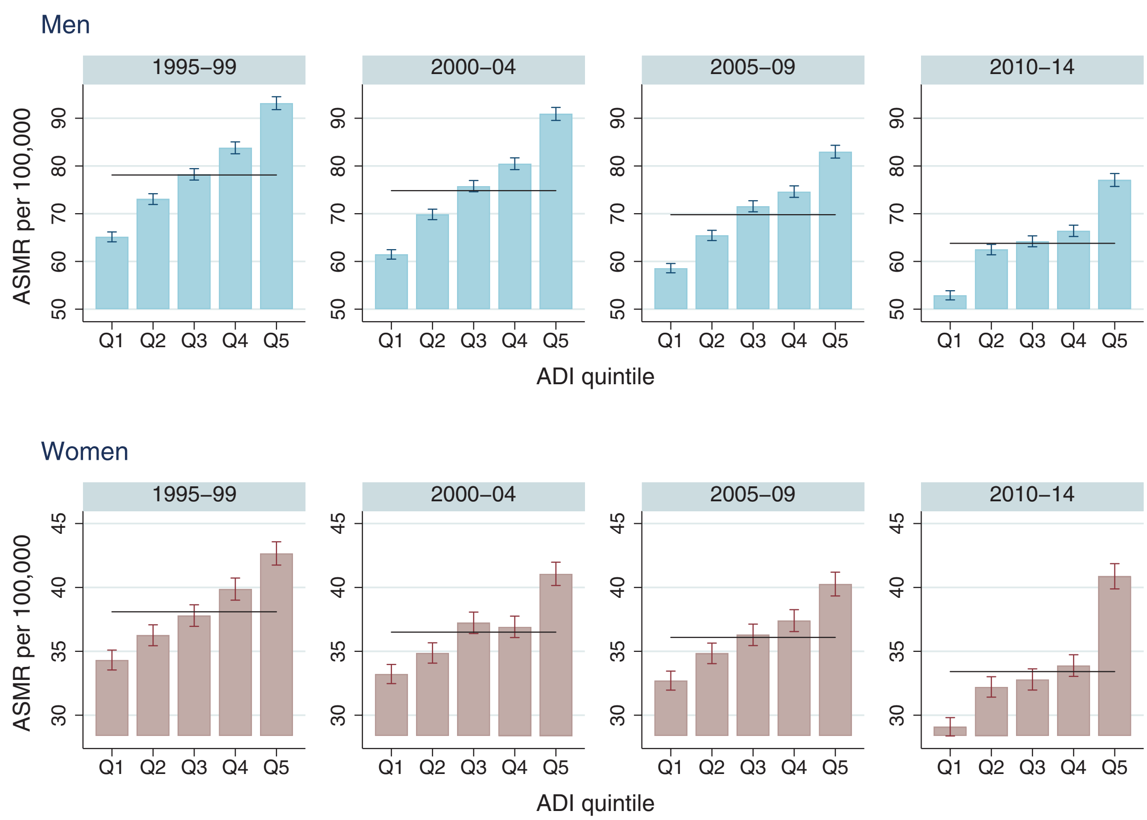


Fig. 3.14 The transition in the ASMR distribution of all causes of death (15–39 years old) by ADI quintile (top: men, bottom: women)

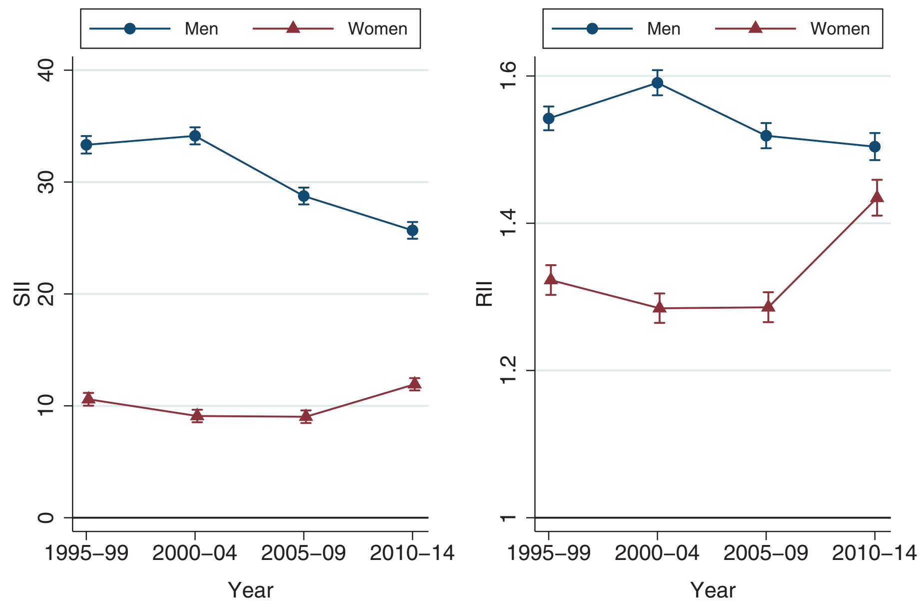


Fig. 3.15 Transition in SII and RII of all causes of death (15–39 years old) from 1995 to 2014 by 5-year period (left: SII, right: RII)

3.4 All Causes of Death (40–64 Years Old): Distinct Association with Socioeconomic Segregation of Social Areas

Tomoki Nakaya

Overview

This age group includes those in the later stage of working age. For this middle-aged population, cancer is the leading cause of death (Table 3.4). Nearly 40% of the deaths in middle-aged men and 50% in middle-aged women are caused by cancer. Therefore, the distribution may strongly reflect the geographic disparity in cancer deaths. On the prismic cartogram SMR maps for the period from 2010 to 2014 (Fig. 3.16), the data highlight geographic disparities of middle-aged SMR corresponding to socioeconomic segregation of social areas in major metropolitan areas. While red-coloured hills representing clusters of areas with high SMRs are present in the inner-city districts of the major metropolitan areas, blue-coloured plains representing areas with low SMRs are present in the suburbs. The patterns of SMRs are well-matched with that of socioeconomic status as shown in Chap. 2, Sect. 2.4. Although Wada et al. (2012) reported that the mortality of the high-status occupation groups, managers and professionals, was larger than that of other occupation groups, the residential areas with higher rates of professional workers still tend to have lower SMRs in the metropolitan area (see Fig. 3.17). Areas with high SMRs are also present in non-metropolitan areas, such as the northern Tohoku region and the tsunami-affected areas on the Pacific coast of the region.

Transitions and Socioeconomic Disparities

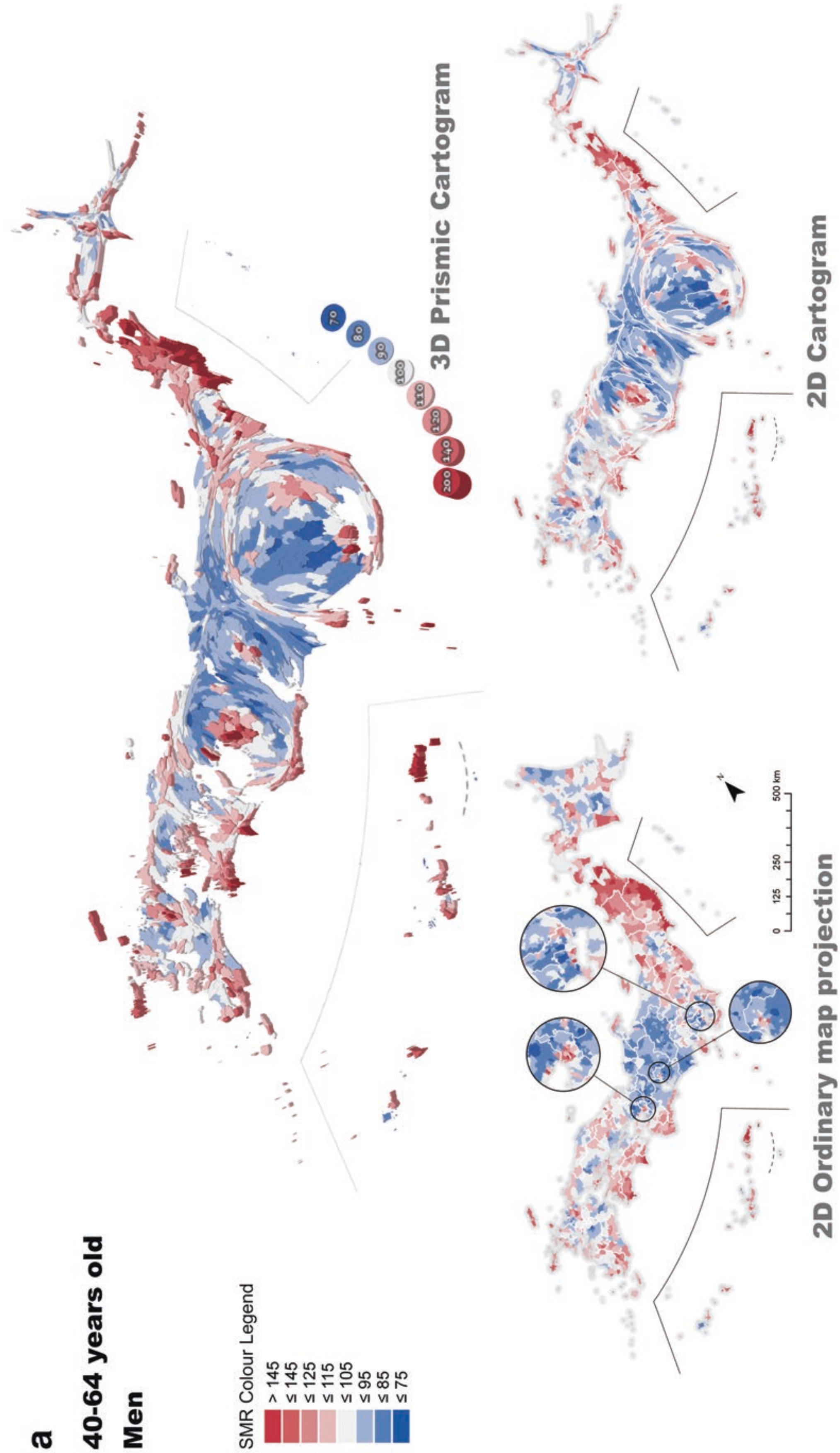
While regional differences in the SMR became larger with keeping the same geographical pattern between 1995 and 2014 (Fig. 3.17). The ASMR of this age group is gradually decreasing (Fig. 3.18). In every 5-year period, the graphs of ASMR by ADI quintile show clear socioeconomic gradients in the middle-aged ASMR for both sexes (Fig. 3.19).

SII indicates that the socioeconomic inequality of the middle-aged mortality for men is much larger than that for women (Fig. 3.20). The transition of SII shows that the SII has been almost unchanged for women and only slightly decreasing for men. The transition of RII shows stable but increasing trends for both sexes (Fig. 3.20).

The magnitude of RII for this middle-aged group is as high as in the case of AYA. RII for men and women is 1.55 and 1.35, respectively, in the latest period from 2010 to 2014. However, since the number of deaths is large for the middle-aged group compared to that for the AYA age group, the socioeconomic inequalities in the middle-aged group should play a more significant role in shaping the overall inequality of mortality among the general population in Japan.

Table 3.4 Leading causes of deaths for 40–64 years old from 2010 to 2014 by 5-year period

	1995–1999		2000–2004		2005–2009		2010–2014	
Rank	Cause of death	%	Cause of death	%	Cause of death	%	Cause of death	%
Men								
1	Cancer	40.3	Cancer	39.1	Cancer	38.7	Cancer	38.0
2	Heart diseases	12.6	Heart diseases	13.3	Heart diseases	14.0	Heart diseases	14.3
3	Cerebrovascular disease	9.9	Suicide	10.5	Suicide	10.2	Suicide	8.9
4	Suicide	8.1	Cerebrovascular disease	9.1	Cerebrovascular disease	8.7	Cerebrovascular disease	8.0
5	Liver diseases	5.3	Liver diseases	4.9	Liver diseases	4.5	Liver diseases	4.3
6	Accident	3.7	Accident	3.3	Accident	2.7	Accident	3.0
7	Pneumonia	2.5	Pneumonia	2.3	Pneumonia	2.5	Pneumonia	2.7
8	Diabetes	1.7	Diabetes	1.6	Diabetes	1.6	Diabetes	1.5
9	Virus hepatitis	1.1	Virus hepatitis	1.1	Aortic aneurysm and dissociation	1.0	Aortic aneurysm and dissociation	1.3
10	Other neoplasms	0.9	Other neoplasms	0.9	Virus hepatitis	0.9	Kidney failure	0.8
Women								
1	Cancer	50.4	Cancer	52.8	Cancer	53.7	Cancer	54.0
2	Cerebrovascular disease	10.7	Cerebrovascular disease	9.5	Cerebrovascular disease	8.6	Heart diseases	8.0
3	Heart diseases	9.1	Heart diseases	8.7	Heart diseases	8.6	Cerebrovascular disease	7.2
4	Suicide	5.6	Suicide	6.2	Suicide	6.4	Suicide	6.5
5	Accident	2.9	Accident	2.2	Liver diseases	2.0	Accident	2.7
6	Liver diseases	2.3	Liver diseases	2.1	Accident	1.9	Liver diseases	2.1
7	Pneumonia	2.0	Pneumonia	1.9	Pneumonia	1.8	Pneumonia	1.9
8	Diabetes	1.4	Diabetes	1.2	Diabetes	1.1	Diabetes	0.9
9	Diseases of the musculoskeletal system and connective tissue	1.2	Other neoplasms	1.1	Other neoplasms	1.1	Other neoplasms	0.9
10	Other neoplasms	1.0	Diseases of the musculoskeletal system and connective tissue	1.0	Diseases of the musculoskeletal system and connective tissue	0.9	Aortic aneurysm and dissociation	0.9
Both sexes								
1	Cancer	43.5	Cancer	43.4	Cancer	43.4	Cancer	43.2
2	Heart diseases	11.5	Heart diseases	11.9	Heart diseases	12.3	Heart diseases	12.3
3	Cerebrovascular disease	10.1	Cerebrovascular disease	9.2	Suicide	9.0	Suicide	8.1
4	Suicide	7.3	Suicide	9.1	Cerebrovascular disease	8.7	Cerebrovascular disease	7.8
5	Liver diseases	4.3	Liver diseases	4.0	Liver diseases	3.8	Liver diseases	3.6
6	Accident	3.5	Accident	3.0	Accident	2.5	Accident	2.9
7	Pneumonia	2.3	Pneumonia	2.2	Pneumonia	2.3	Pneumonia	2.5
8	Diabetes	1.6	Diabetes	1.5	Diabetes	1.4	Diabetes	1.3
9	Virus hepatitis	1.1	Virus hepatitis	1.0	Aortic aneurysm and dissociation	0.9	Aortic aneurysm and dissociation	1.2
10	Other neoplasms	0.9	Other neoplasms	0.9	Other neoplasms	0.9	Other neoplasms	0.8


a
40-64 years old
Men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0
125
250
500 km

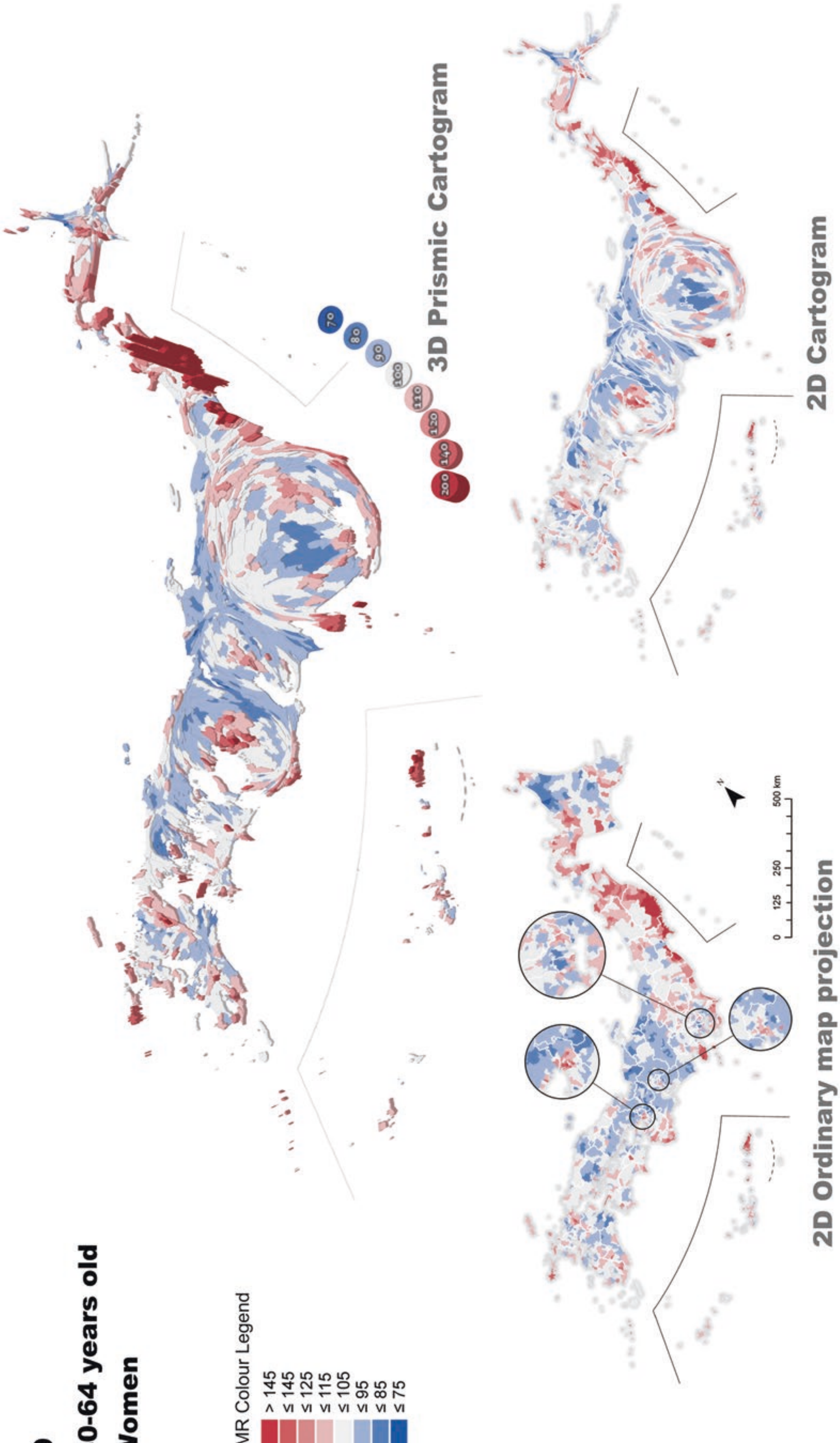
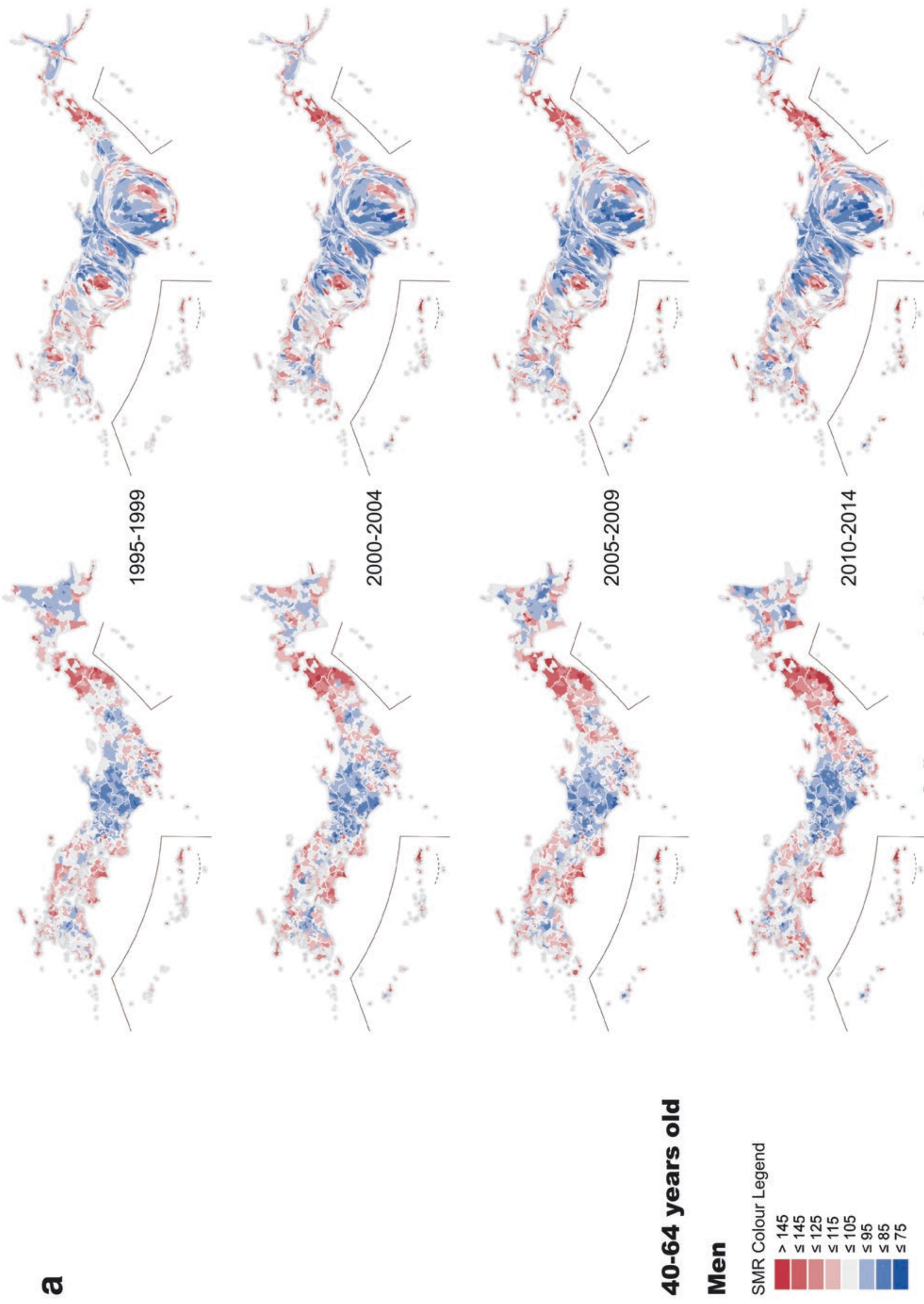


Fig. 3.16 SMR distribution of all causes of death (40–64 years old), 2010–2014. (**a**) Men. (**b**) Women


a
40-64 years old
Men
SMR Colour Legend
> 145
≤ 145
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1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

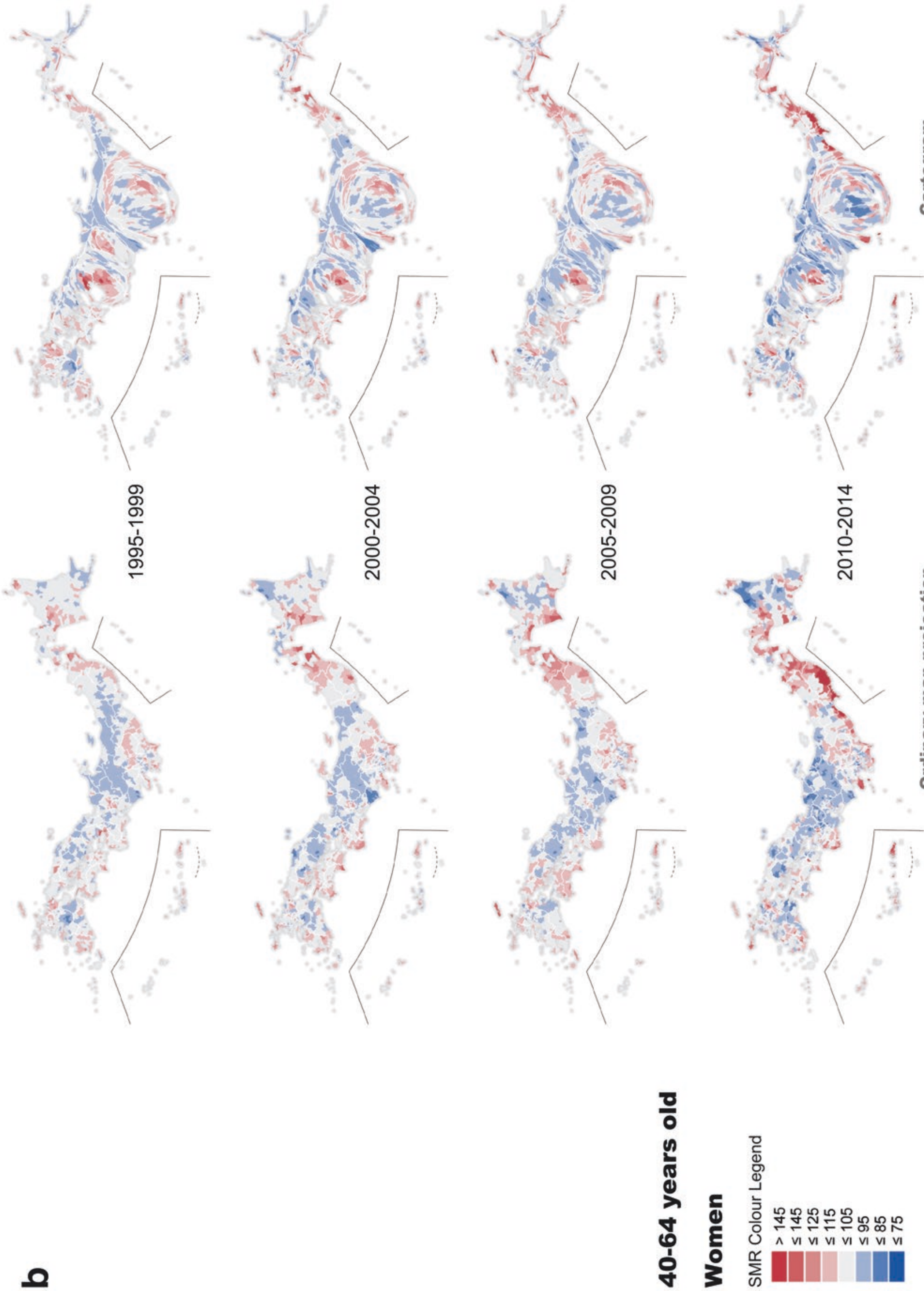
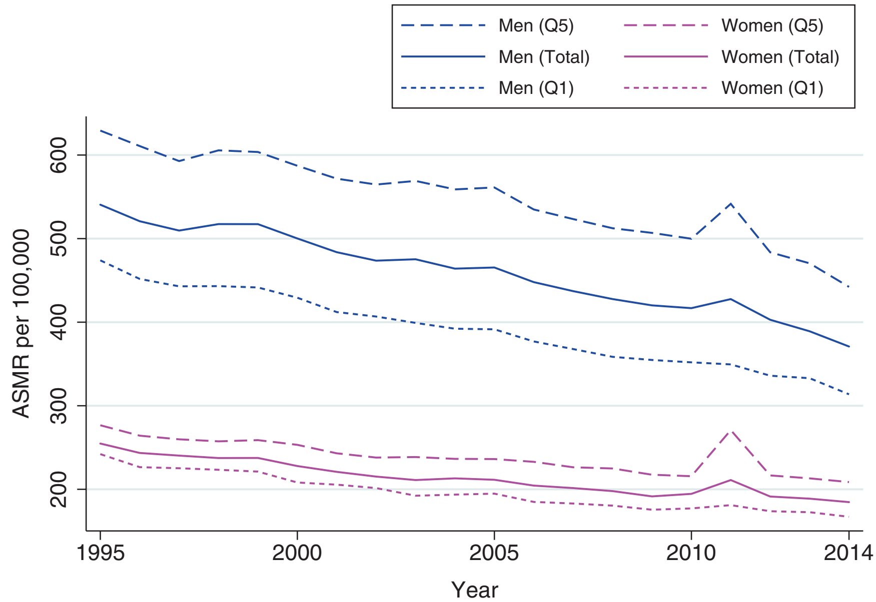


Fig. 3.17 Transition of SMR distribution of all causes of death (40–64 years old) from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 3.18 Annual transition in the ASMR of all causes of death (40–64 years old) from 1995 to 2014



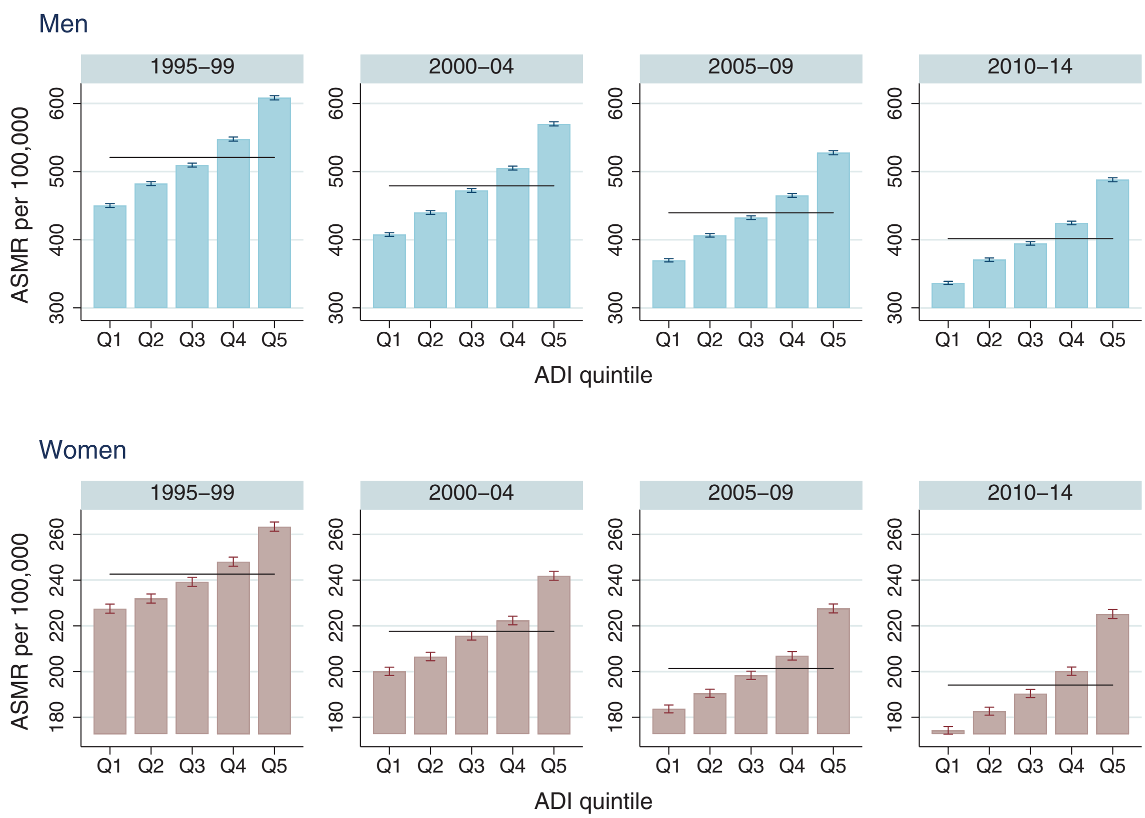


Fig. 3.19 The transition in the ASMR distribution of all causes of death (40–64 years old) by ADI quintile (top: men, bottom: women)

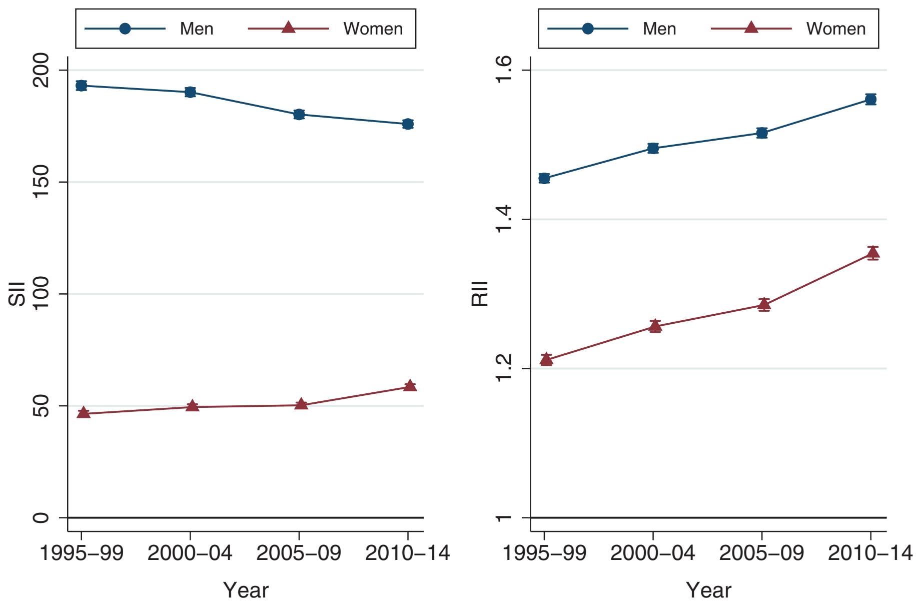


Fig. 3.20 Transition in SII and RII of all causes of death (40–64 years old) from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

3.5 All Causes of Death (65–74 Years Old): Growing Inequalities

Tomoki Nakaya

Overview

In this early stage older adult group, cancer, heart disease, and cerebrovascular disease, which are the top three leading causes of death, account for almost two thirds of all-cause deaths (Table 3.5). Pneumonia follows the fourth most prevalent cause for this age group.

SMR maps based on the ordinary map projection for this age group in the period from 2010 to 2014 show a tendency of high SMRs in major metropolitan areas (Fig. 3.21). The prismic cartogram SMR maps of this age group, however, provide a more detailed view inside the major metropolitan areas. Areas with high SMRs are found in inner-city districts in the major metropolitan areas, particularly in some parts of Osaka City and peripheral areas of the Tokyo metropolitan area. The blue-coloured lowlands representing low SMRs are observed in *Yamanote* suburbs. This distributional pattern of SMR is well-matched to the socioeconomic residential disparities in the metropolitan areas as in the case of middle-aged SMR maps.

Transitions and Socioeconomic Disparities

The transition in the SMR distribution indicates that regional differences in the SMR became larger particularly in the metropolitan areas (Fig. 3.22). The ASMR for this group is gradually declining during the period from 1995 to 2014 (Fig. 3.23), but there are clear socioeconomic gradients in the ASMR by ADI quintiles, particularly in men (Fig. 3.24).

While the SII transitions show quite stable trends, the RII transitions indicate that the relative socioeconomic inequalities in the mortality for this age group have been steadily growing for both sexes over the last two decades (Fig. 3.25). RII for men and women is 1.14 and 1.11, respectively, in the latest period from 2010 to 2014. These numbers are smaller than the two working age groups (15–39 and 40–64 years old) previously shown but their trends exhibit growing socioeconomic gradients in the mortality. This indicates that this group's geographic trends in the mortality also contribute to the widening social inequalities of mortality among the general population in Japan.

Table 3.5 Leading causes of deaths for 65–74 years old from 2010 to 2014 by 5-year period

	1995–1999		2000–2004		2005–2009		2010–2014	
Rank	Cause of death	%	Cause of death	%	Cause of death	%	Cause of death	%
Men								
1	Cancer	44.7	Cancer	45.8	Cancer	45.3	Cancer	45.5
2	Heart diseases	13.2	Heart diseases	13.0	Heart diseases	13.1	Heart diseases	12.9
3	Cerebrovascular disease	11.5	Cerebrovascular disease	10.3	Cerebrovascular disease	9.1	Cerebrovascular disease	7.9
4	Pneumonia	5.5	Pneumonia	5.4	Pneumonia	5.7	Pneumonia	5.6
5	Liver diseases	2.1	Liver diseases	2.1	Liver diseases	2.3	Liver diseases	2.2
6	Accident	1.7	Suicide	2.0	Suicide	2.2	Suicide	2.0
7	Suicide	1.6	Accident	1.5	Diabetes	1.6	Accident	1.5
8	Chronic obstructive pulmonary disease	1.5	Diabetes	1.5	Accident	1.4	Diabetes	1.4
9	Diabetes	1.5	Chronic obstructive pulmonary disease	1.4	Kidney failure	1.3	Kidney failure	1.3
10	Kidney failure	1.3	Kidney failure	1.2	Chronic obstructive pulmonary disease	1.2	Aortic aneurysm and dissociation	1.3
Women								
1	Cancer	39.2	Cancer	42.4	Cancer	44.0	Cancer	46.0
2	Heart diseases	14.5	Heart diseases	13.7	Heart diseases	13.3	Heart diseases	12.0
3	Cerebrovascular disease	13.9	Cerebrovascular disease	11.7	Cerebrovascular disease	9.9	Cerebrovascular disease	8.0
4	Pneumonia	4.6	Pneumonia	4.2	Pneumonia	4.2	Pneumonia	4.0
5	Diabetes	2.1	Suicide	2.1	Suicide	2.2	Suicide	2.3
6	Liver diseases	2.0	Liver diseases	1.9	Liver diseases	1.9	Accident	2.0
7	Suicide	1.9	Diabetes	1.7	Diabetes	1.6	Liver diseases	1.7
8	Accident	1.9	Accident	1.6	Kidney failure	1.5	Aortic aneurysm and dissociation	1.5
9	Kidney failure	1.6	Kidney failure	1.5	Accident	1.4	Kidney failure	1.4
10	Diseases of the musculoskeletal system and connective tissue	1.1	Virus hepatitis	1.4	Virus hepatitis	1.4	Diabetes	1.4
Both sexes								
1	Cancer	42.8	Cancer	44.7	Cancer	44.9	Cancer	45.7
2	Heart diseases	13.6	Heart diseases	13.2	Heart diseases	13.2	Heart diseases	12.6
3	Cerebrovascular disease	12.4	Cerebrovascular disease	10.8	Cerebrovascular disease	9.4	Cerebrovascular disease	7.9
4	Pneumonia	5.2	Pneumonia	5.0	Pneumonia	5.2	Pneumonia	5.1
5	Liver diseases	2.1	Liver diseases	2.1	Suicide	2.2	Suicide	2.1
6	Accident	1.8	Suicide	2.1	Liver diseases	2.2	Liver diseases	2.0
7	Suicide	1.7	Diabetes	1.6	Diabetes	1.6	Accident	1.7
8	Diabetes	1.7	Accident	1.6	Accident	1.4	Diabetes	1.4
9	Kidney failure	1.4	Kidney failure	1.3	Kidney failure	1.3	Aortic aneurysm and dissociation	1.4
10	Chronic obstructive pulmonary disease	1.2	Chronic obstructive pulmonary disease	1.1	Aortic aneurysm and dissociation	1.2	Kidney failure	1.3

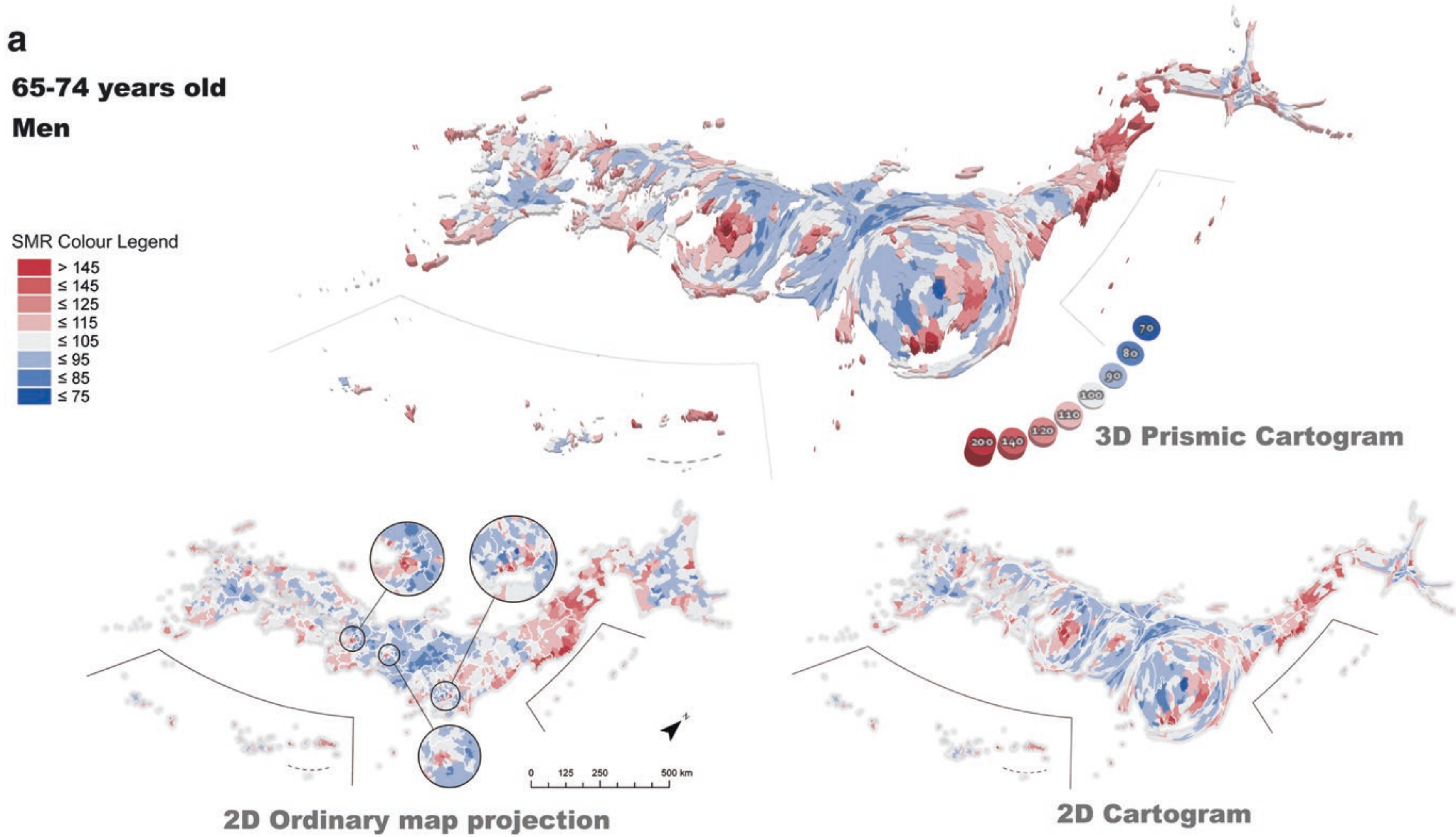


Fig. 3.21 SMR distribution of all causes of death (65–74 years old), 2010–2014. (**a**) Men. (**b**) Women

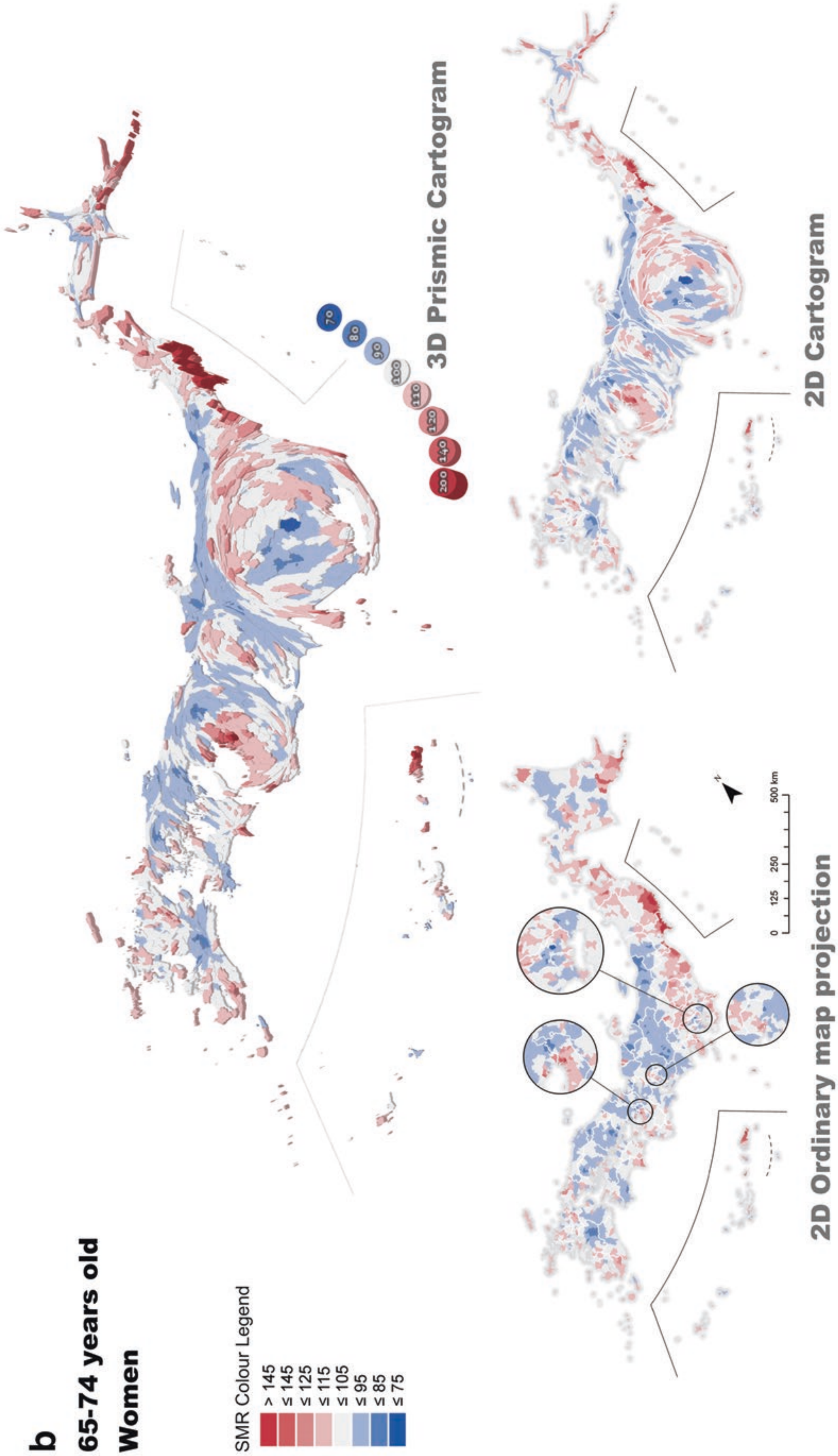


Fig. 3.21 (continued)

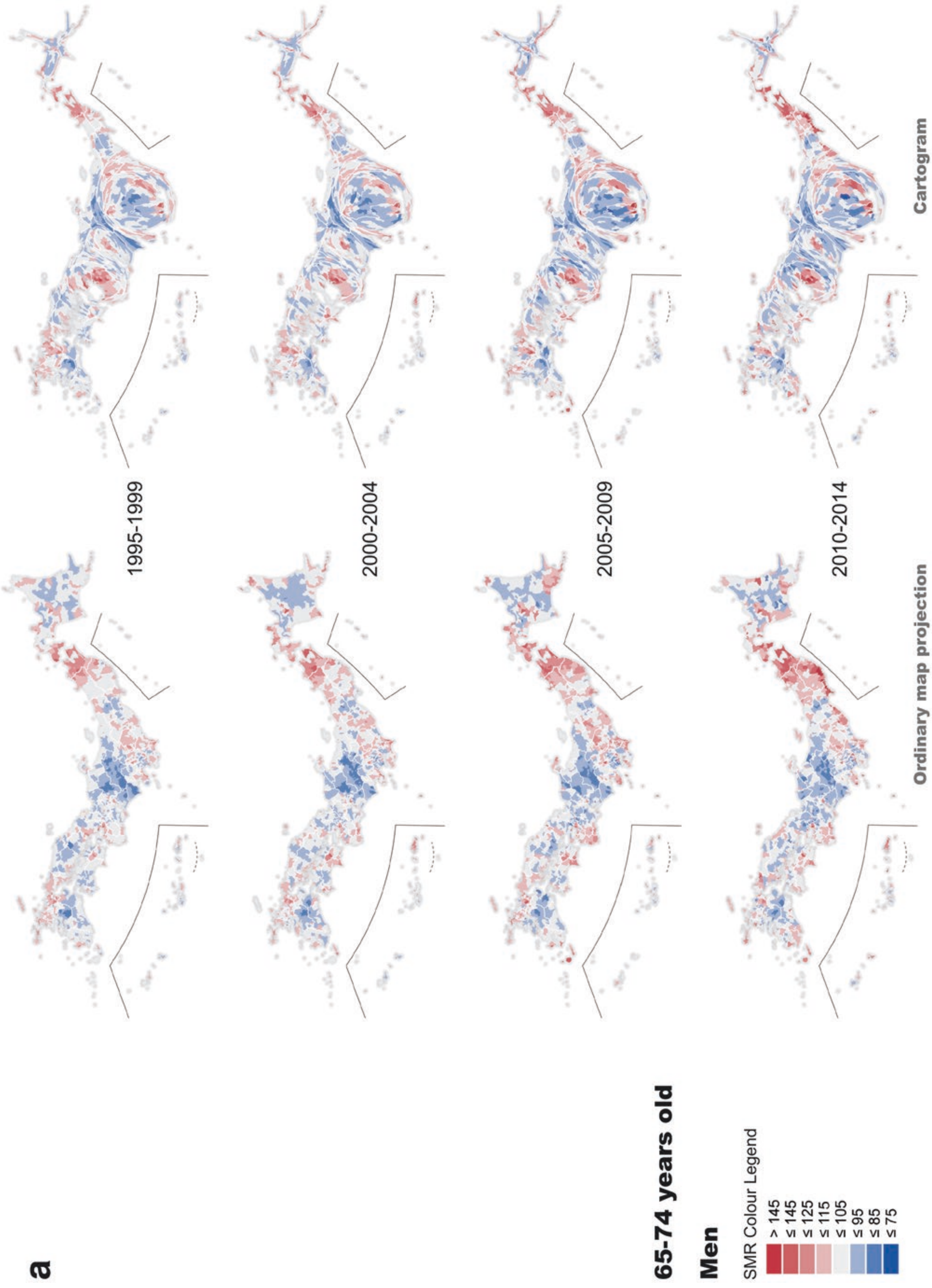


Fig. 3.22 Transition of SMR distribution of all causes of death (65–74 years old) from 1995 to 2014 by 5-year period. **(a)** Men. **(b)** Women

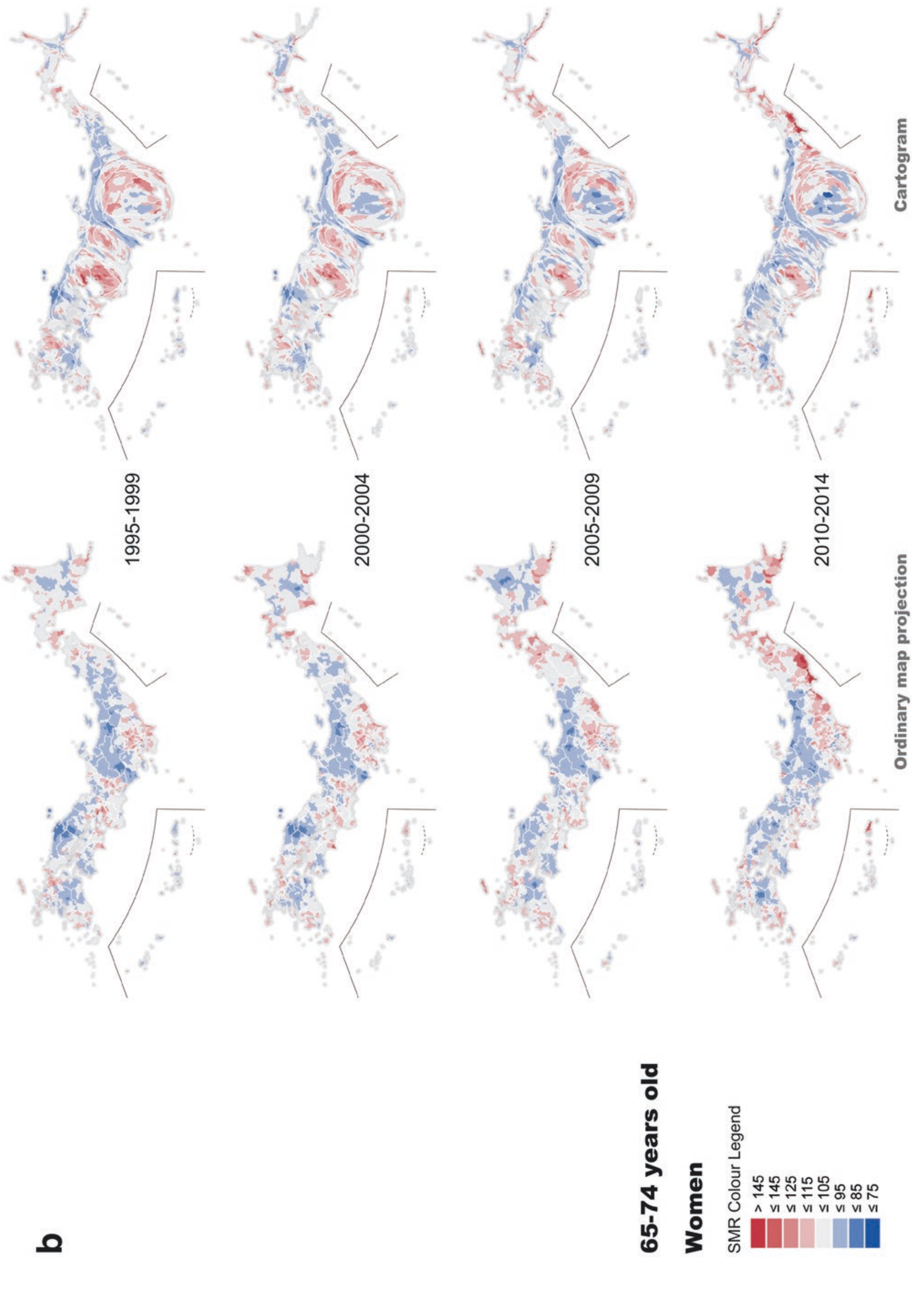
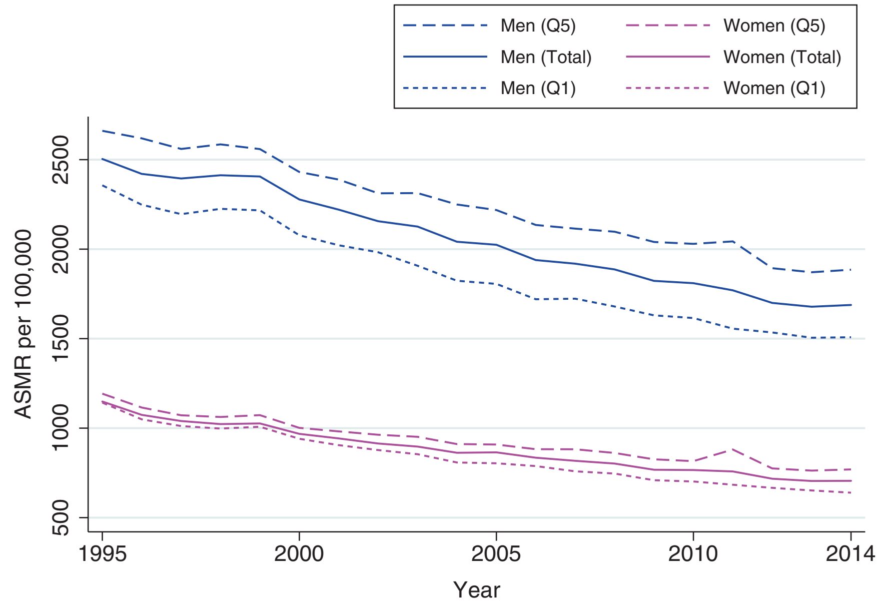


Fig. 3.22 (continued)

Fig. 3.23 Annual transition in the ASMR of all causes of death (65–74 years old) from 1995 to 2014



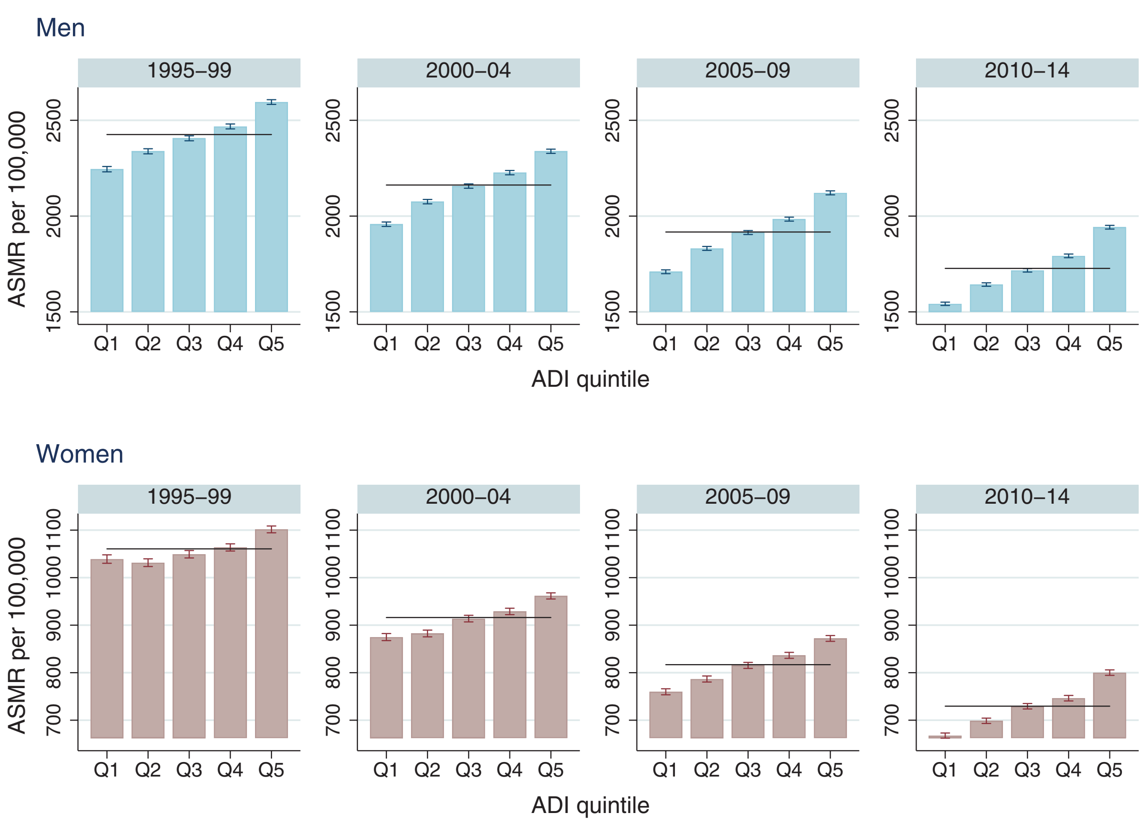


Fig. 3.24 The transition in the ASMR distribution of all causes of death (65–74 years old) by ADI quintile (top: men, bottom: women)

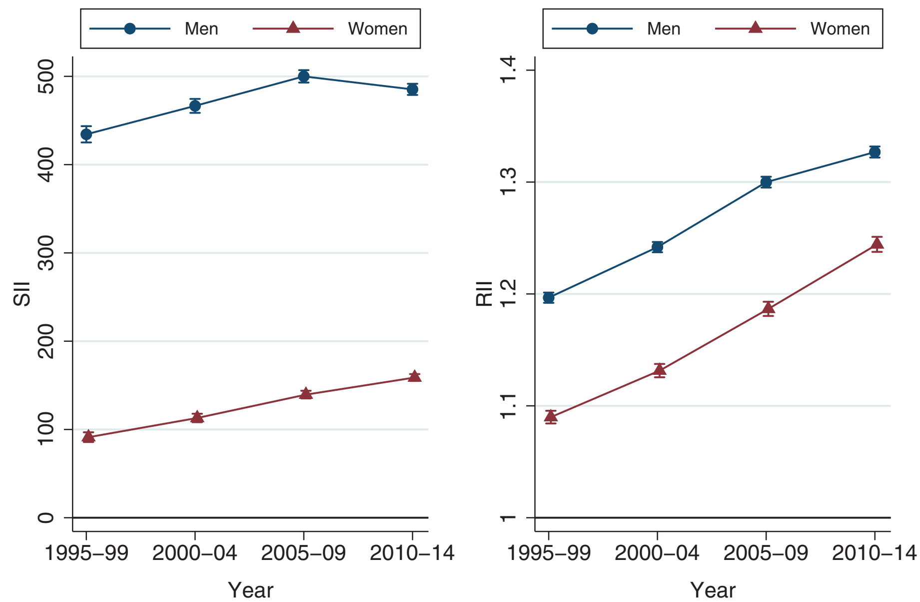


Fig. 3.25 Transition in SII and RII of all causes of death (65–74 years old) from 1995 to 2014 by 5-year period (left: SII, right: RII)

3.6 All Causes of Death (Over 75 Years Old): Steadily Growth of Inequalities

Tomoki Nakaya

Overview

In this late-stage older adult group, following the aforementioned three major chronic diseases and pneumonia, senility is the fifth leading cause of death (Table 3.6). In the latest period from 2010 to 2014, 3.5% of men's deaths and 9.6% of women's deaths were caused by senility.

The variation of SMRs for this older adult group is smaller than that for the early stage older adult group. However, the prismic cartogram SMR maps for this age group consistently show the geographic inequalities that correspond with socioeconomic residential disparities, similar to the working age and early stage older adult groups (Fig. 3.26).

The temporal increase in SMR on the Pacific coast of Tohoku due to the Great East Japan Earthquake is less pronounced in this group than younger groups. This does not mean, however, that the disaster does not have a serious impact on the health of the older adults. Rather, the older adults are more vulnerable to disasters in general (see Chap. 2, Sect. 2.3). However, since mortality is generally high among aged people, even disregarding the disaster, the relative increase of SMR at the occurrence of the disaster is smaller compared to those of younger generations with much lower overall mortality.

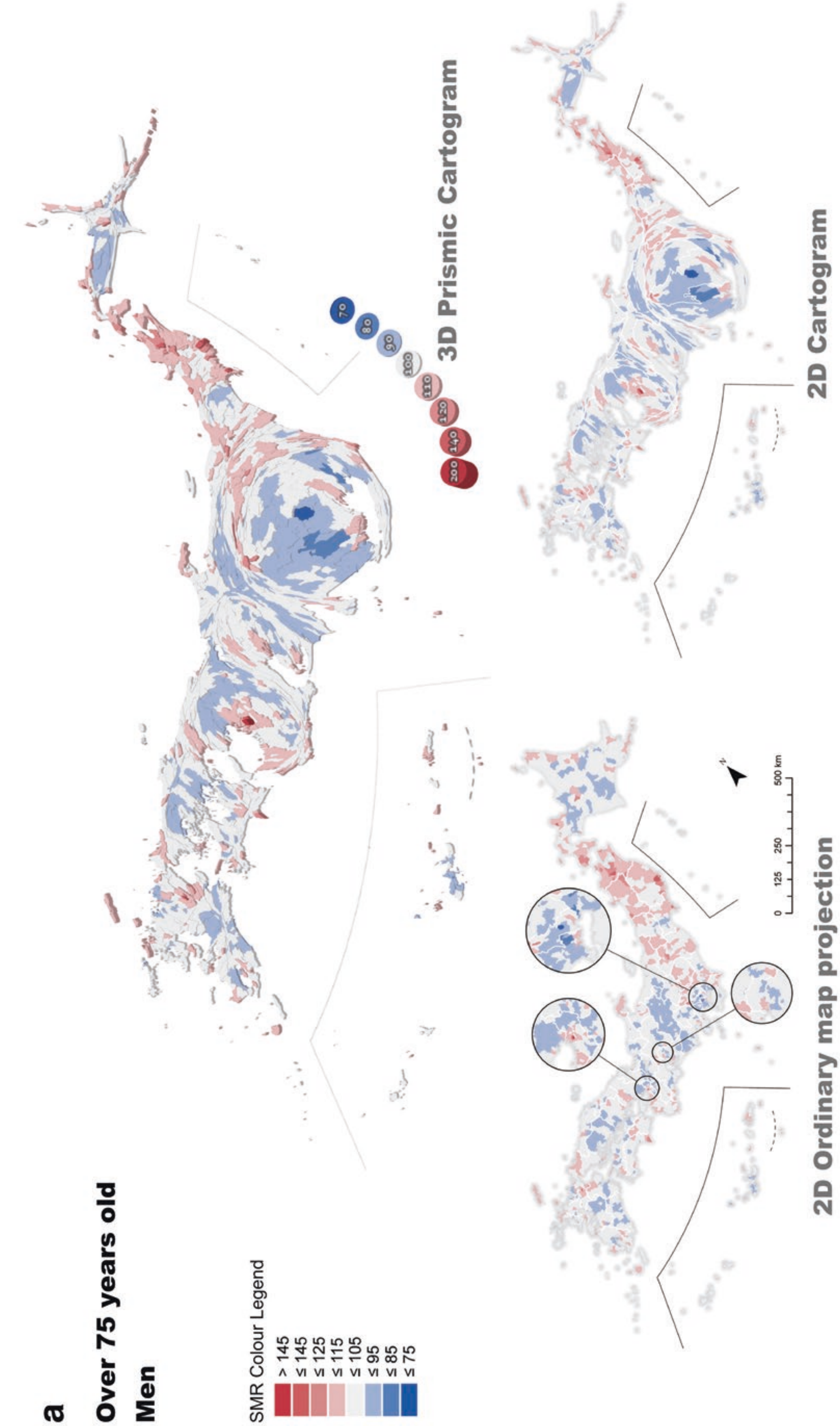
Transitions and Socioeconomic Disparities

The transition in the SMR distribution shown by cartograms indicates that regional differences in the SMR became larger (Fig. 3.27). ASMR for this age group has also been gradually declining over the two decades between 1995 and 2014 (Fig. 3.28). The socioeconomic gradients in ASMR by ADI quintile have been consistently observed for men; however, they have only been observed for women since 2005 (Fig. 3.29). Again, the gradient of ASMR is steeper for men than women.

The most striking characteristics of this age group's mortality are the growing tendency of both absolute and relative socioeconomic inequalities of deaths (Fig. 3.30). The transition of SII shows that the absolute inequalities of ASMR are clearly widening for both sexes over the two decades. The RII for this aged group is 1.1 for men and 1.05 for women in the latest period from 2010 to 2014. Although these RII values are relatively smaller than those in younger generations, the relative socioeconomic inequalities in death have increased for this late-stage older adult group.

Table 3.6 Leading causes of deaths for over 75 years old from 2010 to 2014 by 5-year period

	1995–1999		2000–2004		2005–2009		2010–2014	
Rank	Cause of death	%	Cause of death	%	Cause of death	%	Cause of death	%
Men								
1	Cancer	25.3	Cancer	28.2	Cancer	29.2	Cancer	28.5
2	Cerebrovascular disease	16.6	Heart diseases	15.1	Heart diseases	15.0	Heart diseases	14.7
3	Heart diseases	15.8	Pneumonia	14.1	Pneumonia	14.3	Pneumonia	13.5
4	Pneumonia	13.9	Cerebrovascular disease	14.0	Cerebrovascular disease	11.6	Cerebrovascular disease	9.6
5	Chronic obstructive pulmonary disease	2.8	Chronic obstructive pulmonary disease	2.9	Chronic obstructive pulmonary disease	2.8	Senility	3.5
6	Senility	2.7	Senility	2.2	Senility	2.3	Chronic obstructive pulmonary disease	2.7
7	Kidney failure	2.2	Kidney failure	2.2	Kidney failure	2.2	Kidney failure	2.2
8	Accident	1.2	Aortic aneurysm and dissociation	1.2	Aortic aneurysm and dissociation	1.3	Aortic aneurysm and dissociation	1.3
9	Diabetes	1.1	Accident	1.1	Diabetes	1.0	Accident	1.1
10	Aortic aneurysm and dissociation	0.9	Diabetes	1.0	Accident	1.0	Diabetes	1.0
Women								
1	Cerebrovascular disease	20.2	Heart diseases	20.1	Heart diseases	20.4	Heart diseases	19.6
2	Heart diseases	19.9	Cancer	19.5	Cancer	19.5	Cancer	18.8
3	Cancer	17.7	Cerebrovascular disease	17.2	Cerebrovascular disease	14.1	Cerebrovascular disease	11.2
4	Pneumonia	11.5	Pneumonia	11.7	Pneumonia	12.2	Pneumonia	11.1
5	Senility	5.3	Senility	5.1	Senility	6.1	Senility	9.6
6	Kidney failure	2.5	Kidney failure	2.6	Kidney failure	2.6	Kidney failure	2.5
7	Diabetes	1.4	Diabetes	1.3	Diabetes	1.3	Vascular and unspecified dementia	1.3
8	Hypertensive disease	1.1	Aortic aneurysm and dissociation	0.9	Aortic aneurysm and dissociation	1.1	Aortic aneurysm and dissociation	1.3
9	Chronic obstructive pulmonary disease	1.0	Other neoplasms	0.9	Sepsis	1.0	Diabetes	1.1
10	Accident	0.9	Chronic obstructive pulmonary disease	0.9	Other neoplasms	0.9	Sepsis	1.0
Both sexes								
1	Cancer	21.1	Cancer	23.5	Cancer	24.0	Cancer	23.2
2	Cerebrovascular disease	18.6	Heart diseases	17.8	Heart diseases	17.9	Heart diseases	17.3
3	Heart diseases	18.1	Cerebrovascular disease	15.7	Pneumonia	13.2	Pneumonia	12.2
4	Pneumonia	12.6	Pneumonia	12.8	Cerebrovascular disease	12.9	Cerebrovascular disease	10.5
5	Senility	4.1	Senility	3.8	Senility	4.3	Senility	6.8
6	Kidney failure	2.4	Kidney failure	2.4	Kidney failure	2.4	Kidney failure	2.4
7	Chronic obstructive pulmonary disease	1.8	Chronic obstructive pulmonary disease	1.8	Chronic obstructive pulmonary disease	1.7	Chronic obstructive pulmonary disease	1.6
8	Diabetes	1.3	Diabetes	1.1	Aortic aneurysm and dissociation	1.2	Aortic aneurysm and dissociation	1.3
9	Accident	1.0	Aortic aneurysm and dissociation	1.0	Diabetes	1.1	Diabetes	1.1
10	Hypertensive disease	0.9	Other neoplasms	0.9	Sepsis	0.9	Vascular and unspecified dementia	1.0


a
Over 75 years old
Men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
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3D Prismic Cartogram
70
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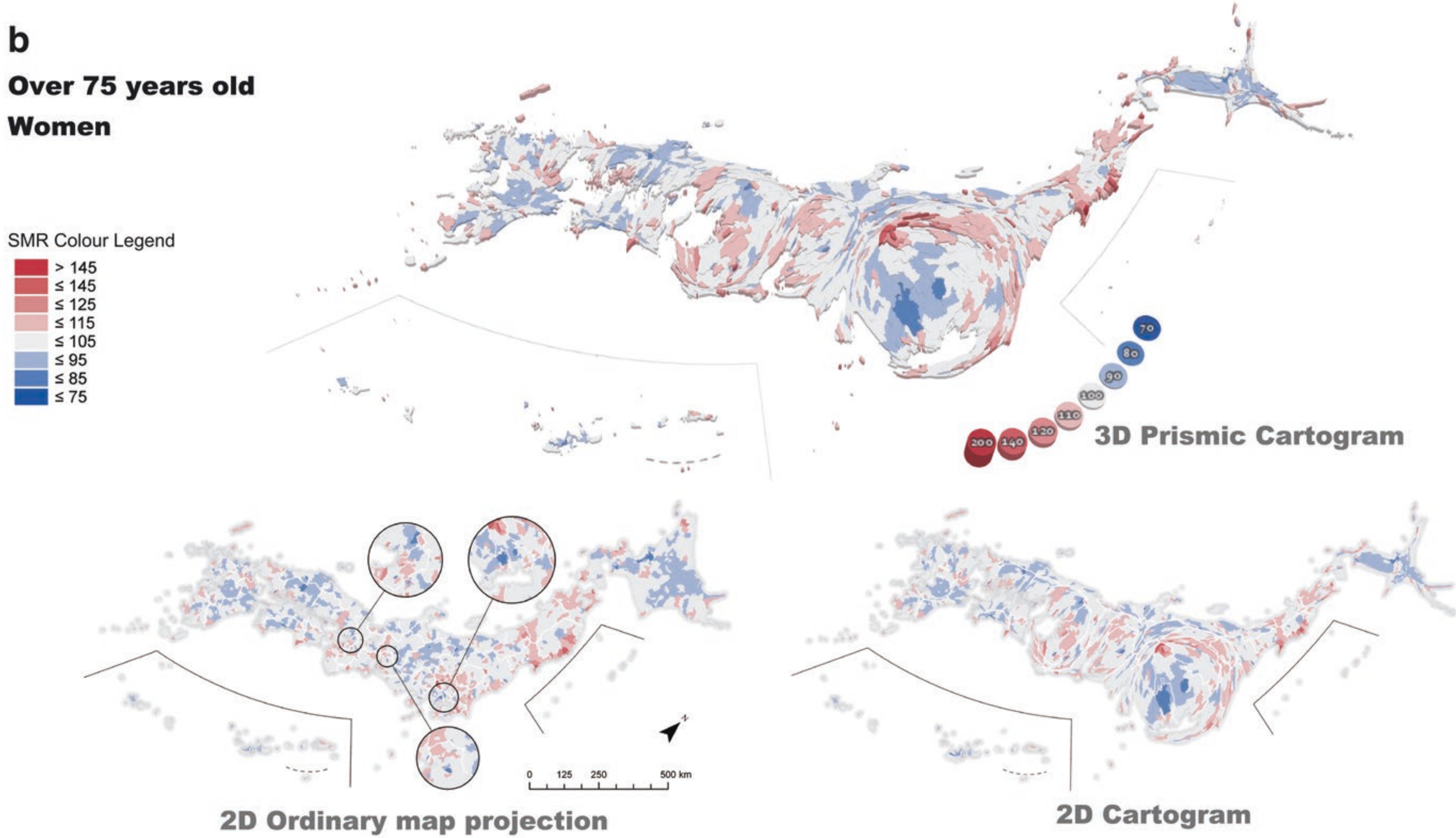
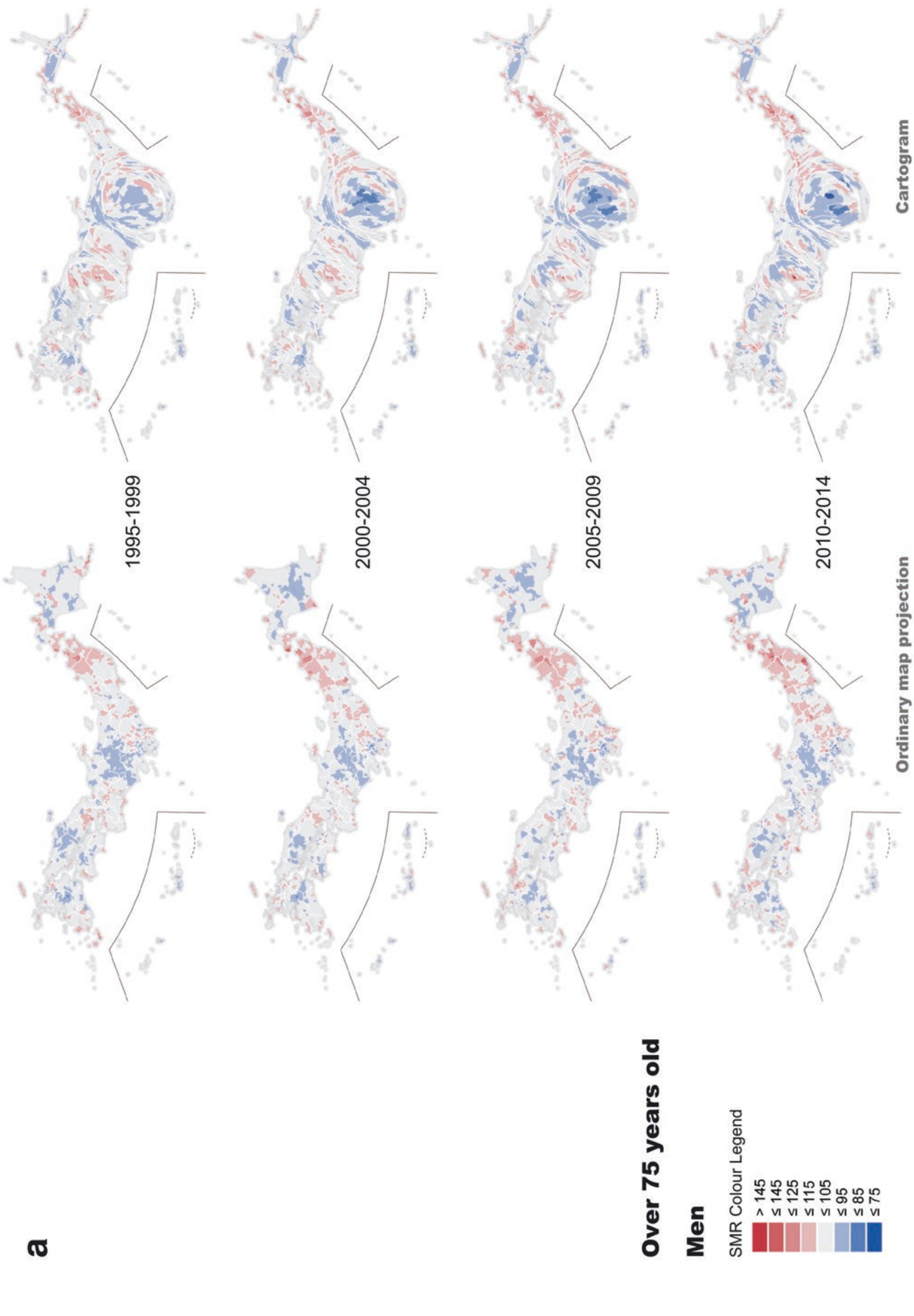


Fig. 3.26 SMR distribution of all causes of death (over 75 years old), 2010–2014. (**a**) Men. (**b**) Women


a
Over 75 years old
Men
SMR Colour Legend
> 145
≤ 145
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1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

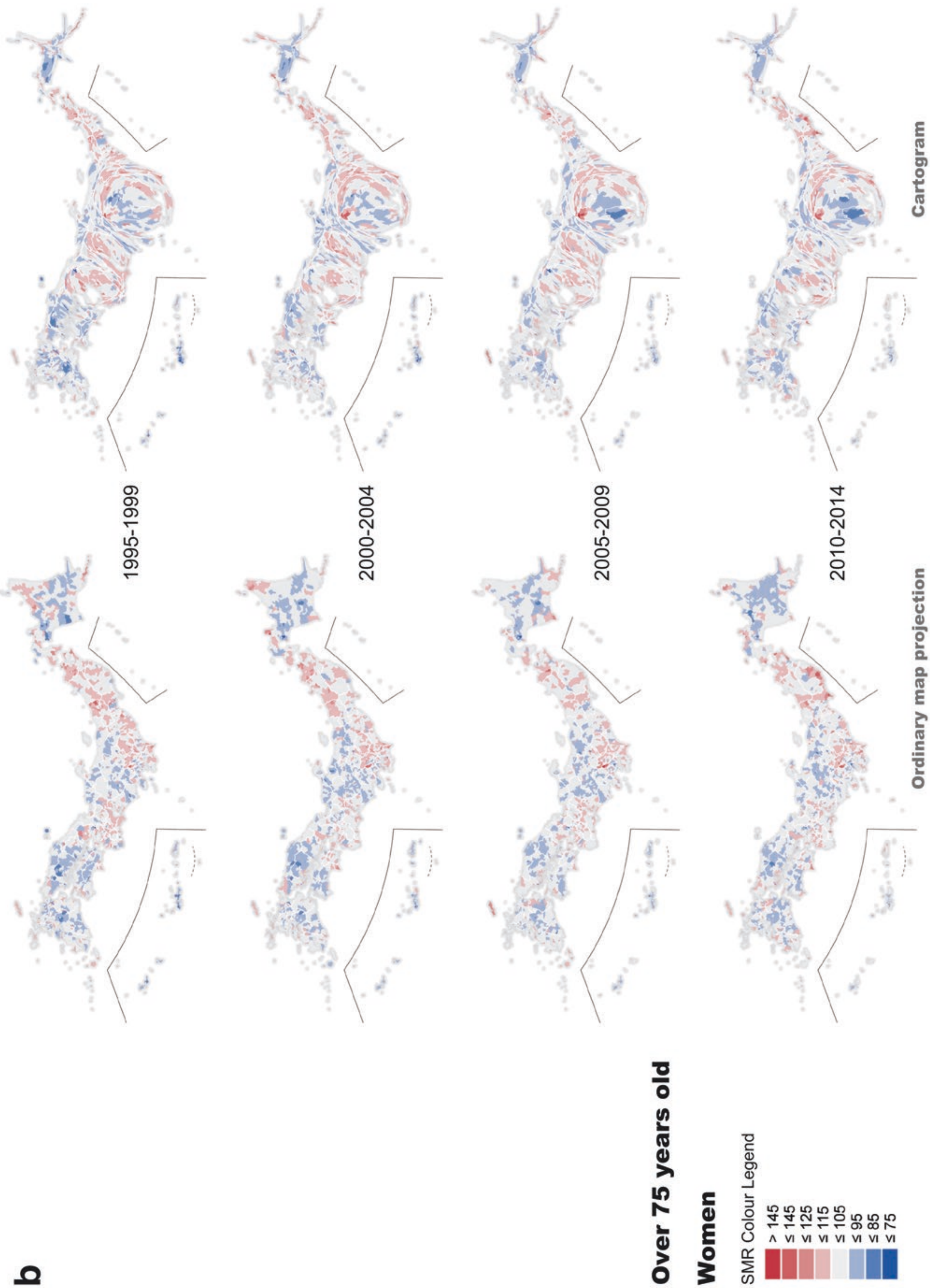
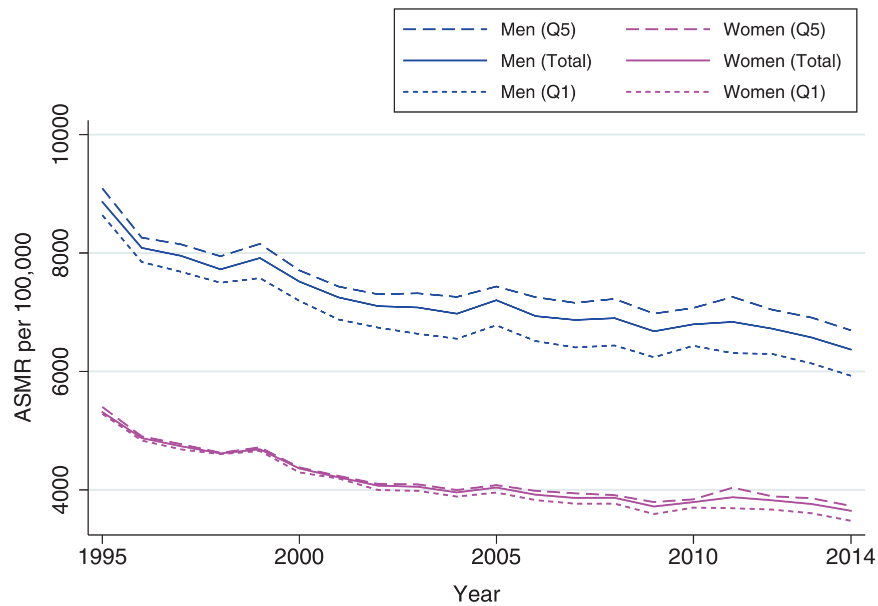


Fig. 3.27 Transition of SMR distribution of all causes of death (over 75 years old) from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 3.28 Annual transition in the ASMR of all causes of death (over 75 years old) from 1995 to 2014



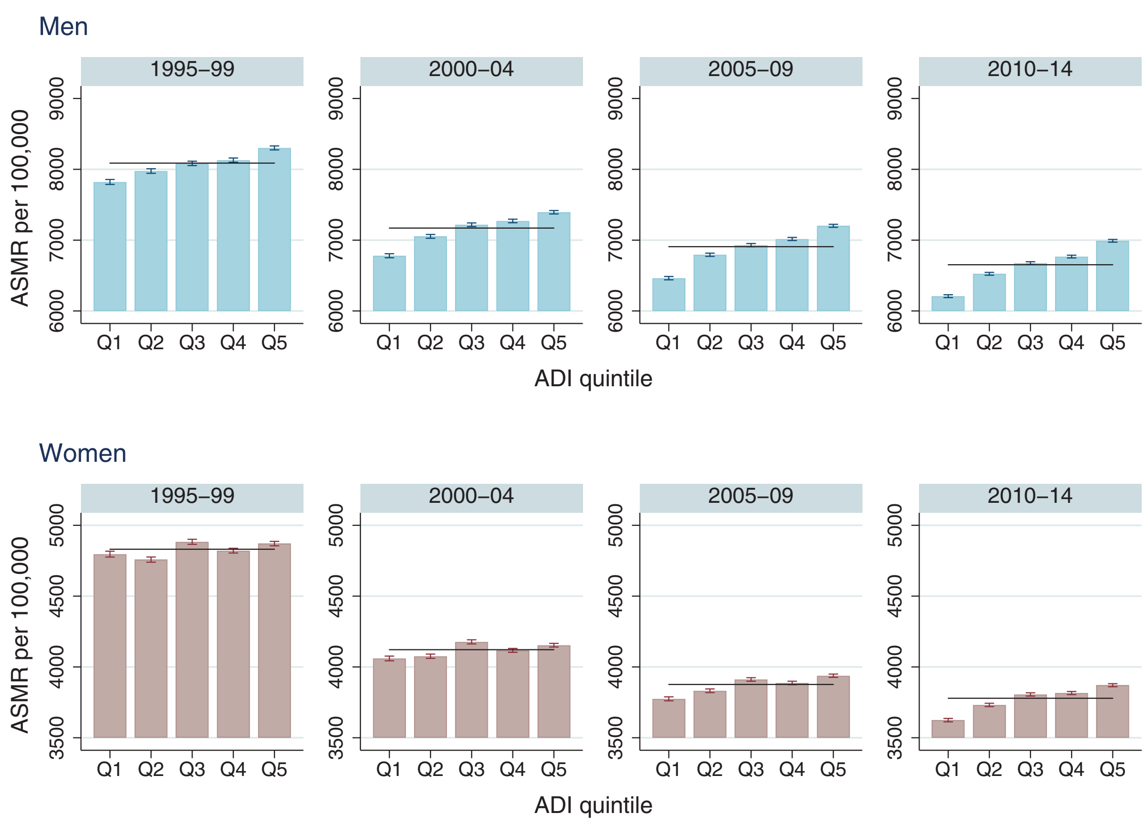


Fig. 3.29 The transition in the ASMR distribution of all causes of death (over 75 years old) by ADI quintile (top: men, bottom: women)

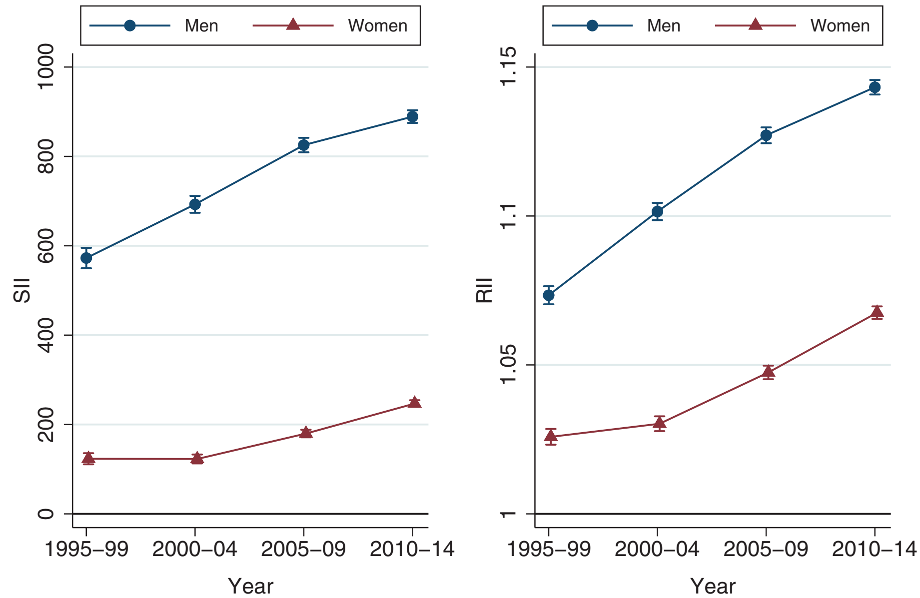


Fig. 3.30 Transition in SII and RII of all causes of death (over 75 years old) from 1995 to 2014 by 5-year period (left: SII, right: RII)

3.7 Maps and Inequalities in Health Behaviour: Tobacco Smoking Prevalence

Yuri Ito and Kazumasa Hanaoka

In this chapter, we have seen geographical disparities in the health of the general population of Japan by focusing on all-cause mortality indices. This supplementary section provides municipal maps (Fig. 3.31) and ADI-based socioeconomic inequalities (Fig. 3.32) in smoking prevalence estimated through the spatial microsimulation technique using the Comprehensive Survey of Living Conditions 2010 (see Technical note T5). Smoking rates are usually reported by prefecture level in the National Health and Nutrition Survey every 3 years in Japan. Although municipality-level smoking rates provide local government with essential information for tobacco control, only a limited number of municipalities produce these figures based on their own sampling survey.

The estimated smoking rate in men was high in Hokkaido and the Tohoku region, eastern Fukushima, Chiba, Aichi, and most of the north of Mie and Hyogo Prefectures, although there were a few exceptions such as the cities of Sapporo and Kobe. Smoking rates in women were substantially lower (less than half) but the whole of Hokkaido, western Kanagawa, Gumma, Tochigi, and the inner cities of Osaka and Aichi Prefectures showed a high smoking rate in women.

Based on the geographical deprivation index, among men, the lowest smoking rate (34.7%) was found in the least deprived area (Q1) while the highest smoking rates (35.9–36.0%) were found in the more deprived areas (Q3–Q5) (Fig. 3.32). Among women, while the highest smoking rate was found in the most deprived group (Q5, 12.3%), the second highest was found in the least deprived group (Q1, 11.9%). As the map shows (Fig. 3.31), the metropolitan core regions which tend to be categorised as less deprived areas are characterised by high smoking rates for women. Individual low socioeconomic status, such as low educational attainment and low income, was substantially associated with unhealthy behaviours, including smoking, for both men and women (Tabuchi and Kondo 2017). A precedent study showed that 'living in an urban area was a negative factor for smoking in men, while a positive factor in women' in Japan (Fukuda et al. 2005).

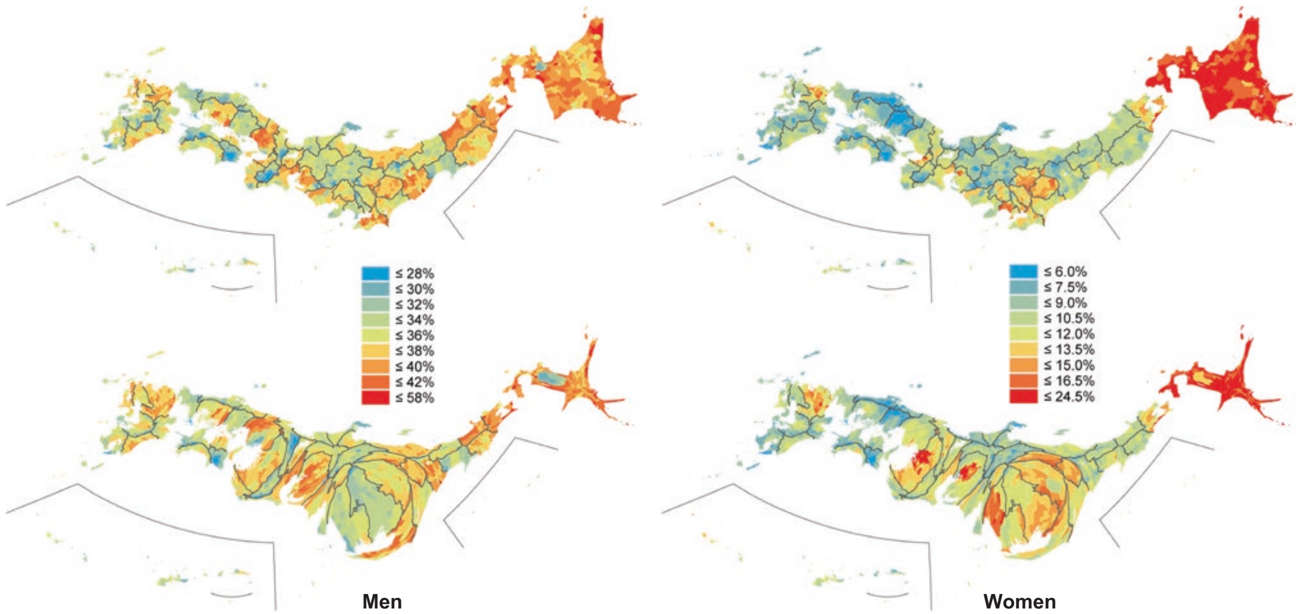


Fig. 3.31 Estimated municipal smoking prevalence rate, 2010

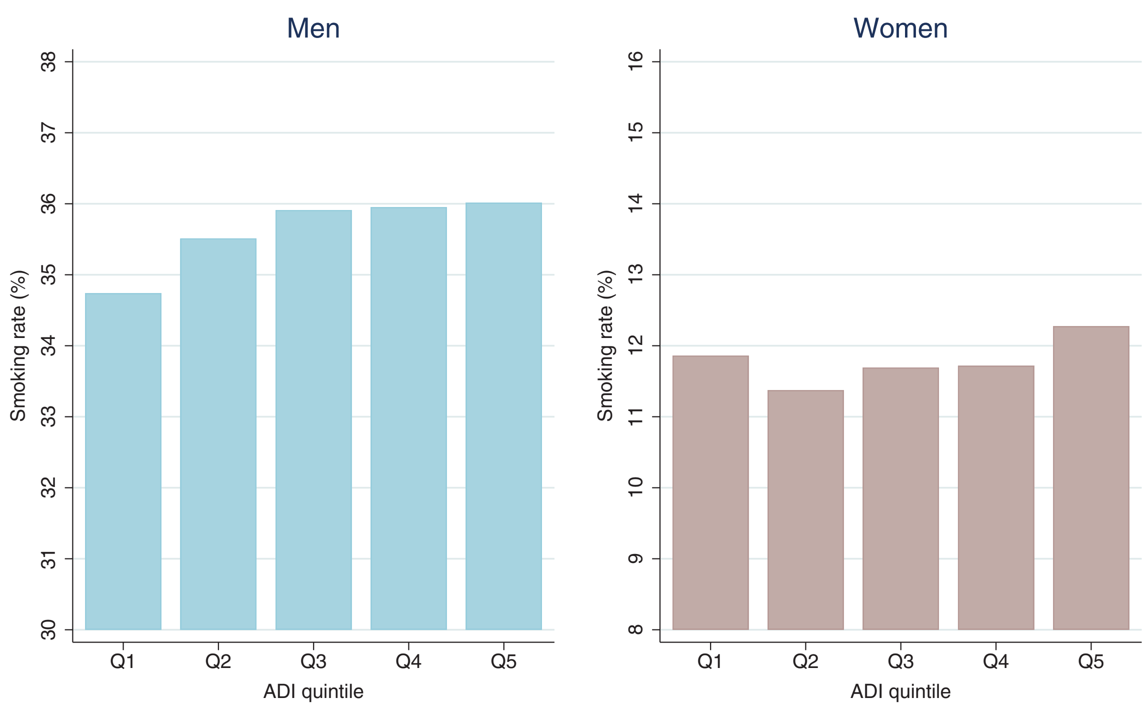


Fig. 3.32 Estimated municipal smoking prevalence rate by ADI quintile, 2010

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4 Deaths from Cancer

Yuri Ito, Yoshikazu Nishino, Seiki Kanemura, and Tomoki Nakaya

This chapter provides maps which show geographical inequalities in mortality from major cancer sites in Japan from 1995 to 2014. Cancer is the most common cause of death in Japan, accounting for 28.9% of all deaths from 2010 to 2014. The geographical distribution of standardised mortality ratios (SMRs) differs according to cancer site, and this is probably related to their risk factors. Cartograms highlight that urban areas, particularly the Tokyo and Osaka metropolitan areas, have higher SMRs for female breast, lung, oesophageal and ovarian cancer. SMRs for stomach, colorectum and lung cancer were higher in the Tohoku region, which might be related to high prevalence of smoking and heavy alcohol consumption. Age-standardised mortality rates (ASMRs) for all cancers have continuously decreased due to the notable reduction in stomach and liver cancer mortality. However, ASMRs for pancreatic, breast, cervical and uterine corpus cancer and malignant mesothelioma have increased. Socioeconomic inequalities in cancer mortality have widened during the last 2 decades. The widest gap in mortality was observed in liver cancer in the 1990s, but this reduced markedly between 2010 and 2014. Recently, lung cancer mortality has shown the widest absolute inequalities for both sexes. Liver cancer and leukaemia mortalities have also shown large relative indices (RIIs) of inequalities for both sexes. Inverse inequalities, i.e. higher ASMRs, in breast and ovarian cancer, were observed in less deprived areas than in more deprived areas; SMRs of these cancers were high in urban areas.

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4.1 All Cancers (ICD10: C00–C97): Anybody Can Die from Cancer

Yuri Ito

Overview

Cancer has been the primary cause of death for contemporary Japanese since 1981. The number of deaths has been steadily increasing and now 1 in 3.6 people die from cancer. In every part of the country, a substantial proportion of people, particularly the older adults, have died from cancer, but mortality varies across the country (Fig. 4.1). Among men, some areas of high SMR (over 150) were found in southern Hokkaido, Aomori and Akita Prefectures in the Tohoku region, Osaka Prefecture in the Kinki region, and Fukuoka and Nagasaki Prefectures in the Kyushu region. Among women, areas of high SMR were found in Osaka Prefecture in the Kinki region.

In Japan, cancer deaths among men were mainly attributed to tobacco smoking (34.4%), infection (23.2%) and alcohol intake (8.6%); among women they were attributed to infection (19.4%), tobacco smoking (6.2%) and alcohol intake (2.5%) (Inoue et al. 2012). High SMR areas roughly corresponded to those with a high prevalence of tobacco smoking and heavy alcohol intake at the prefecture level (Ministry of Health Labour and Welfare 2016). When we look at the prismic cartogram of the SMR, the red peaks of high SMR are found in metropolitan inner-city areas, particularly in Osaka Prefecture. This indicates that socio-economically deprived regions in the metropolitan regions tend to have high SMRs.

T. Nakaya, Y. Ito (eds.), *The Atlas of Health Inequalities in Japan*, Global Perspectives on Health Geography,
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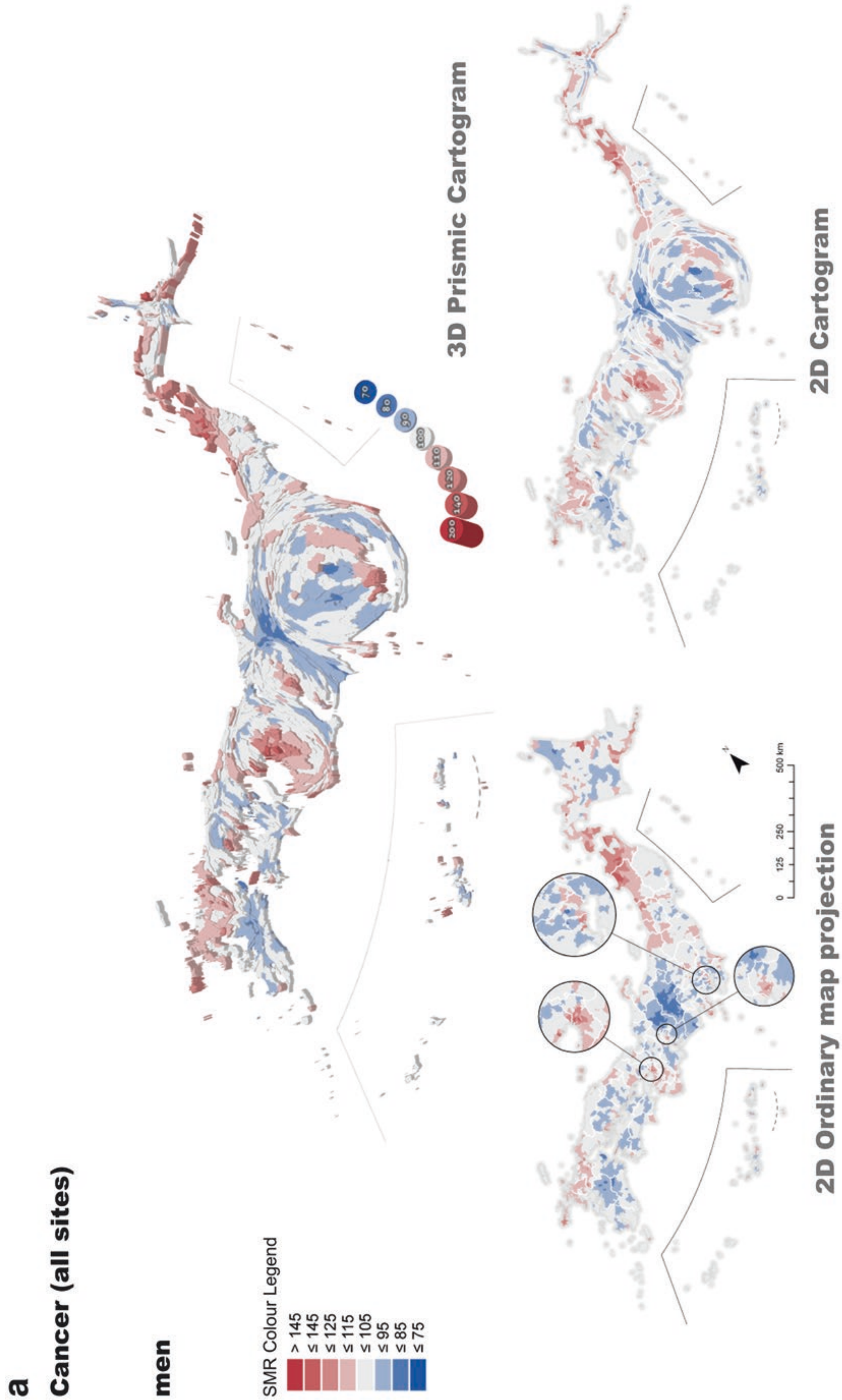
a
Cancer (all sites)
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SMR Colour Legend
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3D Prismic Cartogram
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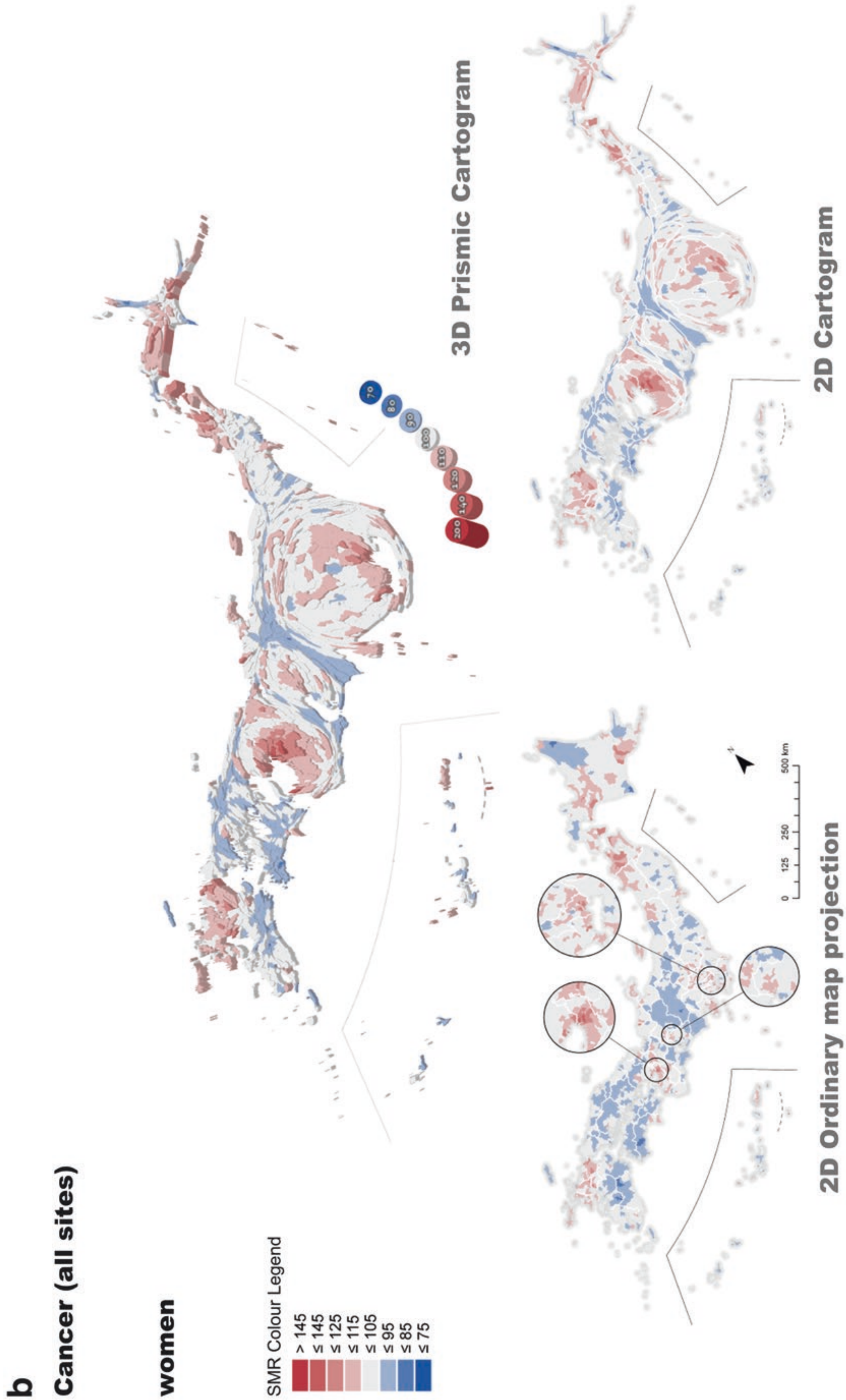
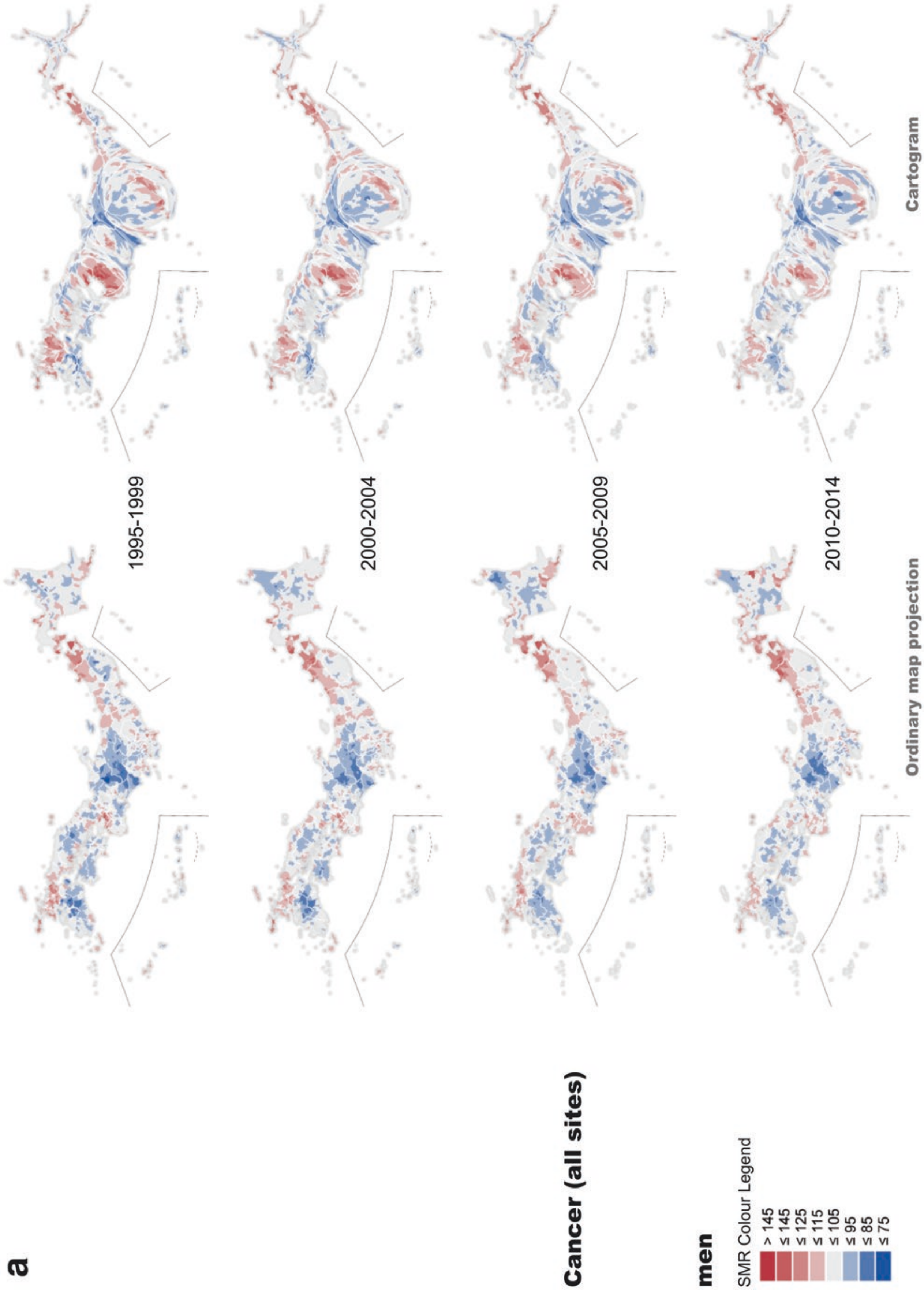


Fig. 4.1 SMR distribution of cancer (all sites), 2010–2014. (**a**) Men. (**b**) Women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Cancer (all sites)
men
SMR Colour Legend
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Ordinary map projection
Cartogram

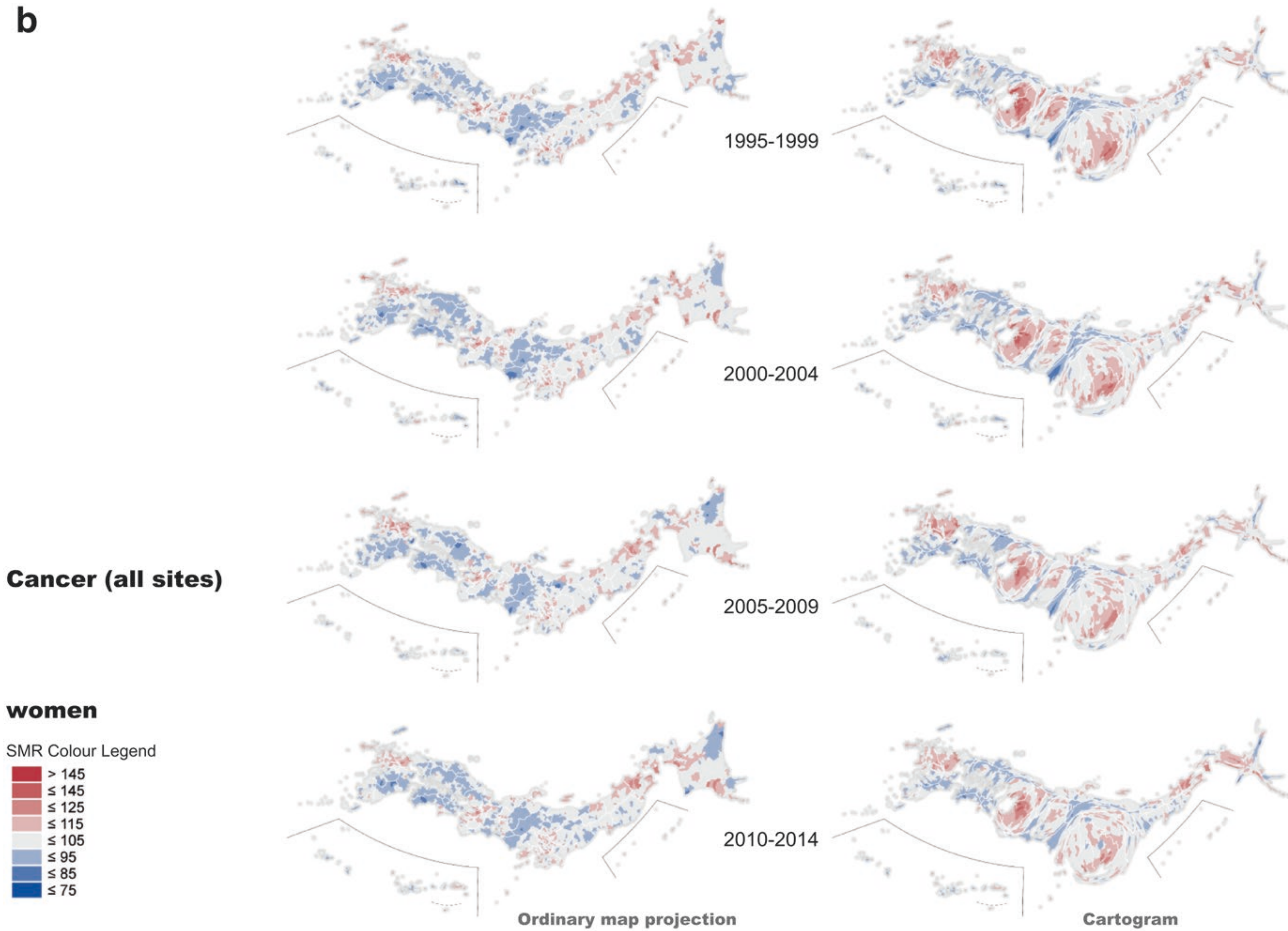


Fig. 4.2 Transition of SMR distribution of cancer (all sites) from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Transitions and Socioeconomic Disparities

There were no large changes of SMR distribution during the period from 1995 to 2014. However, according to cartogram-based SMR mapping, the high SMRs in metropolitan areas have slightly decreased and the contrast between low and high SMR regions has become more prominent within the areas (Fig. 4.2). The geographical inequality of SMRs for all cancers is quite stable across the country, but it has slightly increased within the metropolitan areas.

The ASMR of cancer has decreased over the 20 years (Fig. 4.3). This means that absolute mortality rates from all cancers have persistently decreased. Among men, a clear gradient of ASMR from the least deprived group (Q1) to the most deprived group (Q5) was observed (Fig. 4.4). The slope index of inequalities (SII), the absolute gap of ASMR

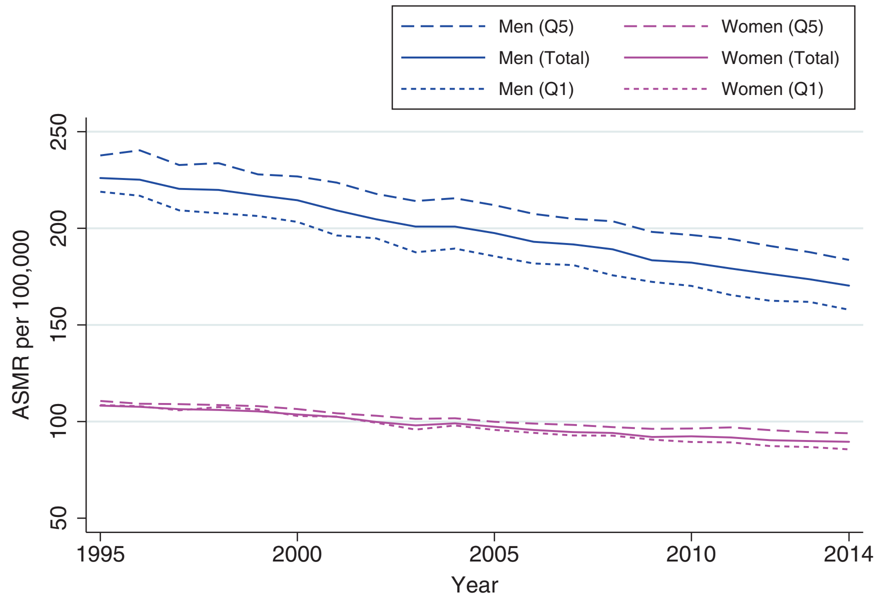


Fig. 4.3 Annual transition in the ASMR of cancer (all sites) from 1995 to 2014

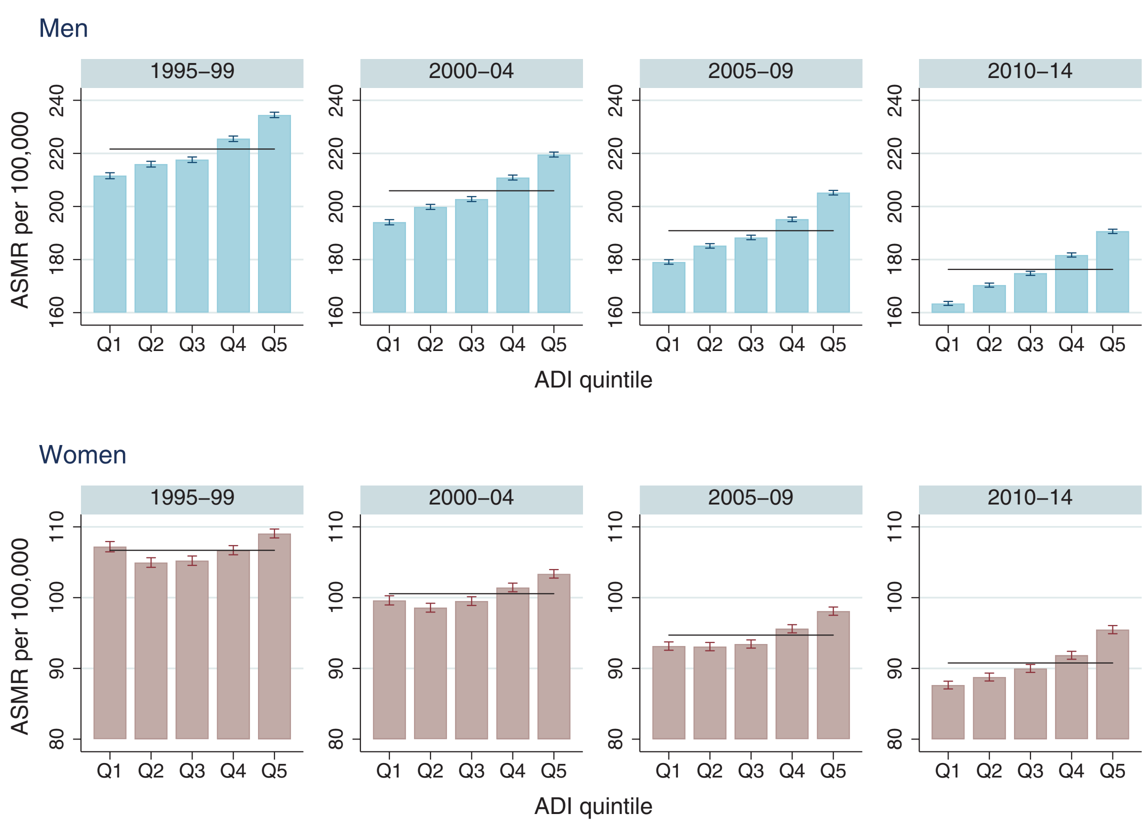


Fig. 4.4 The transition in the ASMR distribution of cancer (all sites) by ADI quintile (top: men, bottom: women)

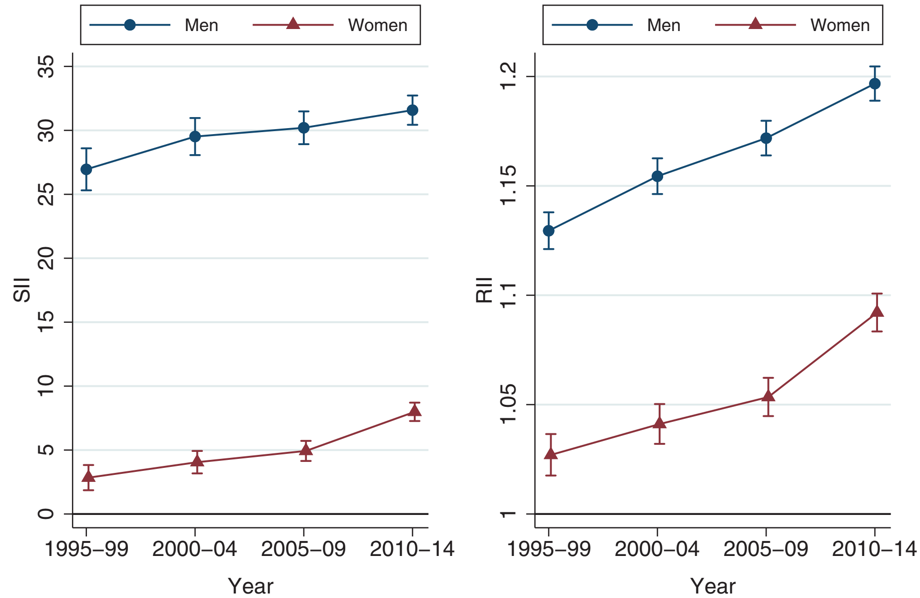


Fig. 4.5 Transition in SII and RII of cancer (all sites) from 1995 to 2014 by 5-year period (left: SII, right: RII)

between the most and least deprived areas, indicated large socioeconomic inequalities (Fig. 4.5). Among women, the second least deprived group (Q2) showed the lowest ASMR as a 'J-shape' curve before 2005 (Fig. 4.4). In the most recent period from 2010 to 2014, a clear gradient of ASMR from Q1 to Q5 and a markedly widening gap were observed. Trends in the RII show that the relative socioeconomic inequalities of ASMR have widened. For the 20 years, the RII among men has been larger than among women (Fig. 4.5).

4.2 Oesophageal Cancer (ICD10: C15): Smoking and Alcohol Cancer

Yuri Ito

Overview

Japan has one of the world's highest incident rates of oesophageal cancer in men. However, while the incidence rate is still increasing, the mortality rate is decreasing (Forman et al. 2013). The incidence and mortality rates observed in men were about six times higher than those in women in Japan. Deaths from oesophageal cancer were mainly attributed to tobacco smoking (58.9%) and alcohol intake (53.8%) in men, and alcohol intake (28.9%) and tobacco smoking (14.7%) in women in Japan (Inoue et al. 2012). Areas of high SMR were associated with high prevalence of tobacco smoking and heavy alcohol intake at the prefectural level (Ministry of Health Labour and Welfare 2016).

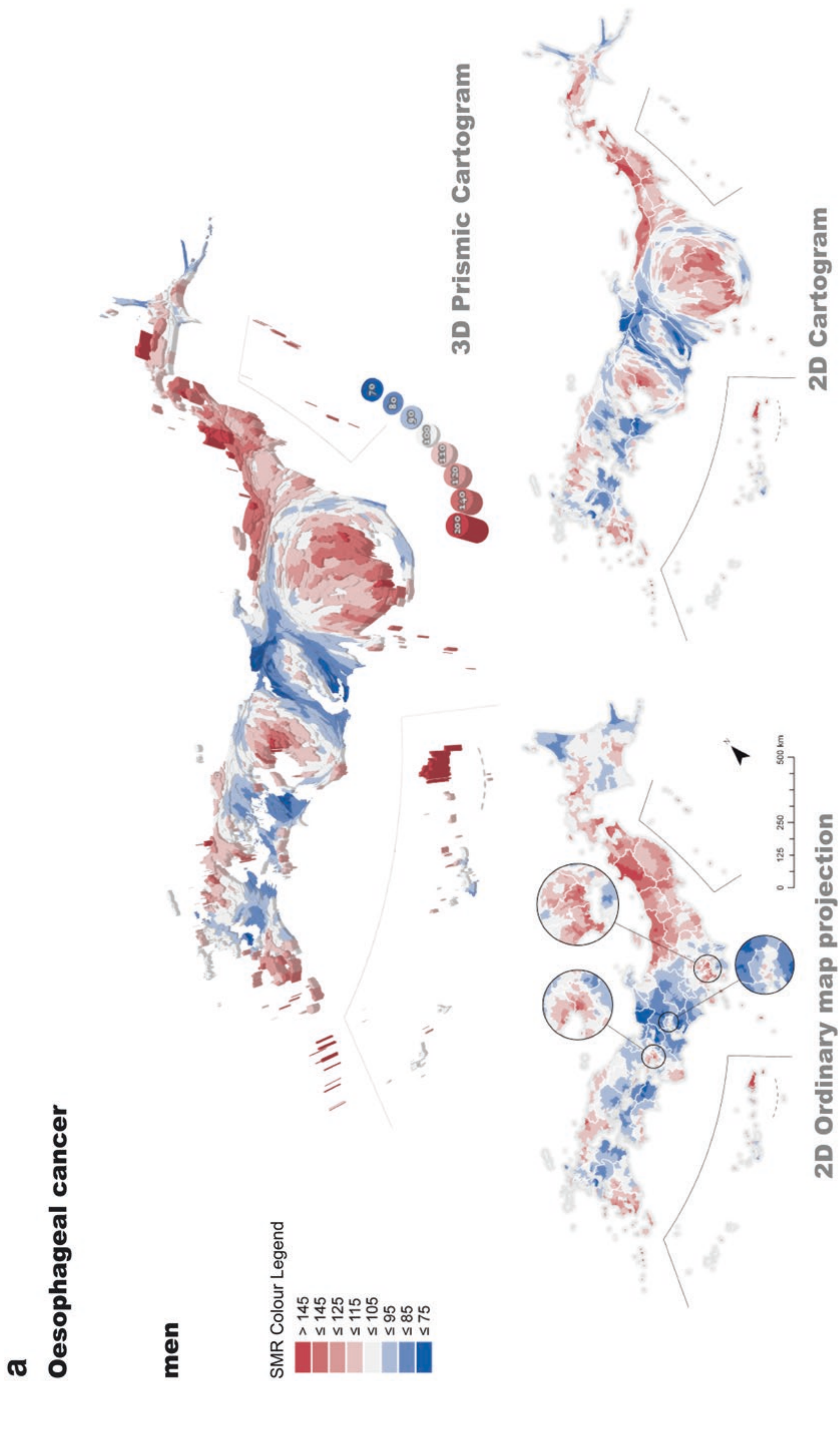
Among men, areas of high SMR (over 150) were spread over the Sea of Japan side of the Tohoku region and the coastal areas of Tokyo, as well as Osaka and Hyogo Prefectures in the Kinki region, Yamaguchi, Fukuoka and Kagoshima Prefectures in the Kyushu region, and Okinawa Prefecture (Fig. 4.6). Among women, areas of high SMR were mostly observed in metropolitan areas such as Tokyo, Osaka and Fukuoka-Kitakyushu, but high SMRs were also found in several non-metropolitan areas in Hokkaido Prefecture and the remote islands around Kagoshima and Okinawa Prefectures.

We observed large differences between men and women on the SMR maps based on the ordinary map projection. However, on the cartogram-based SMR maps, such gender differences become minor. SMRs in the urban areas are lower, and the variation over the entire country is also smaller.

Transitions and Socioeconomic Disparities

Figure 4.7 shows the transitions in the SMR distributions from 1995 to 2014. Among men, higher SMRs were consistently observed in the Sea of Japan side of the Tohoku region, where areas of higher alcohol intake in men were also seen. Among women in the Tohoku region, high regional SMRs decreased in the period 2010–2014, but urban areas continue to show high SMRs. High alcohol intake was reported among women in the urban area (Ministry of Health Labour and Welfare 2016).

The ASMRs of oesophageal cancer have decreased slightly during the last 20 years in men and remain low and stable in women (Fig. 4.8). Among men, Q3 showed the lowest ASMR, a 'J-shape/U-shape' curve, in 1995–2000 in contrast to the high ASMRs in Q1 and Q5 (Fig. 4.9). In the most recent period, the most deprived group showed the highest ASMR. Among women, different patterns of ASMR by deprivation group were observed. In 1995–1999, the highest ASMRs were observed in the least deprived group (Q1),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Oesophageal cancer
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SMR Colour Legend
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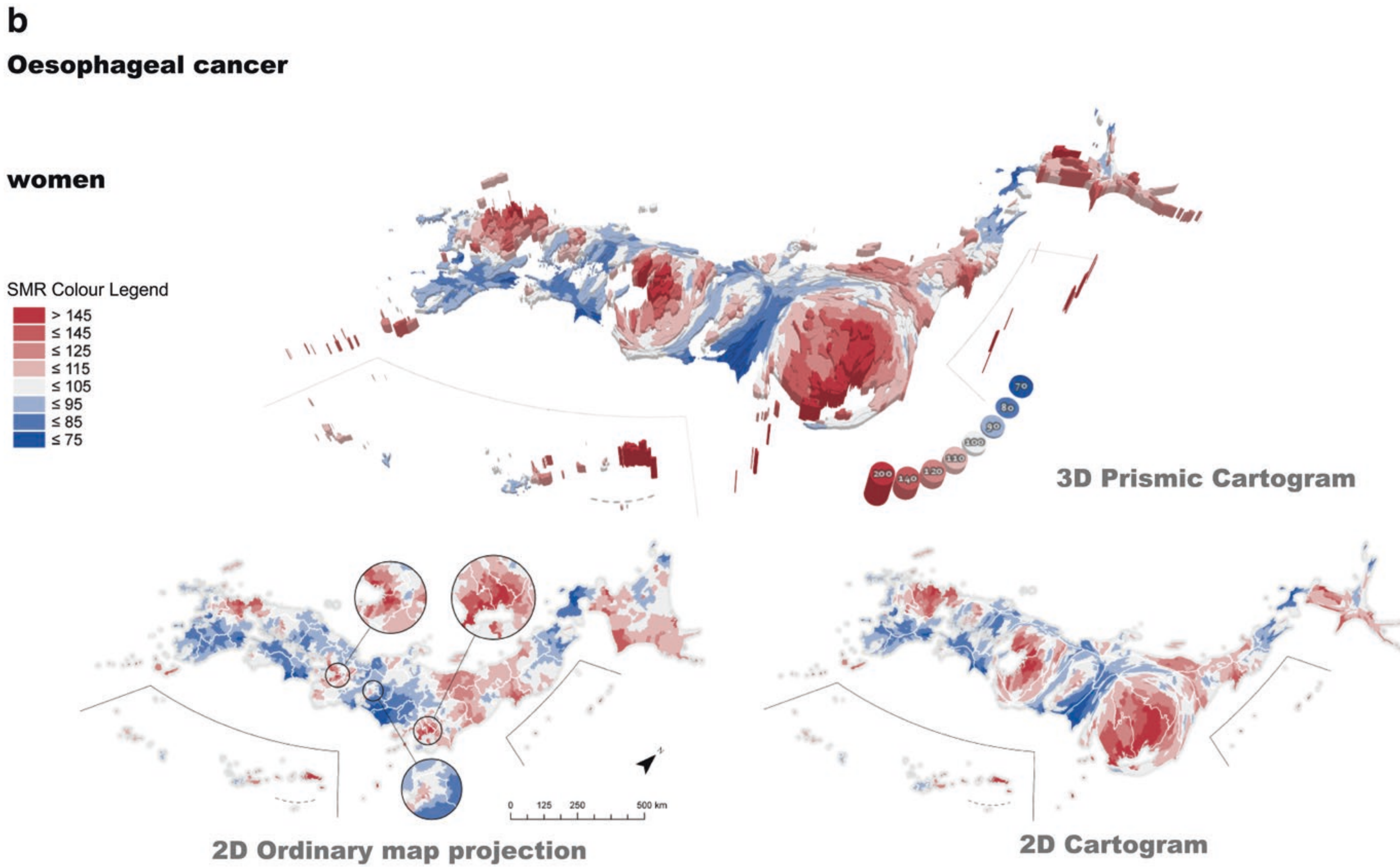
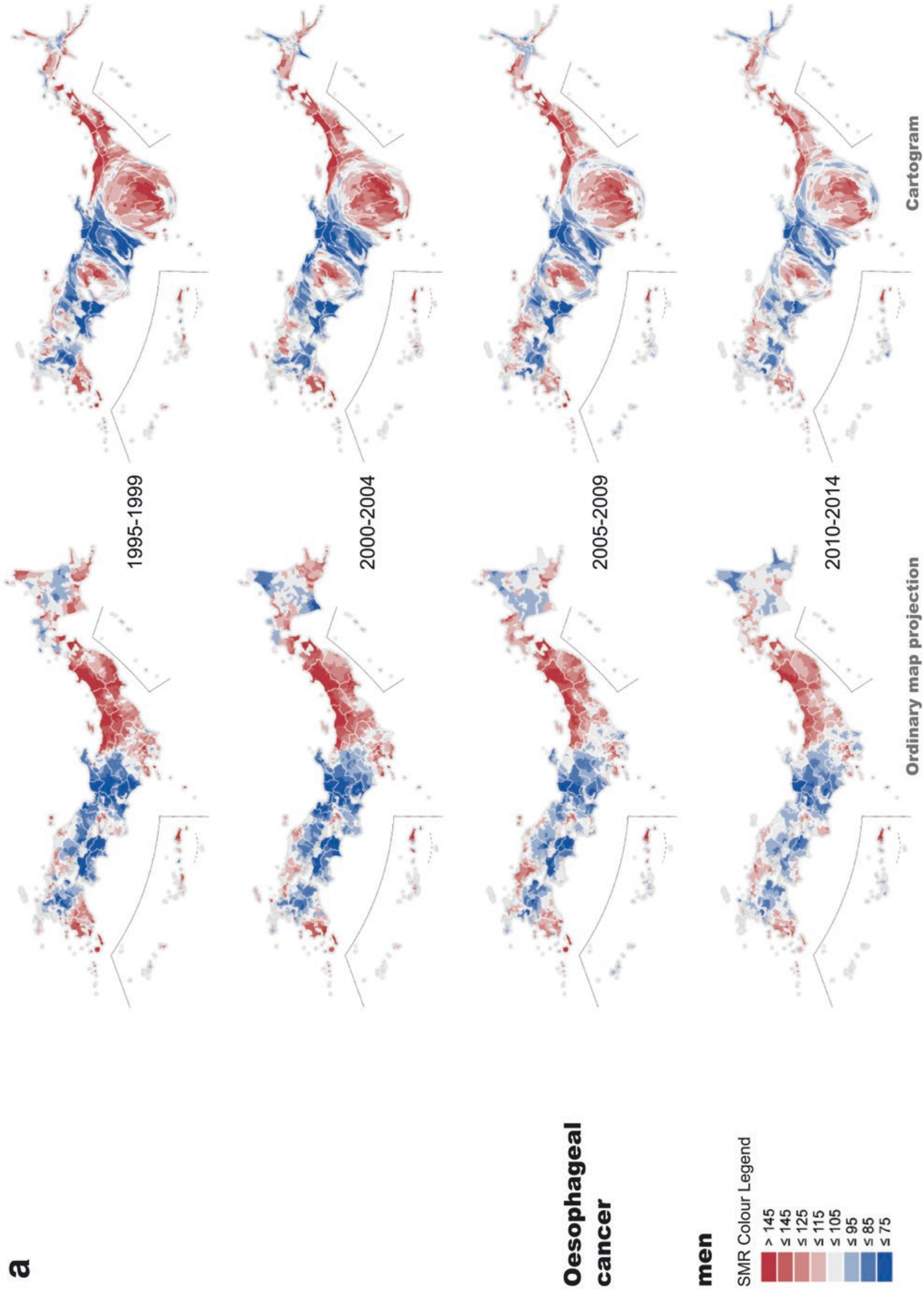


Fig. 4.6 SMR distribution of oesophageal cancer, 2010–2014. (**a**) Men. (**b**) Women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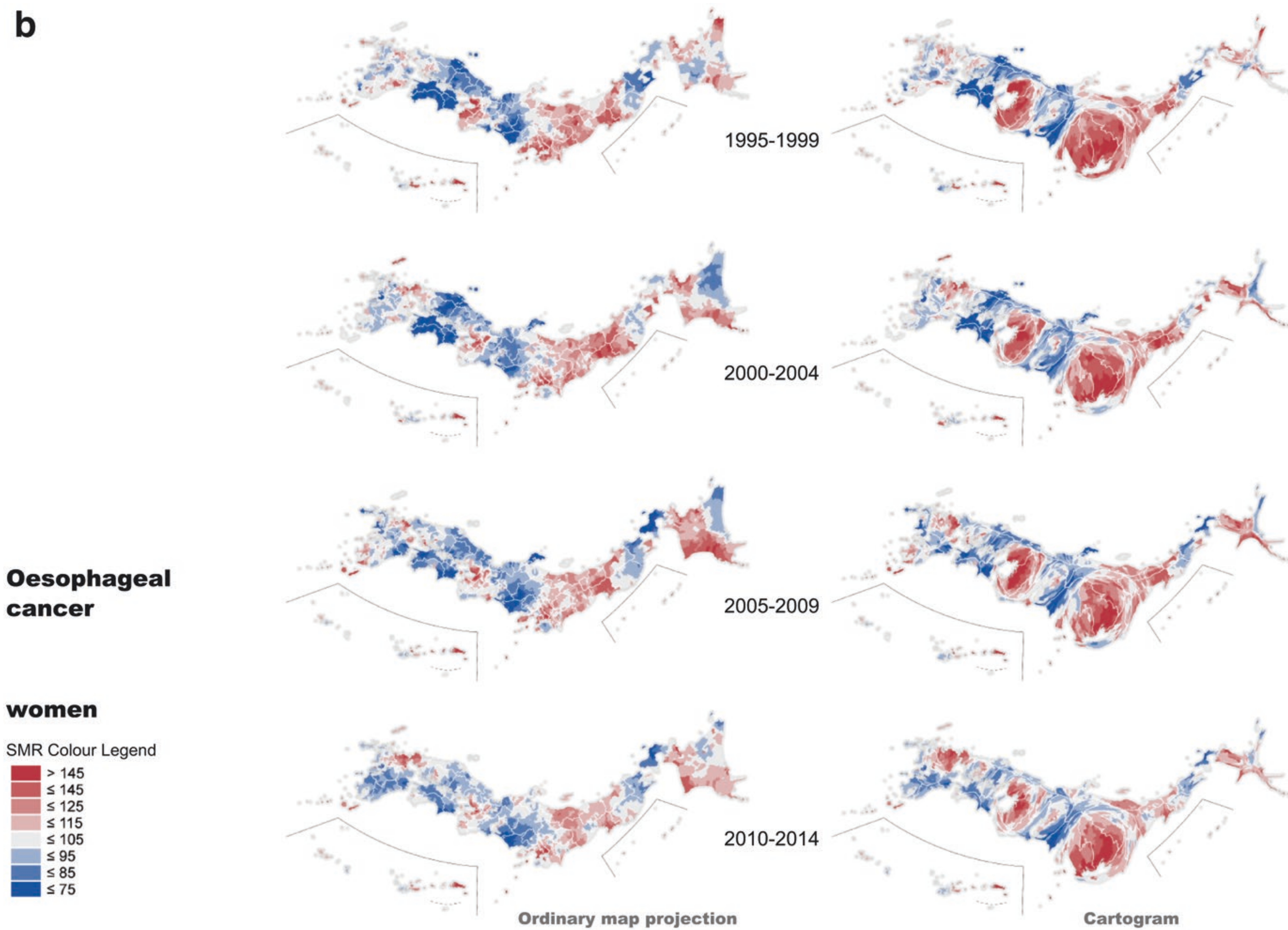
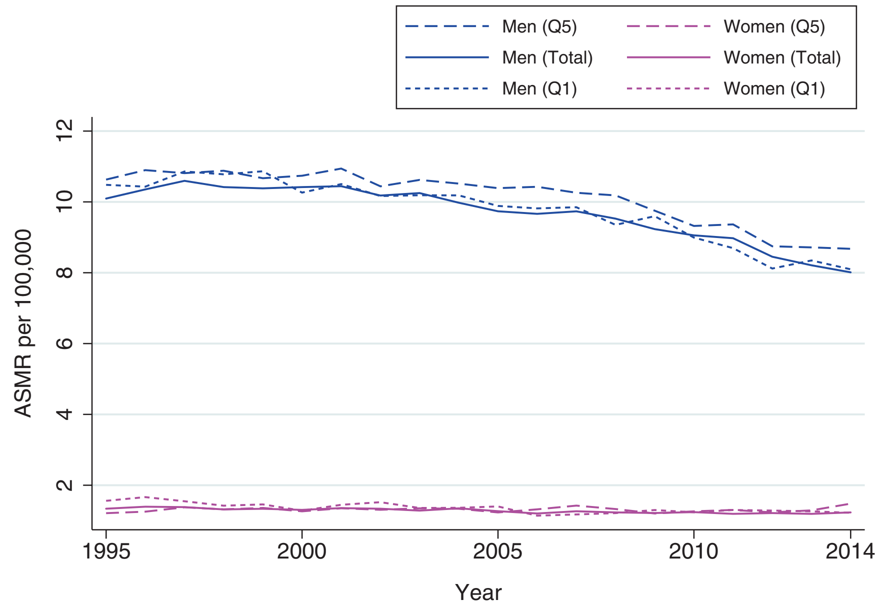


Fig. 4.7 Transition of SMR distribution of oesophageal cancer from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 4.8 Annual transition in the ASMR of oesophageal cancer from 1995 to 2014



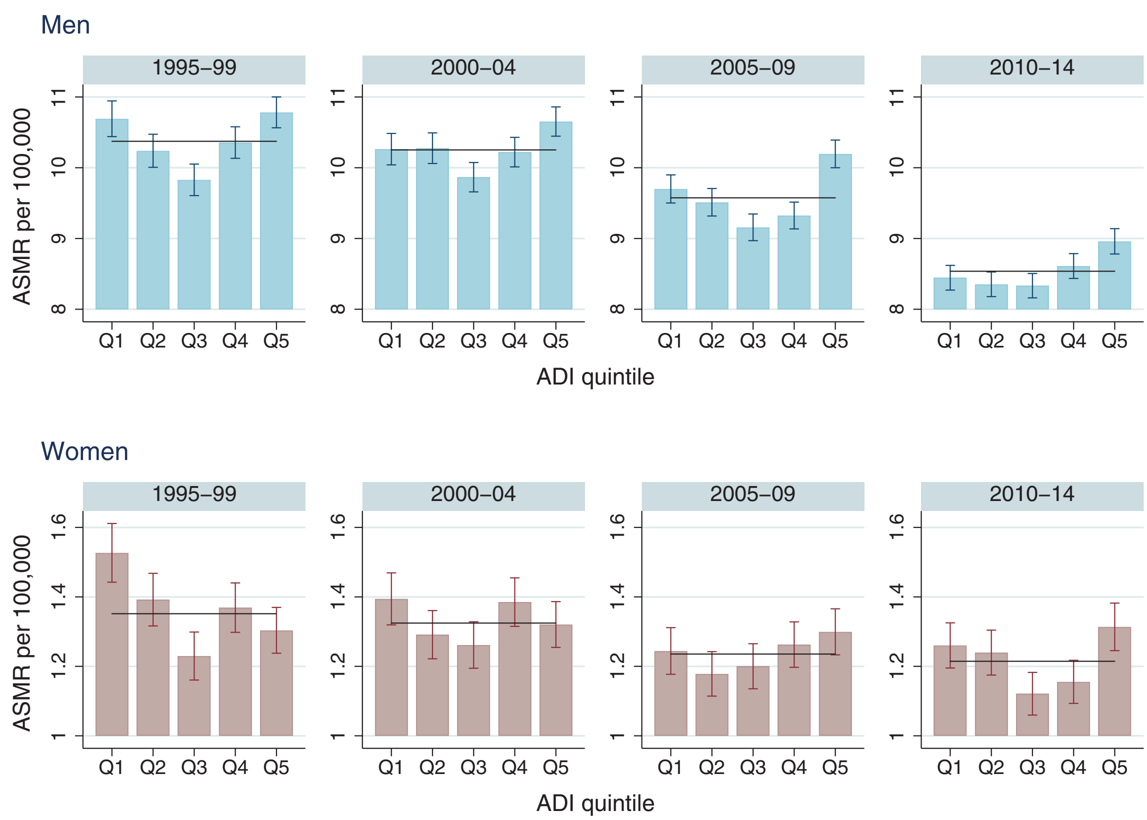


Fig. 4.9 The transition in the ASMR distribution of oesophageal cancer by ADI quintile (top: men, bottom: women)

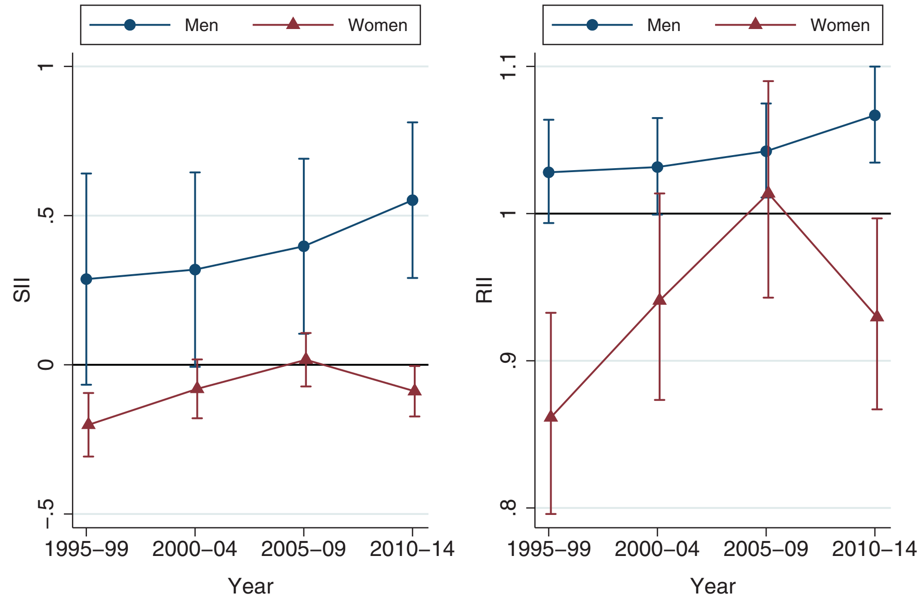


Fig. 4.10 Transition in SII and RII of oesophageal cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)

which is an inverse socioeconomic gradient in the ASMR. While there was a slightly increasing trend in the RII and SII in men, among women they there were inverse socioeconomic gradients in 1995–1999 and 2010–2014 (Fig. 4.10).

4.3 Stomach Cancer (ICD10: C16): A Legacy Cancer

Yuri Ito

Overview

Until recently, stomach cancer was the most common cancer in Japan, although incidence and mortality rates have decreased considerably, due to an improvement in hygiene levels. In 2010–2014, 15% of all cancer deaths in Japanese men and 11.5% in Japanese women were due to stomach cancer, making it the second and third (respectively) most common cause of cancer death in Japan. Infection of *Helicobacter pylori* is the main risk factor for non-cardia stomach cancer incidence; the Population Attributable Risk Fraction (PAF) is 81.5% in men and 69.9% in women. Other attributable risk factors are salt intake (PAF = 8.9%) and active tobacco smoking (23.5% in men and 3.4% in women) (Inoue et al. 2012).

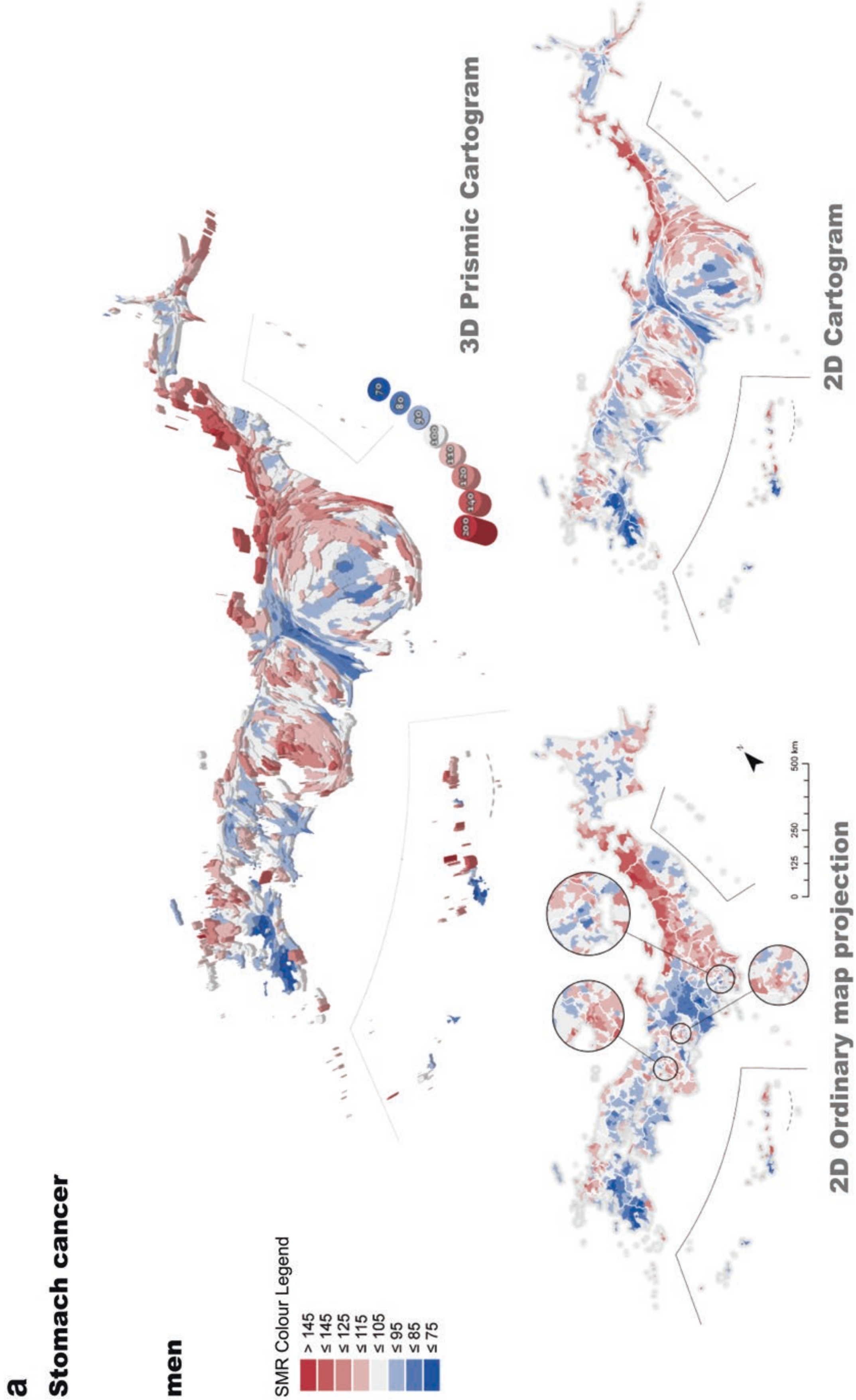
High SMR areas were related to high intake of salt and prevalence of tobacco smoking (Ministry of Health Labour and Welfare 2016). Mass screening for stomach cancer was introduced in Miyagi Prefecture during the 1960s, the earliest phase of screening worldwide. In 1983, the Japanese government started nationwide mass screening for stomach cancer using photofluorography, under the Health Service Law for the Aged (Hamashima et al. 2008). In the global surveillance of cancer survival 2018, Japan had the highest stomach cancer survival (Allemani et al. 2018).

According to the SMR distribution of stomach cancer (Fig. 4.11), among men, high SMR areas were spread across the Sea of Japan side of the Tohoku and Chubu regions, Osaka and Hyogo Prefectures in the Kinki region, and Okinawa Prefecture. Among women, high SMR areas were observed in the Sea of Japan side of the Tohoku and Chubu regions, Nagoya City in the Chubu region, Osaka and Hyogo Prefectures in the Kinki region, and Okinawa Prefecture.

Transitions and Socioeconomic Disparities

High SMRs were persistently observed in the Sea of Japan side of the Tohoku and Chubu regions for both sexes for the period from 1995 to 2014 (Fig. 4.12). In the affluent suburbs in the western Tokyo metropolitan area, SMRs have decreased, especially in women, resulting in a widening socioeconomic disparity of stomach cancer mortality in the metropolitan area.

The ASMR of stomach cancer has markedly decreased during the 20 years for both sexes (Fig. 4.13). For men, the highest and lowest ASMRs were observed for Q3 and Q5, respectively, in the period 1995–1999, indicating that the socioeconomic gradient in the mortality was not clearly identified (Fig. 4.14). According to the SII trend, the absolute socioeconomic inequalities in ASMR widened in men, although an inverse socioeconomic gradient of mortality was observed in 1995–1999 (Fig. 4.15). For women, inverse socioeconomic gradients were observed in 1995–2009, and the gap between the least and most deprived areas disappeared in the most recent period, 2010–2014 (Fig. 4.14).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Stomach cancer
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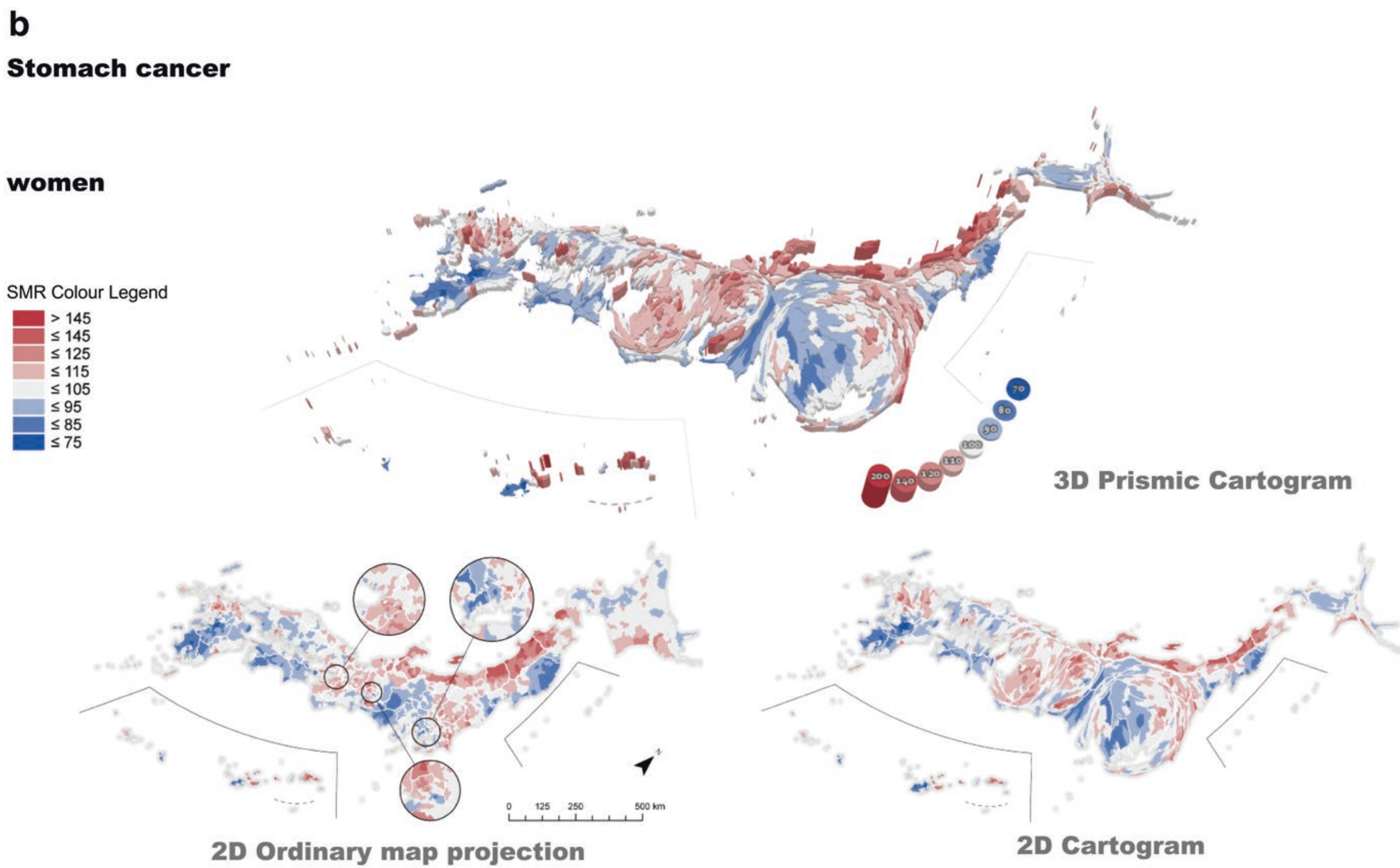
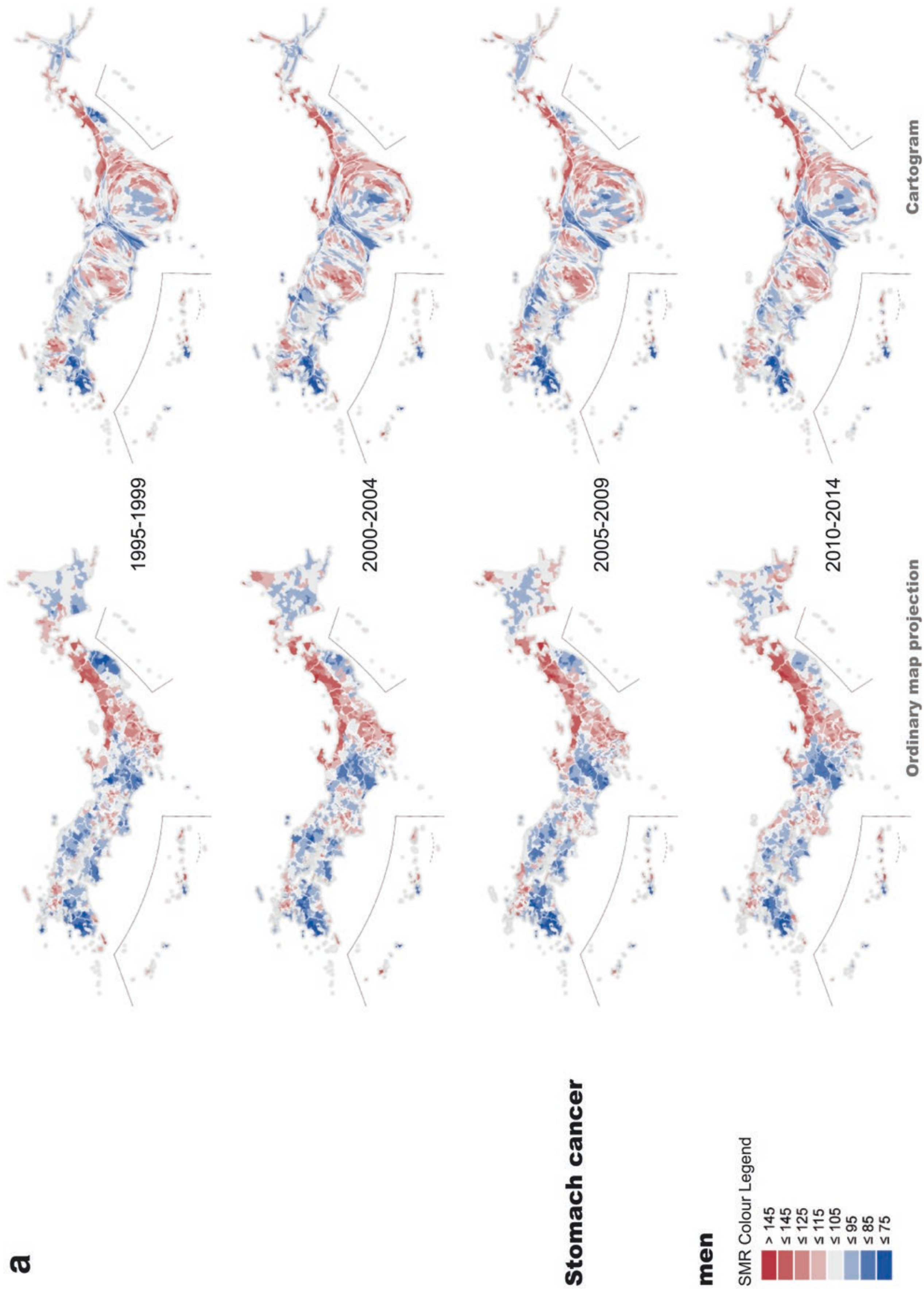


Fig. 4.11 SMR distribution of stomach cancer, 2010–2014. (**a**) Men. (**b**) Women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Ordinary map projection
Cartogram

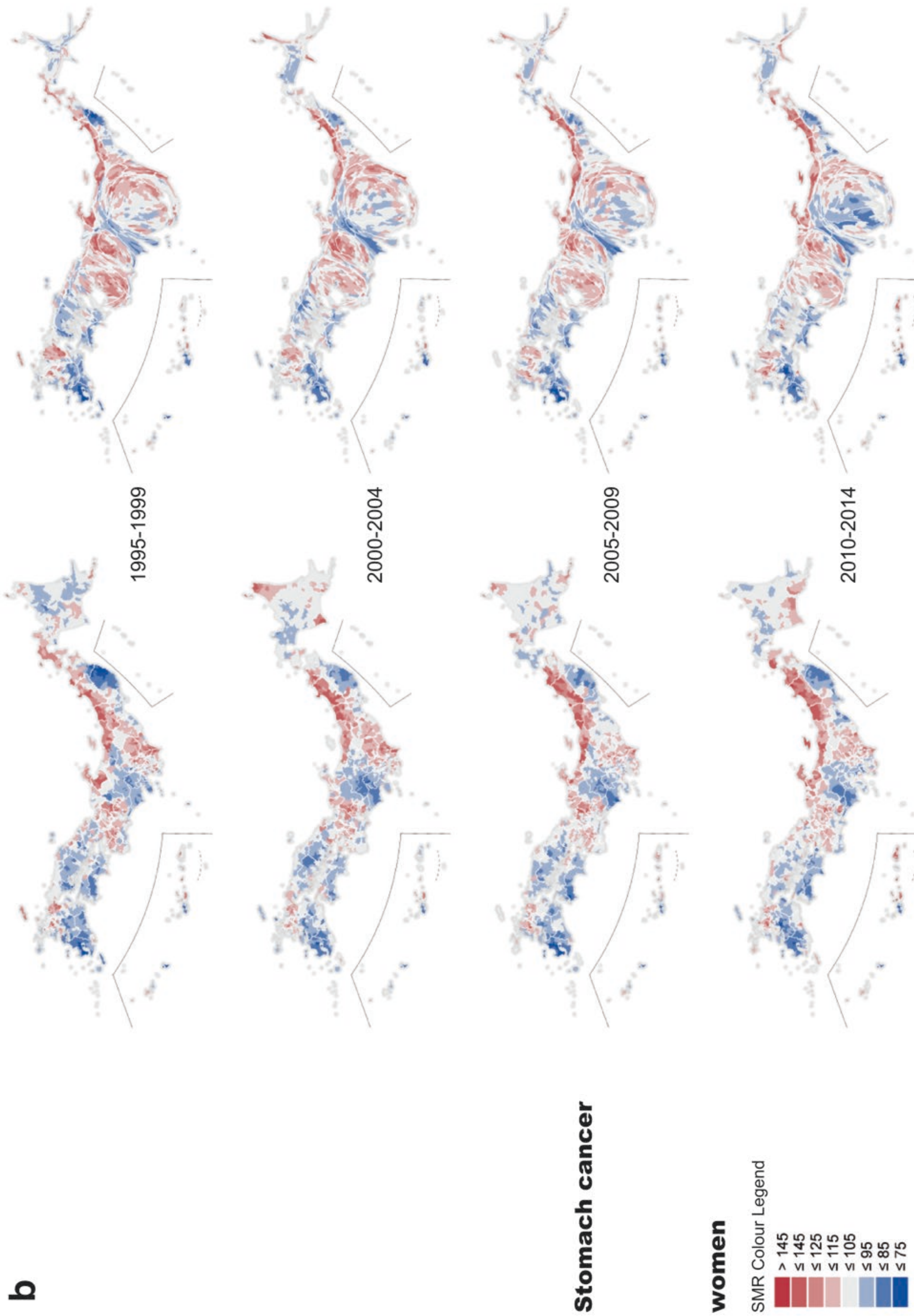


Fig. 4.12 Transition of SMR distribution of stomach cancer from 1995 to 2014 by 5-year period. **(a)** Men. **(b)** Women

Fig. 4.13 Annual transition in the ASMR of stomach cancer from 1995 to 2014

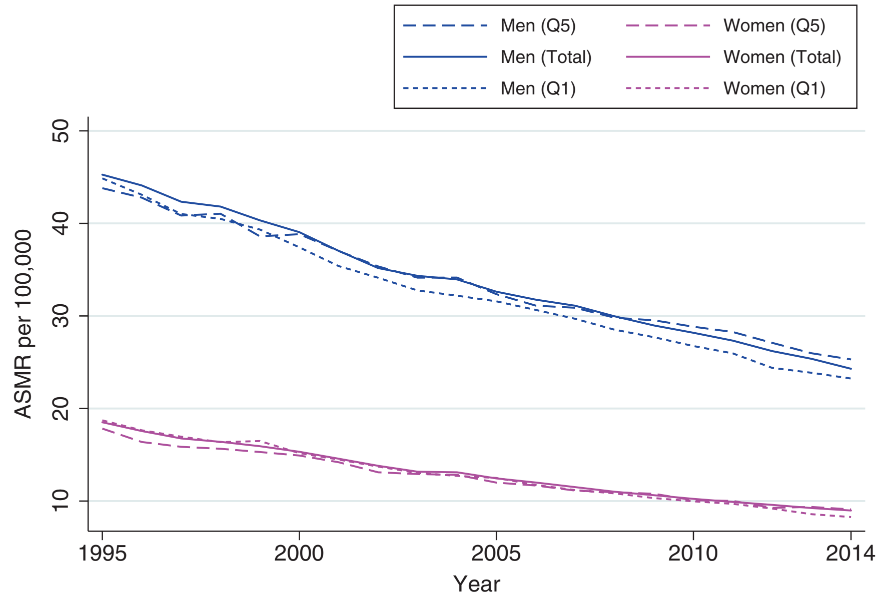
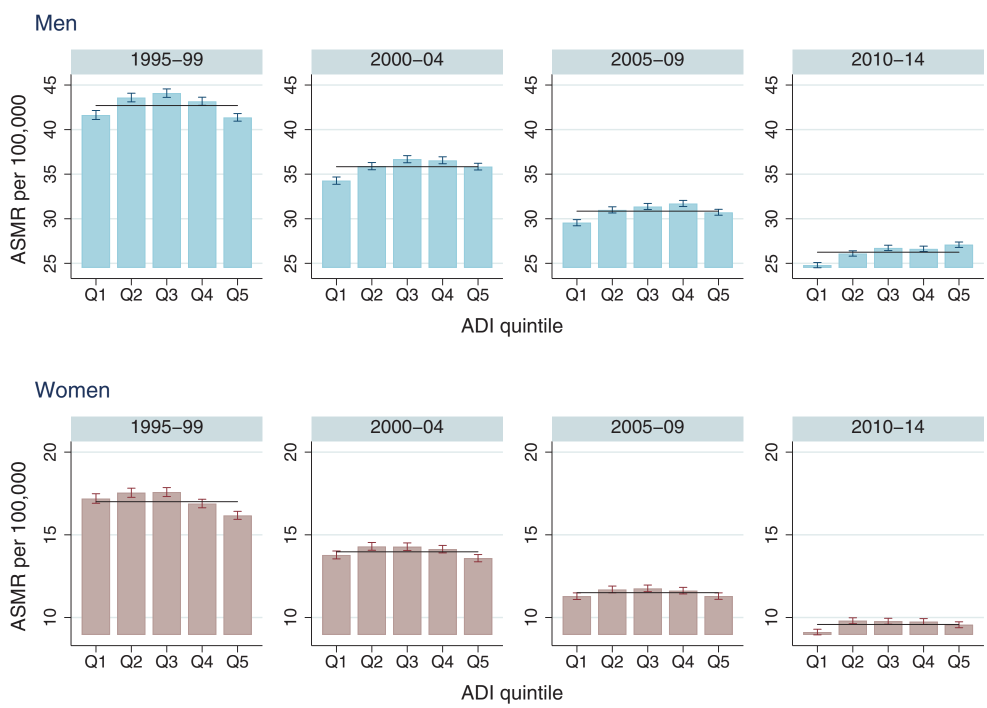


Fig. 4.14 The transition in the ASMR distribution of stomach cancer by ADI quintile (top: men, bottom: women)



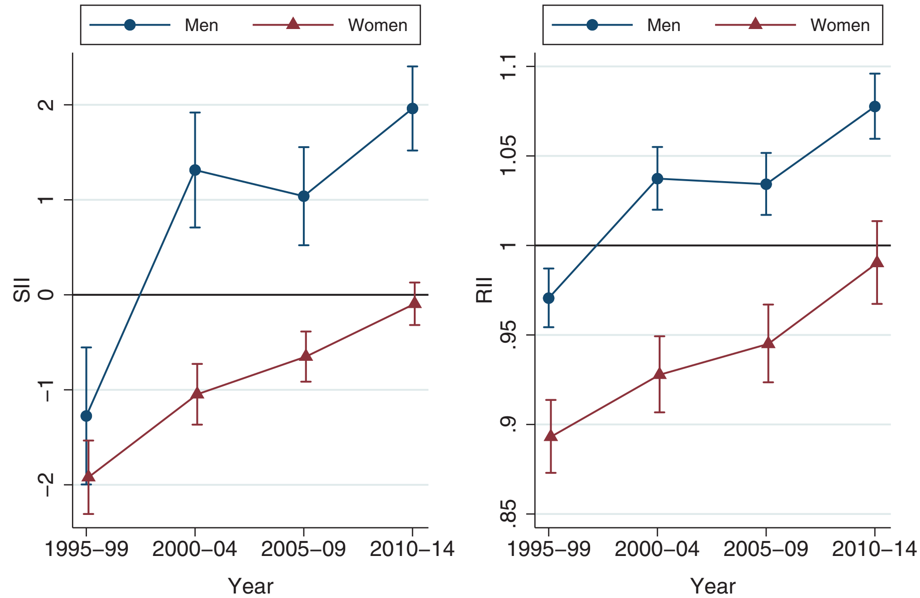


Fig. 4.15 Transition in SII and RII of stomach cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)

4.4 Colorectal Cancer (ICD10: C18–C20): Preventable but Still a Serious Enemy

Yuri Ito

Overview

According to the most recent reports for cancer incidence in 2014, colorectal cancer is the most common cancer incidence site in Japan (Cancer Information Service 2018). The colorectal cancer mortality rate increased until the mid-1990s and then decreased slightly. Japan has one of the highest incidence rates in the world, and it is still increasing. One of the reasons for the steady increase in both incidence and mortality rates until the 1990s was the change from traditional Japanese food to a more Western style diet in Japan. In 1992, the Japanese government started a screening programme for colorectal cancer using the Faecal Occult Blood Test, which was the earliest implementation of such a programme in the world, but coverage was still insufficient.

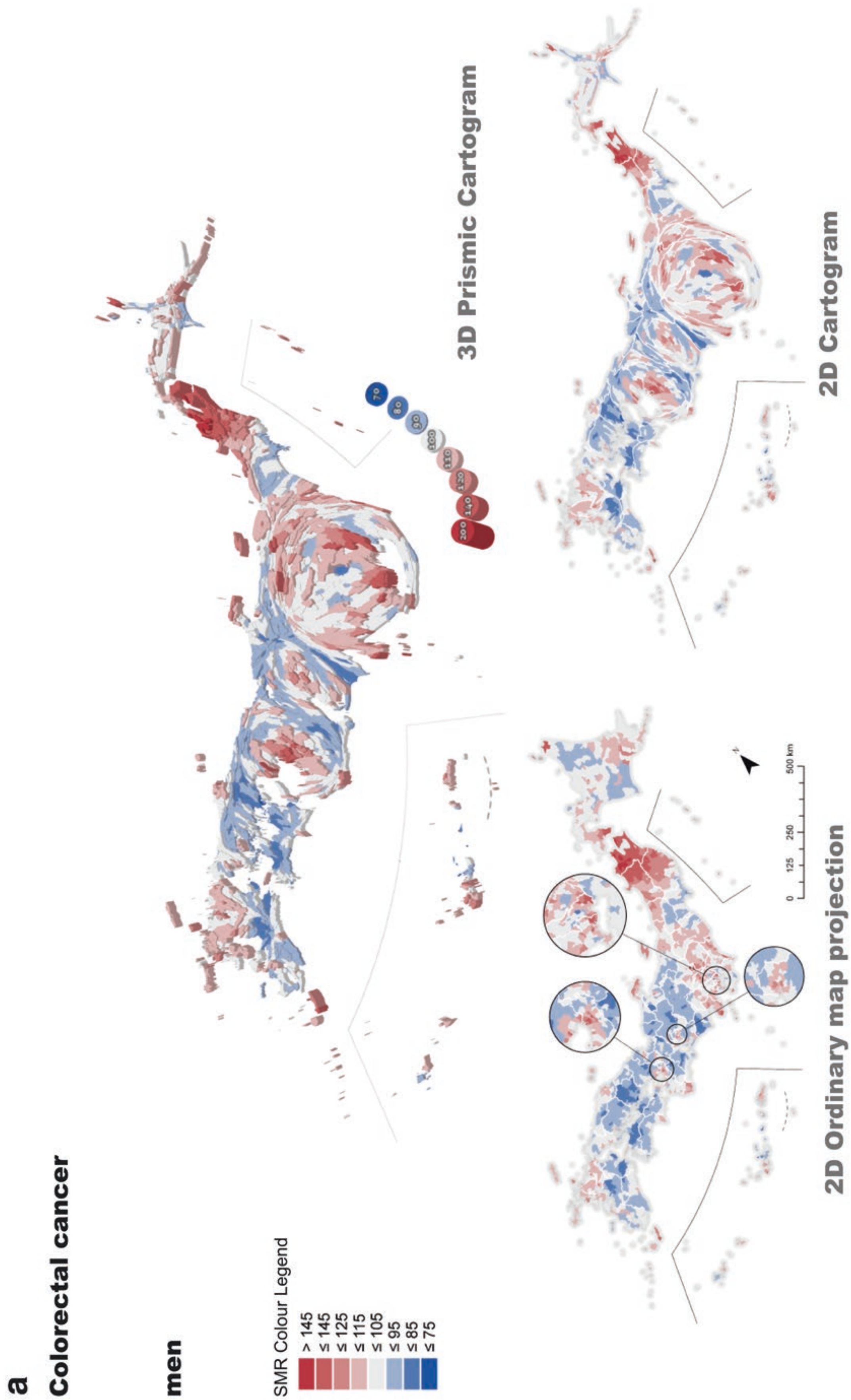
The SMR maps (Fig. 4.16) show that among men, high SMR areas were spread over the northern part of the Tohoku region including Aomori, Akita and Iwate Prefectures, and the metropolitan areas of the Kanto and Kinki regions. Among women, high SMR areas were observed in Aomori and the South of Hokkaido Prefecture.

In Japan, colorectal cancer incidence is mainly attributed to active tobacco smoking (20.4% in men, 4.5% in women), alcohol intake (32.9% in men, 2.1% in women), overweight and obesity (5.2% in men and 4.0% in women) (Inoue et al. 2012). The high SMRs in Aomori Prefecture could be related to the high prevalence of these risk factors (Ministry of Health Labour and Welfare 2016).

Transitions and Socioeconomic Disparities

High SMRs in the Tohoku region have slightly increased for both sexes, while SMRs have decreased in the Tokyo metropolitan areas (Fig. 4.17). In the most recent period from 2010 to 2014, a clear variation in SMRs within the Tokyo metropolitan area was observed in men.

The ASMR of colorectal cancer slightly decreased until 2010, and then stabilised for both sexes (Fig. 4.18). Among men, the lowest ASMR was in Q3 and the highest in Q1 and Q5 in 1995–1999 (Fig. 4.19). After 2000, clear socioeconomic gradients were observed for the ASMR of colorectal cancer, and this became wider in men, according to the transition of SII (Fig. 4.20). Among women, an inverse gradient of the deprivation gap was observed in 1995–1999 (Fig. 4.19). In the most recent period from 2010 to 2014, a clear deprivation gap in mortality between the least and most deprived areas was observed in women. The RII is slightly higher in men than in women and has increased during the 20 years from 1995 to 2014 (Fig. 4.20).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Colorectal cancer
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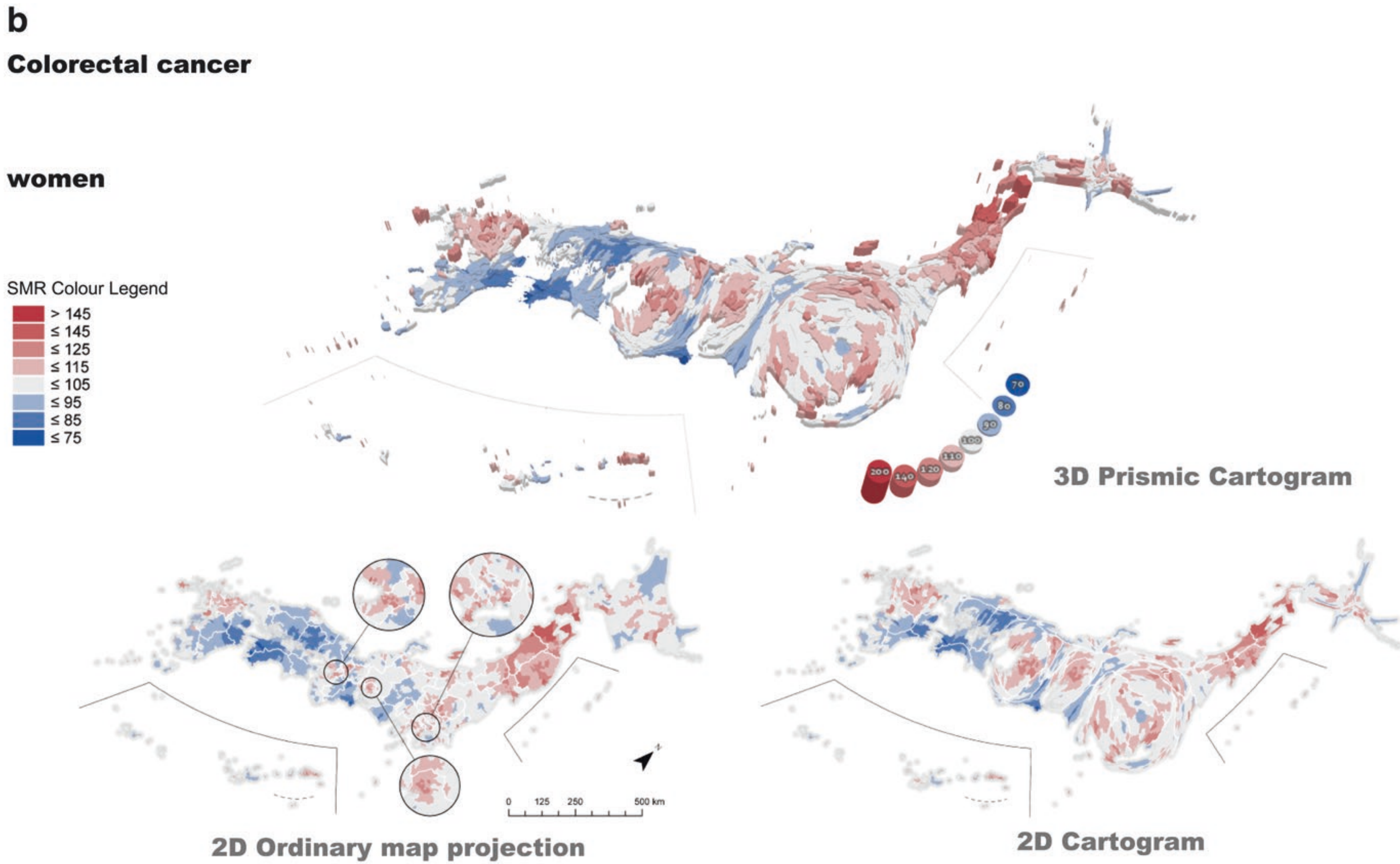
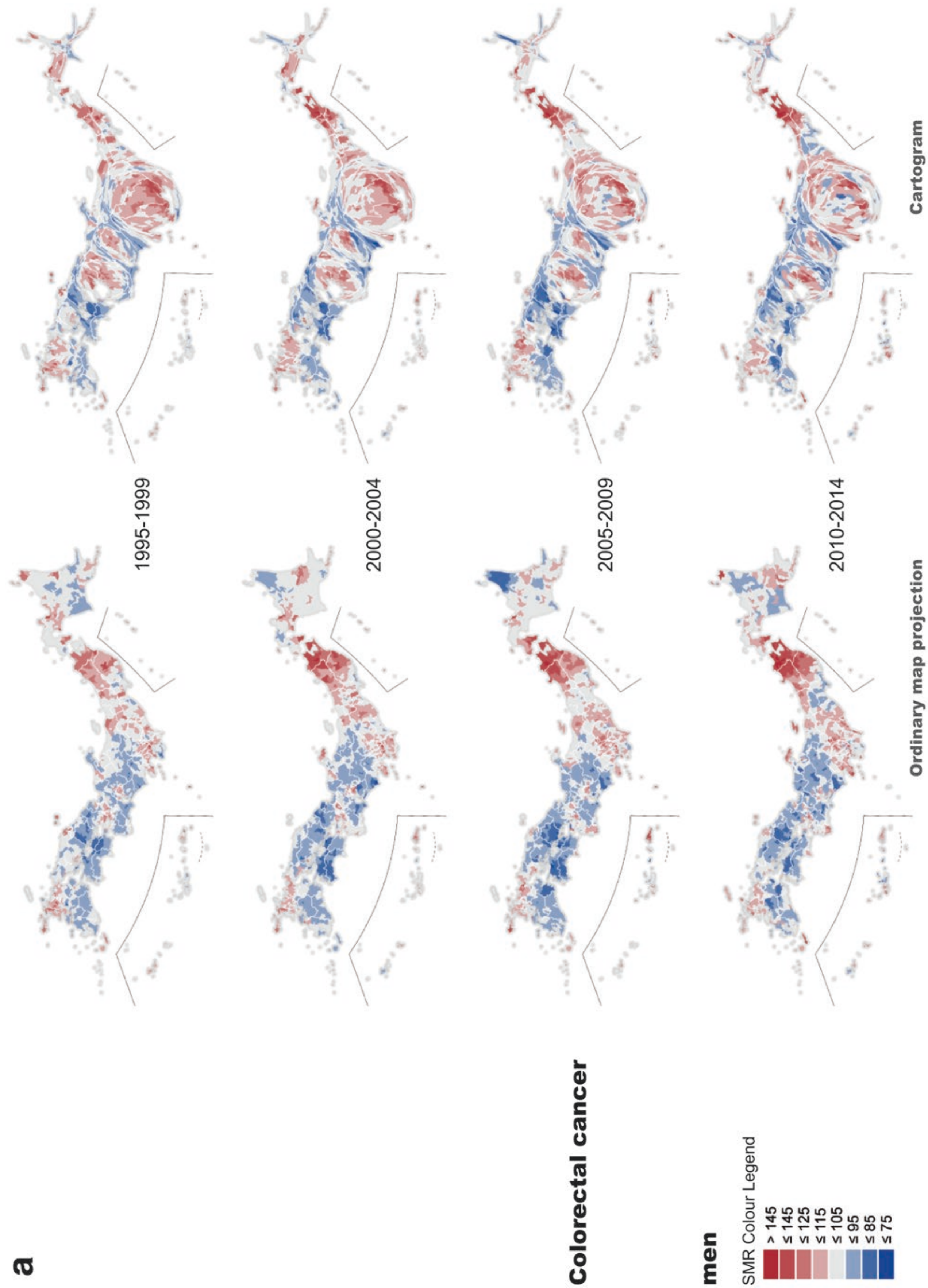


Fig. 4.16 SMR distribution of colorectal cancer, 2010–2014. (**a**) Men. (**b**) Women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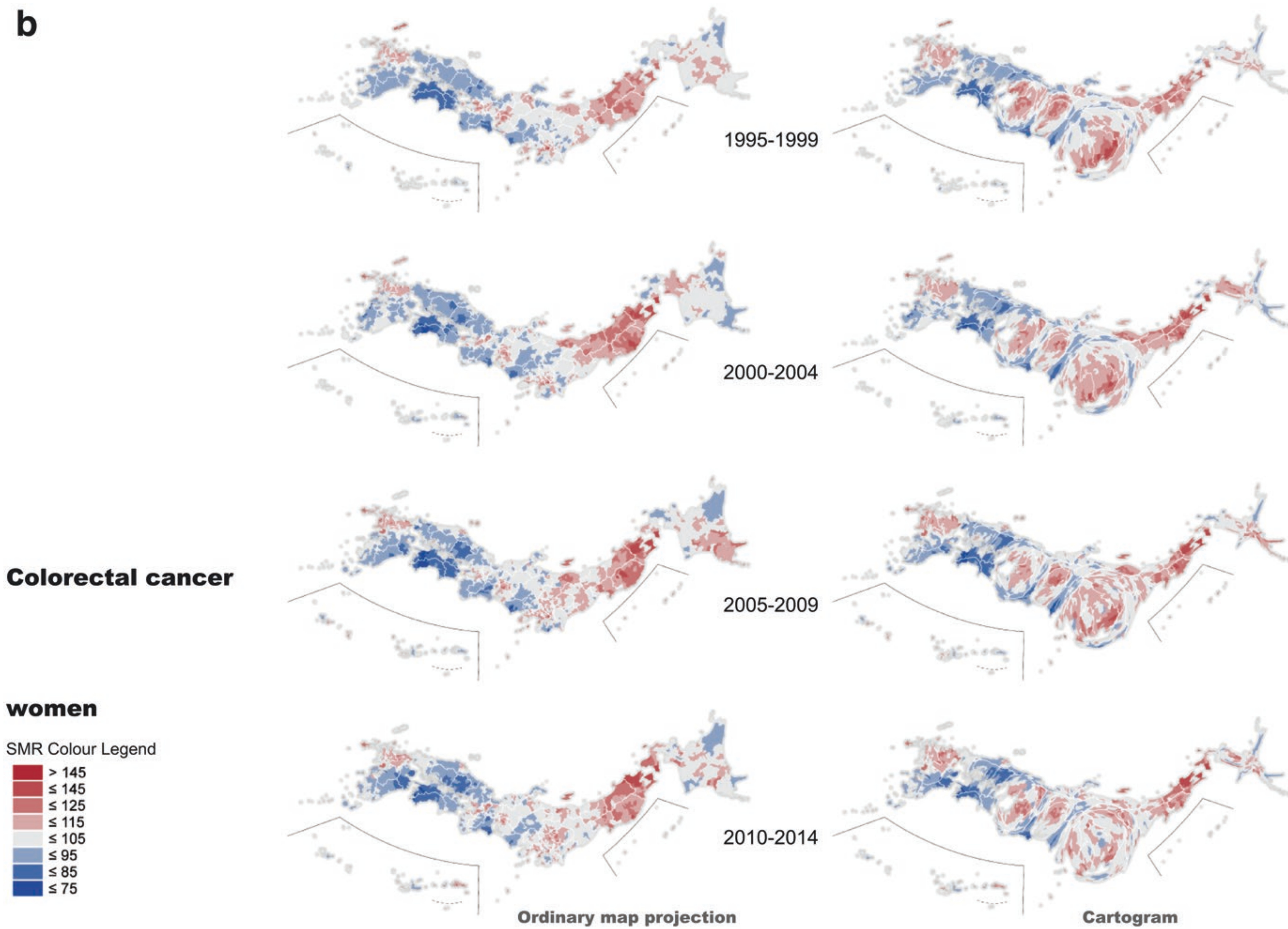
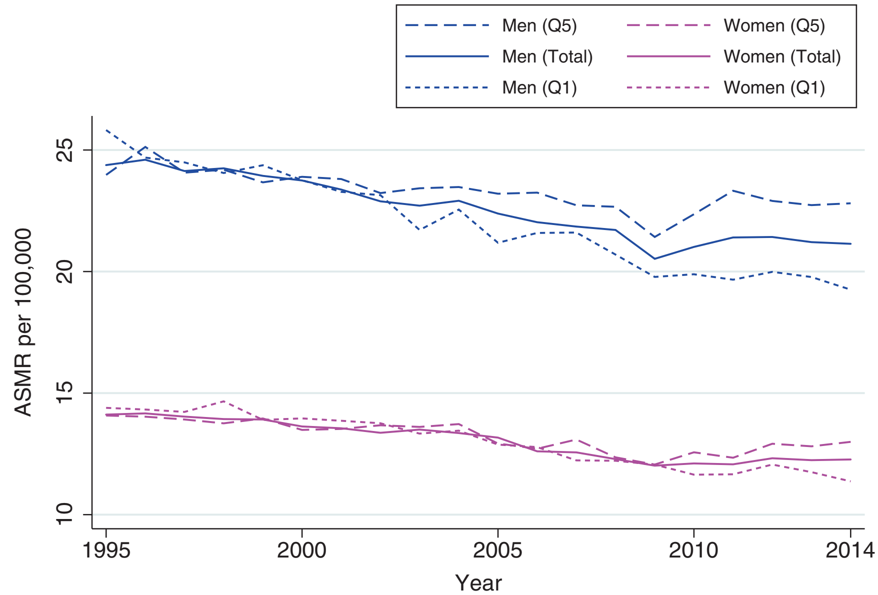


Fig. 4.17 Transition of SMR distribution of colorectal cancer from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 4.18 Annual transition in the ASMR of colorectal cancer from 1995 to 2014



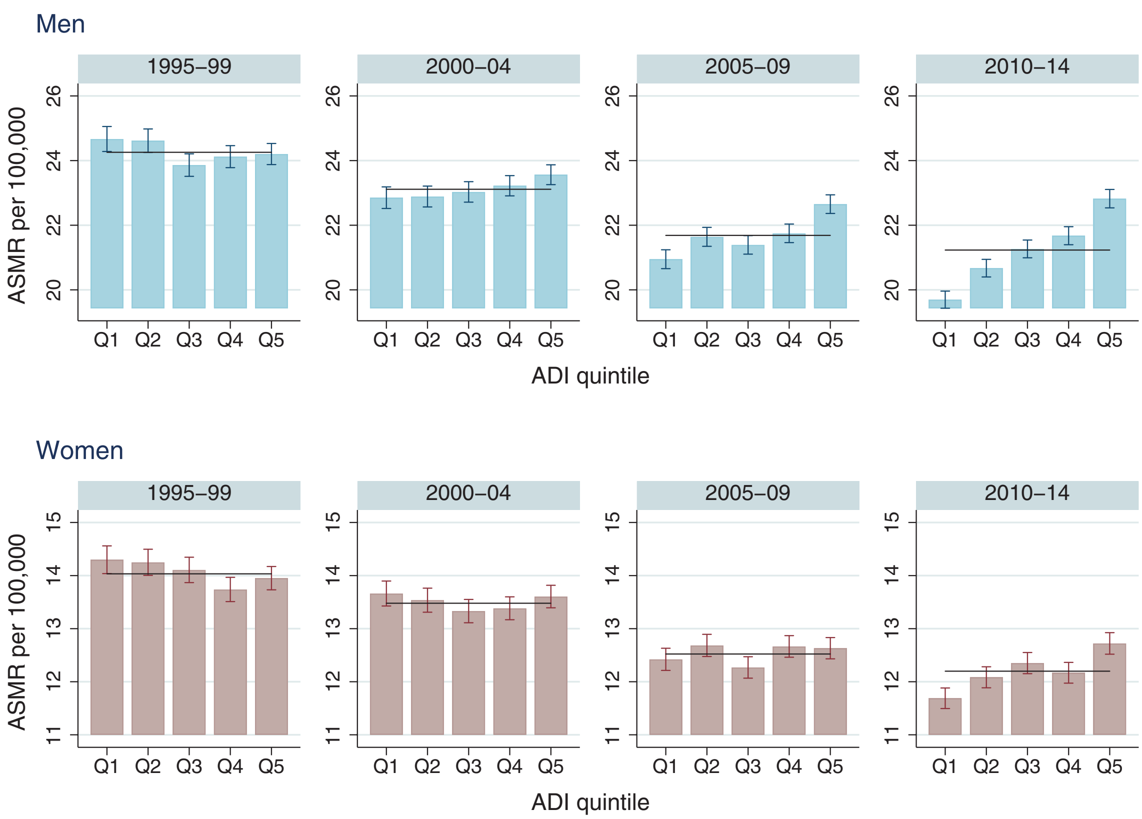


Fig. 4.19 The transition in the ASMR distribution of colorectal cancer by ADI quintile (top: men, bottom: women)

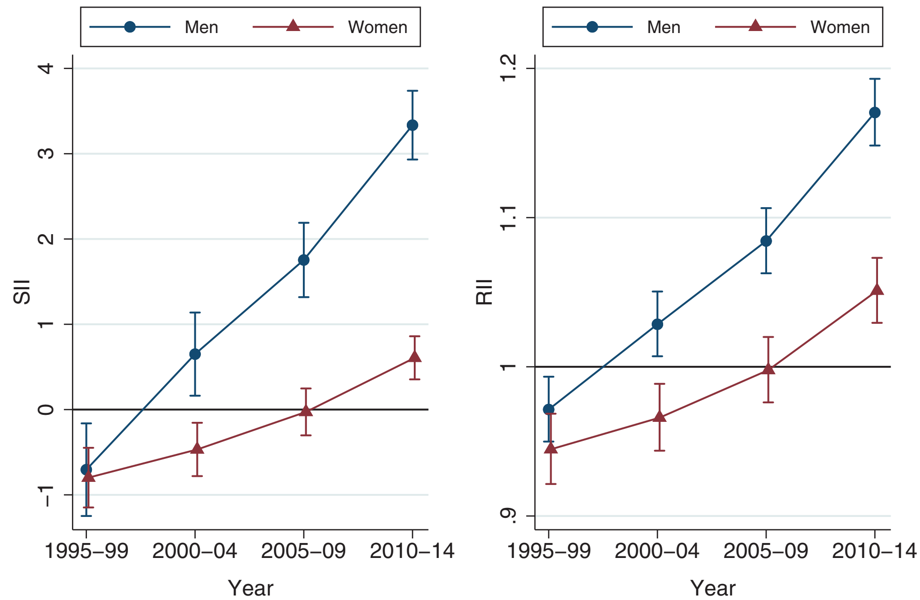


Fig. 4.20 Transition in SII and RII of colorectal cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)

4.5 Liver and Intrahepatic Bile Duct Cancer (ICD10: C22): Eliminating Cancer in the Near Future

Yuri Ito

Overview

Trends in liver and intrahepatic bile ducts cancer (hereafter called liver cancer) incidence and mortality rates were very distinctive in Japan, showing a steady increase until the end of the 1990s, and then a dramatic decrease, which was related to the change in prevalence of hepatitis C viruses (HCV) in Japan (Tanaka et al. 2008). In Japan, the highly prevalent HCV caused high incidence and death rates due to hepatocellular carcinoma (HCC). The population born in the early 1930s has the highest risk of HCV, due to transmission through blood transfusions and parenteral medical procedures (Tanaka et al. 2008; Ito et al. 2011). The birth cohort born in 1925–1935 showed the highest peak of incidence and mortality, and after this cohort, incidence decreased markedly, due to the decrease in HCV prevalence.

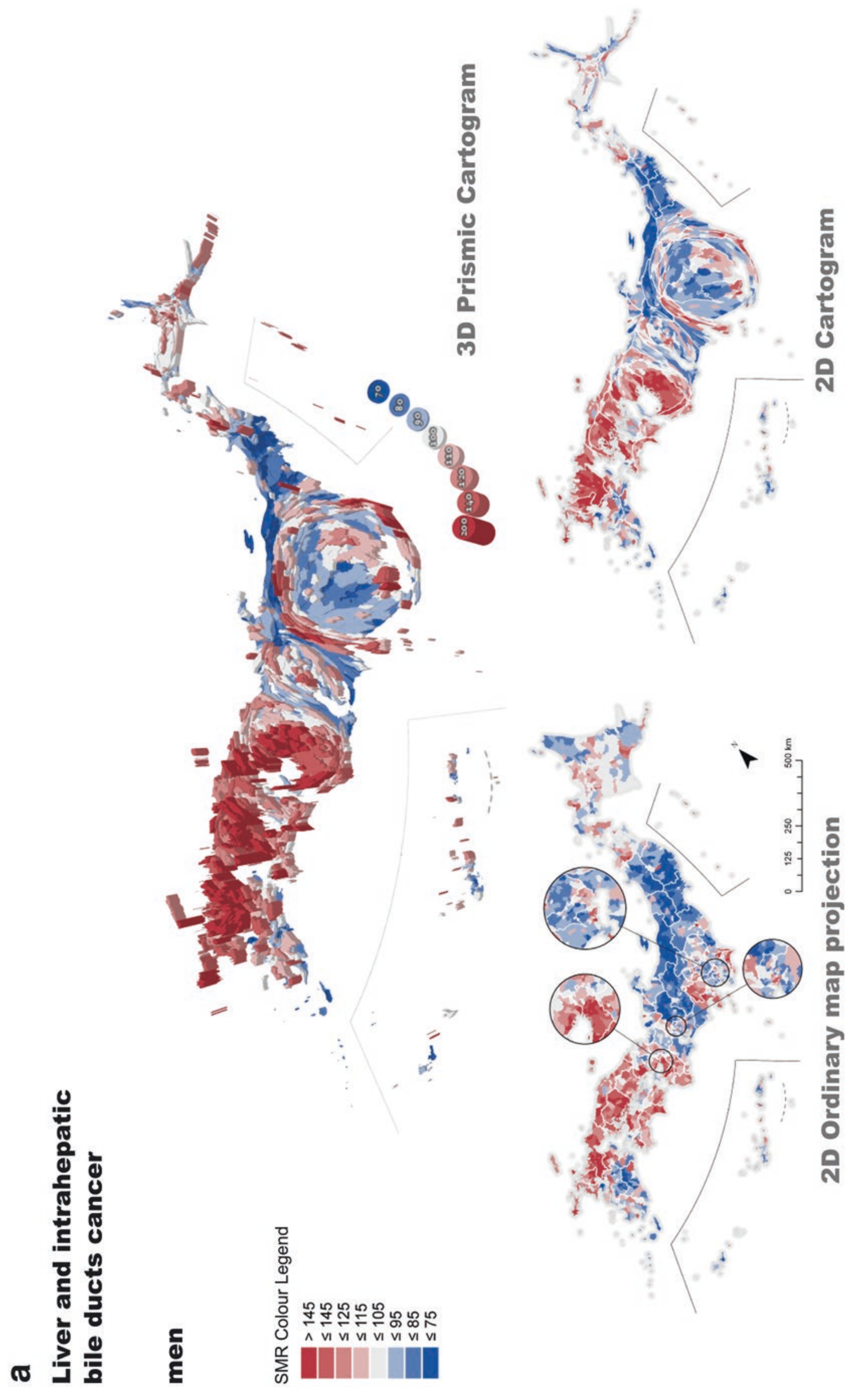
SMRs are much higher in south-western Japan than in the north-east for both sexes (Fig. 4.21). Apart from western Japan, high SMR areas were observed in several local areas in Aomori, Shizuoka, Yamanashi, Fukui and Saitama Prefectures.

In Japan, liver cancer is mainly attributed to infection with hepatitis C viruses (HCV, 70–80%) and hepatitis B viruses (HBV, about 10%), active tobacco smoking (35.1% in men, 6.8% in women) and alcohol intake (11.6% in men, 12.3% in women) (Inoue et al. 2012). A recent report showed high prevalence of both HBV and HCV in the western areas of Japan and low prevalence in the Kanto and Hokuriku/Chubu regions (Tanaka et al. 2018). High prevalence of smoking as well as heavy alcohol intake is also thought to be related to the high SMR areas at the prefecture level (Ministry of Health Labour and Welfare 2016).

Transitions and Socioeconomic Disparities

A clear regional contrast between the high mortality in the south-west and the low mortality in the north-east has not fundamentally changed during the 20 years from 1995 to 2014 (Fig. 4.22). In Tokyo City, a regional difference between the higher SMR in the affluent western suburbs and the lower SMR in the east of the city was observed, but in the period from 2010 to 2014 the regional difference became less pronounced.

While the ASMR of liver cancer has steadily decreased (Fig. 4.23), the ASMR by deprivation group showed clear socioeconomic disparities for both sexes (Fig. 4.24). Both absolute and relative gaps were higher in men than in women. In the period 1995–1999, the SII of liver cancer was the largest among major cancer sites (12.5 death per 100,000 person), which contributed 46% to the SII of ASMR of all cancers (27.0 deaths per 100,000 person) in men (Fig. 4.25). In 2010–2014, the SII of liver cancer in men decreased and contributed 25% to the SII of all cancers. This means that socioeconomic inequality in liver cancer mortality was one


a
Liver and intrahepatic
bile ducts cancer
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0
125
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500 km

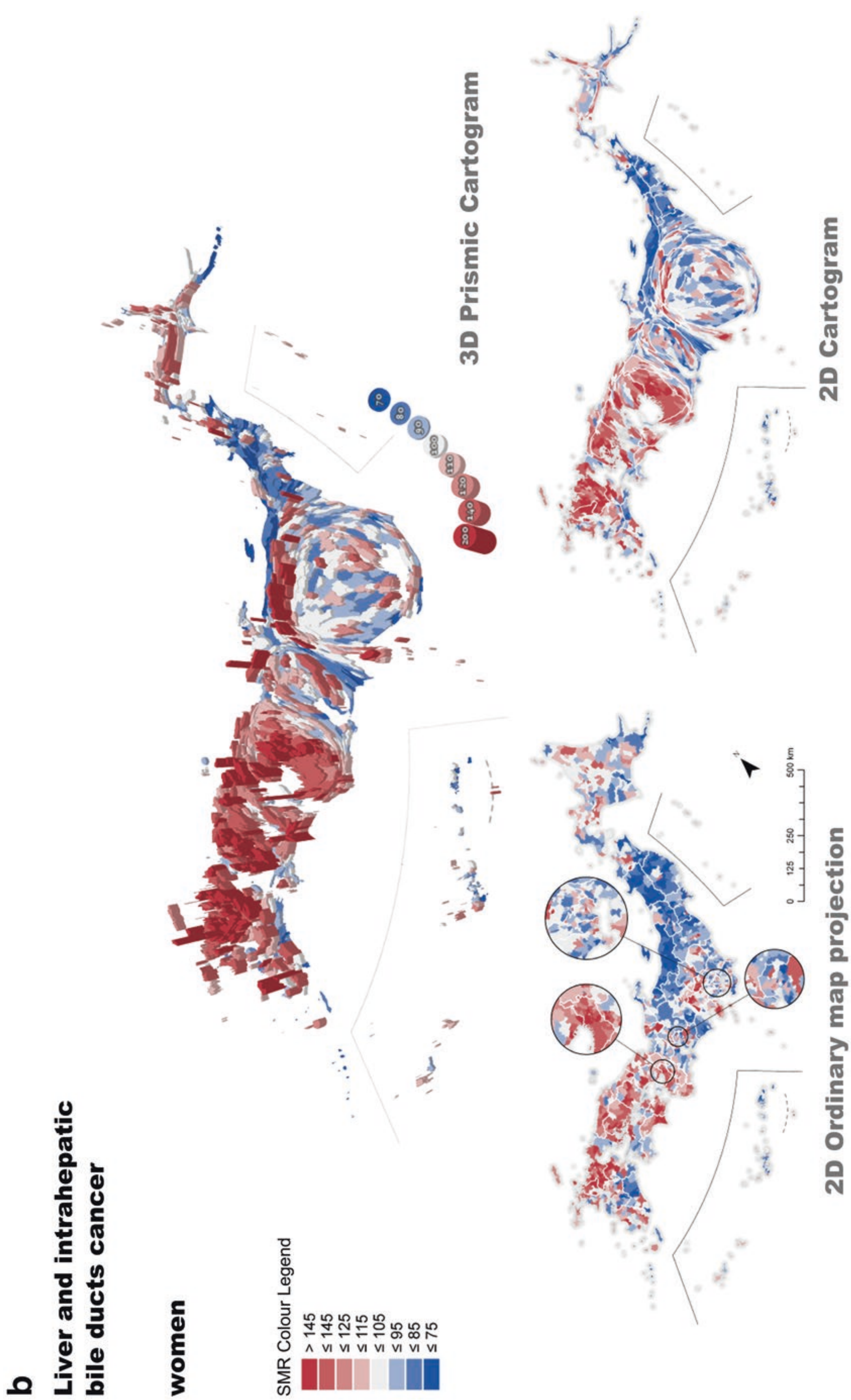
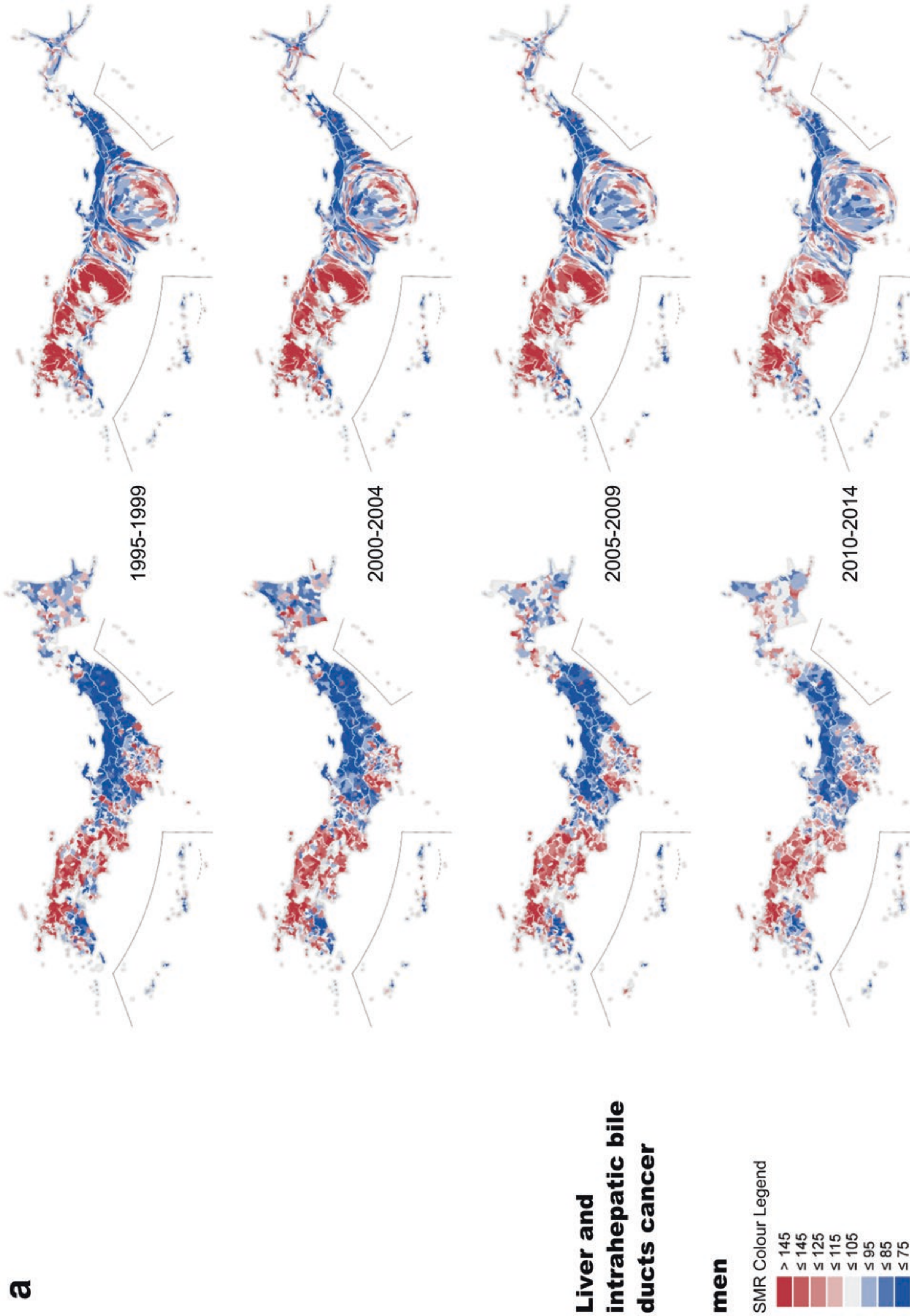


Fig. 4.21 SMR distribution of liver and intrahepatic bile ducts cancer, 2010–2014. (**a**) Men. (**b**) Women


a
Liver and intrahepatic bile ducts cancer
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

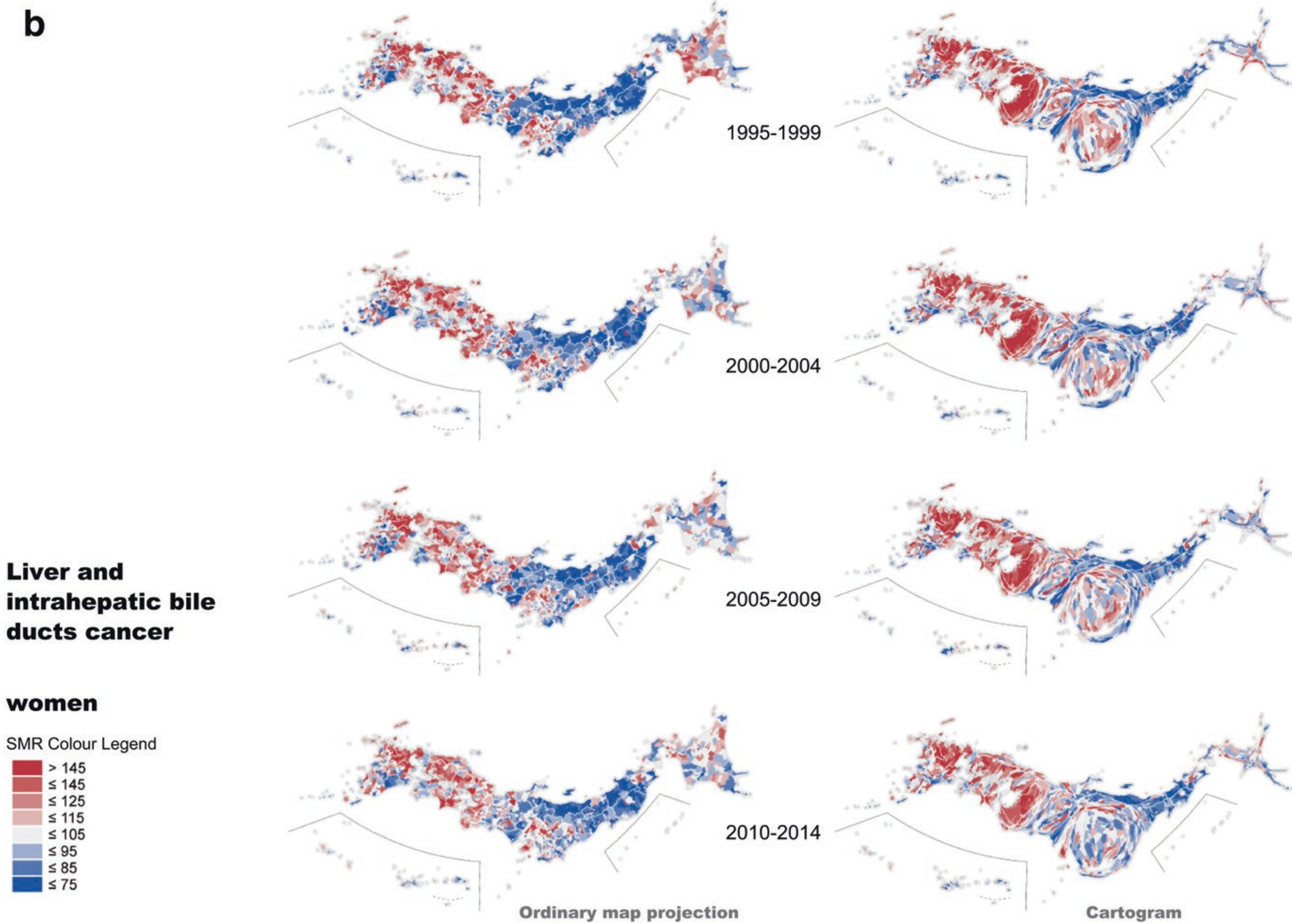
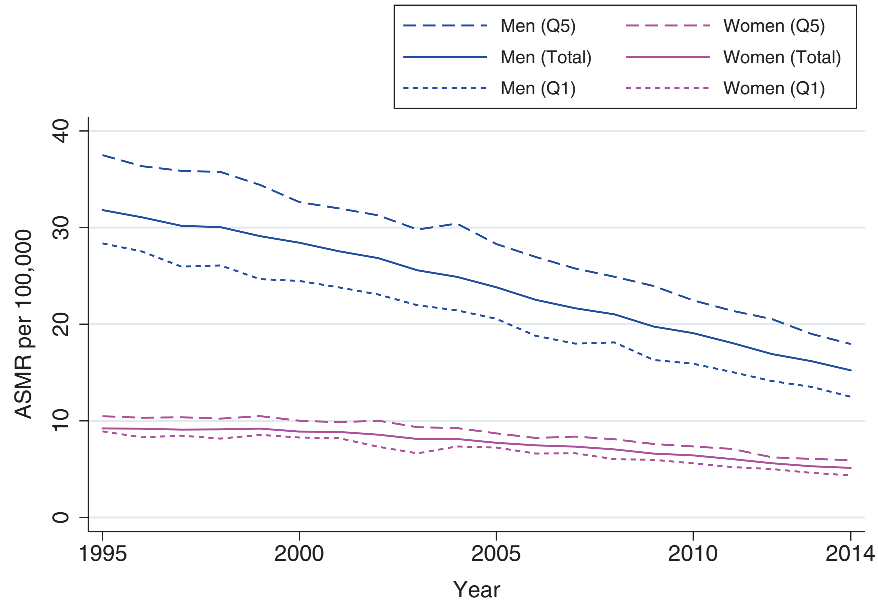


Fig. 4.22 Transition of SMR distribution of liver and intrahepatic bile ducts cancer from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 4.23 Annual transition in the ASMR of liver and intrahepatic bile ducts cancer from 1995 to 2014



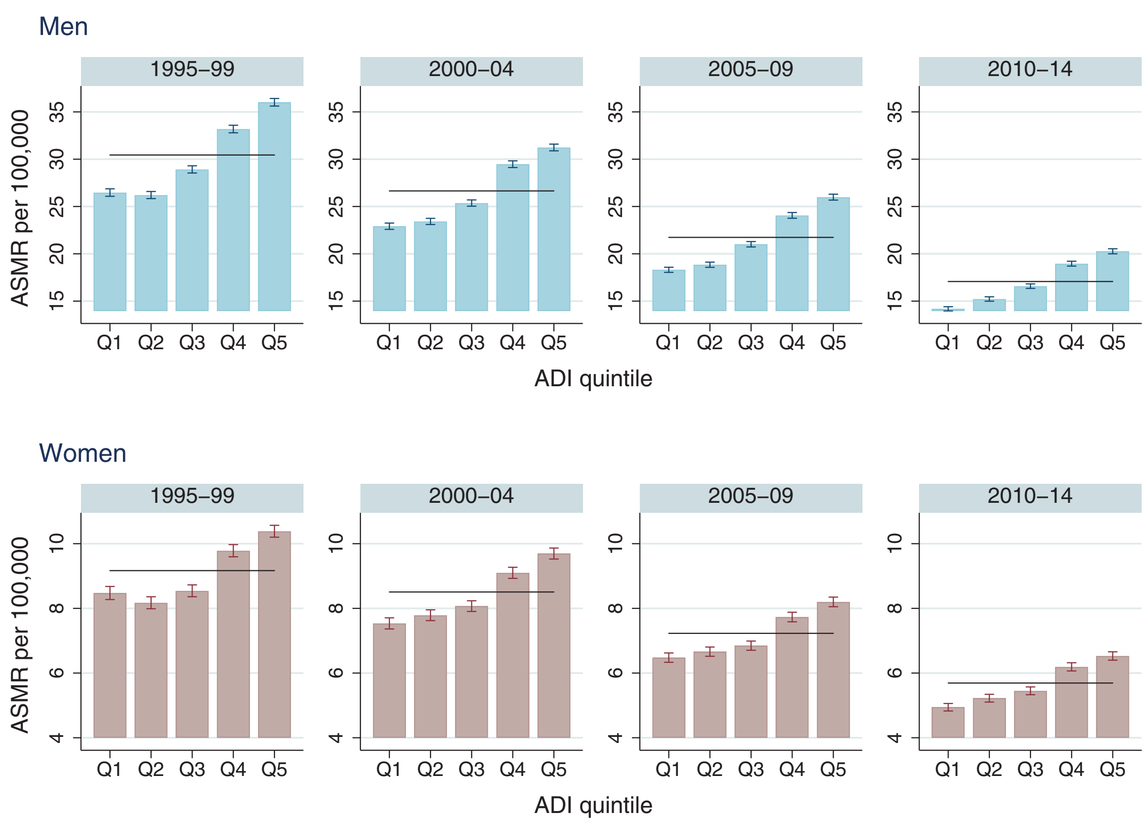


Fig. 4.24 The transition in the ASMR distribution of liver and intrahepatic bile ducts cancer by ADI quintile (top: men, bottom: women)

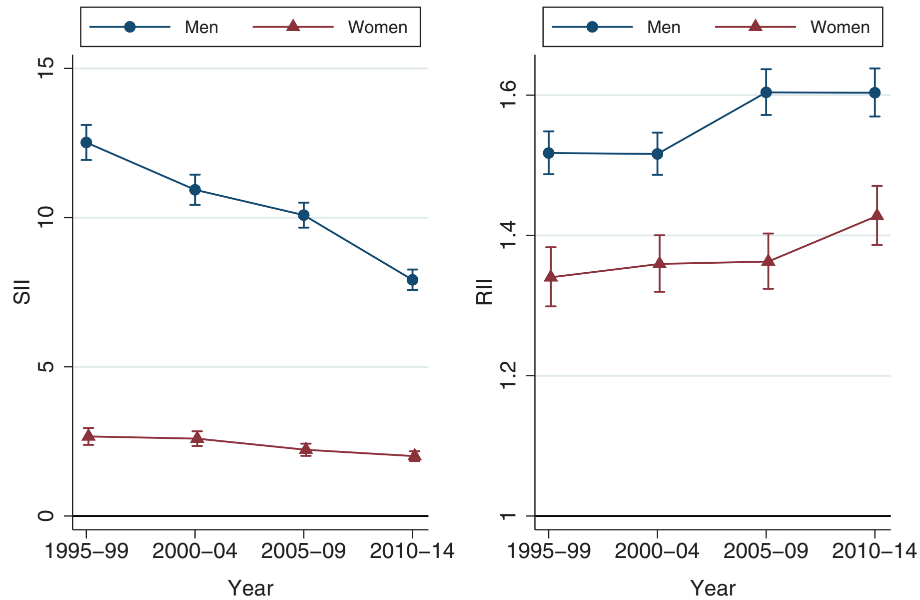


Fig. 4.25 Transition in SII and RII of liver and intrahepatic bile duct cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)

of the largest issues in Japan, and despite decreasing in absolute terms, it still exists. After World War II, HCV infection spread mainly in western Japan and deprived people were more likely to transmit the viruses, due to unsafe practices (use of unsterilised needles and syringes) during illegal plasma donation. In addition, the wide deprivation gap might be related to differences in access to treatment for HBV/HCV carriers and prevalence of other risk factors by deprivation group.

4.6 Gallbladder and Other Biliary Tract Cancer (ICD10: C23–C24): A Rural Cancer

Yoshikazu Nishino

Overview

Gallbladder and other biliary tract cancer (hereafter called gallbladder cancer) is the eighth most common cause of cancer death in men and the seventh in women, which equates to 4% and 6% of all cancer deaths, respectively.

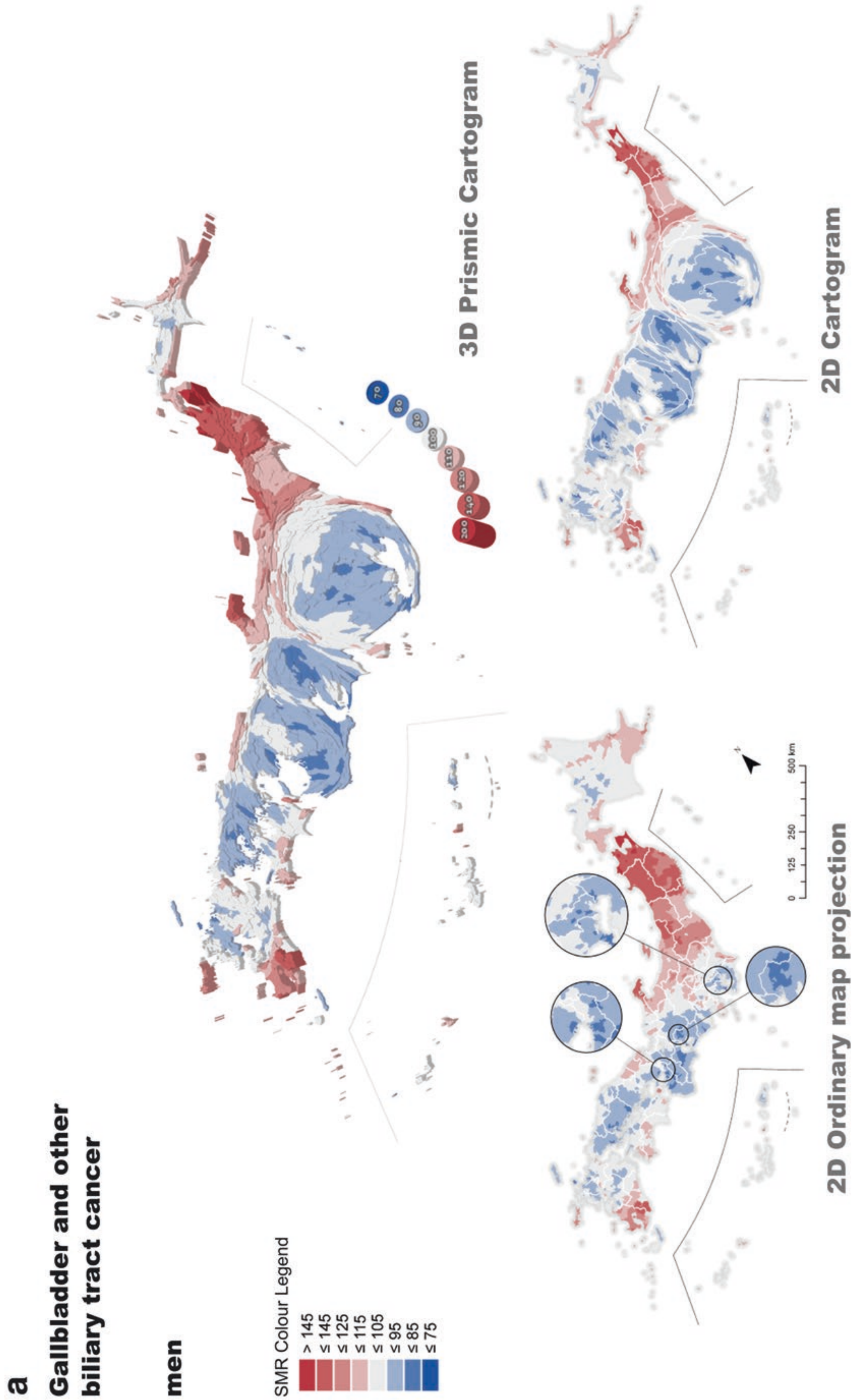
High SMRs for gallbladder cancer in both sexes were observed in the northern part of mainland Japan centred on the Tohoku region, the south of the Kyusyu region, the Noto Peninsula in the Hokuriku region and the Gotoh islands of Nagasaki Prefecture (Fig. 4.26). Among women, high SMRs were also observed in the west of the Kyushu region including Nagasaki and Kumamoto Prefectures. Low SMRs were mainly observed along the so-called Taiheiyo (Pacific) belt, a huge conurbation stretching from the Tokyo metropolitan area to northern Kyusyu through the Nagoya and Osaka metropolitan areas and the industrialised cities of the Chugoku region.

High SMR areas are located in the agricultural area (mainly rice growing) in northern Japan. High SMRs for gallbladder cancer in Niigata prefecture, in the northern rice growing area, were found to be related to the high concentration of the chemical herbicide, chlornitrofen (CNP), in tap water (Yamamoto et al. 1993). Following publication of this study, use of CNP as a chemical herbicide has been prohibited.

Transitions and Socioeconomic Disparities

For the 20 years from 1995 to 2014, high SMRs were consistently observed in the north of the main island of Japan (Fig. 4.27). During the 20 years, low SMRs have been observed among men in the Tokyo, Chukyo/Nagoya and Keihanshin metropolitan areas. Similar trends were observed for women in the Tokyo and Keihanshin/Osaka metropolitan areas. While high SMRs were observed in 1995–2000 in the Chukyo region, they decreased after 2000.

The ASMR of this cancer has decreased during the 20 years (Fig. 4.28). Both absolute and relative deprivation gaps between Q1 and Q5 were large for both sexes (Fig. 4.29). According to the trends in RII, the relative socioeconomic inequalities of ASMR have widened in women, but sex difference in RII has disappeared (Fig. 4.30).


a
Gallbladder and other
biliary tract cancer
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
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125
250
500 km

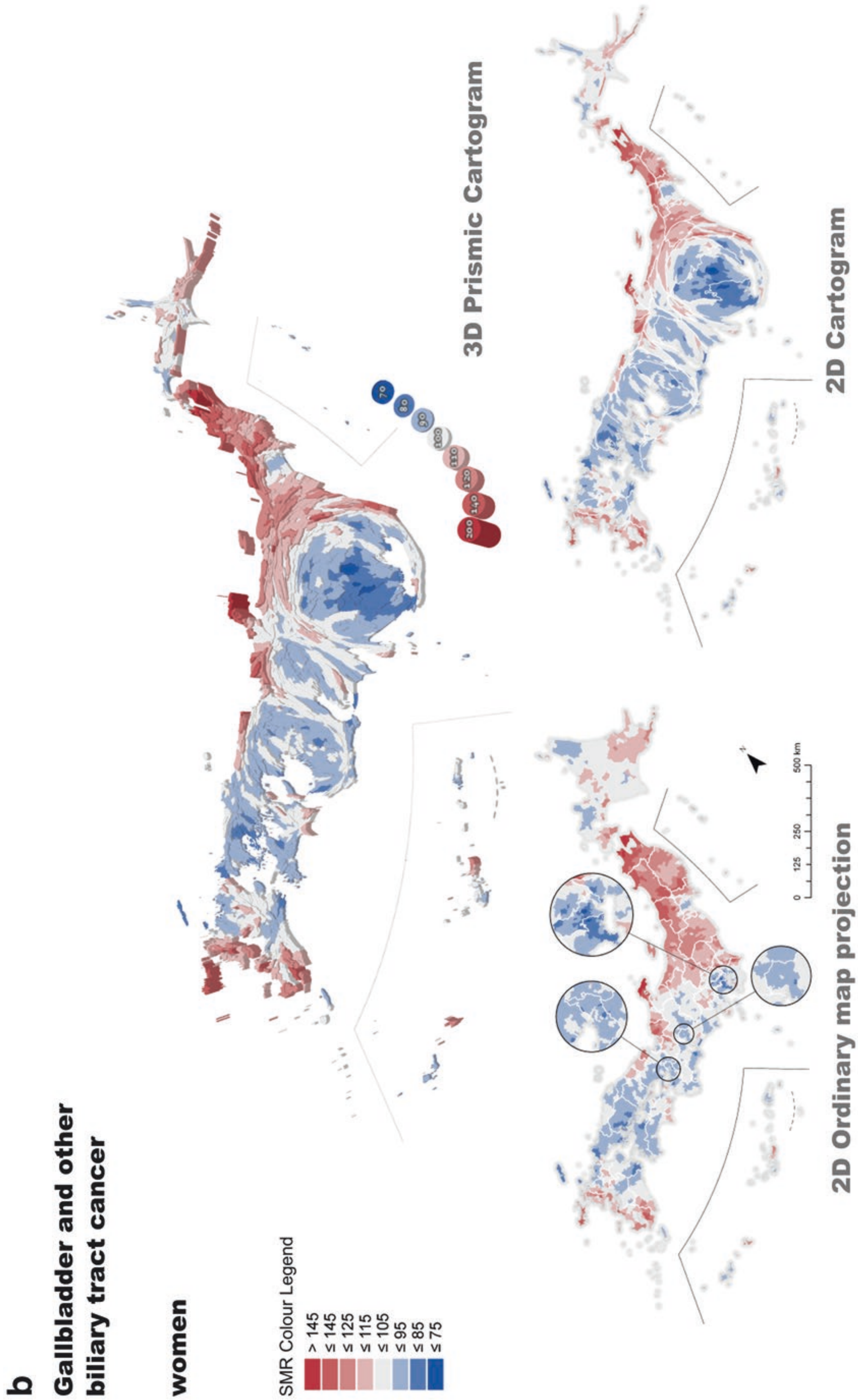
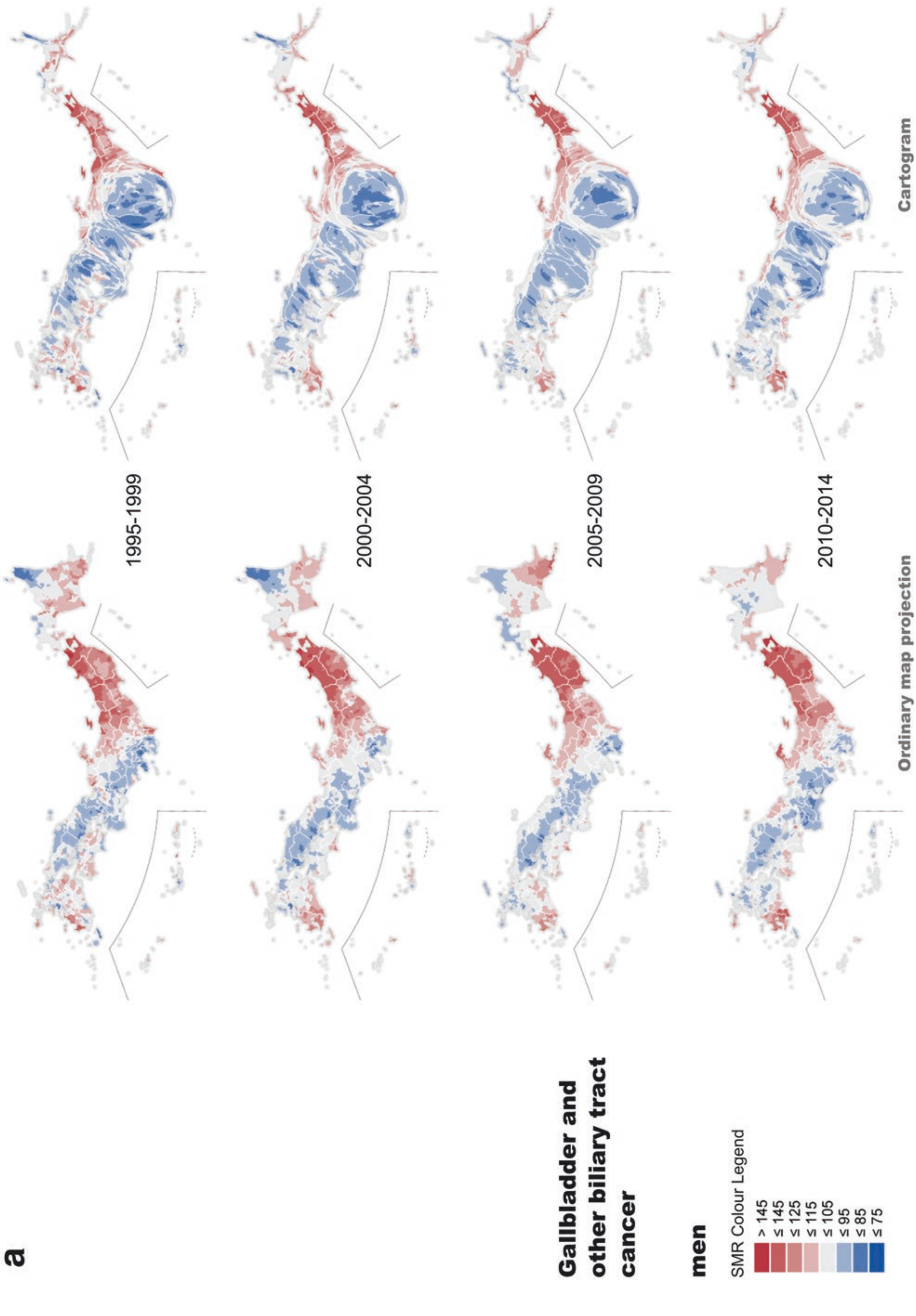


Fig. 4.26 SMR distribution of gallbladder and other biliary tract cancer, 2010–2014. (**a**) Men. (**b**) Women


a
Gallbladder and other biliary tract cancer
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

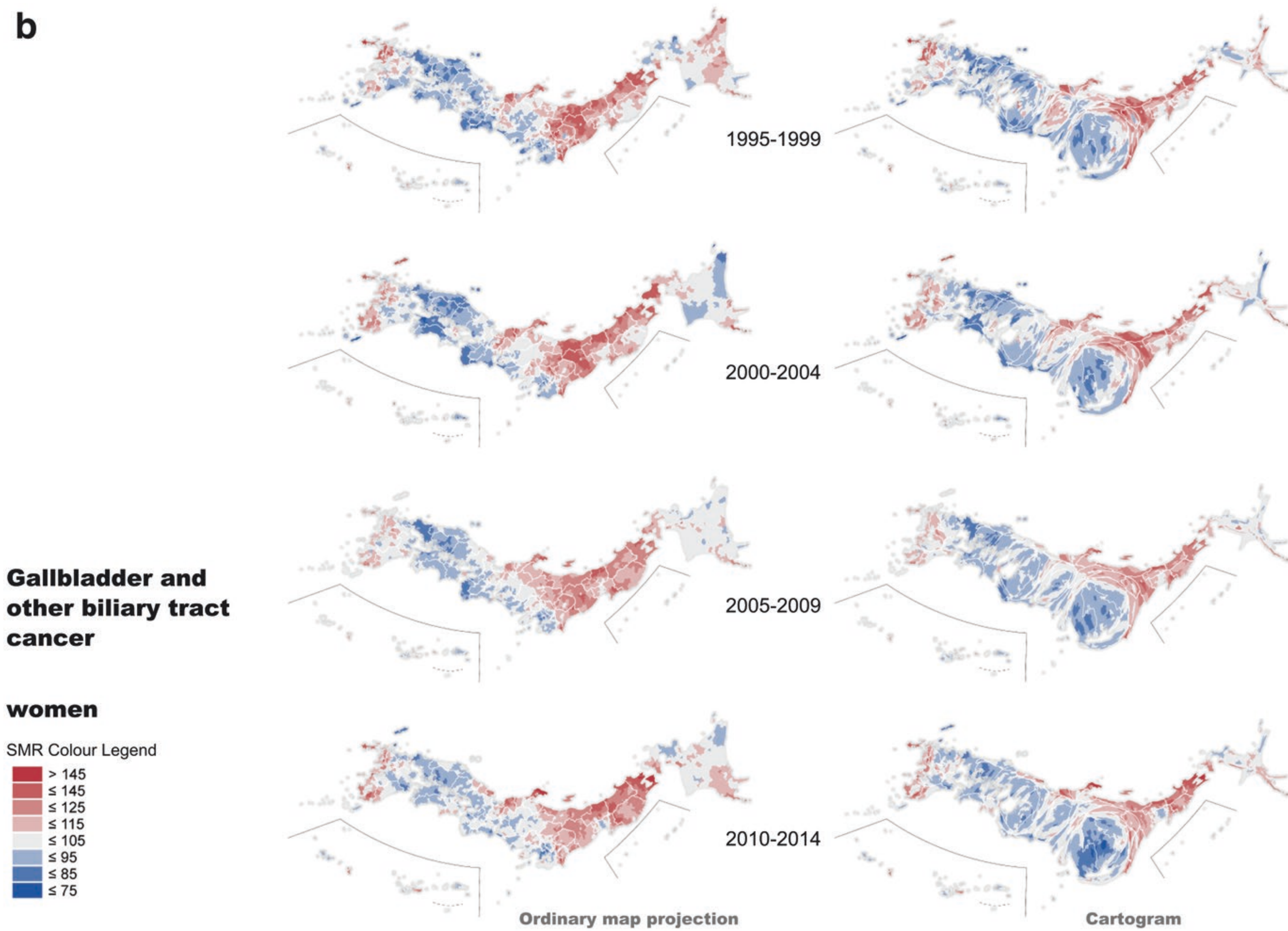
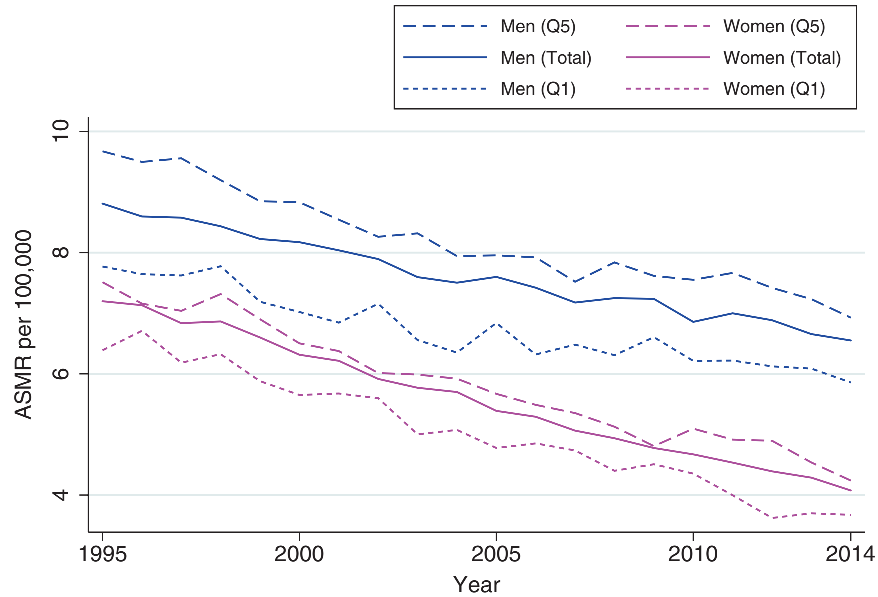


Fig. 4.27 Transition of SMR distribution of gallbladder and other biliary tract cancer from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 4.28 Annual transition in the ASMR of gallbladder and other biliary tract cancer from 1995 to 2014



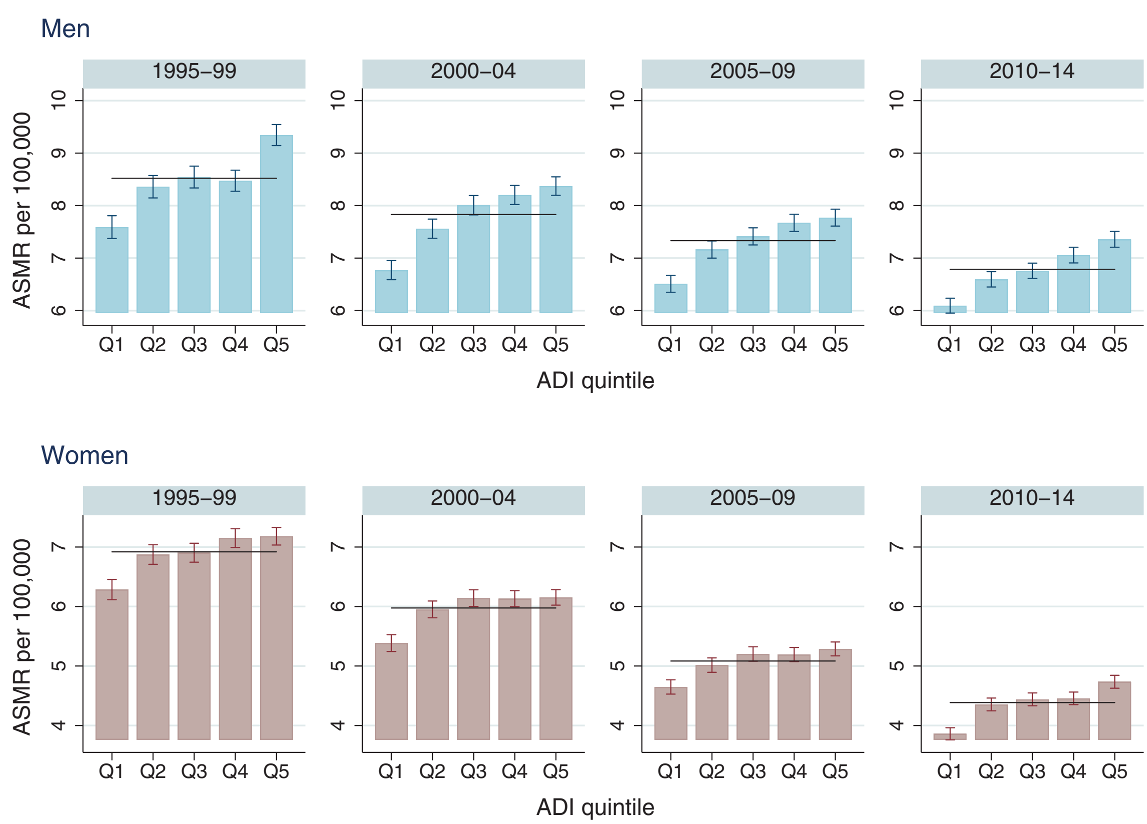


Fig. 4.29 The transition in the ASMR distribution of gallbladder and other biliary tract cancer by ADI quintile (top: men, bottom: women)

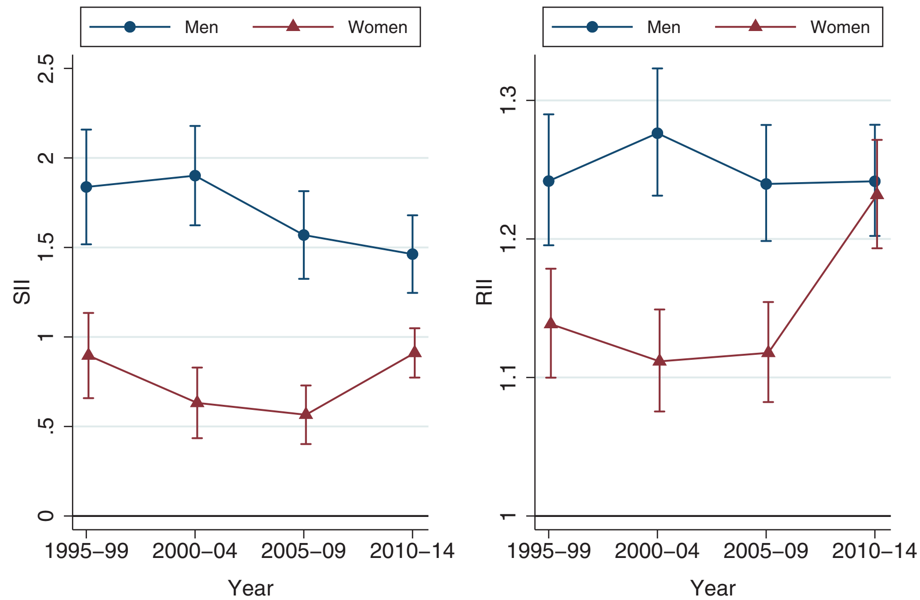


Fig. 4.30 Transition in SII and RII of gallbladder and other biliary tract cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)

4.7 Pancreatic Cancer (ICD10: C25): The Rise of a Killer Without Symptoms

Yoshikazu Nishino

Overview

Pancreatic cancer is the fifth most common cause of cancer death in men and the third in women, equating 8% and 10% of all cancer deaths, respectively. The ASMR of pancreatic cancer in Japan is at the same level as in Western countries.

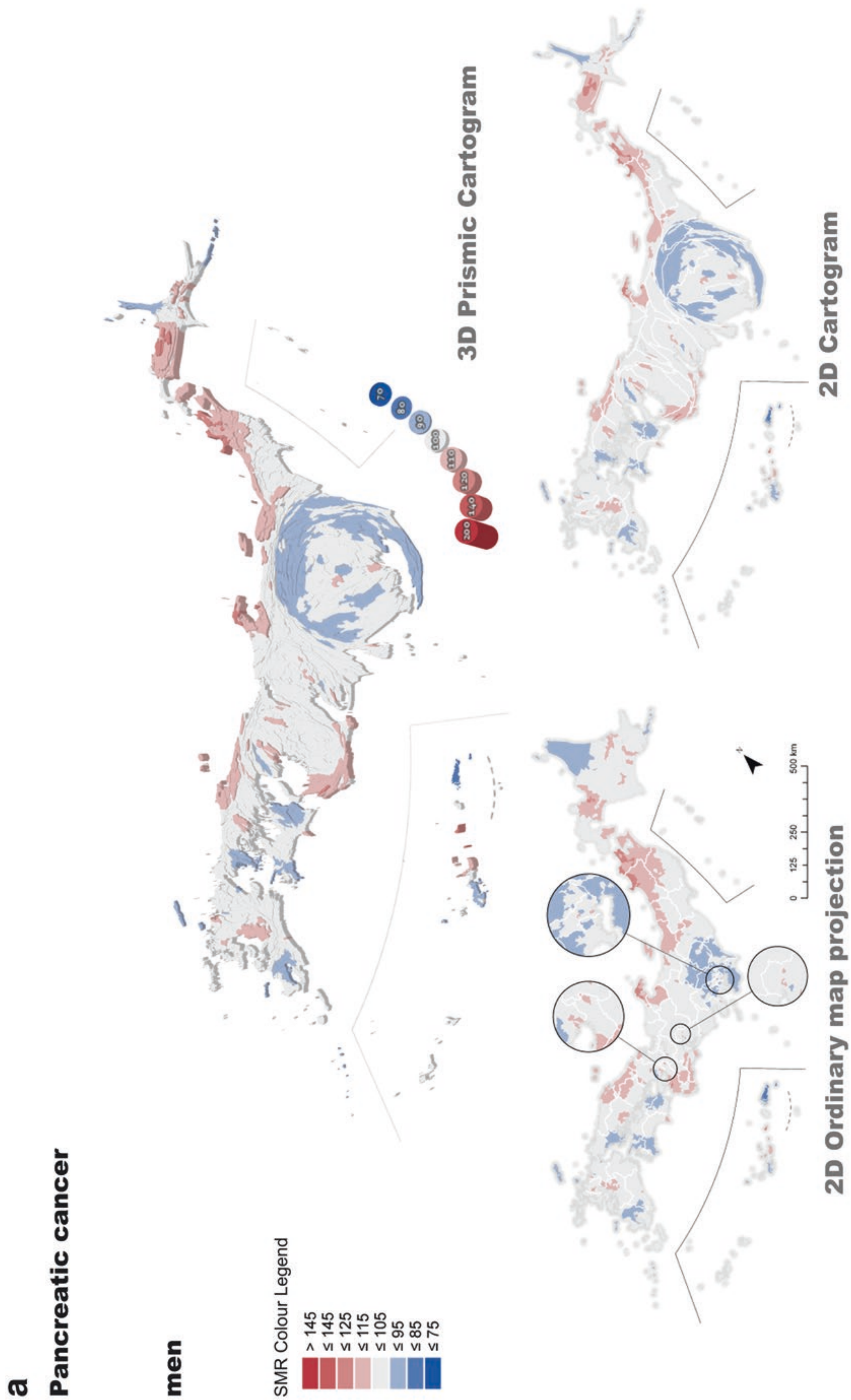
High SMRs of pancreatic cancer were observed in central Hokkaido and the Tohoku regions centred in Aomori Prefecture for both sexes and in the Hokuriku region for men (Fig. 4.31). Conversely, low SMRs were observed in the marginal areas of the Kanto region, the west of the Chugoku region and the east of the Shikoku region.

The risk factors for pancreatic cancer in Japan are tobacco smoking and diabetes. High smoking prevalence has been reported in Hokkaido and Aomori Prefectures for both sexes (Ministry of Health Labour and Welfare 2016). A high mortality rate due to diabetes was also reported in Aomori Prefecture.

Transitions and Socioeconomic Disparities

In the period 1995–1999, high SMRs were observed throughout the entire Tohoku region; they were especially high among men in Aomori and the north of Akita Prefecture. SMRs in the Tohoku region have decreased since 2000 (Fig. 4.32). The high SMR areas were limited to the north and the Sea of Japan side of the Tohoku region. Among women, the regional variation was small compared with men, but a similar distribution pattern of SMRs was observed.

The ASMR of pancreatic cancer increased during the 20 years from 1995 to 2014 (Fig. 4.33). Although wide gaps in ASMR between Q5 and Q1 were observed in men, the trend has not changed (Fig. 4.34). Among women, both absolute and relative socioeconomic inequalities have widened in the most recent period, according to RII and SII trends (Fig. 4.35).


a
Pancreatic cancer
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

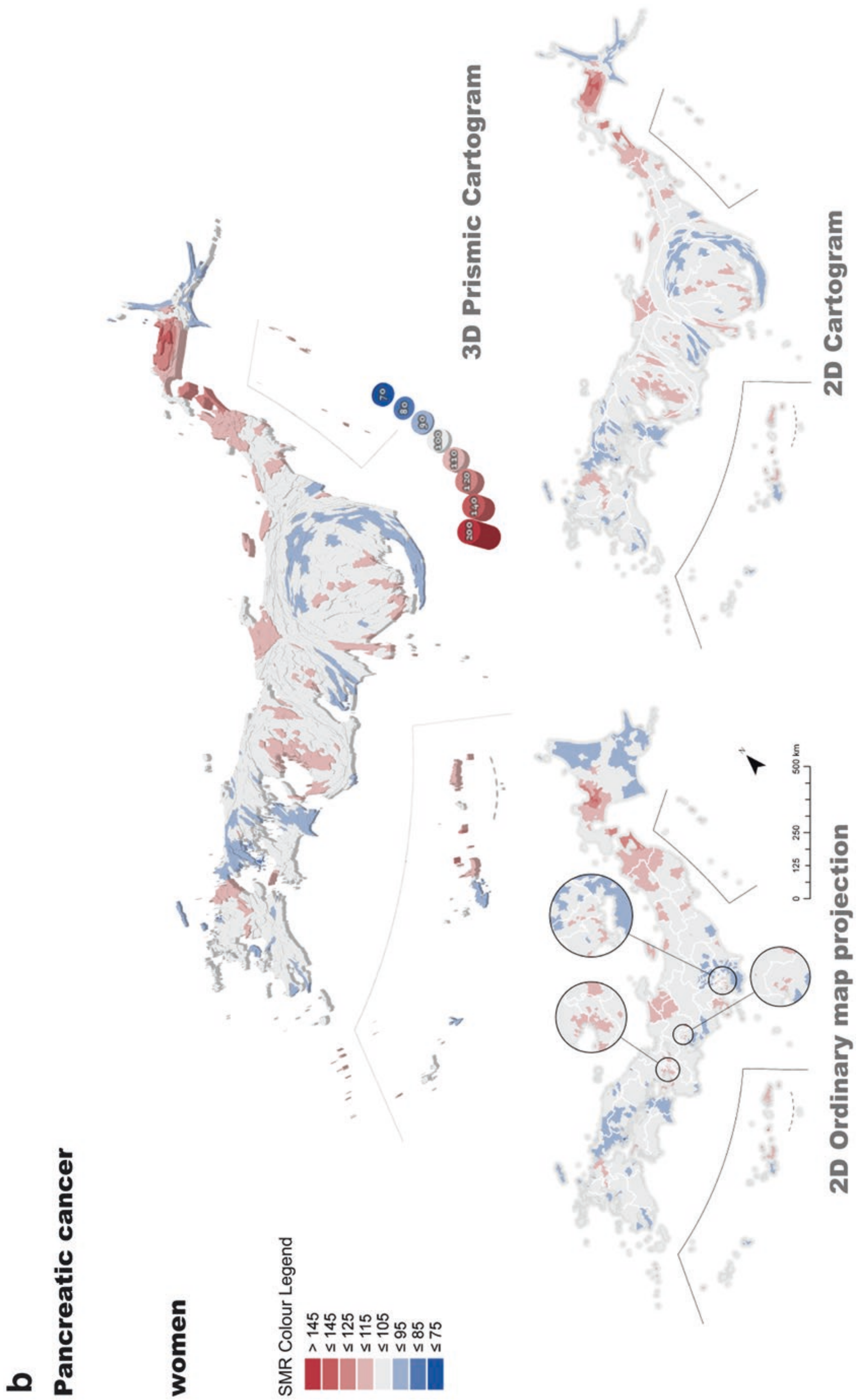
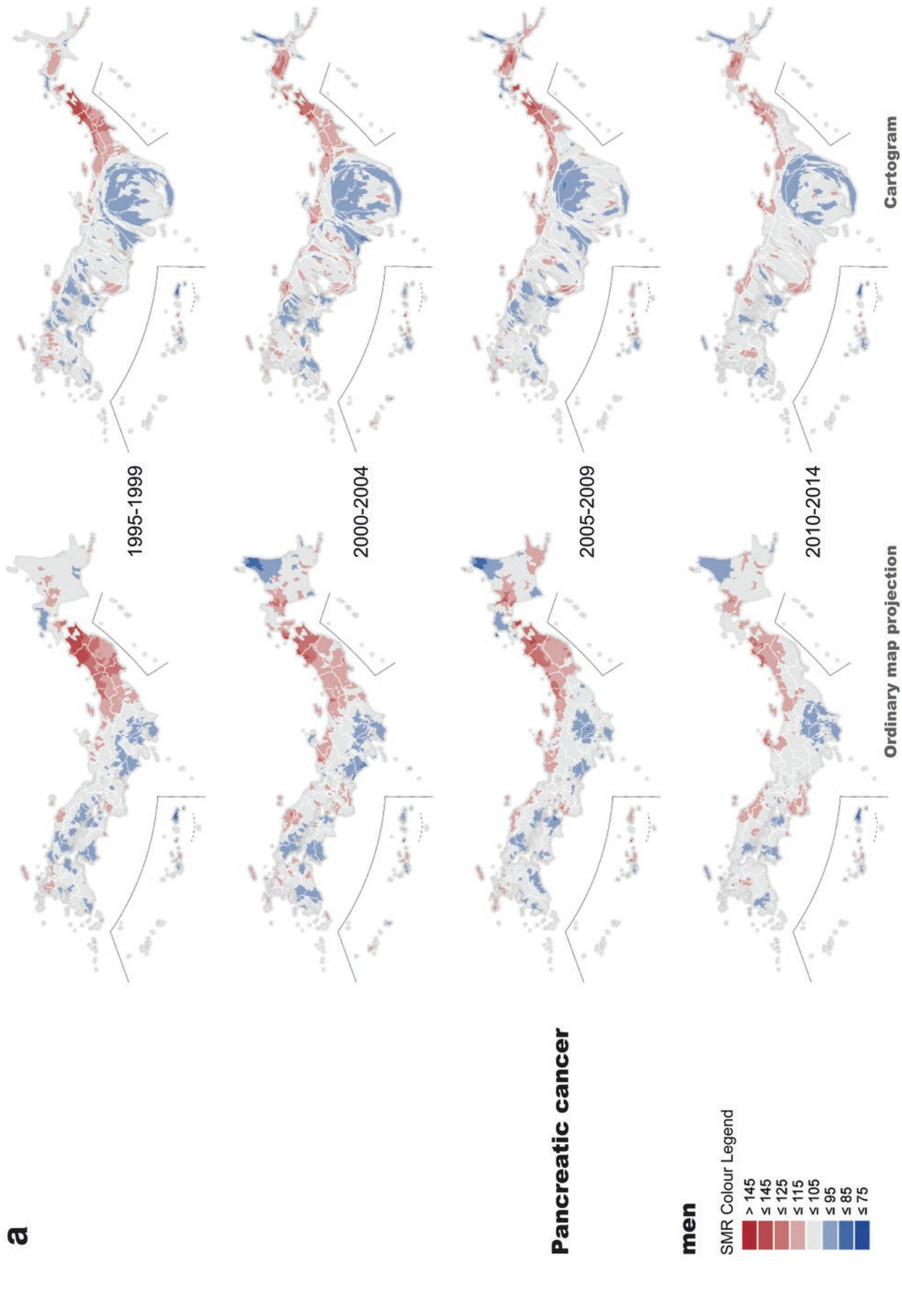


Fig. 4.31 SMR distribution of pancreatic cancer, 2010–2014. **(a)** Men. **(b)** Women


a
men
Pancreatic cancer
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

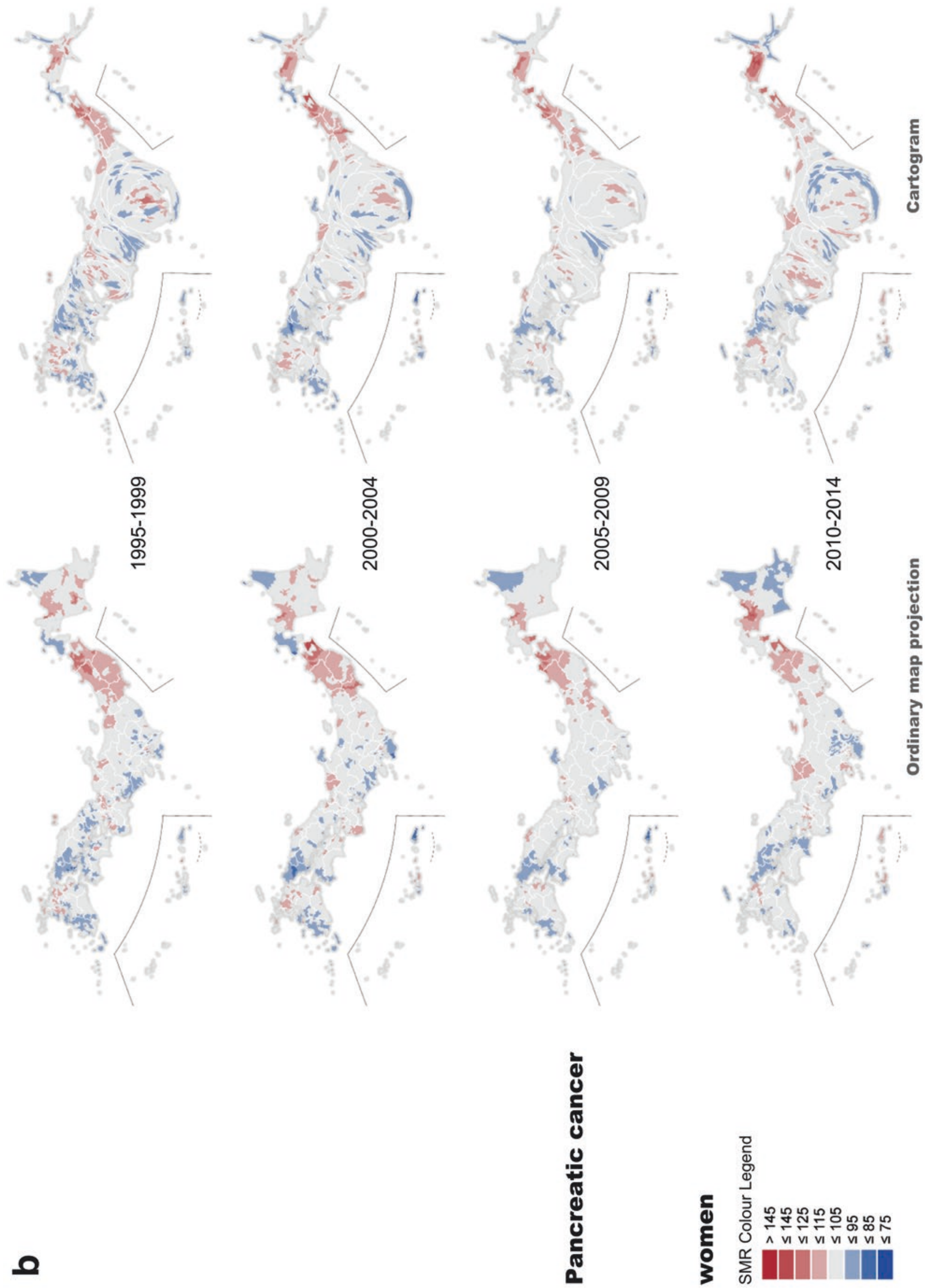


Fig. 4.32 Transition of SMR distribution of pancreatic cancer from 1995 to 2014 by 5-year period. **(a)** Men. **(b)** Women

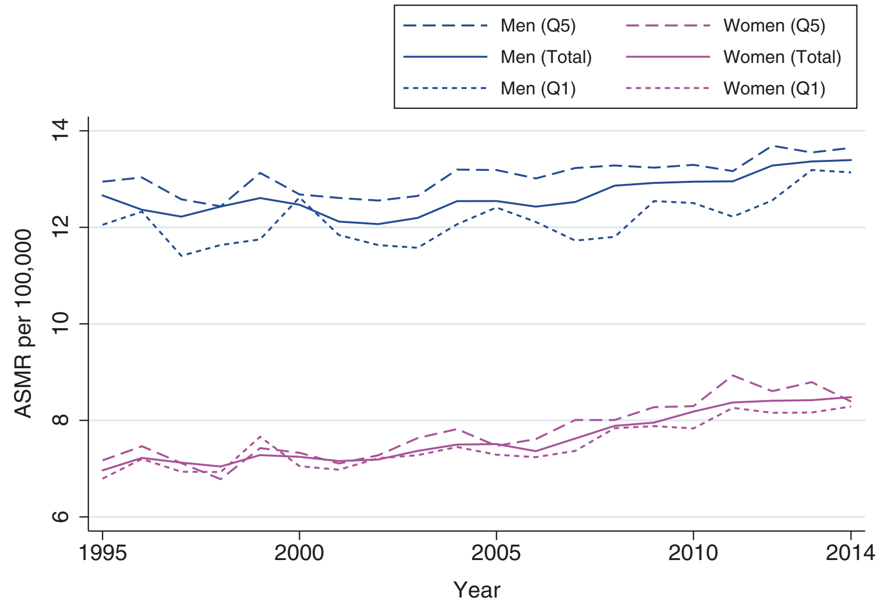


Fig. 4.33 Annual transition in the ASMR of pancreatic cancer from 1995 to 2014

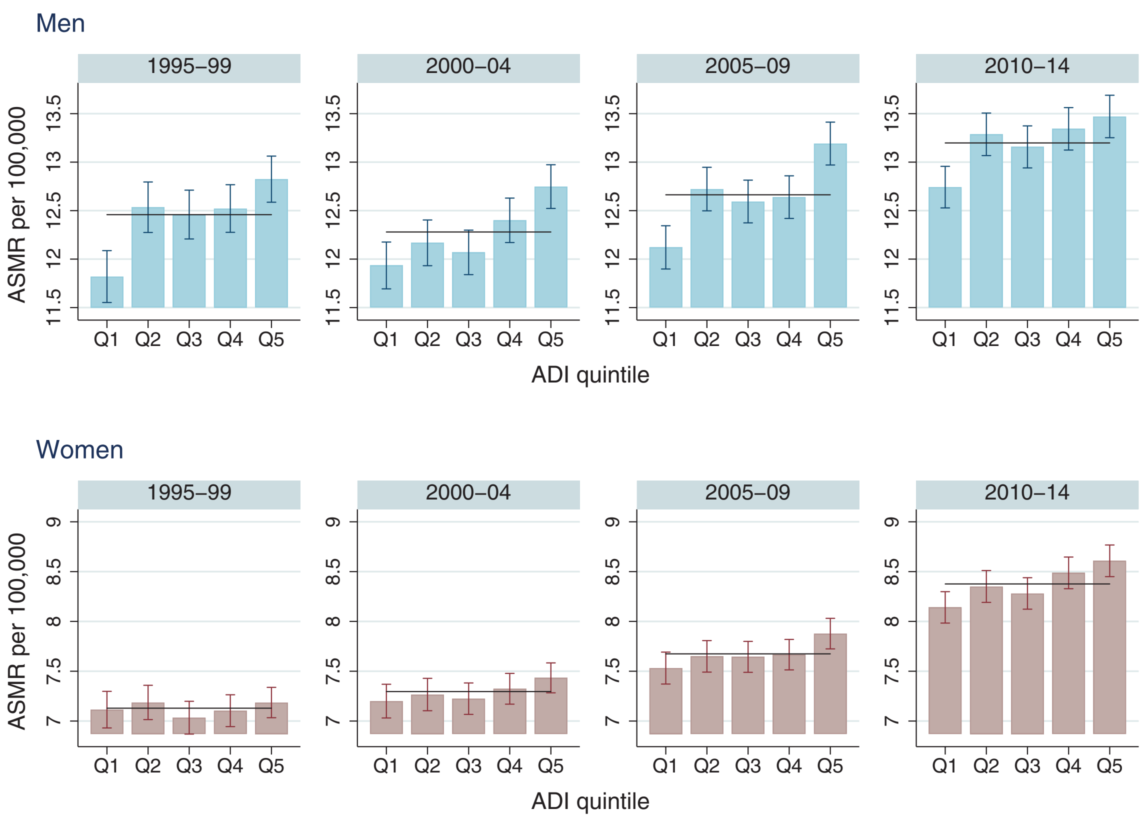


Fig. 4.34 The transition in the ASMR distribution of pancreatic cancer by ADI quintile (top: men, bottom: women)

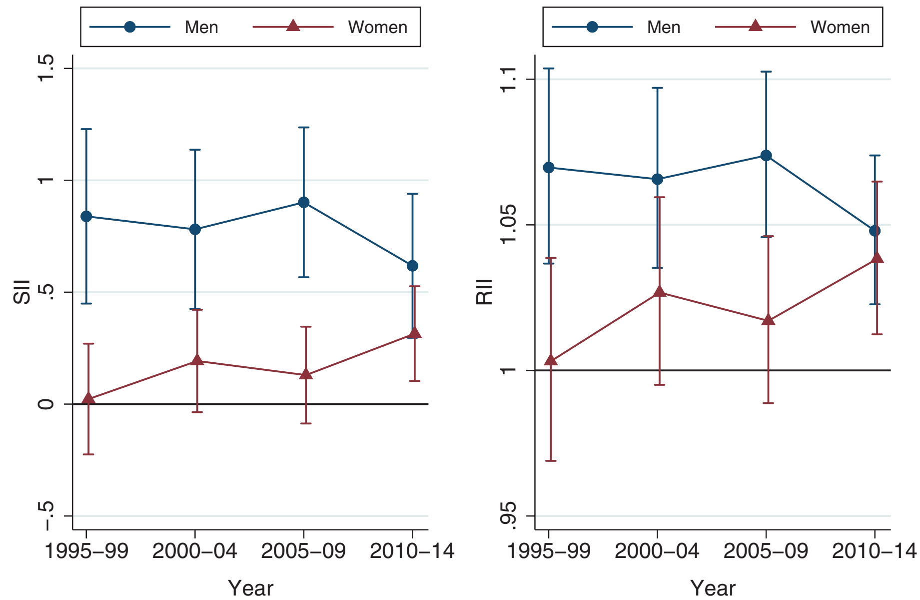


Fig. 4.35 Transition in SII and RII of pancreatic cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)

4.8 Trachea, Bronchus and Lung Cancer (ICD10: C33–C34): A Big Killer Cancer

Yoshikazu Nishino

Overview

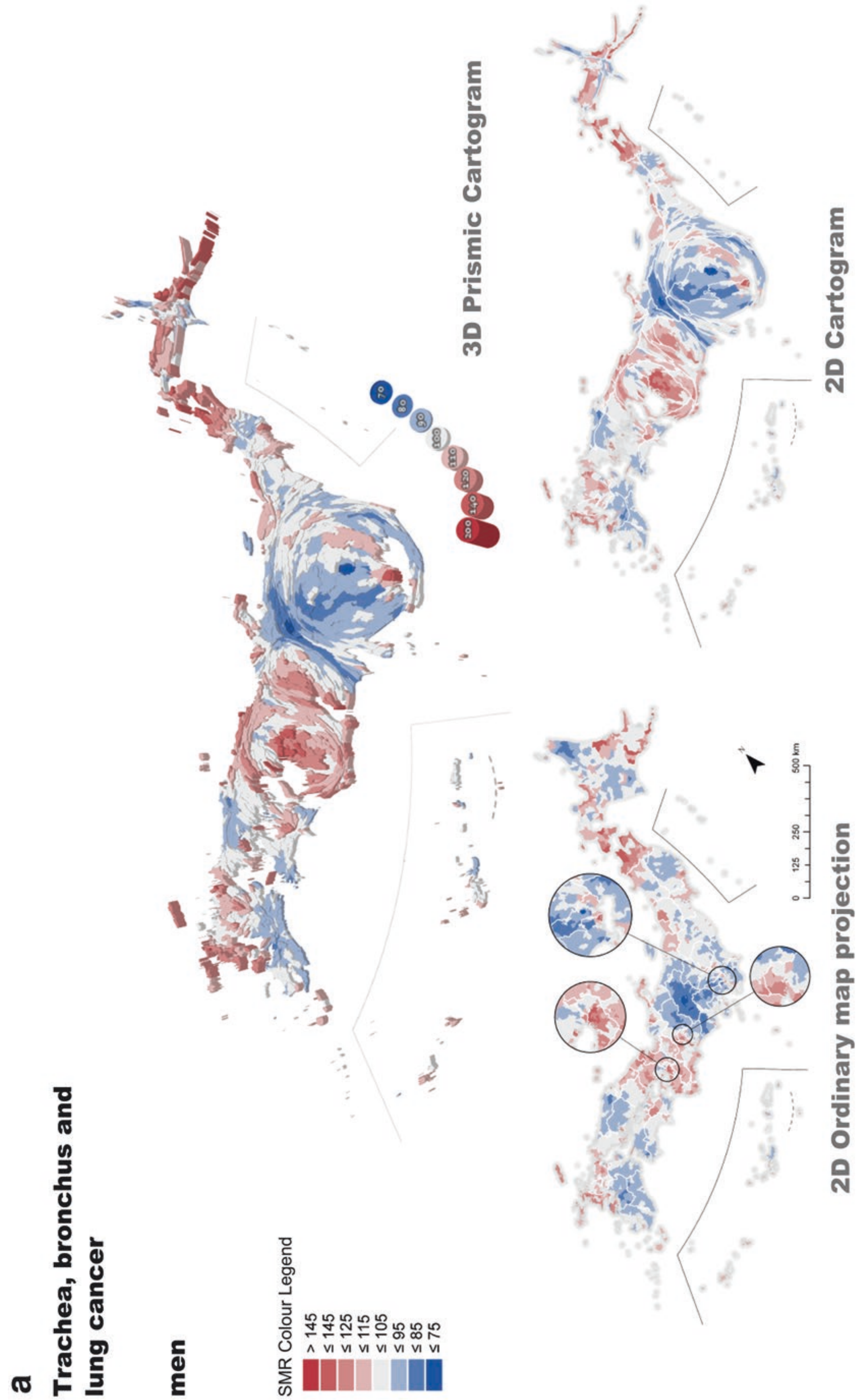
Trachea, bronchus and lung cancer (hereafter called lung cancer) is the most common cause of cancer death for men and the second most common for women equating to 24% and 14% of all cancer deaths, respectively.

Regional clusters with high SMRs of lung cancer in men were observed in metropolitan areas including Tokyo, Nagoya and Osaka as well as non-metropolitan areas including eastern and central Hokkaido, Aomori Prefecture in the Tohoku region, Nagasaki Prefecture in the Kyushu region and the coastal areas of the main island of Japan (Fig. 4.36). Conversely, low SMRs were observed in the mountainous central part of the main island around Nagano Prefecture and the eastern and southern areas of the Kyushu region. Among women, SMRs were more clearly visible in the metropolitan areas including Tokyo, Nagoya and Osaka as well as Kitakyushu-Fukuoka in northern Kyusyu, Sapporo City and several coastal areas of Hokkaido.

The main risk factor for lung cancer is smoking tobacco. About 69.1% of lung cancer deaths were attributed to smoking in men and 36.5% in women (Inoue et al. 2012). A high smoking prevalence has been reported in Hokkaido and Aomori Prefectures for both sexes (Ministry of Health Labour and Welfare 2016).

Transitions and Socioeconomic Disparities

There was no fundamental change of SMR distribution during the 20 years from 1995 to 2014 (Fig. 4.37). The ASMR of lung cancer has decreased (Fig. 4.38). The deprivation gap in ASMR between Q1 and Q5 was large (Fig. 4.39). In 2010–2014, the SII of lung cancer was 9.8 deaths per 100,000, contributing 31% to the SII of all cancers, 31.6 deaths per 100,000, which is the largest among major cancer sites (Fig. 4.40). The socioeconomic gradient of ASMR by deprivation group was different between men and women. Among men, a clear socioeconomic gradient in ASMR was observed, but among women, 'J-shape' gradients in which Q2 and Q3 had the lowest ASMRs were observed (Fig. 4.39). This was due, in part, to the high prevalence of smoking among women in urban areas (see Fig. 3.31). The RII for lung cancer was increasing in both sexes.


a
Trachea, bronchus and
lung cancer
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

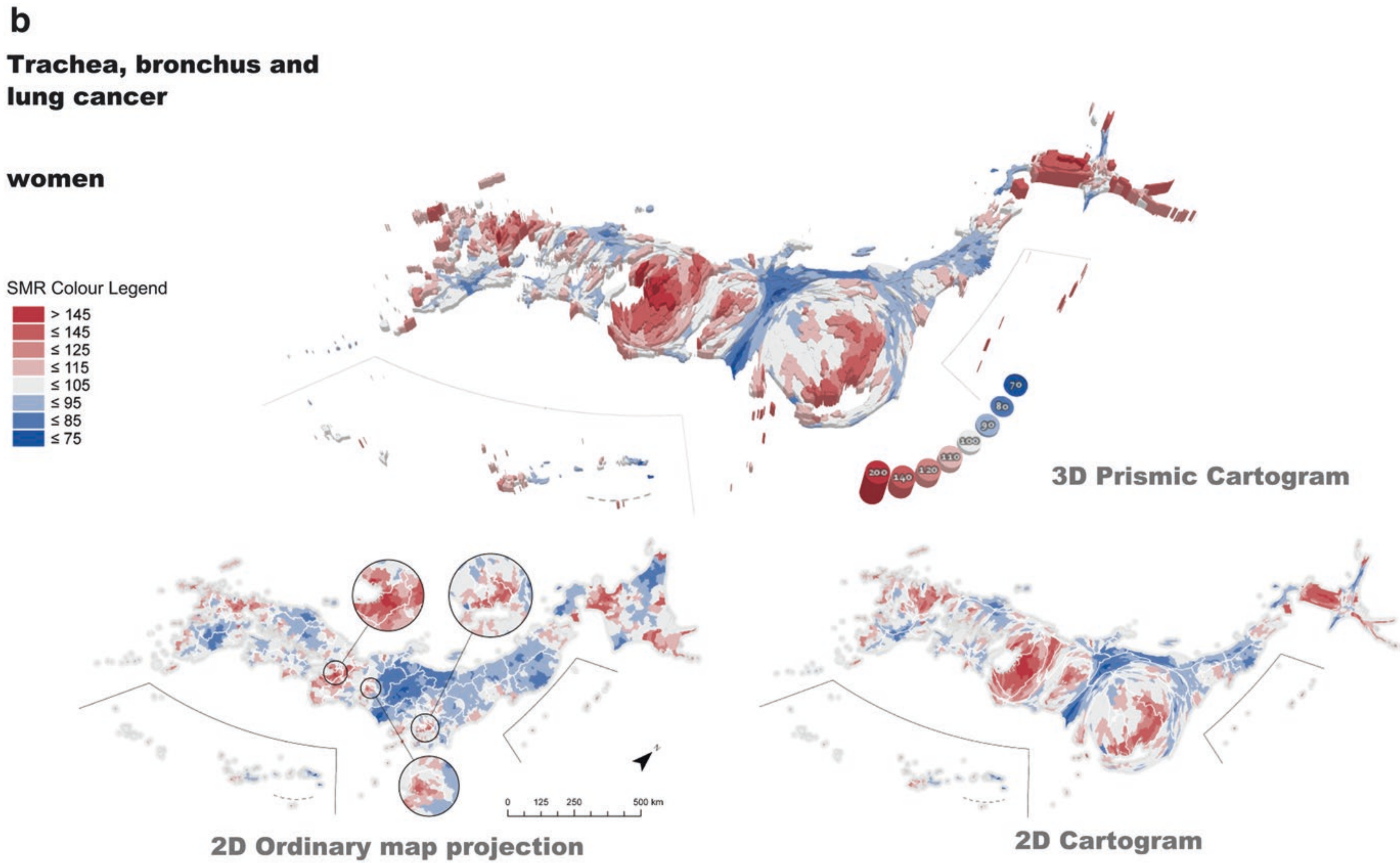
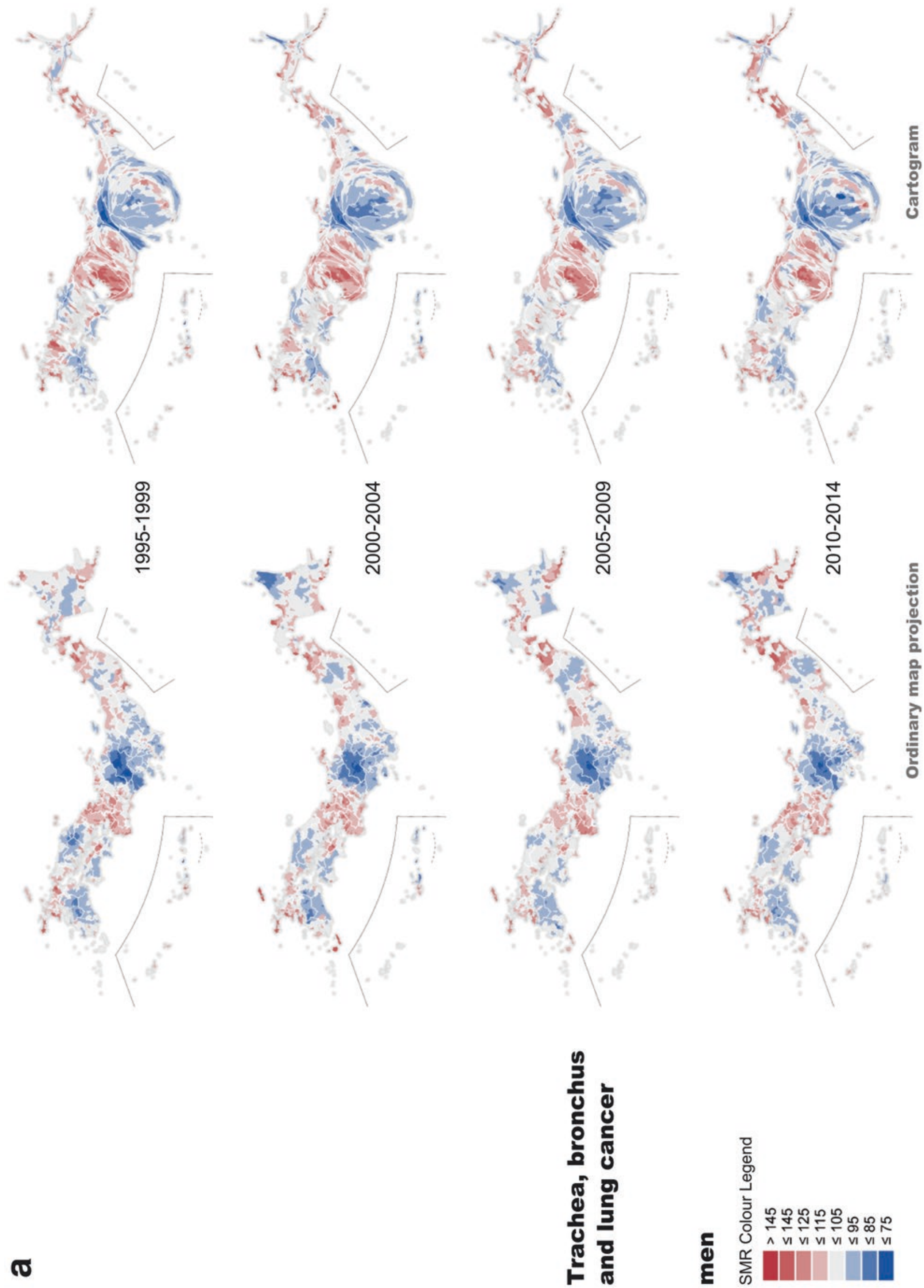


Fig. 4.36 SMR distribution of trachea, bronchus and lung cancer, 2010–2014. (**a**) Men. (**b**) Women



a
Trachea, bronchus and lung cancer
men
SMR Colour Legend
> 145
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≤ 125
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≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

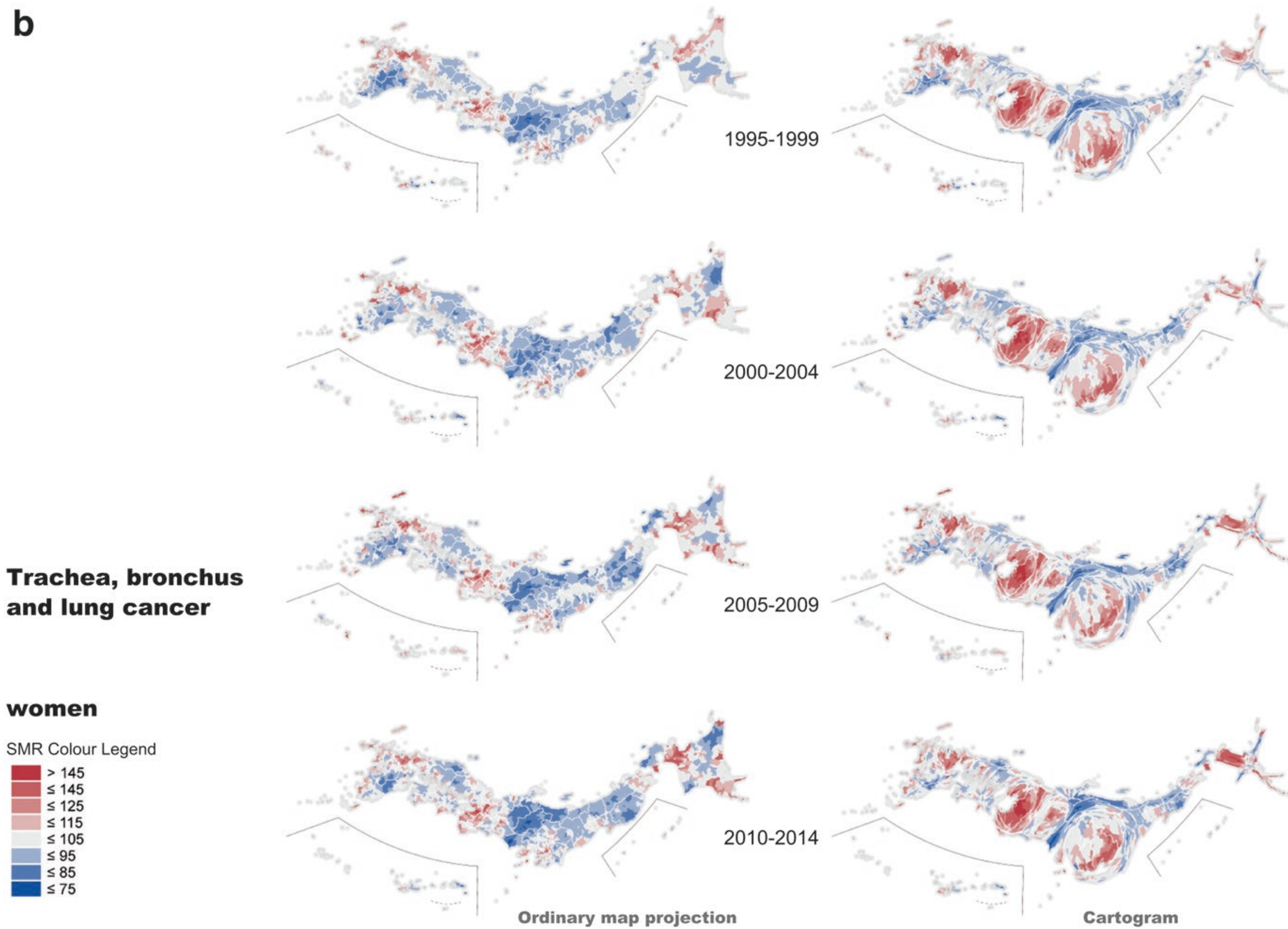
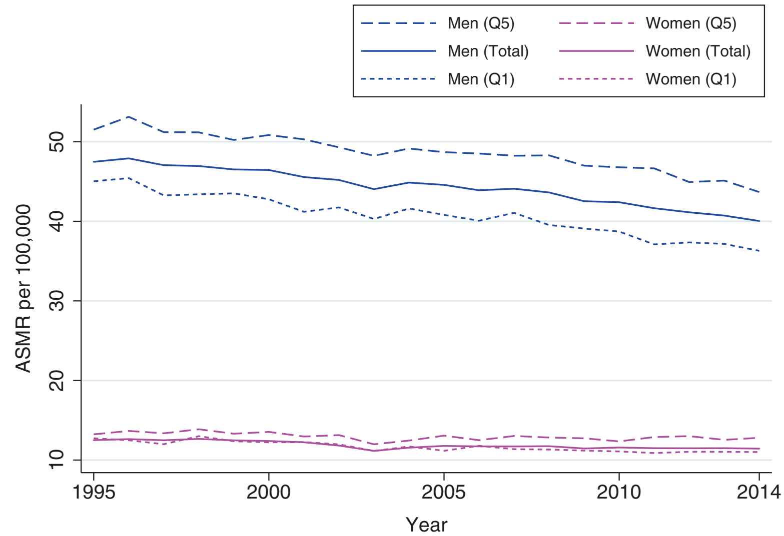


Fig. 4.37 Transition of SMR distribution of trachea, bronchus and lung cancer from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 4.38 Annual transition in the ASMR of trachea, bronchus and lung cancer from 1995 to 2014



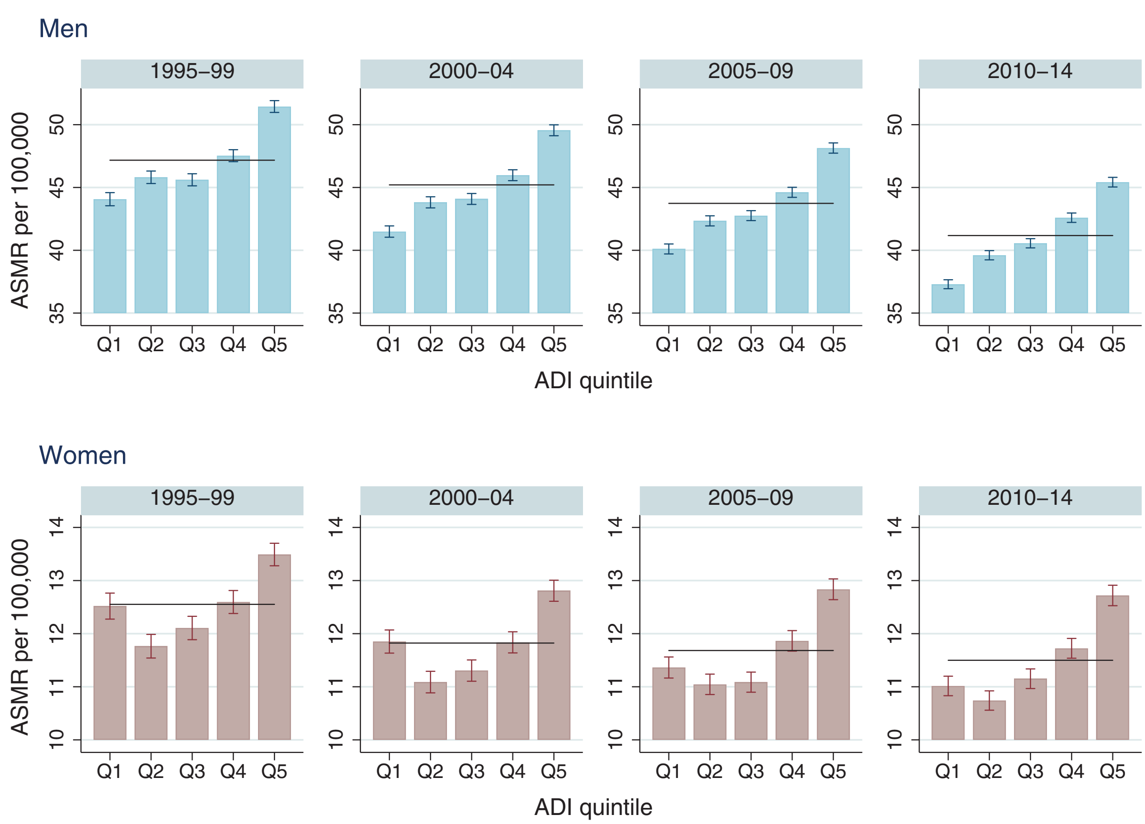


Fig. 4.39 The transition in the ASMR distribution of trachea, bronchus and lung cancer by ADI quintile (top: men, bottom: women)

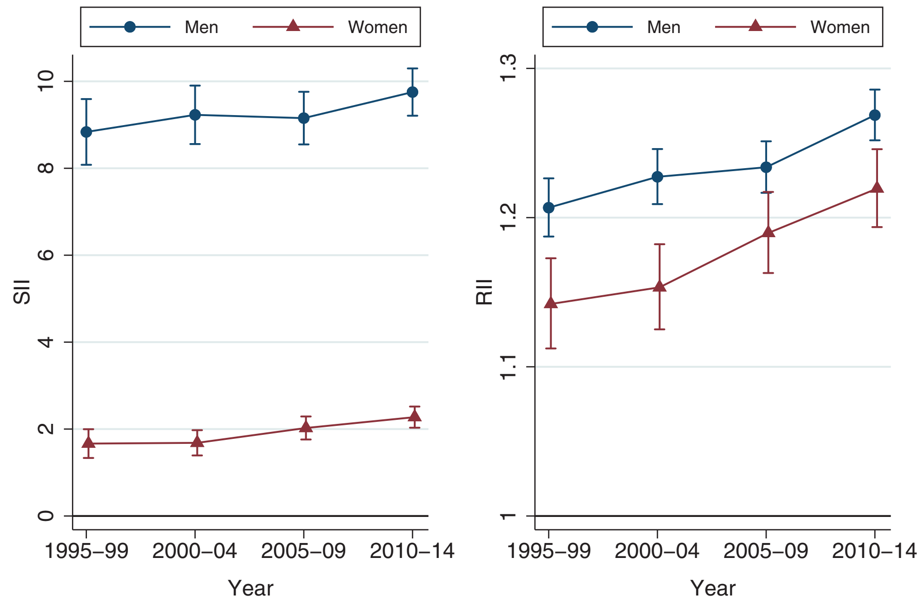


Fig. 4.40 Transition in SII and RII of trachea, bronchus and lung cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)

4.9 Malignant Mesothelioma (ICD10: C45): Time Bomb

Tomoki Nakaya

Overview

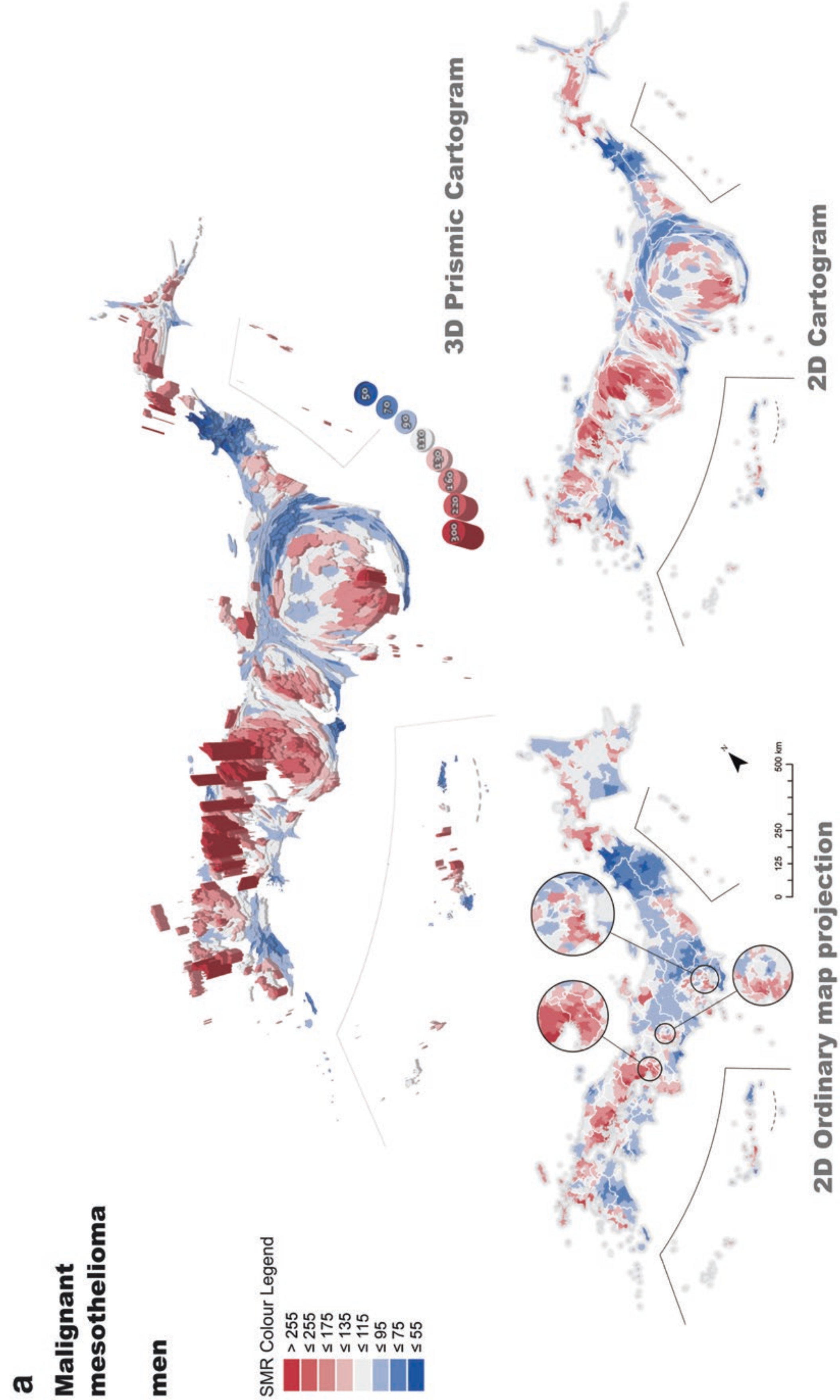
Asbestos, a natural mineral with excellent fire resistance and heat insulation properties, has been used for a variety of industrial purposes. In particular, between 1970 and 1990, large quantities of asbestos were imported and used extensively in building materials. Asbestos microfilaments are easily scattered in the air and, if inhaled, can cause pulmonary disease. Malignant mesothelioma is a cancer that is specifically caused by exposure to asbestos and is referred to as a 'time bomb' as the disease is not usually diagnosed until 10–50 years after exposure.

Among men who are likely to be heavily exposed in the workplace, areas with high SMRs are biased towards western Japan (Fig. 4.41). Markedly high SMRs are observed in areas where asbestos-related factories and shipbuilding industries flourished in the past (Nakaya 2015). On the other hand, among women, the SMR in Amagasaki City, Hyogo Prefecture is unusually high. It is known that asbestos diffused from a former asbestos cement pipe manufacturer in the region has caused a large number of malignant mesotheliomas among neighbouring residents and that women were more likely than men to be at home and thus exposed to the diffused asbestos winds (Kurumatani and Kumagai 2008).

Transitions and Socioeconomic Disparities

Overall, the mortality rate is high in western Japan and low in the Tohoku region. However, in the Tohoku region, the SMRs in the coastal areas of Miyagi and Fukushima Prefectures have gradually increased (Fig. 4.42). According to the cartogram, the SMRs are generally high in metropolitan areas. The increase in the mortality ratio in Aichi Prefecture, which is the core prefecture of the Chukyo metropolitan area, is notable.

Mortality from malignant mesothelioma is expected to continue to rise (Fig. 4.43), reflecting past exposure to asbestos (Murayama et al. 2006). The higher the level of deprivation, the higher the mortality rate tended to be in men between 1995 and 1999, but this tendency seems to have diminished since then (Figs. 4.44 and 4.45). There may be geographical differences in the magnitude and timing of exposure to asbestos. In addition, considering the long incubation period, those who have been exposed to asbestos may migrate to other locations, mainly in metropolitan areas. These situations might hide the regional socioeconomic inequalities in asbestos exposure.


a
Malignant mesothelioma
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
≤ 95
≤ 75
≤ 55
3D Prismic Cartogram
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70
90
110
130
160
220
300
2D Cartogram
2D Ordinary map projection
0
125
250
500 km

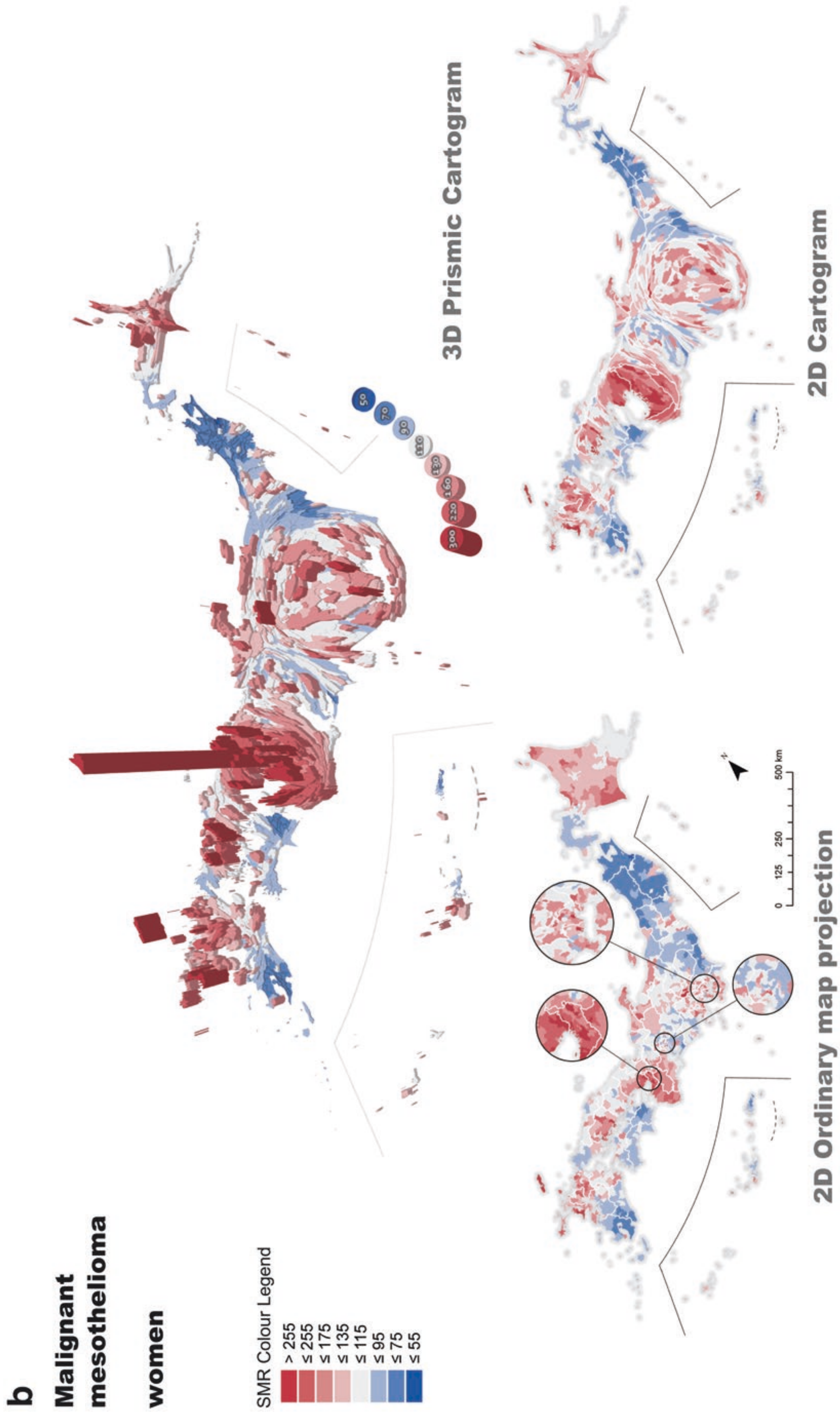
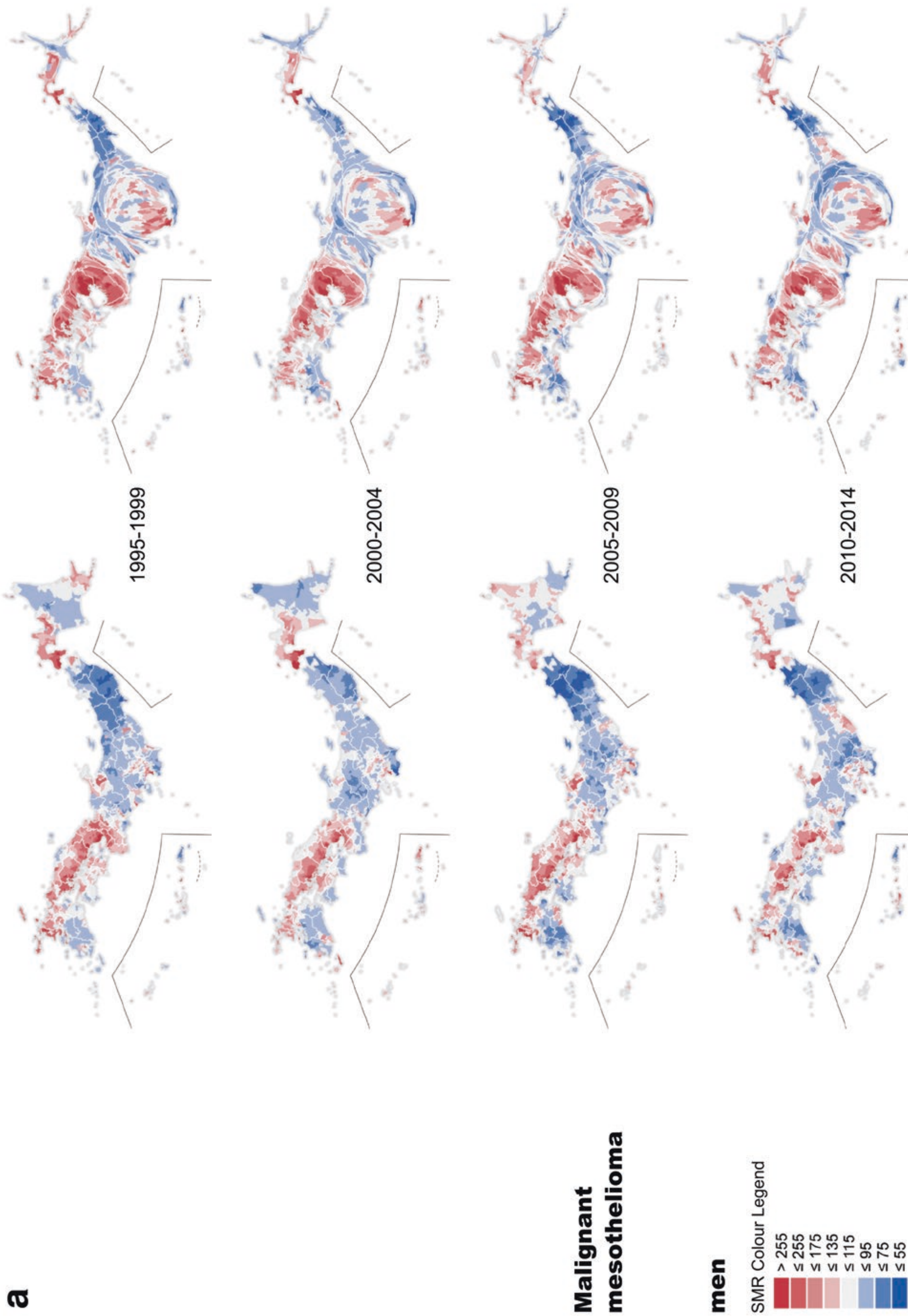


Fig. 4.41 SMR distribution of malignant mesothelioma, 2010–2014. (**a**) Men. (**b**) Women


a
Malignant mesothelioma
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
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≤ 75
≤ 55
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

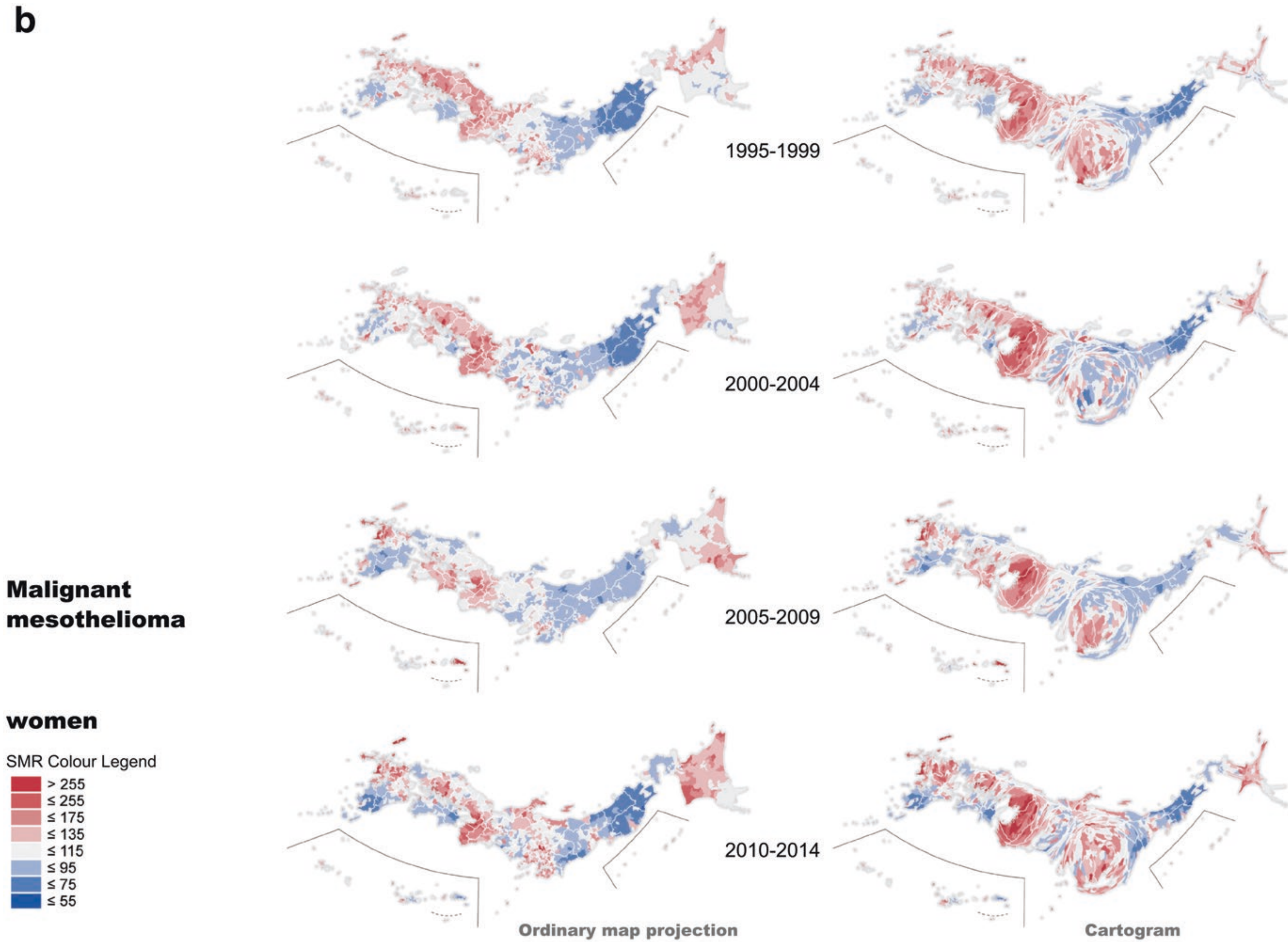


Fig. 4.42 Transition of SMR distribution of malignant mesothelioma from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 4.43 Annual transition in the ASMR of malignant mesothelioma from 1995 to 2014

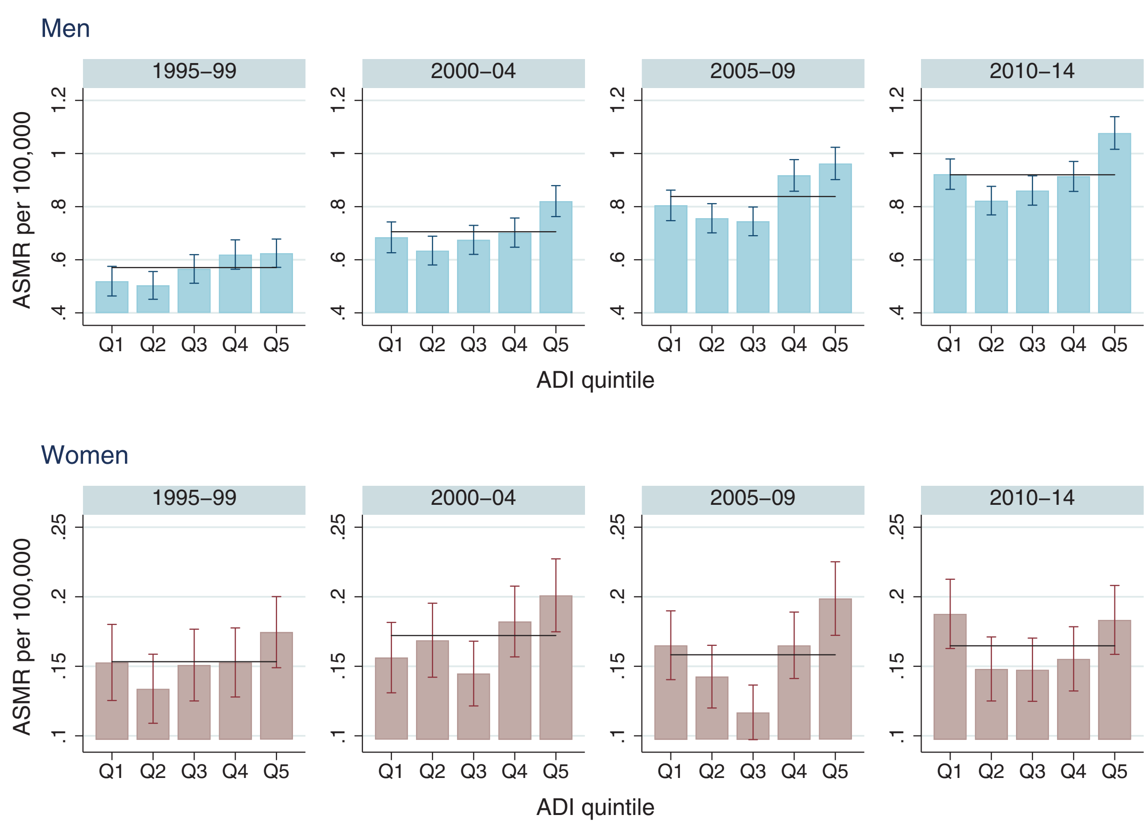


Fig. 4.44 The transition in the ASMR distribution of malignant mesothelioma by ADI quintile (top: men, bottom: women)

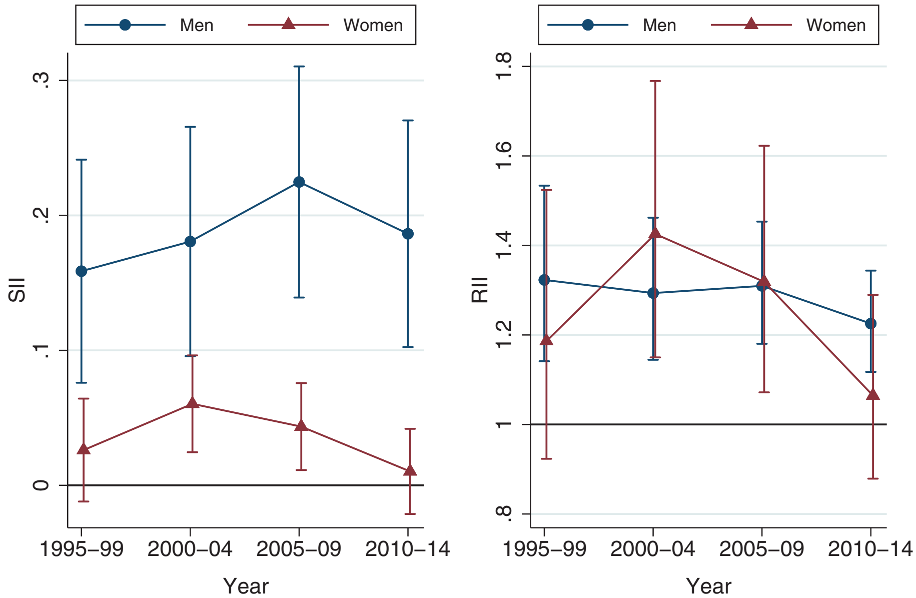


Fig. 4.45 Transition in SII and RII of malignant mesothelioma from 1995 to 2014 by 5-year period (left: SII, right: RII)

4.10 Breast Cancer (ICD10: C50): The most Common Cancer for Women

Seiki Kanemura

Overview

Breast cancer is the most common cancer in women in Japan. In 2014, one in five newly diagnosed cancer cases among women was breast cancer (Cancer Information Service 2018). The ASMR of breast cancer has steadily increased since the 1960s. It is now the fifth most common cause of death among all cancer deaths in women in Japan.

Higher SMRs of breast cancer were mainly observed in Sapporo, Tokyo, Nagoya, Osaka and Fukuoka cities, which are the major high-density urban areas in Japan (Fig. 4.46). Small clusters of high SMR regions in non-metropolitan areas were found in some parts of the Hokkaido, Tohoku and Kyushu regions. According to the cartogram, almost all of the Tokyo, Nagoya and Osaka Prefectures, core regions of the three largest metropolitan areas, clearly showed high breast cancer mortality.

Transitions and Socioeconomic Disparities

While there was no fundamental change in the spatial patterns of breast cancer SMRs between 1995 and 2014, the regional gap has gradually diminished as the dark red colour representing high SMRs in metropolitan regions has faded to a lighter shade (Fig. 4.47).

The ASMR of breast cancer has increased during the period from 1995 to 2014 (Fig. 4.48). An inverse socioeconomic gradient was observed in the breast cancer mortality. The highest ASMR was observed in the least deprived group (Q1) and the lowest ASMR in the most deprived group (Q5) (Fig. 4.49). The pattern is quite different from those of other cancer sites. An inverse gradient in ASMR for breast cancer has also been reported in other countries (Lundqvist et al. 2016; Strand et al. 2007). More highly educated women or those of higher socioeconomic status had a greater risk of death from breast cancer, which could be related to the risk factors for breast cancer including reproductive factors. During the two decades from 1995 to 2014, the ASMR of breast cancer has increased, while both the absolute and relative inverse gaps in ASMR shrank according to the SII and RII trends (Fig. 4.50).

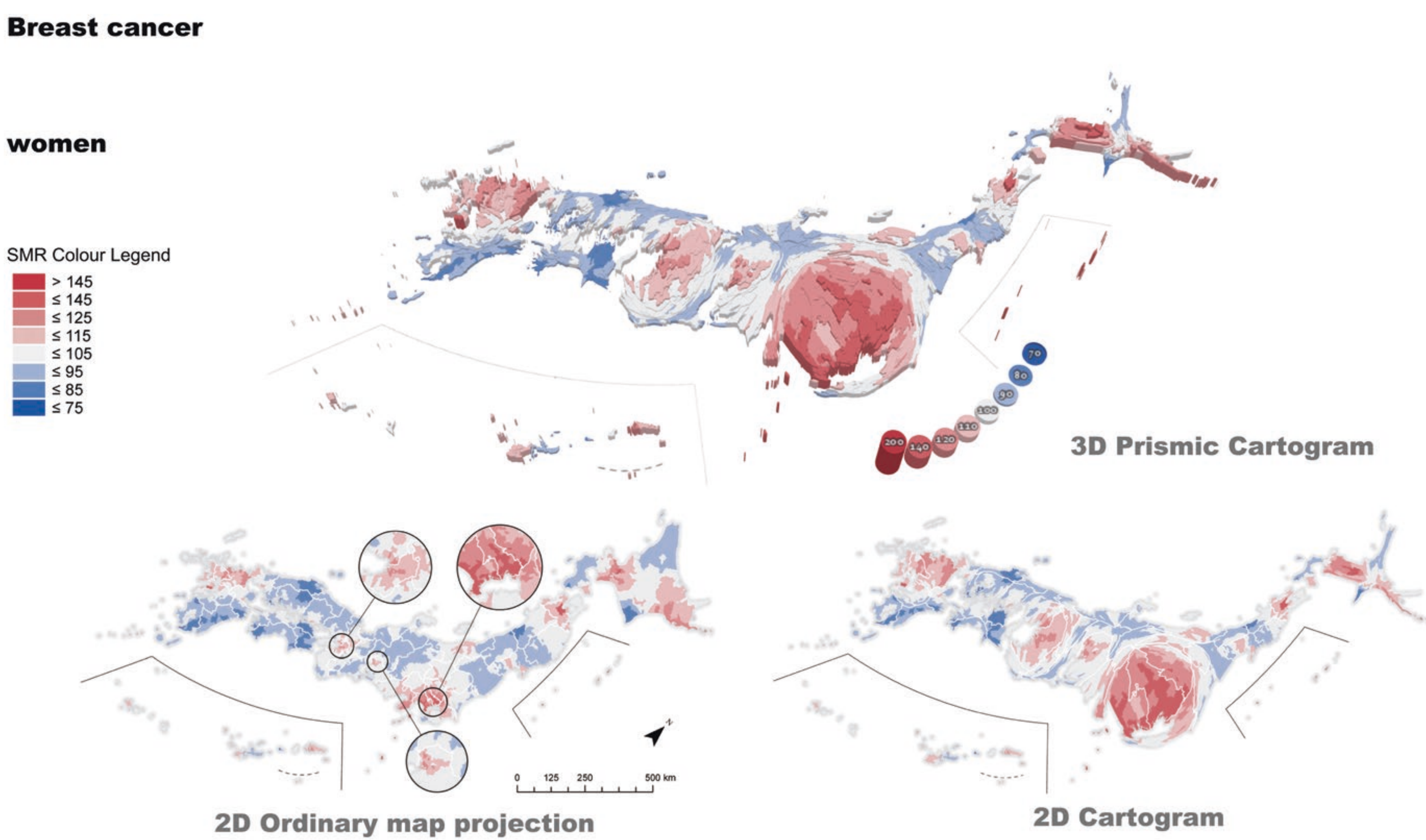


Fig. 4.46 SMR distribution of breast cancer, women, 2010–2014

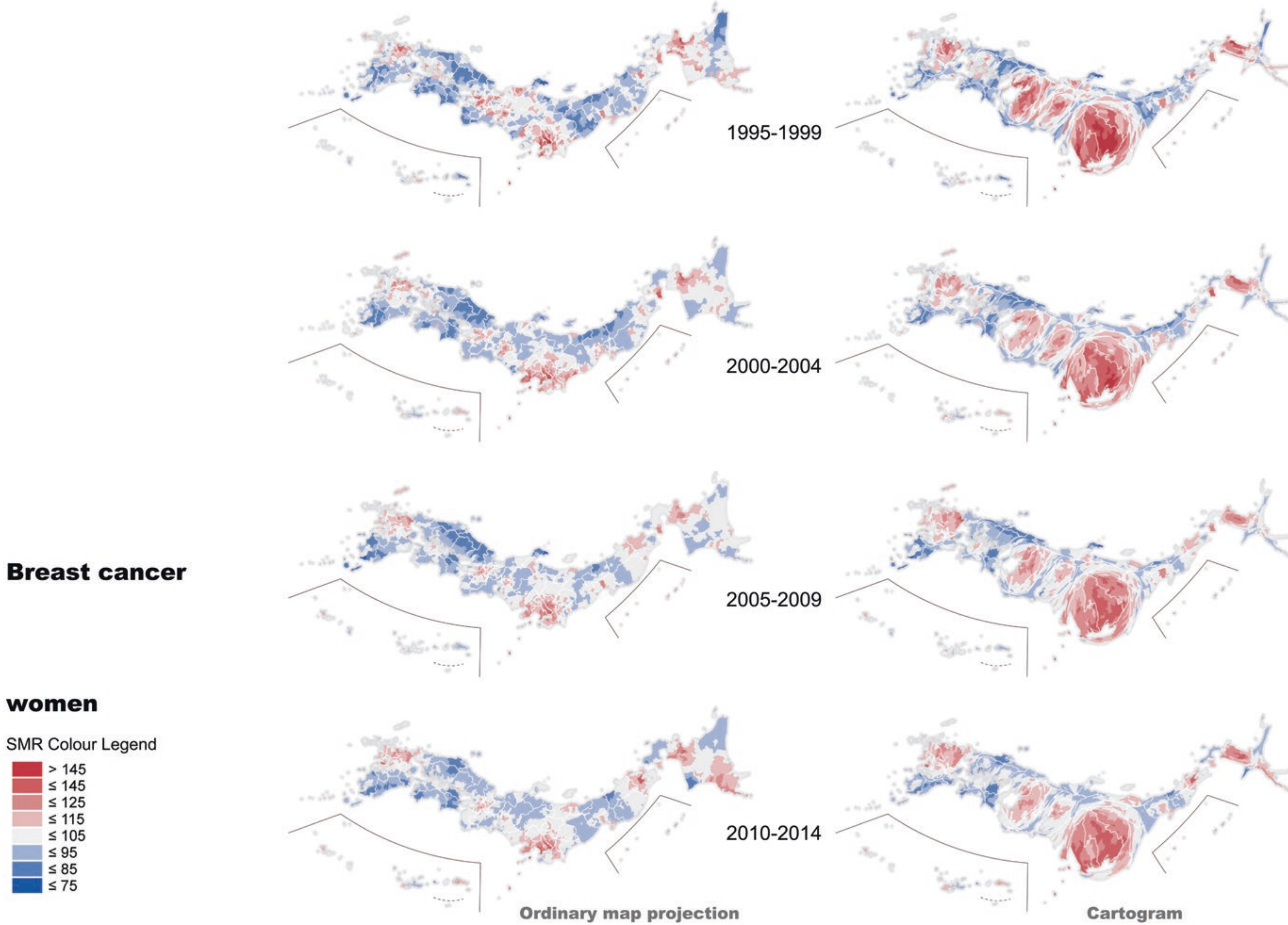
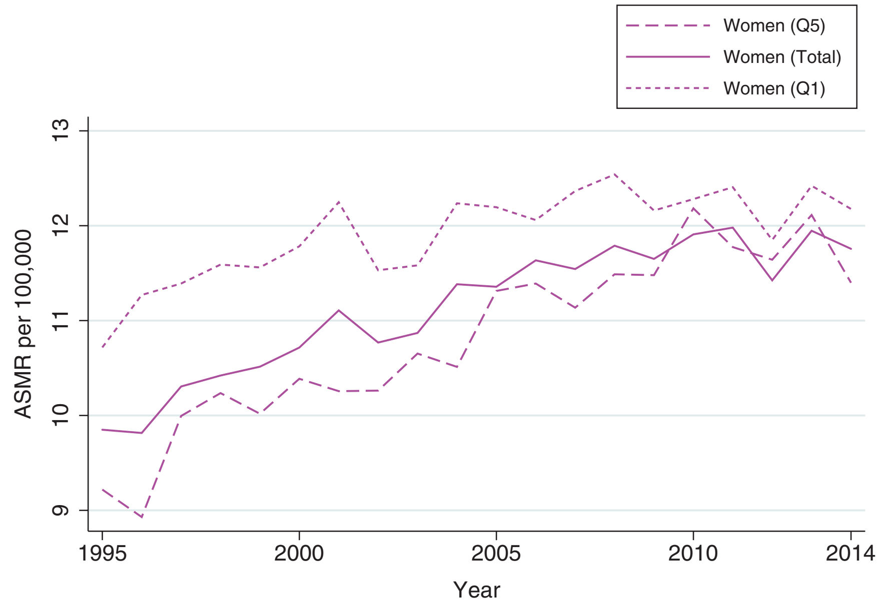


Fig. 4.47 Transition of SMR distribution of breast cancer, women, from 1995 to 2014 by 5-year period

Fig. 4.48 Annual transition in the ASMR of breast cancer from 1995 to 2014



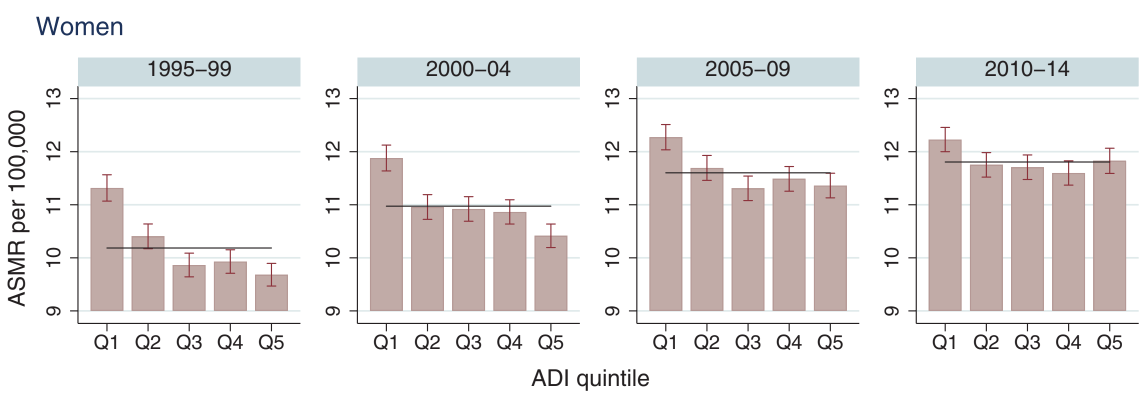
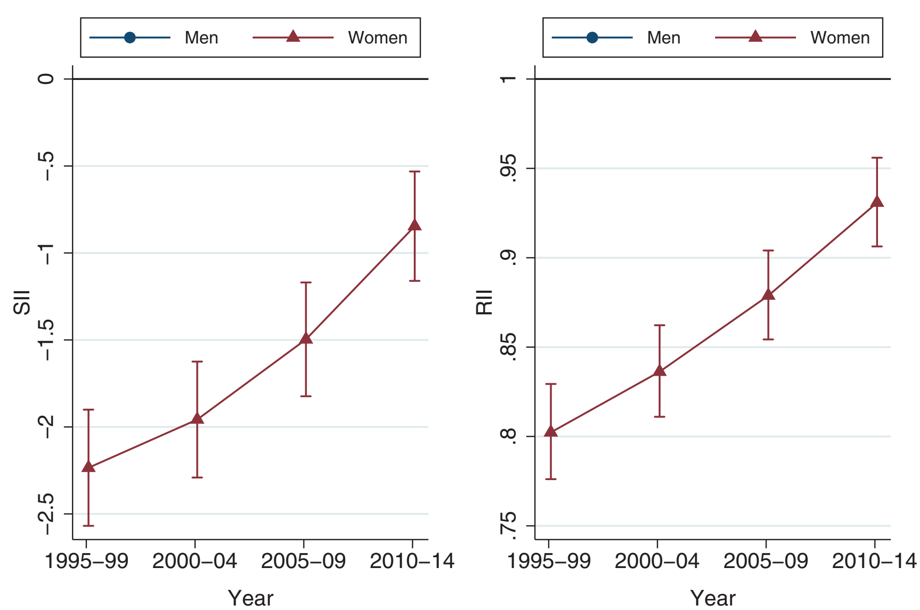


Fig. 4.49 The transition in the ASMR distribution of breast cancer by ADI quintile (top: men, bottom: women)

Fig. 4.50 Transition in SII and RII of breast cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)



4.11 Cervical Cancer (ICD10: C53): A Preventable Female Cancer, but Inequalities Still Exist

Seiki Kanemura

Overview

Cervical cancer incidence is associated with persistent human papillomavirus (HPV) infection. Higher incidence is observed in young women aged in their late 20s to 40s, and it is an urgent priority to control this cancer among young women in Japan. Universal vaccination programmes for HPV have been implemented in many high-income countries. In Japan, the HPV vaccination programme was implemented in 2010; however, it was stopped in 2013, due to complaints of post-vaccination pain and other disorders. In addition, the screening uptake was quite low in Japan. Cervical cancer is a preventable cancer in women, and scaling up of the vaccination and screening programme is essential in Japan.

While lower SMRs were observed in the Tohoku and Chugoku regions, higher SMRs were observed in some parts of the Hokkaido, Kanto, Tokai, Hokuriku and Kyushu regions (Fig. 4.51). The cartogram showed high SMR areas around the outer suburbs of the Tokyo and Nagoya/Chukyo metropolitan areas.

Transitions and Socioeconomic Disparities

According to the series of cartogram (Fig. 4.52), the higher SMR areas have spread from the core of the Tokyo and Osaka metropolitan areas to the outer suburbs of those cities during the two decades from 1995 to 2014. Within the metropolitan areas, while the ASMRs of the affluent suburbs have tended to become lower (coloured in blue), the inner city has tended to remain high (coloured in red).

The ASMR of cervical cancer is still increasing slightly, despite strategies for its elimination (Fig. 4.53). Several high-income countries have shown decreasing trends in the ASMR of cervical cancer. The highest ASMRs were observed in the most deprived group (Q5) and the lowest ASMRs were observed in the least deprived group (Q1) (Fig. 4.54). According to the trends in SII and RII (Fig. 4.55), both the absolute and relative socioeconomic inequalities of mortality widened slightly. Socioeconomic inequalities in cervical cancer incidence before the HPV vaccination era have been reported in some countries (Simard et al. 2012; Pukkala et al. 2010). Some evidence of a reduction in the deprivation gap in cervical cancer incidence following the introduction of a universal vaccination programme was also reported (Cameron et al. 2017; Malagon et al. 2015). Scaling up of HPV vaccination could help to reduce the gap in the future in Japan and other countries (Simms et al. 2019).

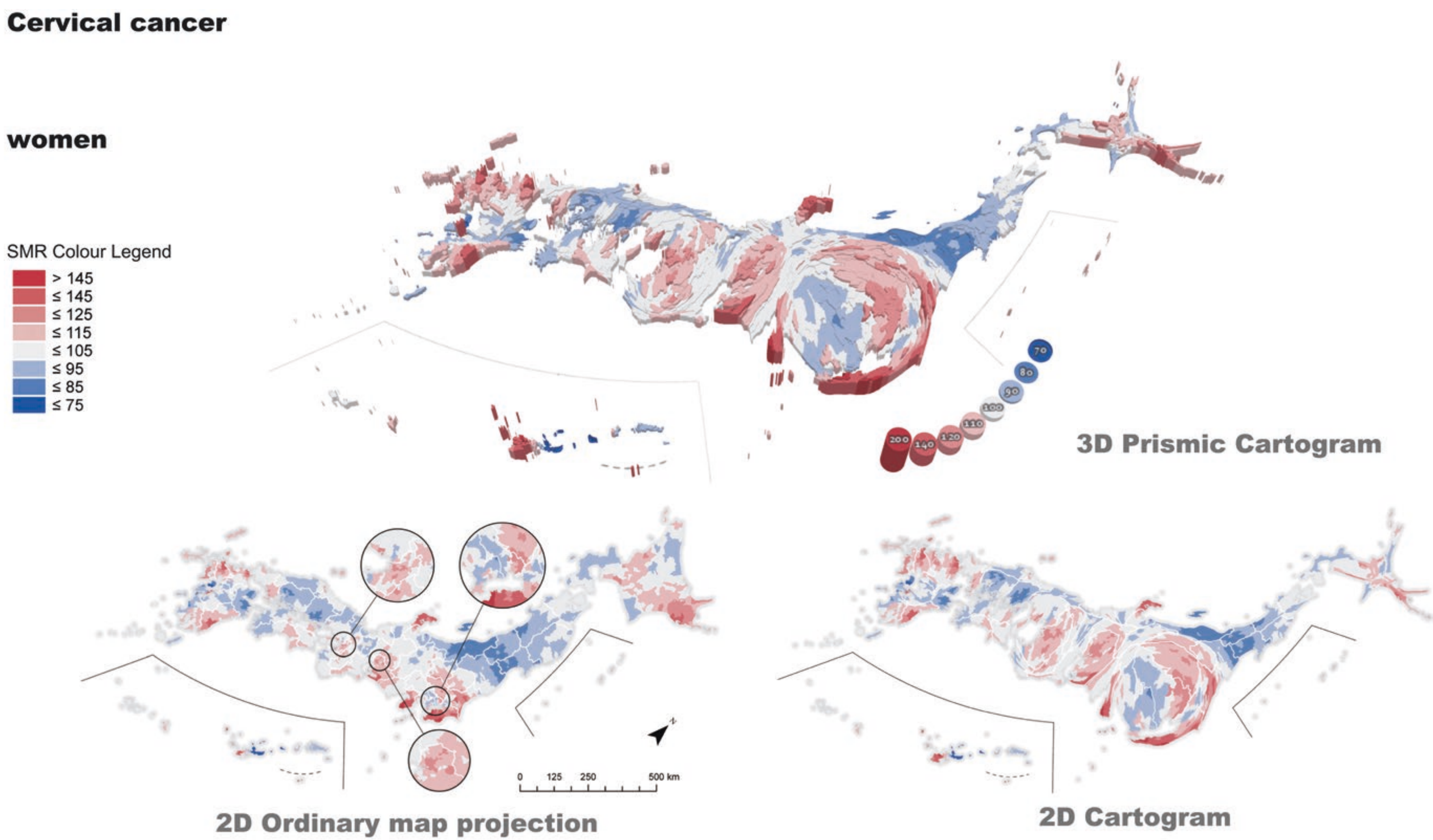


Fig. 4.51 SMR distribution of cervical cancer, women, 2010–2014

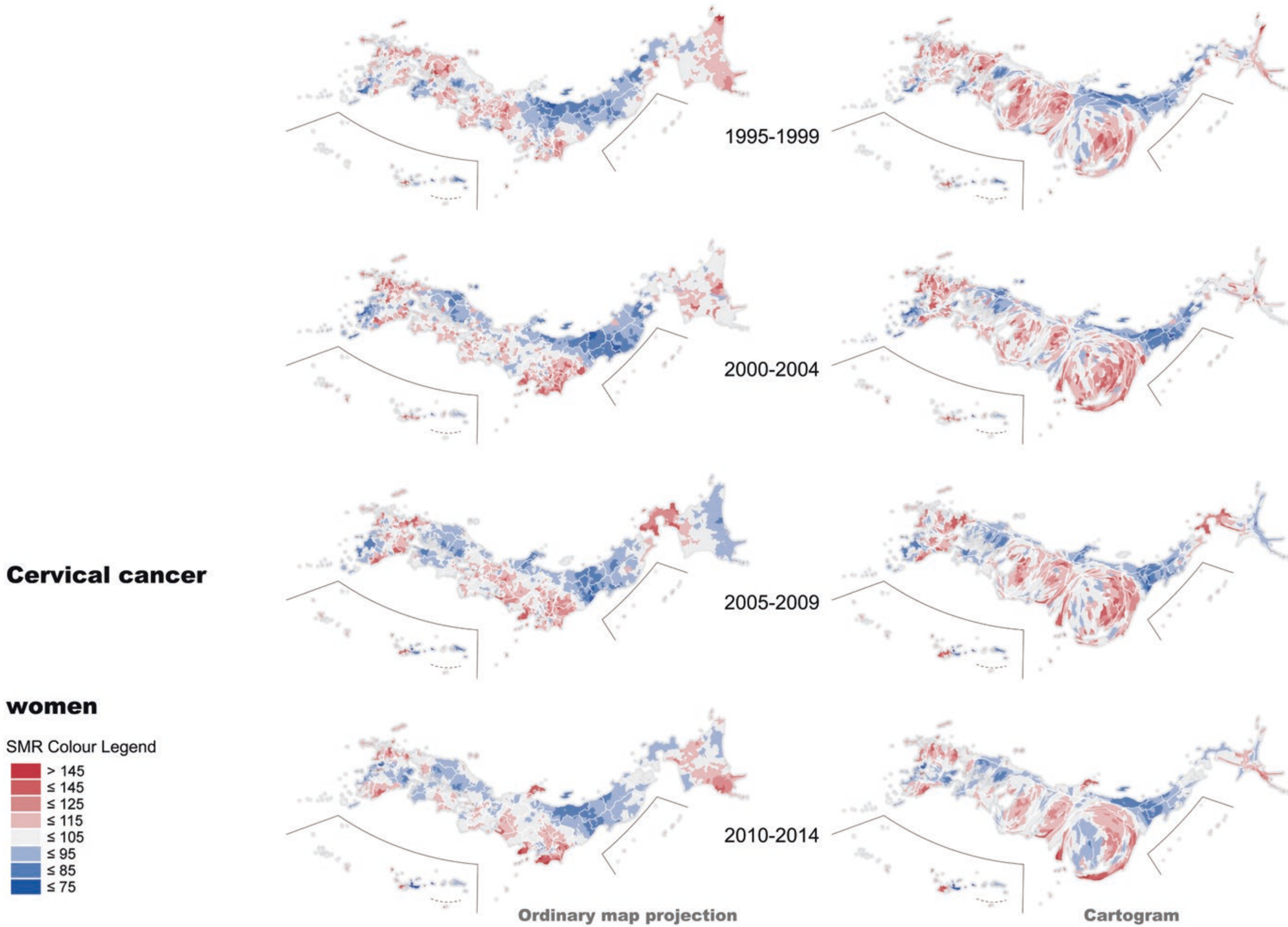
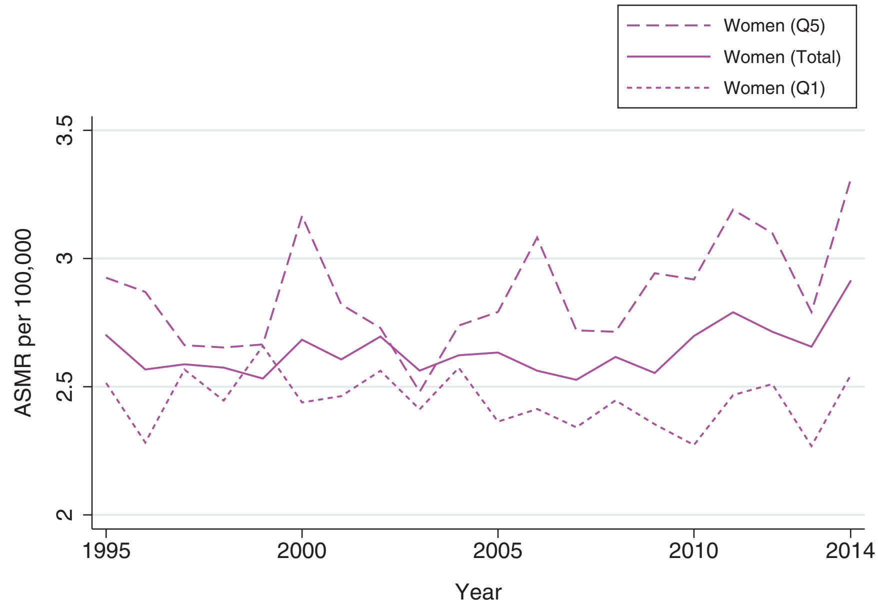


Fig. 4.52 Transition of SMR distribution of cervical cancer, women, from 1995 to 2014 by 5-year period

Fig. 4.53 Annual transition in the ASMR of cervical cancer from 1995 to 2014



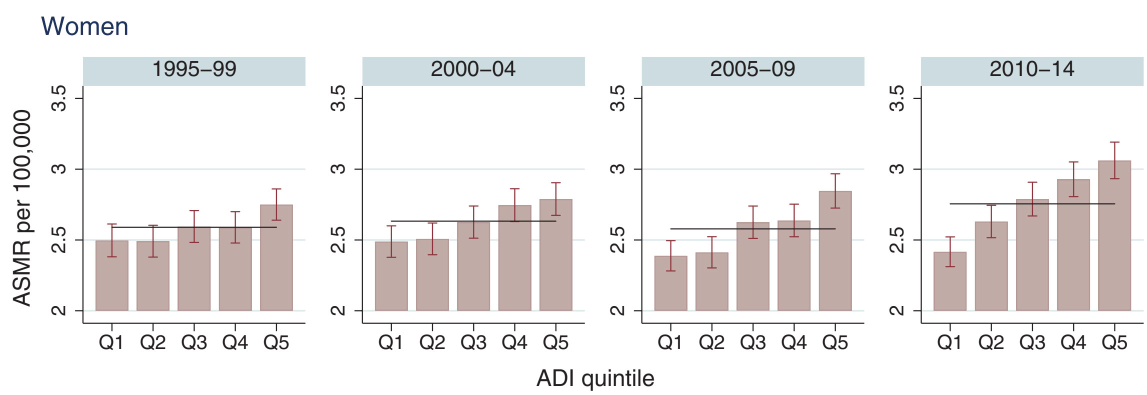
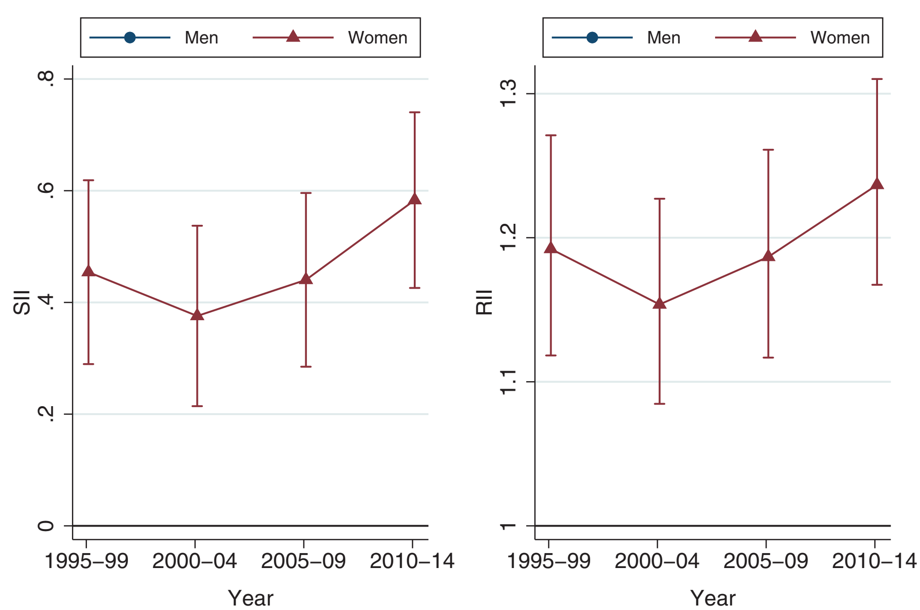


Fig. 4.54 The transition in the ASMR distribution of cervical cancer by ADI quintile (top: men, bottom: women)

Fig. 4.55 Transition in SII and RII of cervical cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)



4.12 Uterine Corpus Cancer (ICD10: C54): An Increasingly Common Female Cancer

Seiki Kanemura

Overview

Incidence of uterine corpus cancer is associated with obesity and long-term exposure to the sex hormone (oestrogen). The peak of age at diagnosis for uterine corpus cancer is the 50s and 60s, whereas it is the 20s to 40s for cervical cancer. In Japan, screening was implemented for uterine corpus cancer, combined with cervical cancer screening in 1987, but since the scientific evidence for a reduction in mortality was poor, the government stopped this screening.

Overall geographical variations in the SMRs of uterine corpus cancer are small (Fig. 4.56). Lower SMR areas were observed in the mid-west of Japan and the Chugoku and Shikoku regions, while higher SMR areas were observed in the Kanto and Kyushu regions. There are no areas of extremely high or low SMRs.

Transitions and Socioeconomic Disparities

The regional inequality of SMR declined from 1995 to 2014. The series of cartogram shows that the high SMR in the Tokyo metropolitan area has clearly decreased (Fig. 4.57).

The ASMR of uterine neoplasms showed an increasing trend (Fig. 4.58), which might relate to dietary and reproductive factors in Japan. The socioeconomic inequalities in ASMR, based on the areal deprivation index, were not clear when compared with cervical cancer (Fig. 4.59). Inverse socioeconomic gradients of mortality were observed in 2000–2004, but these disappeared in the period from 2010 to 2014. The RII of uterine corpus cancer has been around 1 (Fig. 4.60), indicating that there is no clear sign of areal-based social inequality in death from uterine corpus cancer.

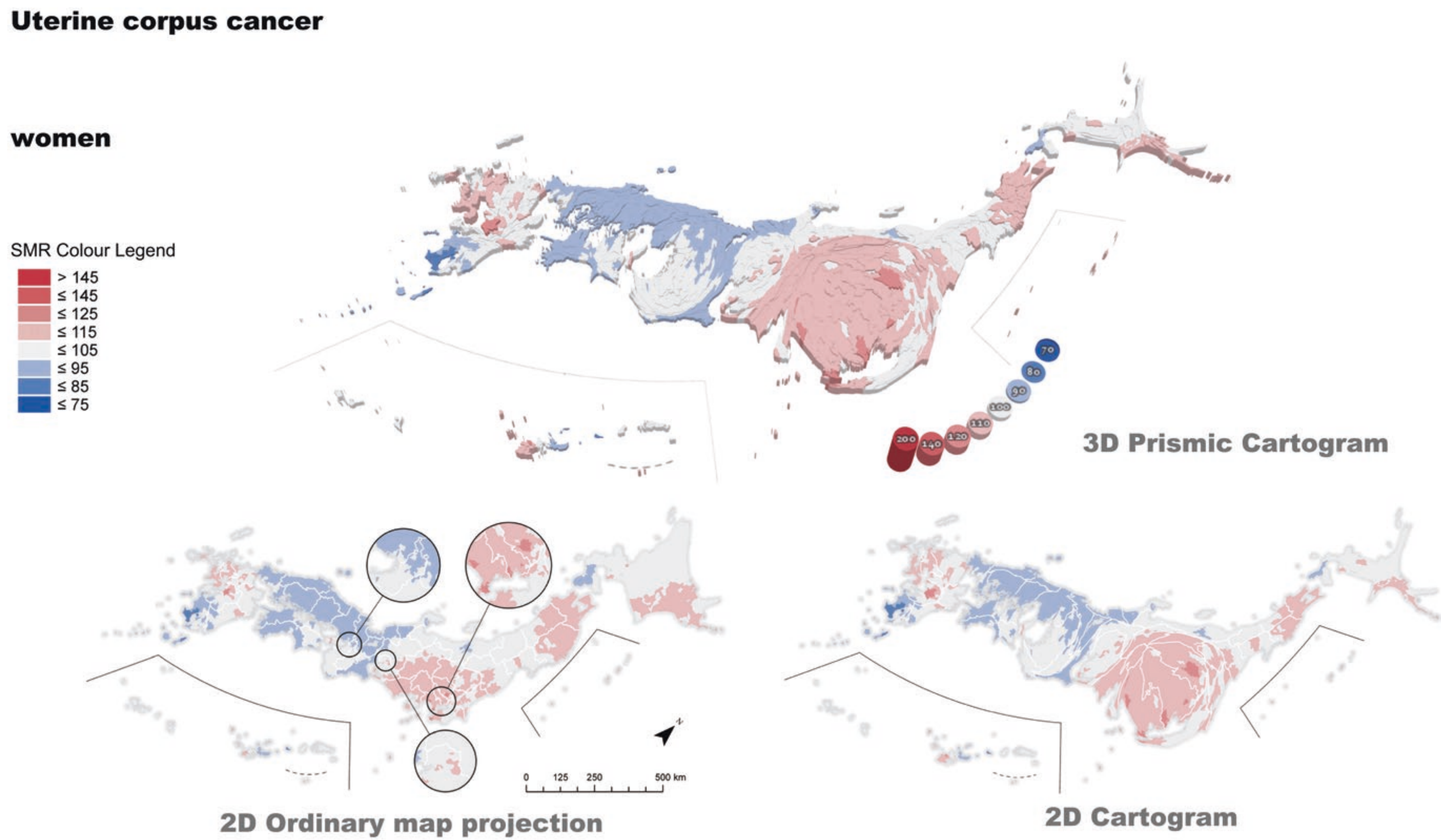


Fig. 4.56 SMR distribution of uterine corpus cancer, women, 2010–2014

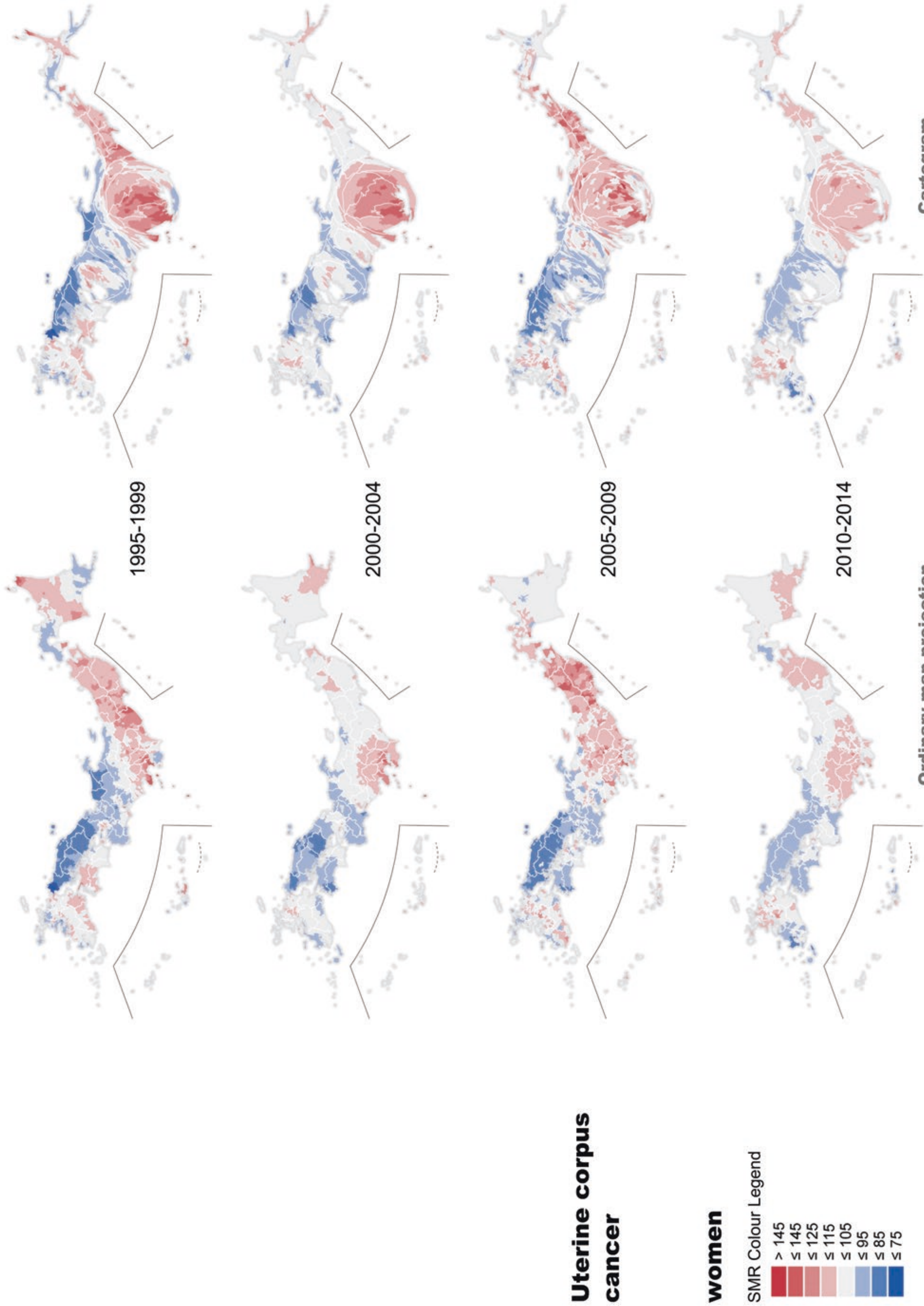
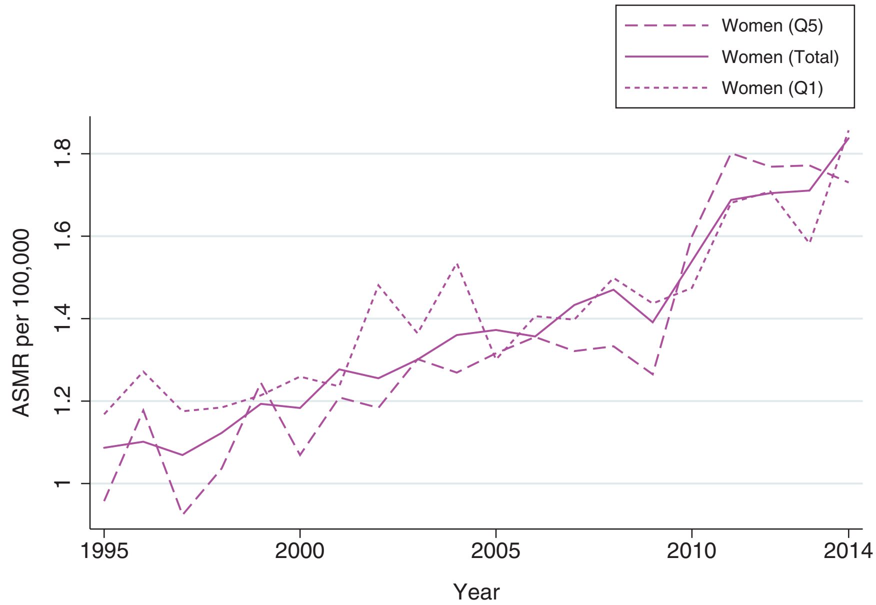


Fig. 4.57 Transition of SMR distribution of uterine corpus cancer, women, from 1995 to 2014 by 5-year period

Fig. 4.58 Annual transition in the ASMR of uterine corpus cancer from 1995 to 2014



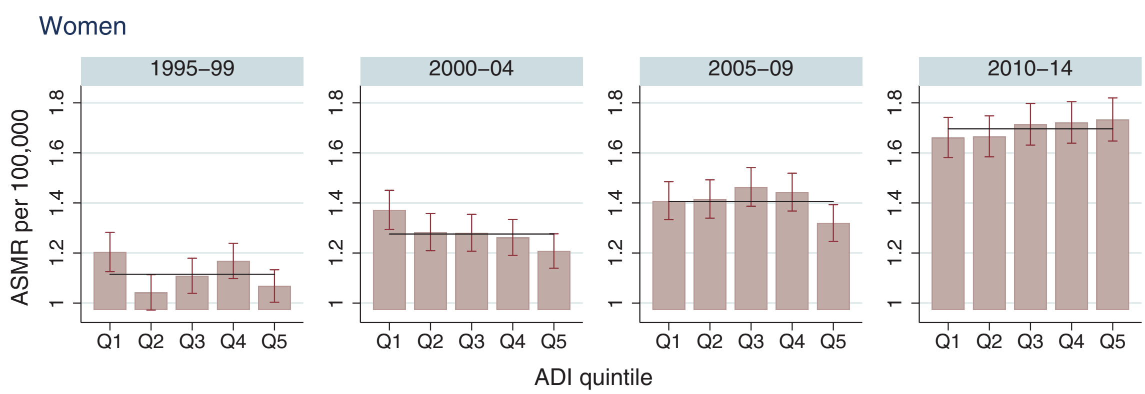
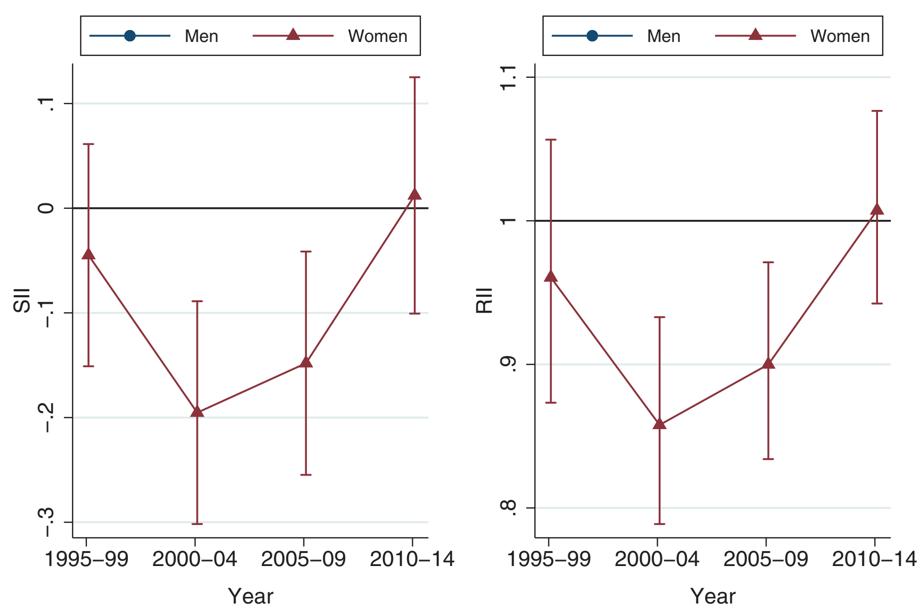


Fig. 4.59 The transition in the ASMR distribution of uterine corpus cancer by ADI quintile (top: men, bottom: women)

Fig. 4.60 Transition in SII and RII of uterine corpus cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)



4.13 Ovarian Cancer (ICD10: C56): A Cancer with Inverse Socioeconomic Gradient

Seiki Kanemura

Overview

Multiple risk factors were related to ovarian cancer incidence and about 10% of these were attributed to genetics. Higher incidence was observed in 40–60 years old women; germ cell or gonadal tumours showed high incidence in women in their teens and 20s. The distribution of histological type in ovarian cancer varies in different countries of the world. Japanese incident cases varied, while the dominant histology type was serum cell cancer in other countries (Coburn et al. 2017). Sufficient evidence was found to suggest that the risk of ovarian cancer is increased by exposure to asbestos, oestrogen menopausal therapy, tobacco smoking (Cogliano et al. 2011) and adult attained height and body fatness. There is limited sufficient evidence to suggest that lactation may reduce the risk (World Cancer Research Fund 2018).

The geographical variation in the SMR of ovarian cancer is relatively small (Fig. 4.61). Low SMR areas were observed in the Chugoku and Shikoku regions, and high SMR areas were observed in the Hokkaido, Tohoku, Kanto and Kyushu regions. According to the cartogram, the Tokyo metropolitan area had a high SMR.

Transitions and Socioeconomic Disparities

While the spatial patterns of SMR were stable for the 20 years from 1995 to 2014, regional inequalities of SMR have decreased (Fig. 4.62). Although we can see darker shades of red (meaning higher SMR) in the northern Tohoku region and the Tokyo metropolitan area in 1995–1999, these areas now have less dark red meaning moderately high SMR in later years. The ASMRs of ovarian cancer were temporarily fluctuated but showed a slight decreasing trend (Fig. 4.63).

An inverse socioeconomic gradient in the ASMR based on the areal deprivation index was observed (Fig. 4.64). The highest and lowest ASMRs were observed in Q1 and Q5, respectively, as in the case of breast cancer. A small decrease in ASMR was observed, but the absolute and relative socioeconomic inequalities have not largely changed according to the trends in SII and RII (Fig. 4.65).

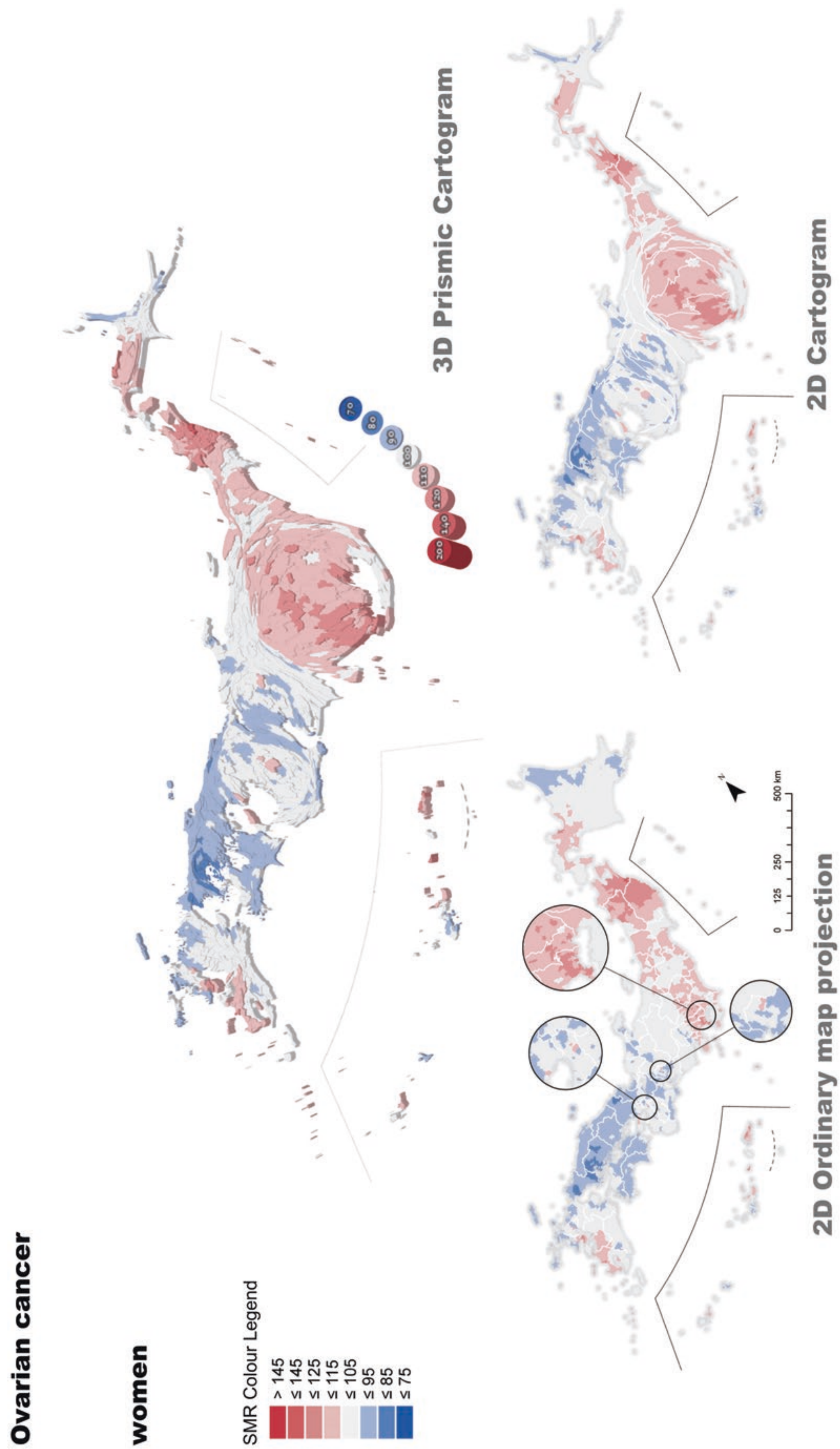


Fig. 4.61 SMR distribution of ovarian cancer, women, 2010–2014

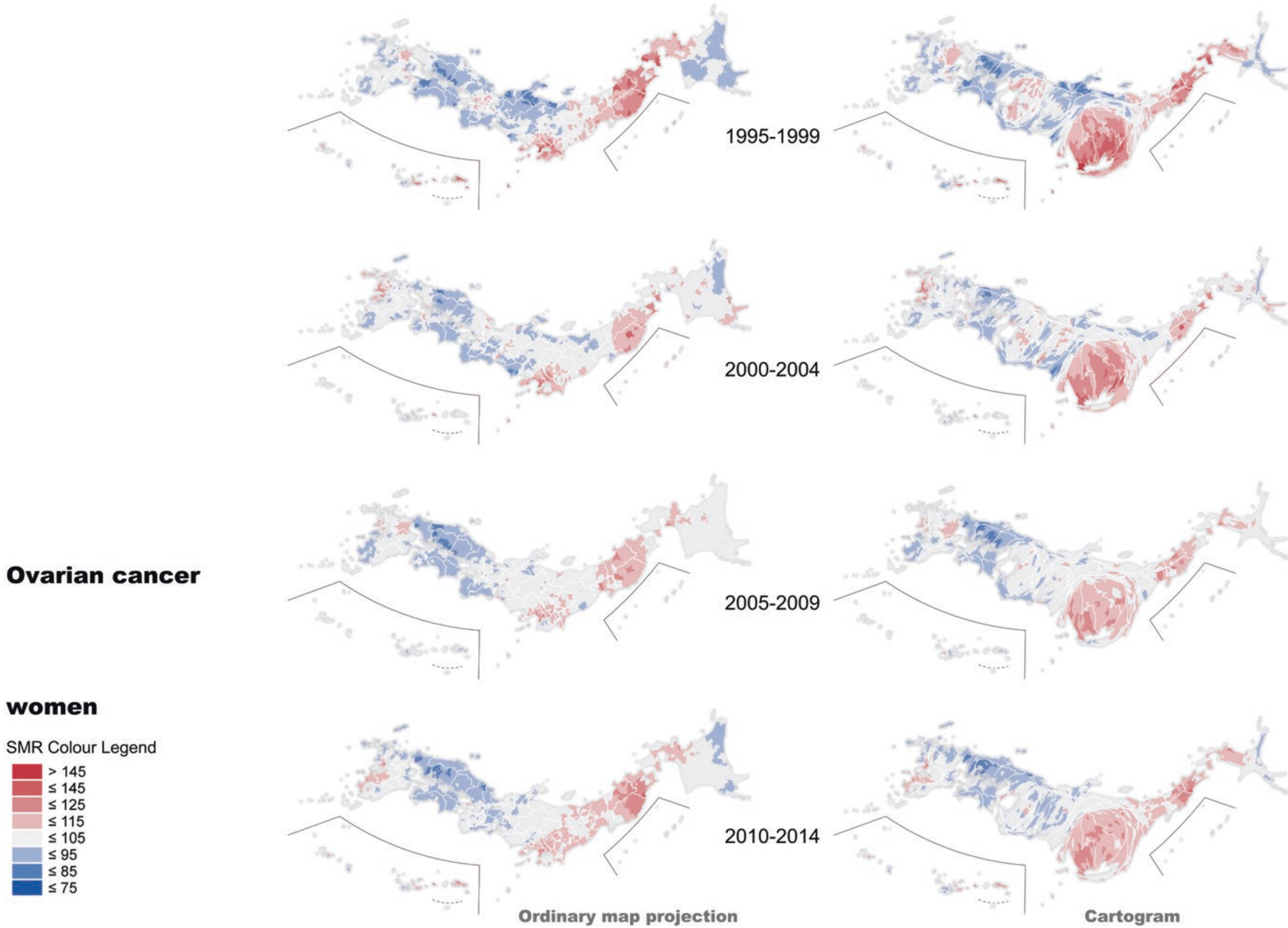
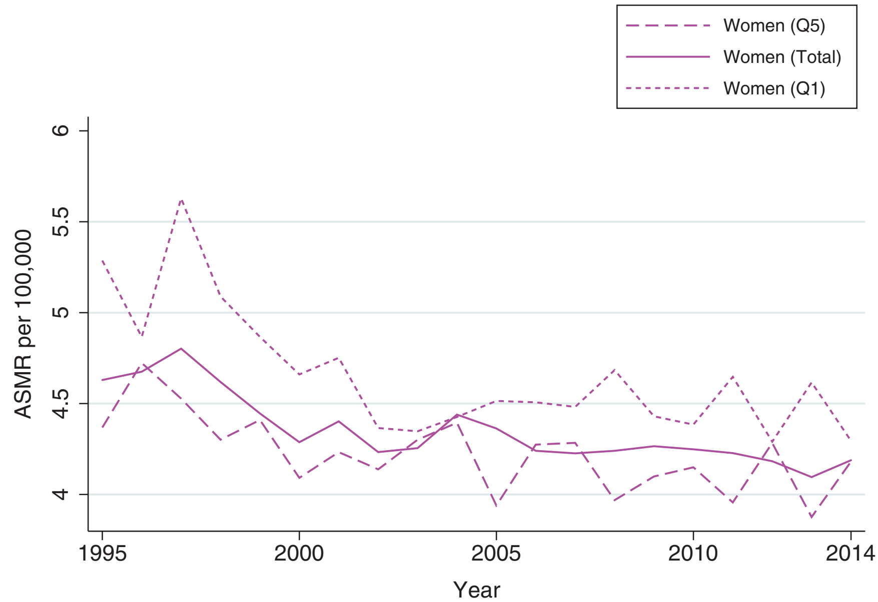


Fig. 4.62 Transition of SMR distribution of ovarian cancer, women, from 1995 to 2014 by 5-year period

Fig. 4.63 Annual transition in the ASMR of ovarian cancer from 1995 to 2014



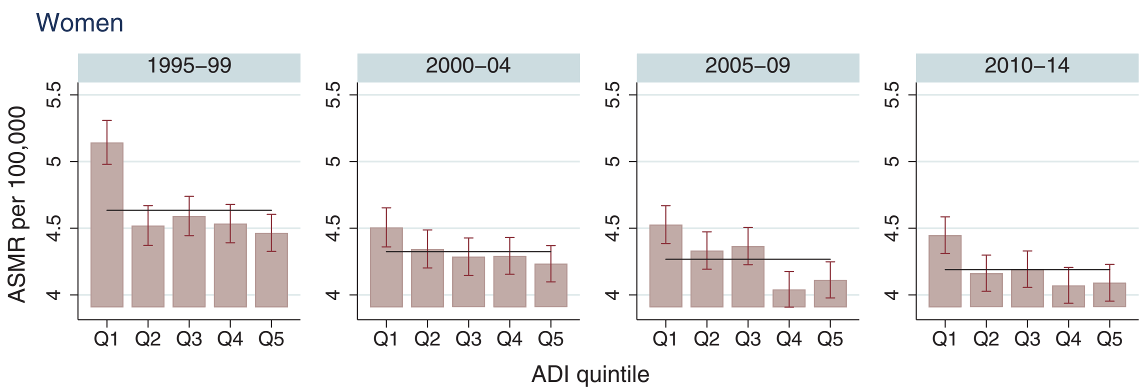
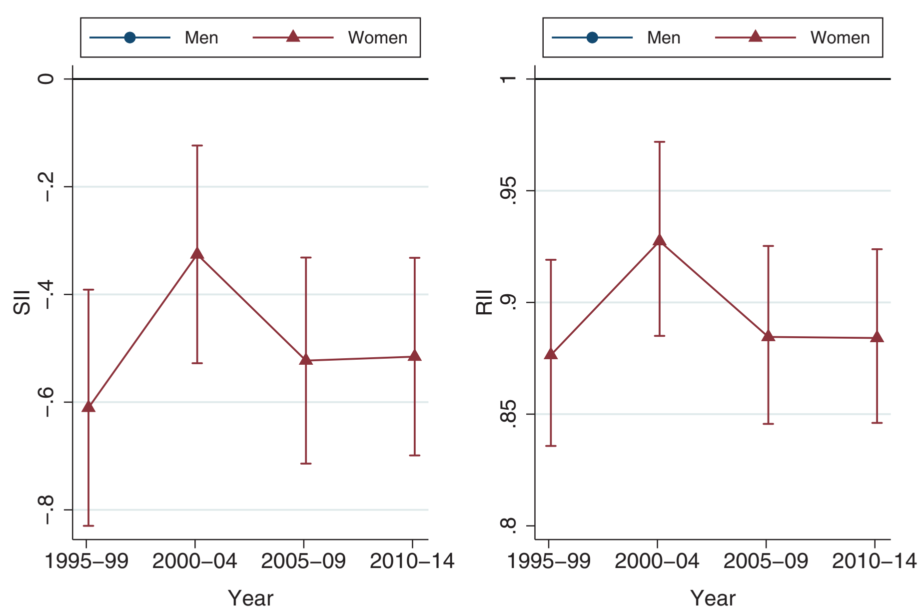


Fig. 4.64 The transition in the ASMR distribution of ovarian cancer by ADI quintile (top: men, bottom: women)

Fig. 4.65 Transition in SII and RII of ovarian cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)



4.14 Prostate Cancer (ICD10: C61): Increasing Cancer due to Screening detection

Seiki Kanemura

Overview

Prostate cancer incidence and mortality are higher in older men. Recently, incidence has increased considerably, due to the spread of PSA-based screening, but the mortality rate has been quite stable. Despite government guidelines to the contrary, over 70% of municipalities in Japan have implemented PSA testing for population screening, and the increasing incidence has been linked to overdiagnosis due to this screening.

Areas with low SMR were observed in the Kinki, Chugoku and Shikoku regions and high SMR in the Hokkaido, Tohoku, Kanto and Kyushu regions (Fig. 4.66). According to the cartogram-based SMR maps, the Tokyo metropolitan area had high SMRs.

Transitions and Socioeconomic Disparities

The general geographical tendency of the SMR distribution has been unchanged but in the northern Tohoku region, the SMR was higher in 2005–2014 than in 1995–2004 (Fig. 4.67).

The ASMR of prostate cancer had increased slightly by 2000 but has decreased slightly since 2005 (Fig. 4.68). After 2000, the socioeconomic gradient in the ASMR based on ADI has become apparent (Fig. 4.69). Both the absolute and relative socioeconomic disparities in mortality have been widened as indicated by the trends in RII and SII (Fig. 4.70).

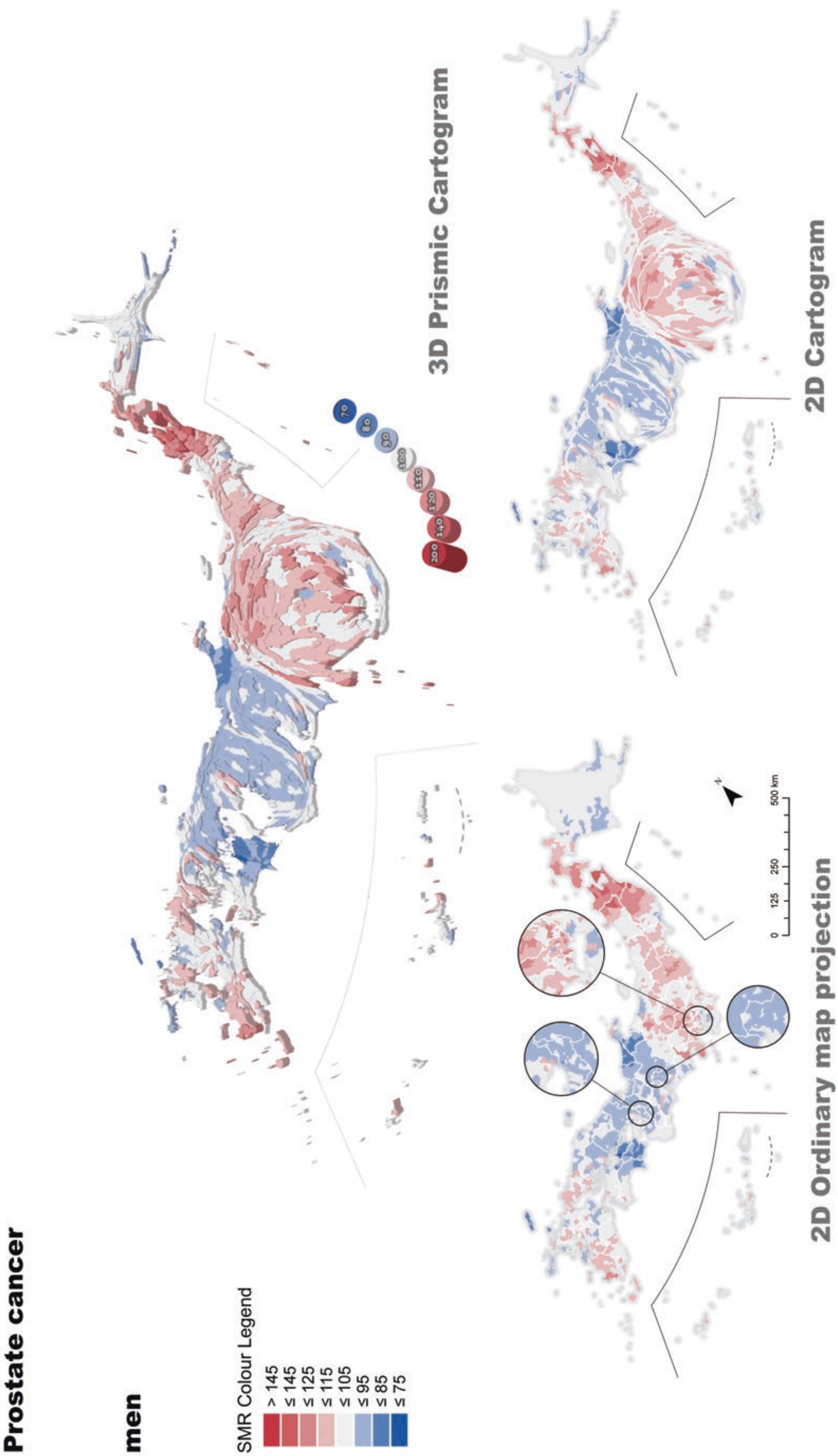


Fig. 4.66 SMR distribution of prostate cancer, men, 2010–2014

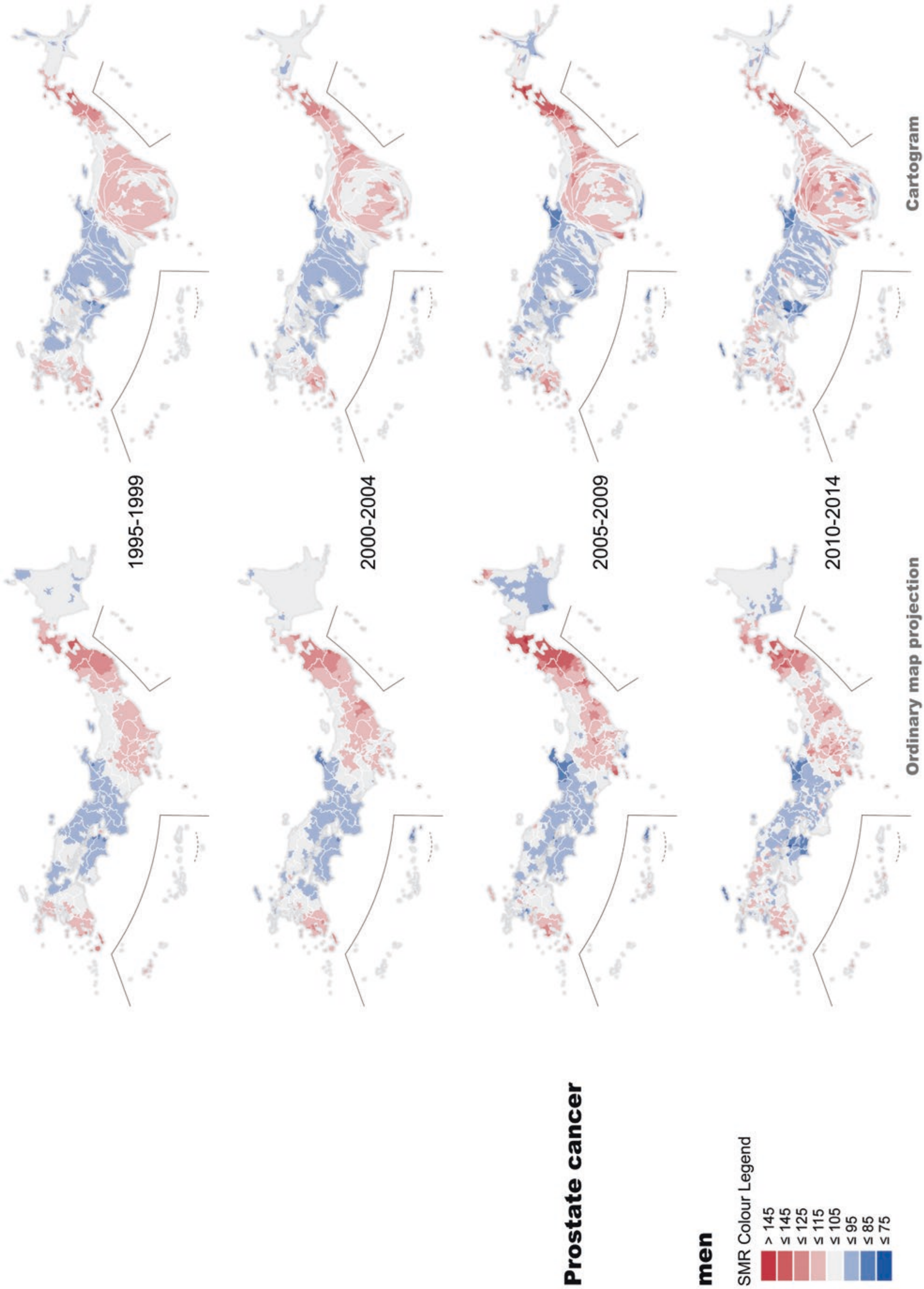
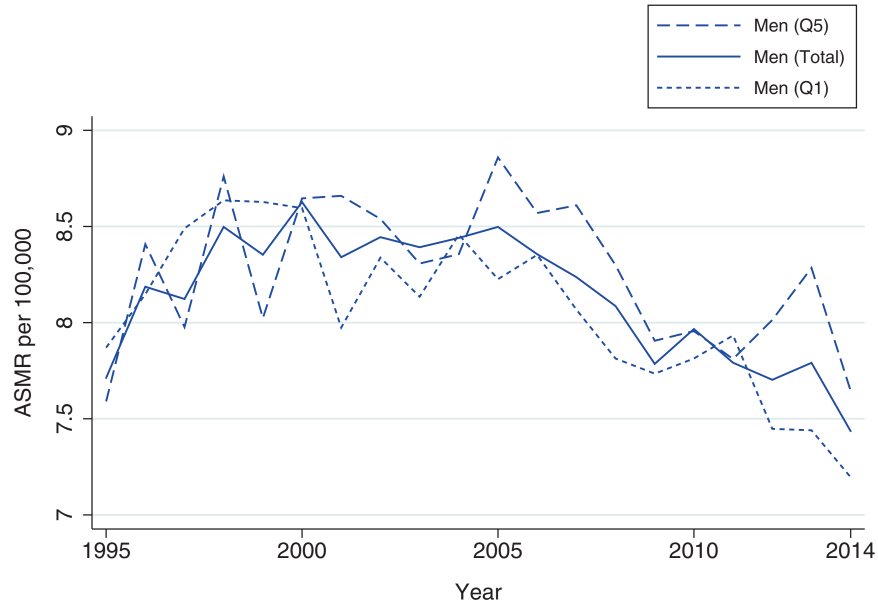


Fig. 4.67 Transition of SMR distribution of prostate cancer, men, from 1995 to 2014 by 5-year period

Fig. 4.68 Annual transition in the ASMR of prostate cancer from 1995 to 2014



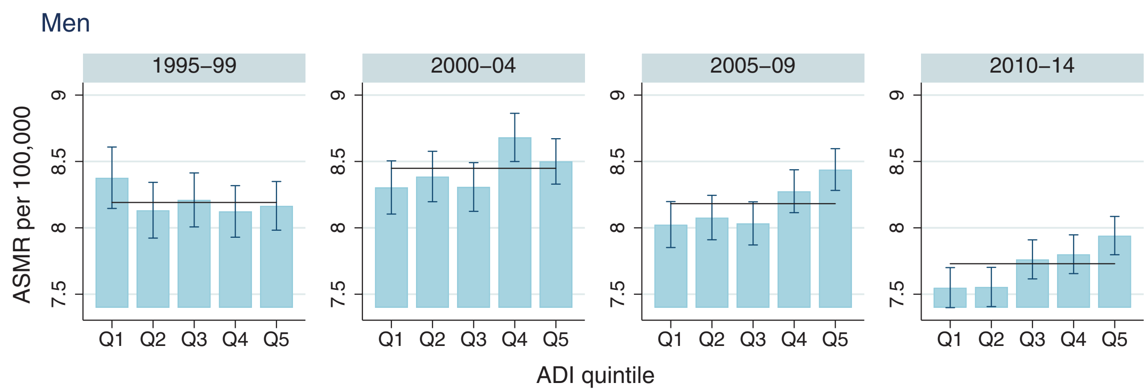
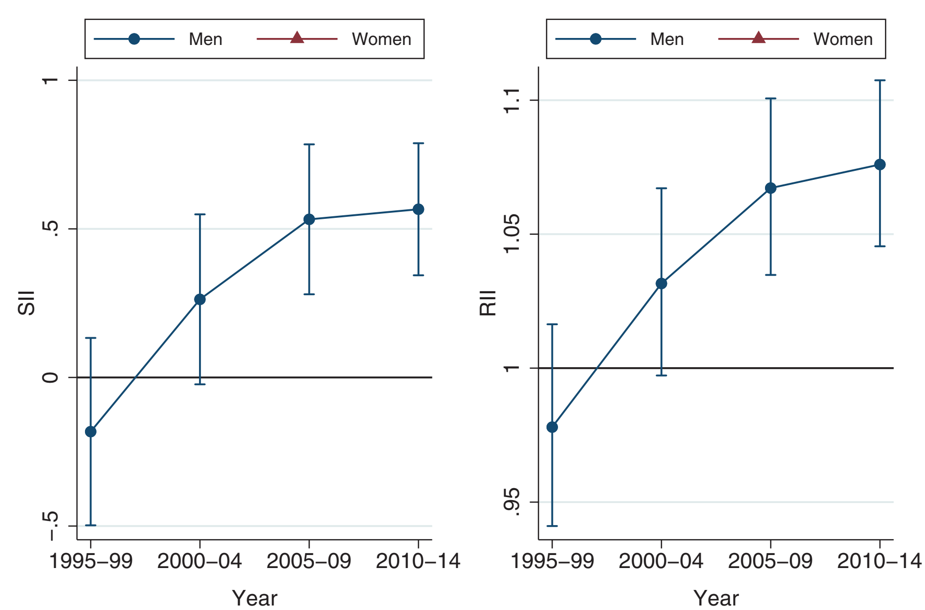


Fig. 4.69 The transition in the ASMR distribution of prostate cancer by ADI quintile (top: men, bottom: women)

Fig. 4.70 Transition in SII and RII of prostate cancer from 1995 to 2014 by 5-year period (left: SII, right: RII)



4.15 Malignant Lymphoma (ICD10: C81–C85, C96): An East-West Dividing Cancer

Yoshikazu Nishino

Overview

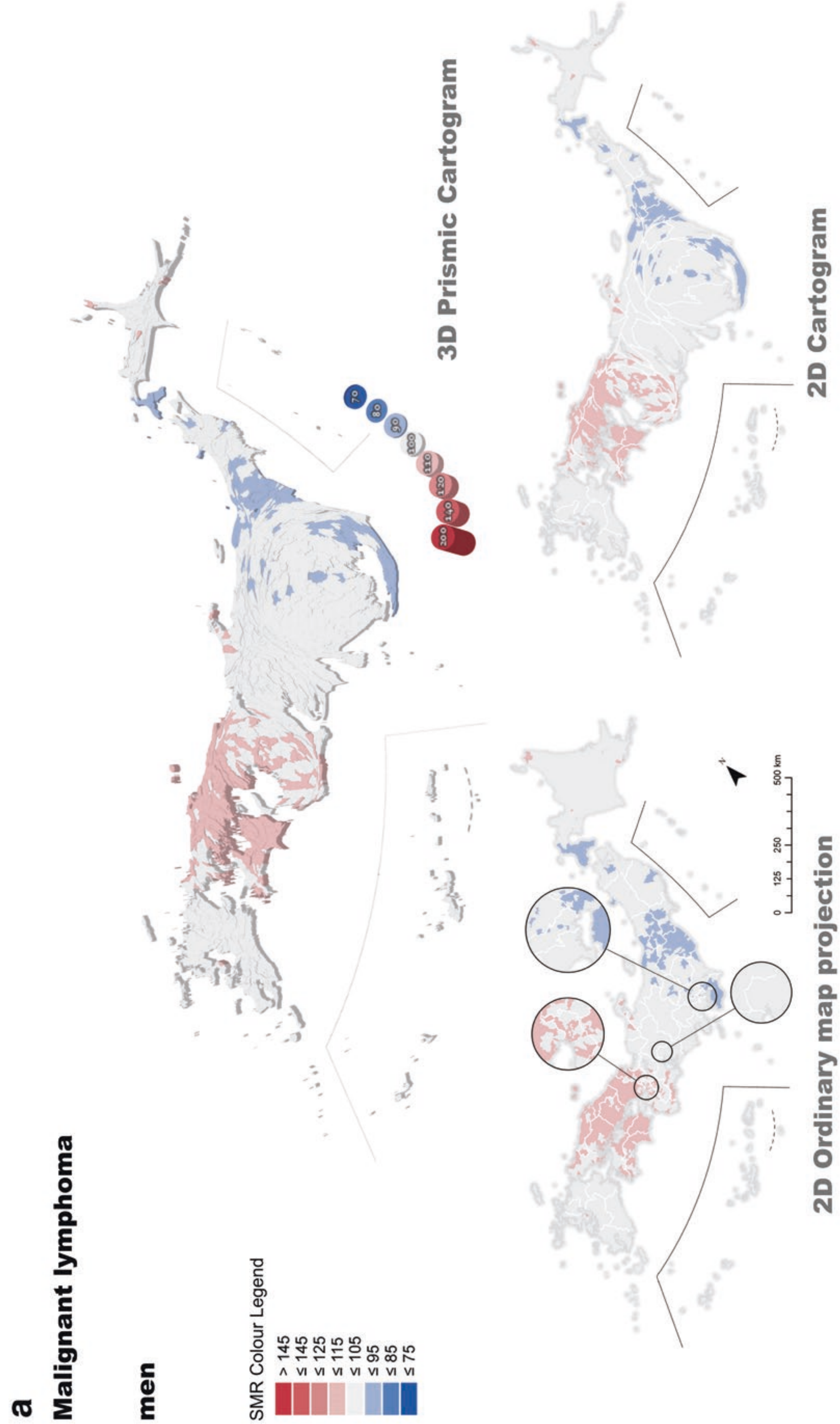
Malignant lymphoma is the ninth most common cause of all cancer deaths in both sexes, equating to 3% of all cancer deaths. Although the regional variation in the SMRs of this disease is small, there is a clear east-west pattern in the SMR map (Fig. 4.71). The observed SMRs of malignant lymphoma were high in the west of Japan, but low in the east. Among men, SMRs were high in the Chugoku and Shikoku regions, low in South Hokkaido, Fukushima Prefecture and the surrounding areas in the Tohoku region and Chiba Prefecture in the Kanto region. Among women, SMRs were high in the Kinki region and low in the Tohoku region and Chiba Prefecture.

HCV infection increases the risk of non-Hodgkin lymphoma incidence (Pozzato et al. 2017). In Japan, the prevalence of HCV is high in western Japan, which might explain the high incidence of malignant lymphoma in the area.

Transitions and Socioeconomic Disparities

The distributional pattern of high SMRs in the west and low SMRs in the east remained fundamentally unchanged during the 20 years from 1995 to 2014 (Fig. 4.72). Among men, low SMR areas were more widely spread before 2010 than the most recent period, 2010–2014. Among the metropolitan areas emphasised by the cartogram, the Keihanshin/Osaka metropolitan area generally showed high SMRs in the 1995–1999 period, but the number of areas with high (over 100) SMRs has decreased since then.

The ASMR of malignant lymphoma has decreased slightly during the 20 years (Fig. 4.73). The socioeconomic gradient of the ASMR was not clear in 1995–2004 but has become apparent since 2005 (Figs. 4.74 and 4.75).


a
Malignant lymphoma
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
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3D Prismic Cartogram
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200
2D Cartogram
2D Ordinary map projection
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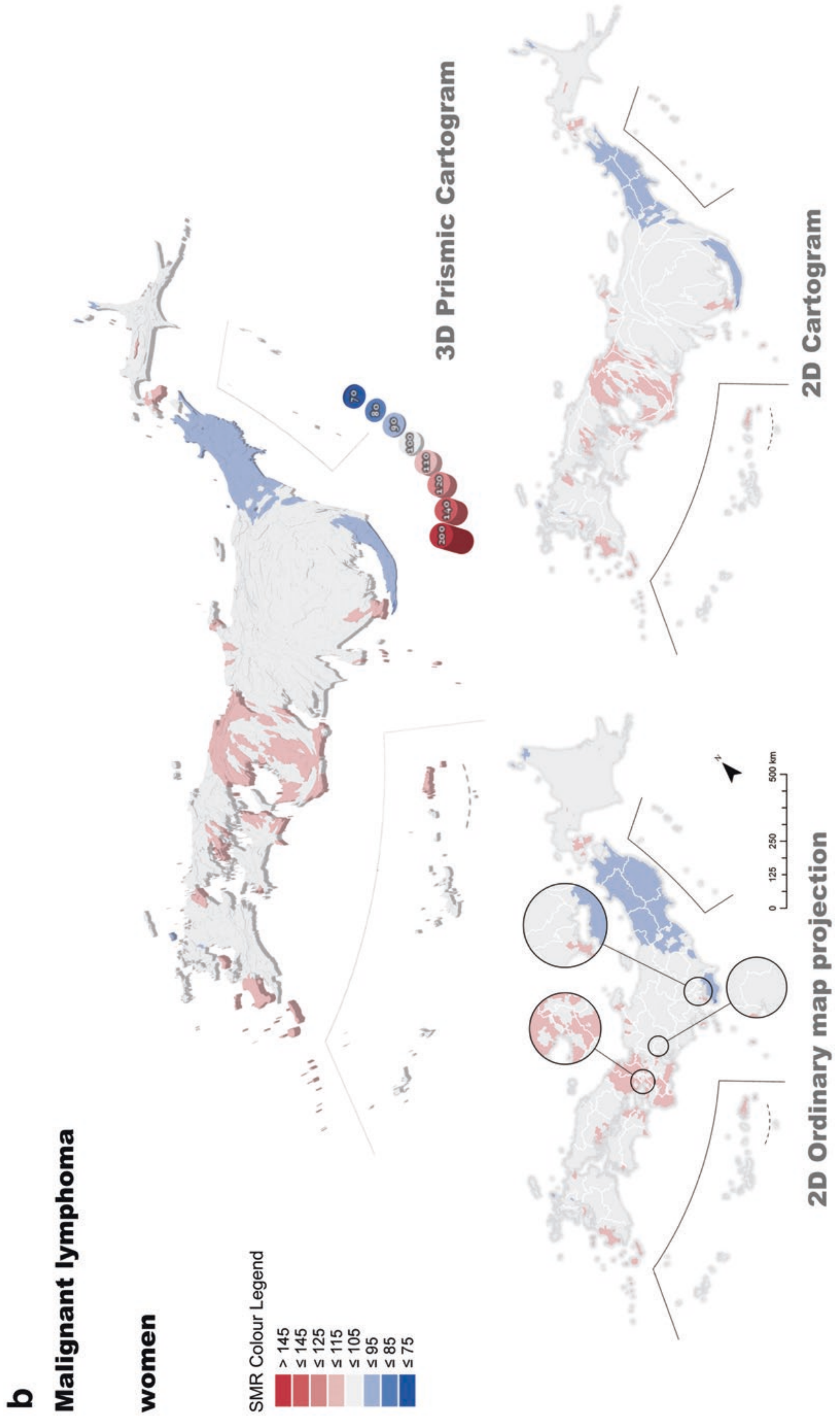


Fig. 4.71 SMR distribution of malignant lymphoma, 2010–2014. (**a**) Men. (**b**) Women

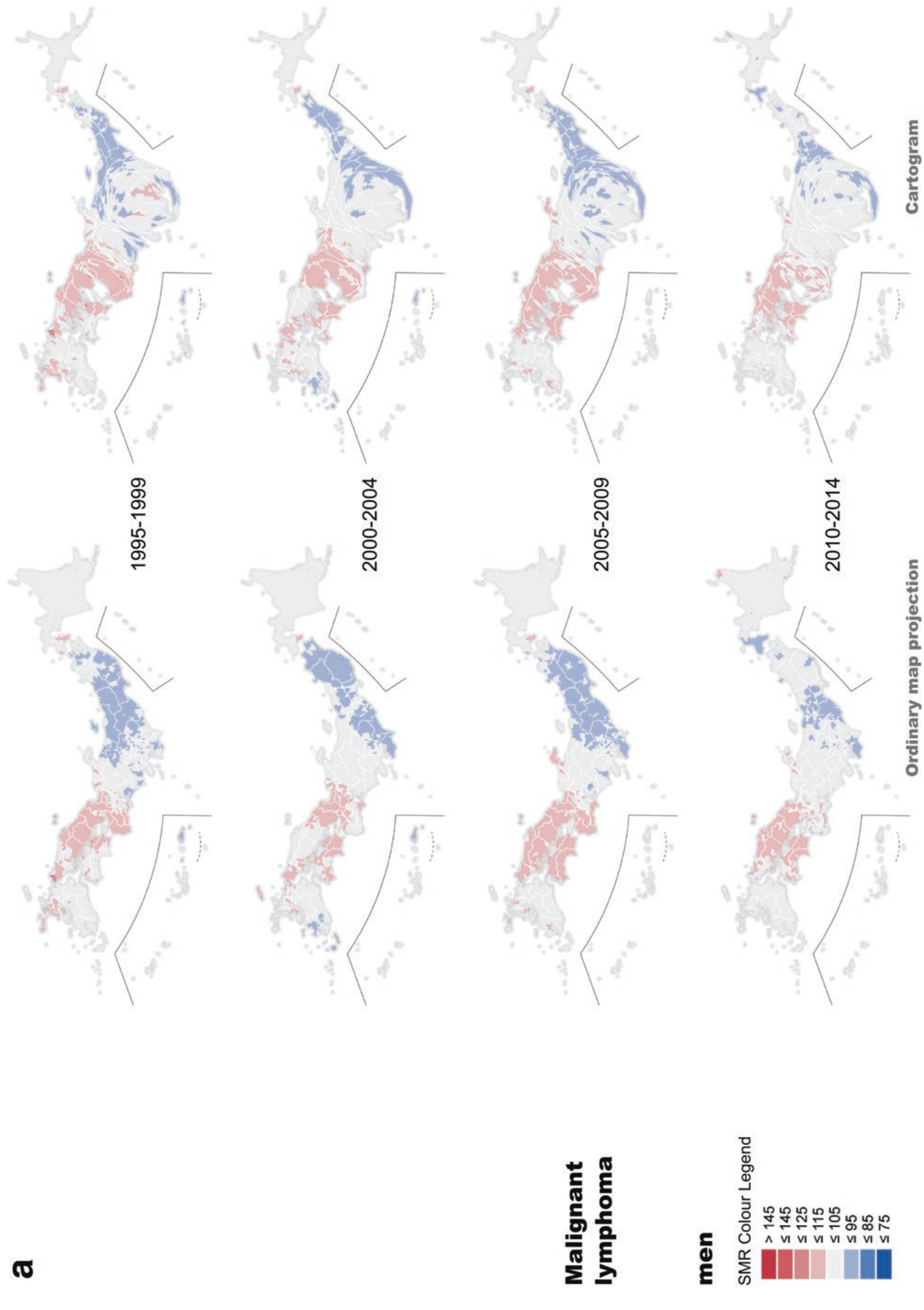

a
Malignant lymphoma
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

Fig. 4.72 Transition of SMR distribution of malignant lymphoma from 1995 to 2014 by 5-year period. **(a)** Men. **(b)** Women

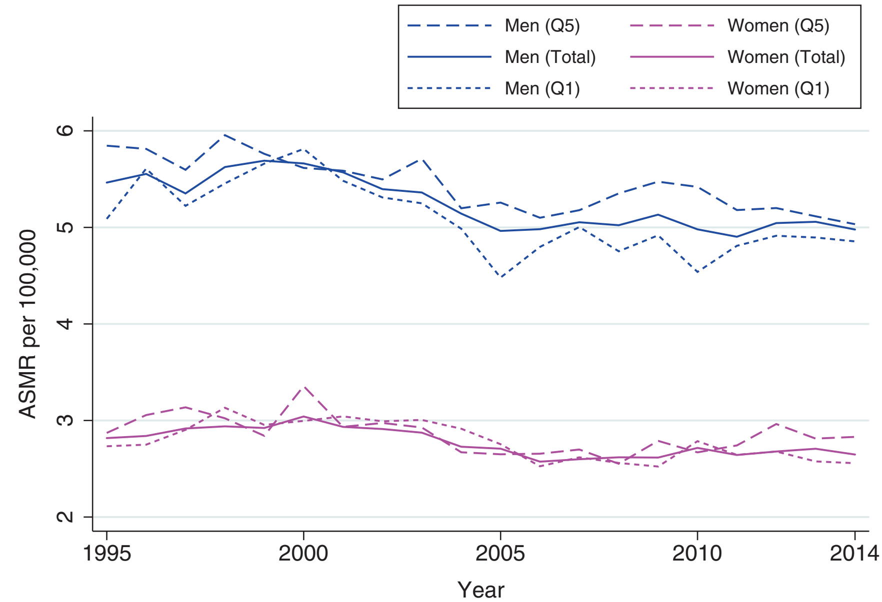


Fig. 4.73 Annual transition in the ASMR of malignant lymphoma from 1995 to 2014

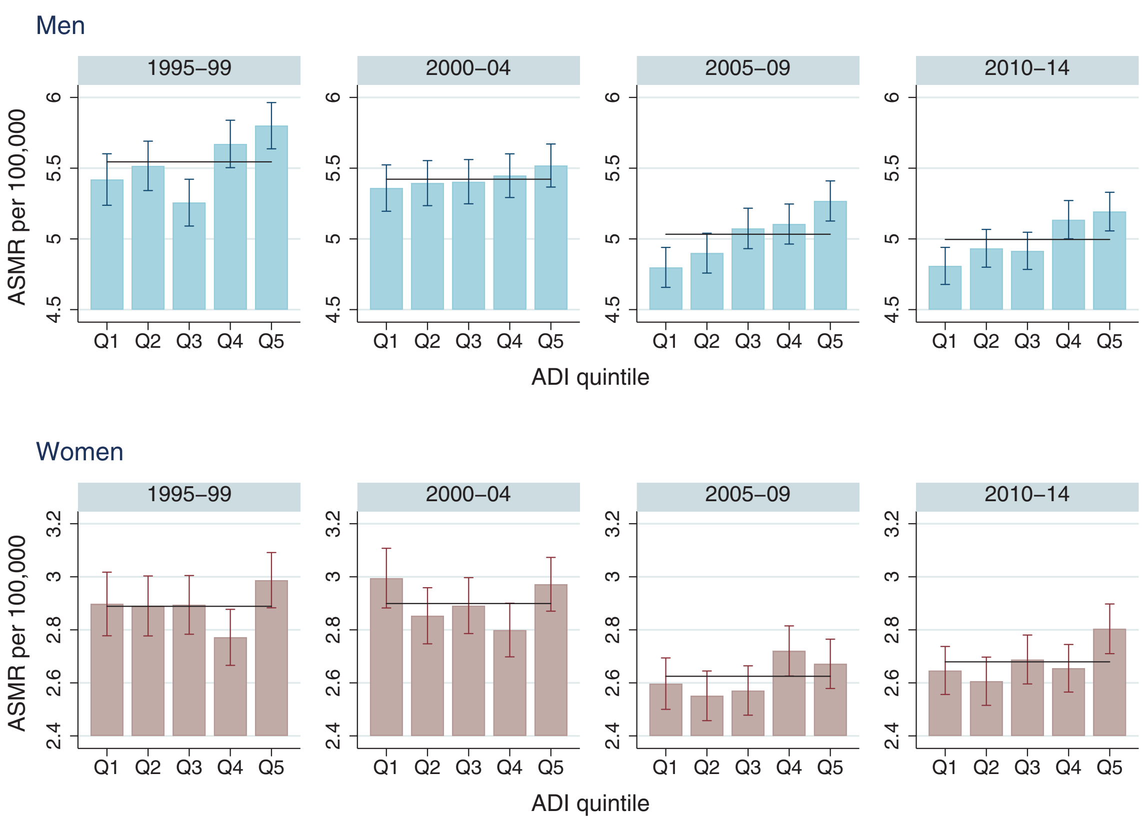


Fig. 4.74 The transition in the ASMR distribution of malignant lymphoma by ADI quintile (top: men, bottom: women)

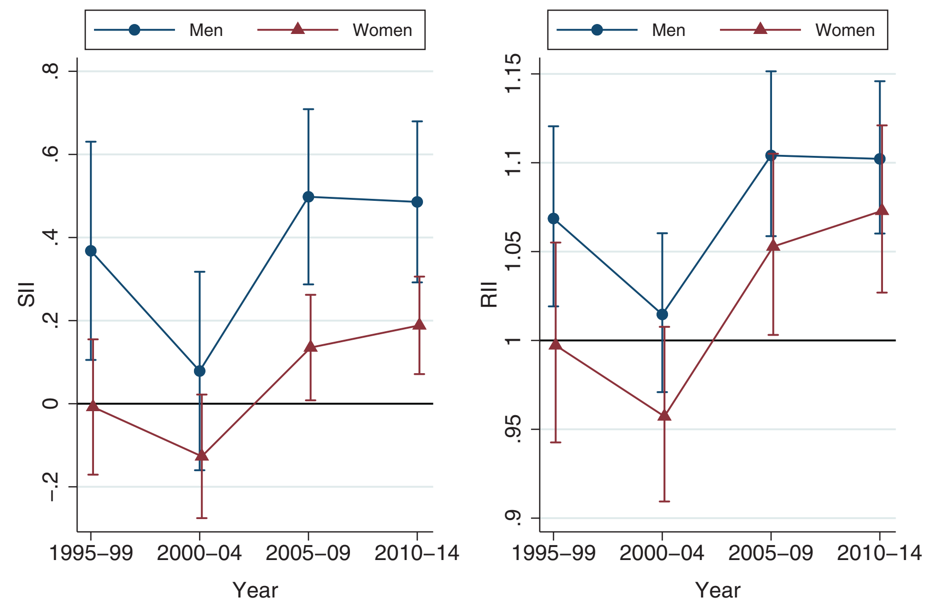


Fig. 4.75 Transition in SII and RII of malignant lymphoma from 1995 to 2014 by 5-year period (left: SII, right: RII)

4.16 Leukaemia (ICD10: C91–C95): Historical Footprints of Past Coastal Migration

Yoshikazu Nishino

Overview

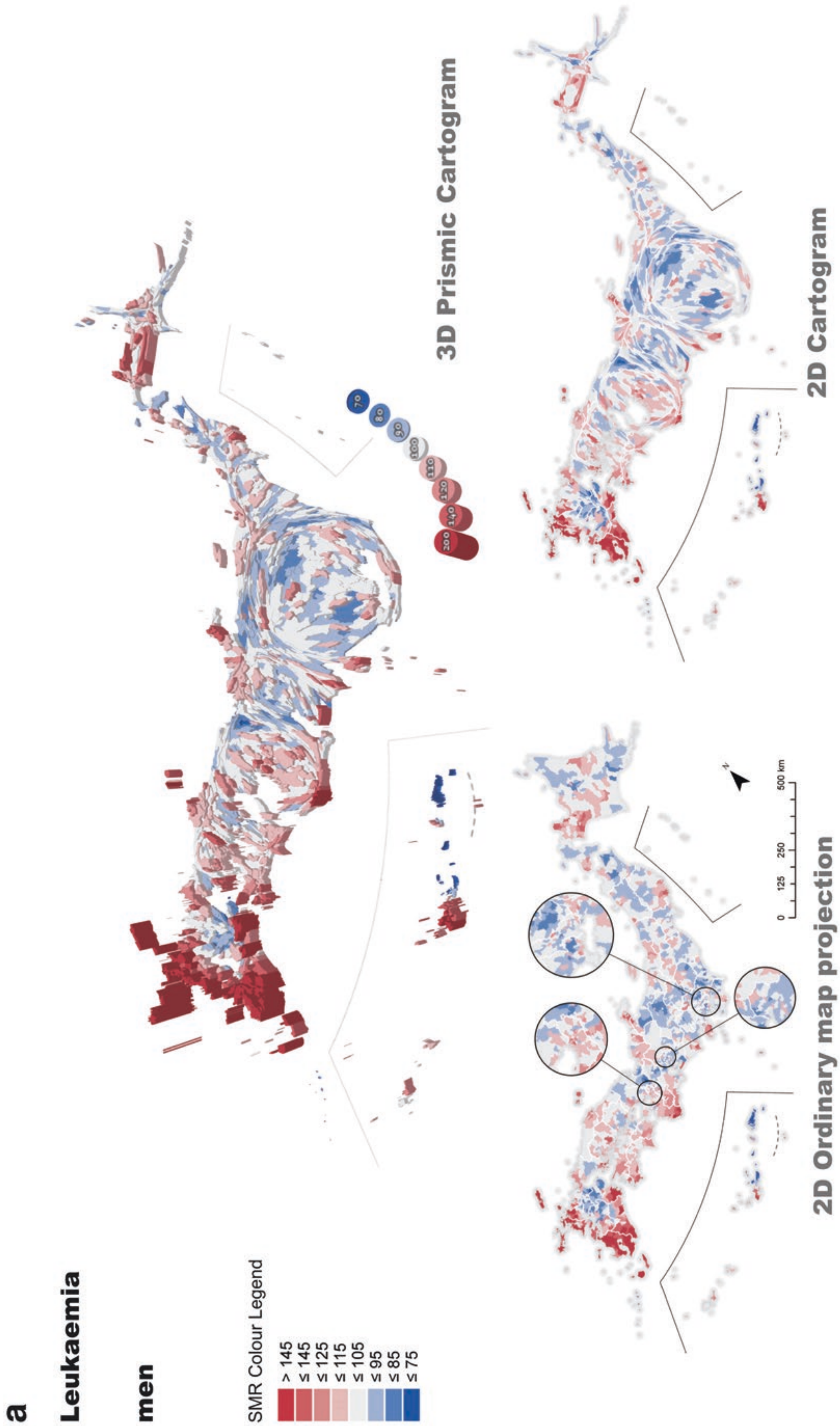
Approximately 2% of all cancer deaths are due to leukaemia. The ASMR of leukaemia in Japan is lower than that in Western countries.

SMRs of leukaemia were very high in the Kyushu region, but some high SMR areas were scattered across the maritime areas covering Hokkaido, Honsyu (the main island of Japan), Shikoku and the Okinawan islands (Fig. 4.76).

The distribution of Adult T-cell leukaemia (ATL) incidence is strongly related to the regional differences in leukaemia incidence in Japan. ATL incidence in the middle-aged and the older adults was attributed to vertical infection of human T-lymphotropic virus type I (HTLV-1) through breastfeeding. Although high prevalence of HTLV-1 and high incidence of ATL have been reported in the Kyushu and Okinawa regions, birth areas of ATL patients are widely distributed throughout Hokkaido, Honsyu—the main island of Japan—and Shikoku. Local hotspots of ATL incidence were reported on the Pacific Ocean side of the Tohoku region, Kii Peninsula in Wakayama and Mie Prefectures, and the southern coastal part of Shikoku region (Tajima 1990). Some transmission could be attributable to past migration of HTLV-1 carriers along sea routes from the Kyusyu region to other parts of Japan.

Transitions and Socioeconomic Disparities

While there was no fundamental change of SMR distribution during the 20 years from 1995 to 2014 (Fig. 4.77), the ASMR of leukaemia decreased (Fig. 4.78). The distributions of ASMR by ADI quintile show that in Q5, the most deprived quintile group of areas, the ASMR has been consistently highest (Fig. 4.79). In addition, the RII was large, especially among women (Fig. 4.80). These indicate that the coastal regions which have high leukaemia mortality tend to have high areal deprivation. Trends in the RII were stable during the 20 years.


a
Leukaemia
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
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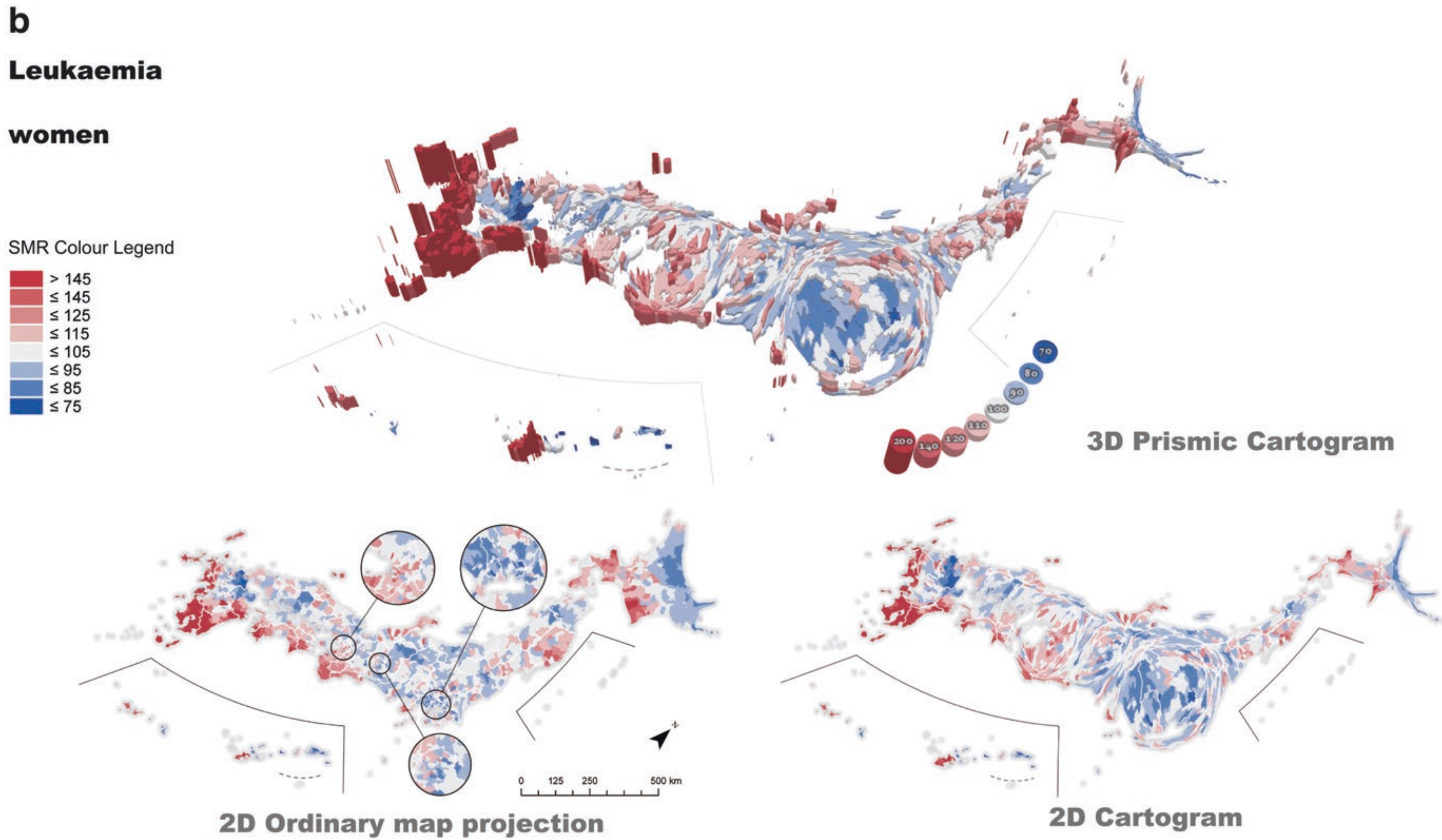
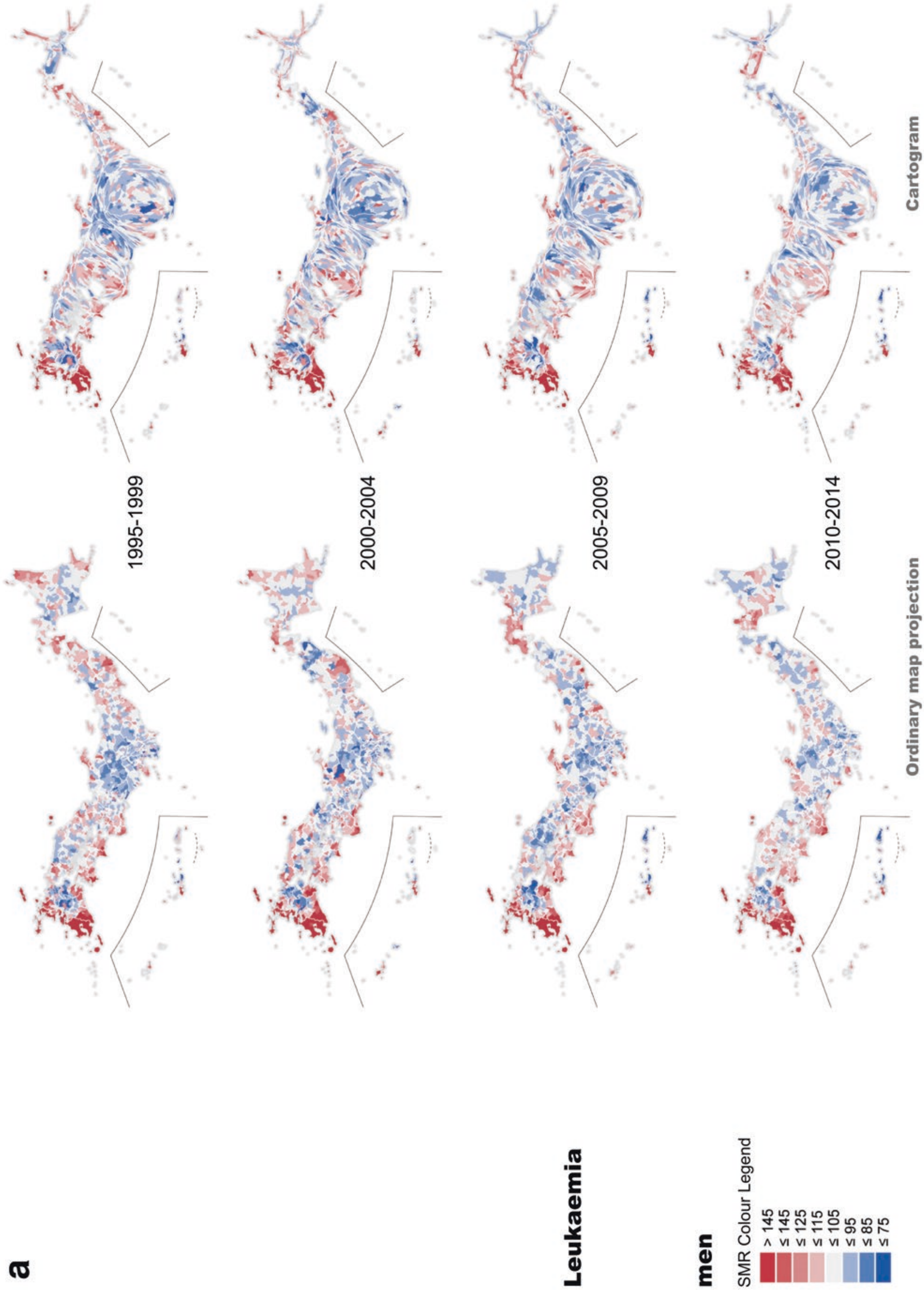


Fig. 4.76 SMR distribution of leukaemia, 2010–2014. (**a**) Men. (**b**) Women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SMR Colour Legend
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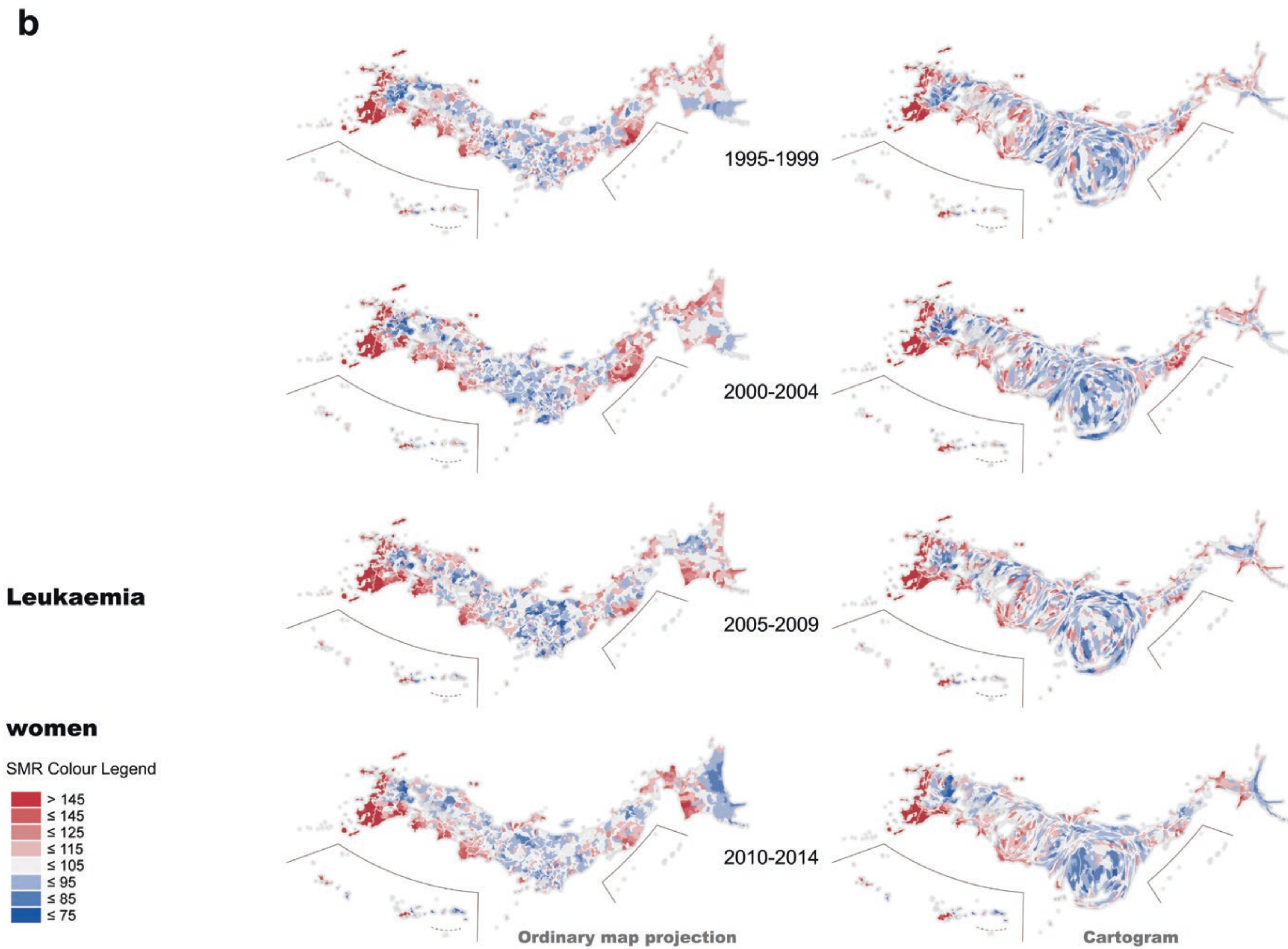
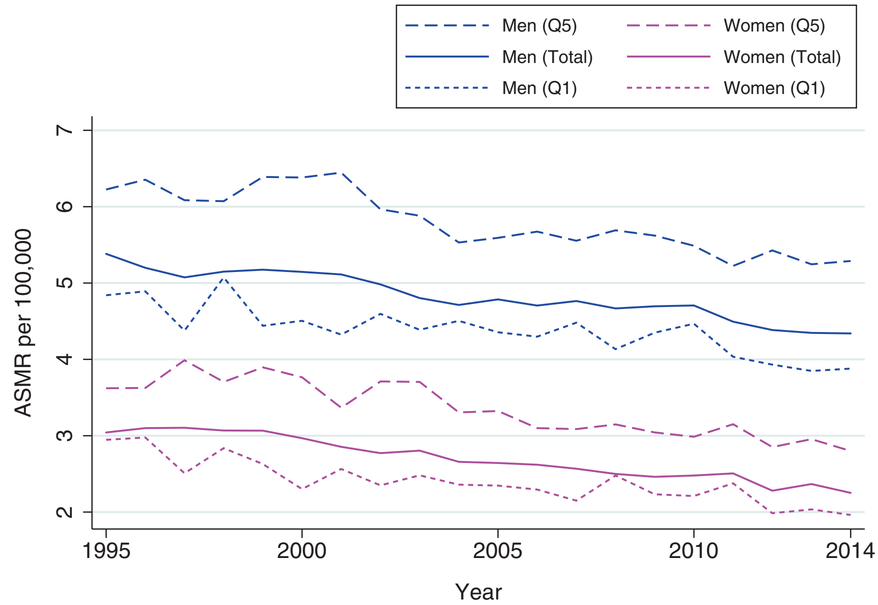


Fig. 4.77 Transition of SMR distribution of leukaemia from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 4.78 Annual transition in the ASMR of leukaemia from 1995 to 2014



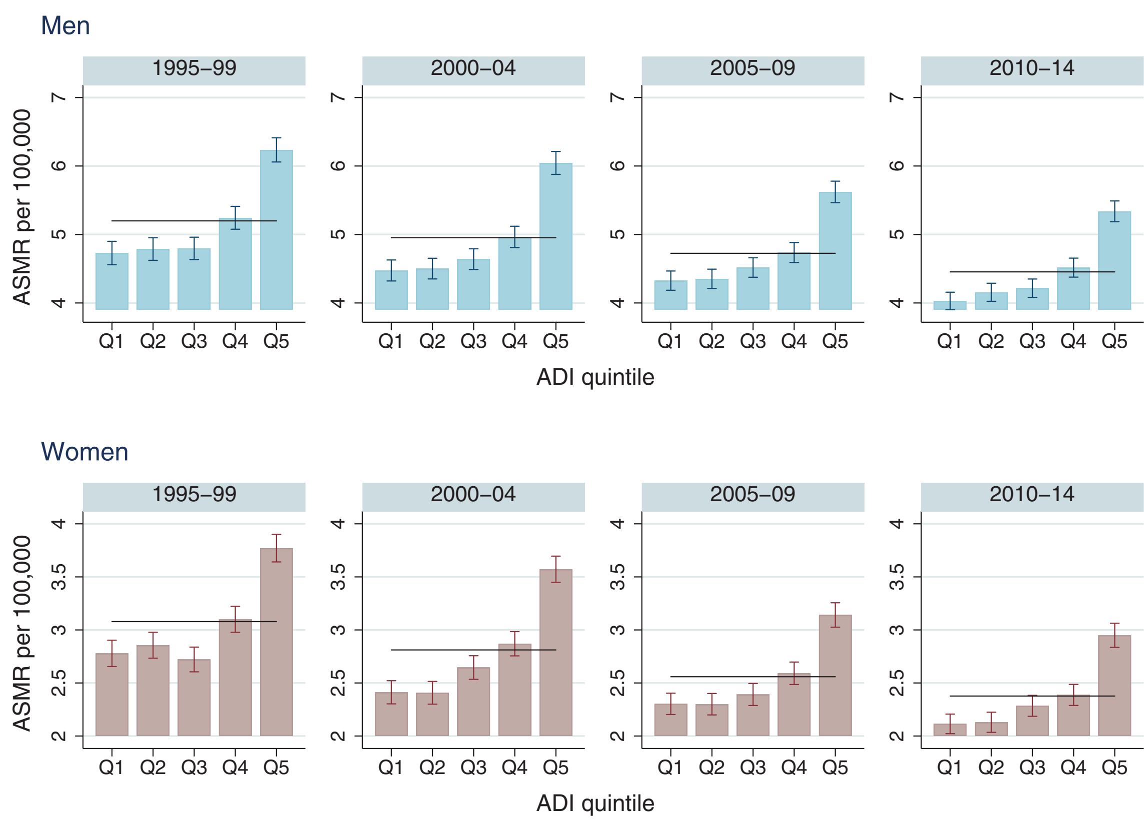


Fig. 4.79 The transition in the ASMR distribution of leukaemia by ADI quintile (top: men, bottom: women)

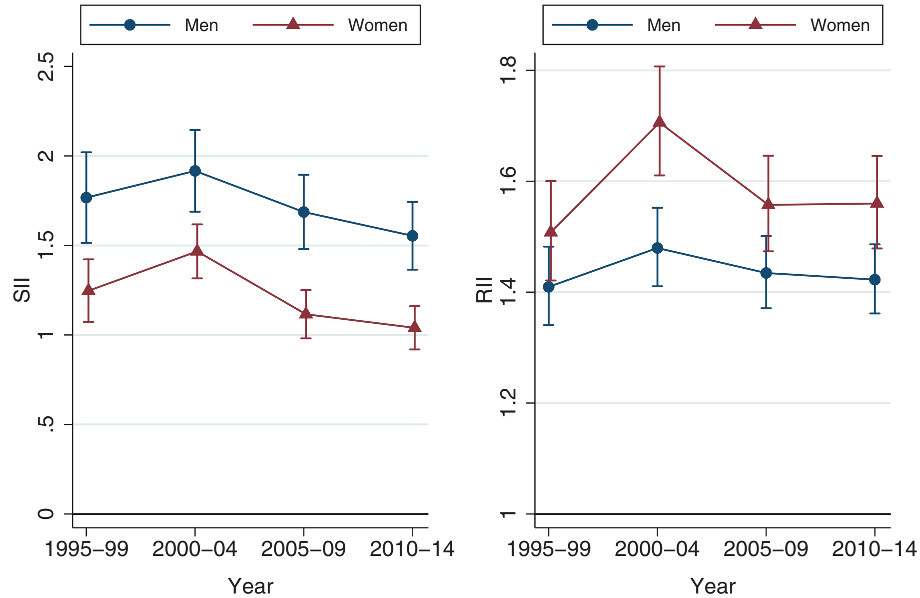


Fig. 4.80 Transition in SII and RII of leukaemia from 1995 to 2014 by 5-year period (left: SII, right: RII)

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5 Deaths from Circulatory Diseases

Ryozo Matsuda, Shigeru Inoue, Hiroyuki Kikuchi, and Yuri Ito

This chapter has maps showing geographical inequalities in mortality from major circulatory diseases including cardiovascular disease and cerebrovascular disease known as heart disease as well as other closely related diseases, such as diabetes millets, in Japan from 1995 to 2014. The categories of cardiovascular and cerebrovascular diseases are the second and fourth leading causes of death respectively in Japan, accounting for 15.8% and 9.6% of all deaths from 2010 to 2014. The maps show that the standardized mortality ratios (SMRs) of many circulatory diseases are generally low in urban areas and tend to be high in rural areas. Cartograms-based SMR maps highlight that urban areas, particularly the Tokyo and Osaka metropolitan areas, have lower SMRs but high SMRs for inner-city parts within those areas. Area-based socioeconomic disparities (deprivation gaps) in the age-standardized mortality rate (ASMR) are observed in many types of circulatory diseases, particularly for men. While most socioeconomic disparities have been gradually widening, there are some inverse geographic disparities, such as the category of other ischemic heart diseases. For these, higher mortality tends to be observed in urban and less deprived areas.

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5.1 Heart Disease (Excluding Hypertensive Disease) (ICD10: I01-I02.0, I05-I09, I20-I25, I27, I30-I52): High Burden in Rural and Metropolitan Edges

Shigeru Inoue and Hiroyuki Kikuchi

Overview

This is an integrated category of heart disease covering most types of heart diseases, such as ischemic heart disease, valvular disease, heart failure, pericarditis, cardiomyopathy, arrhythmias, and cardiac arrest. It excludes hypertensive (heart) diseases.

It includes cardiac diseases ranging from those requiring the most urgent treatment to those requiring chronic management, and it is believed that access to comprehensive health care measures for heart disease is related to the mortality rates from this disease. SMRs are high in some parts of Hokkaido, the northern part of Tohoku and Kanto regions, and peripheral regions of the Tokyo and Osaka metropolitan areas (Fig. 5.1). Affluent suburbs within the Tokyo metropolitan area as well as areas in the central mountainous region around Nagano Prefecture have low SMRs. The geographical distribution is similar for both men and women.

Transitions and Socioeconomic Disparities

Overall, the regional contrast between high and low SMRs has been getting clearer over the period from 1995 to 2014 (Fig. 5.2). In the core part of Nagoya/Chukyo metropolitan area, the cartogram-based series of SMR maps reveals one

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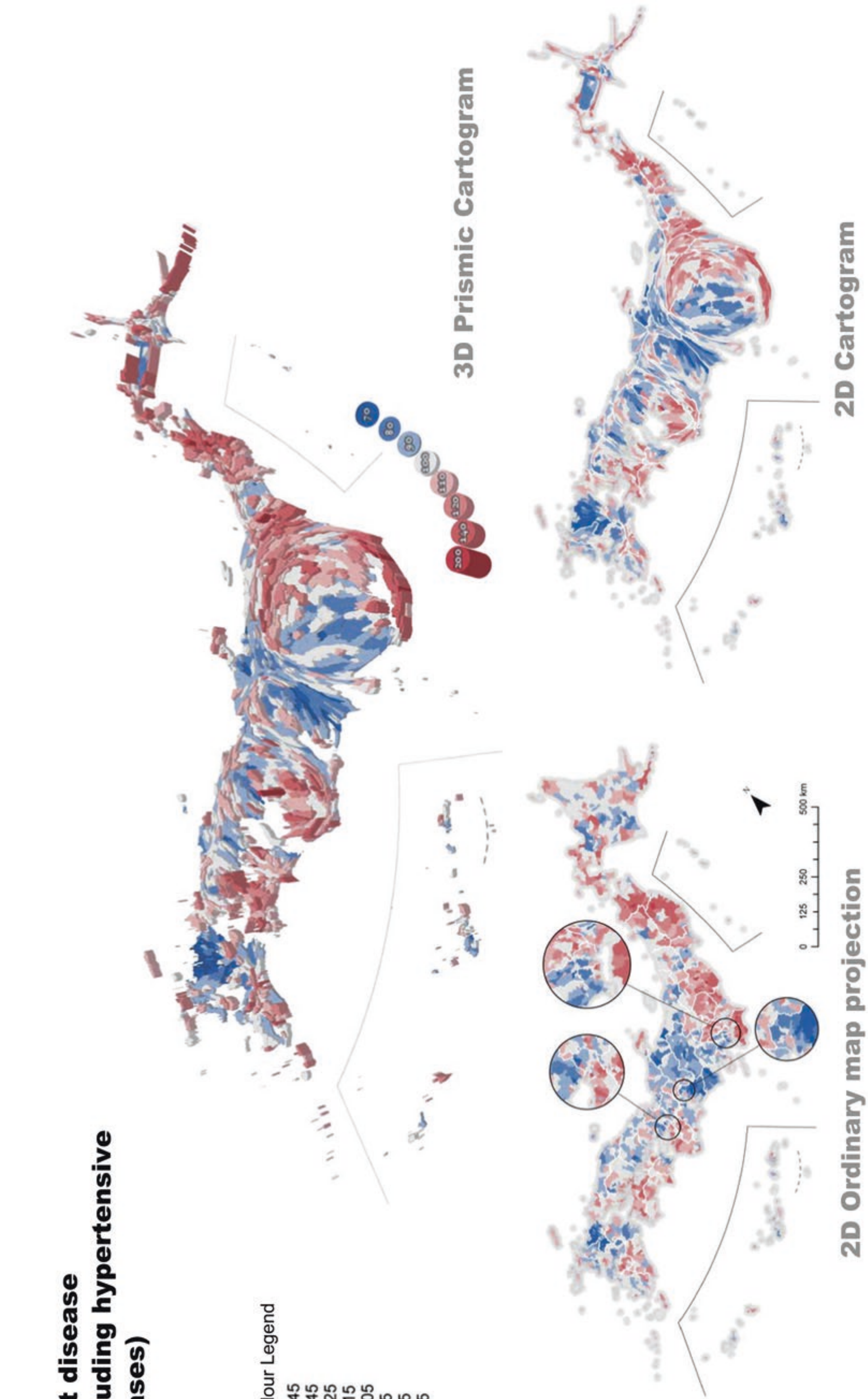
a
Heart disease (excluding hypertensive diseases)
men
SMR Colour Legend
> 145
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3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
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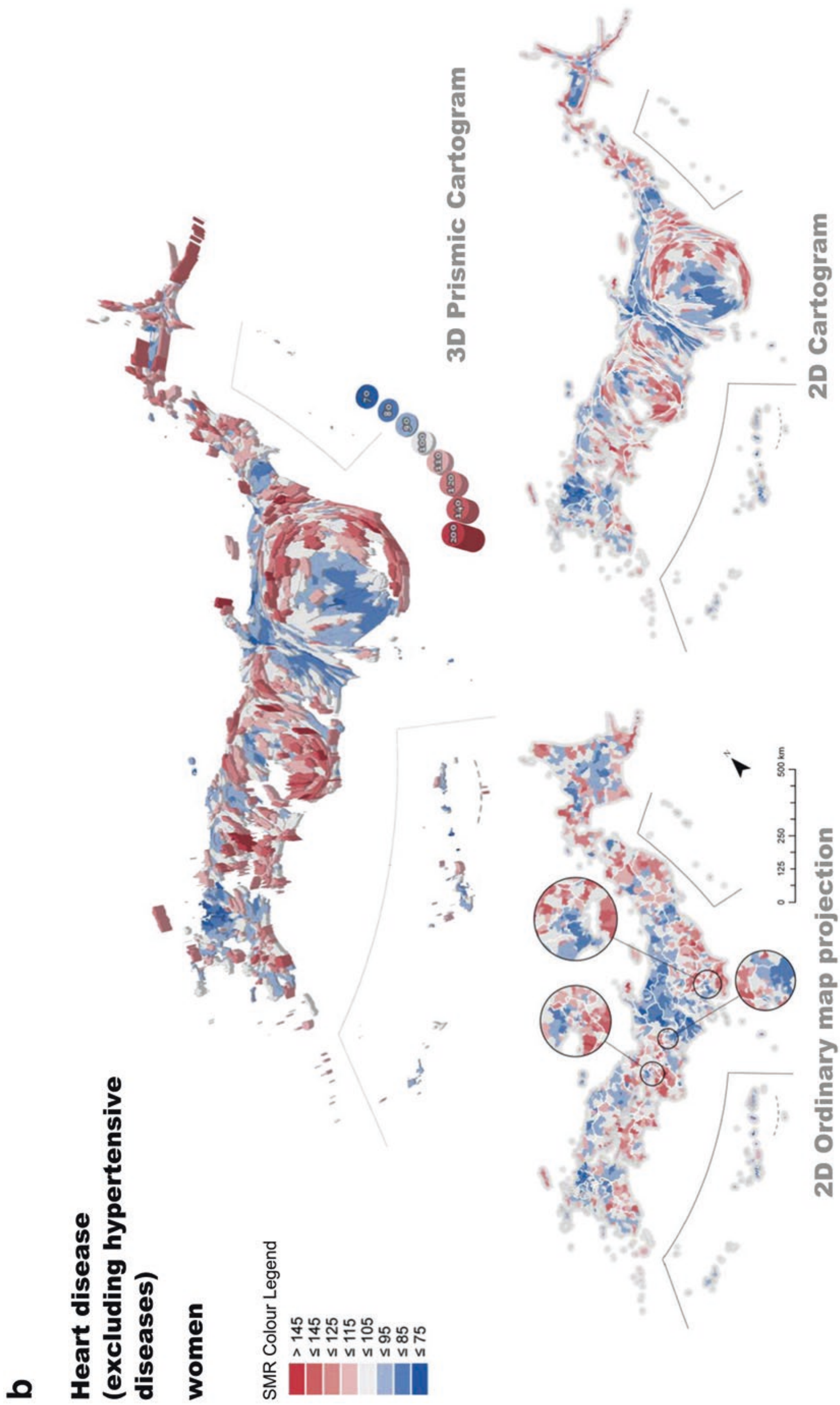
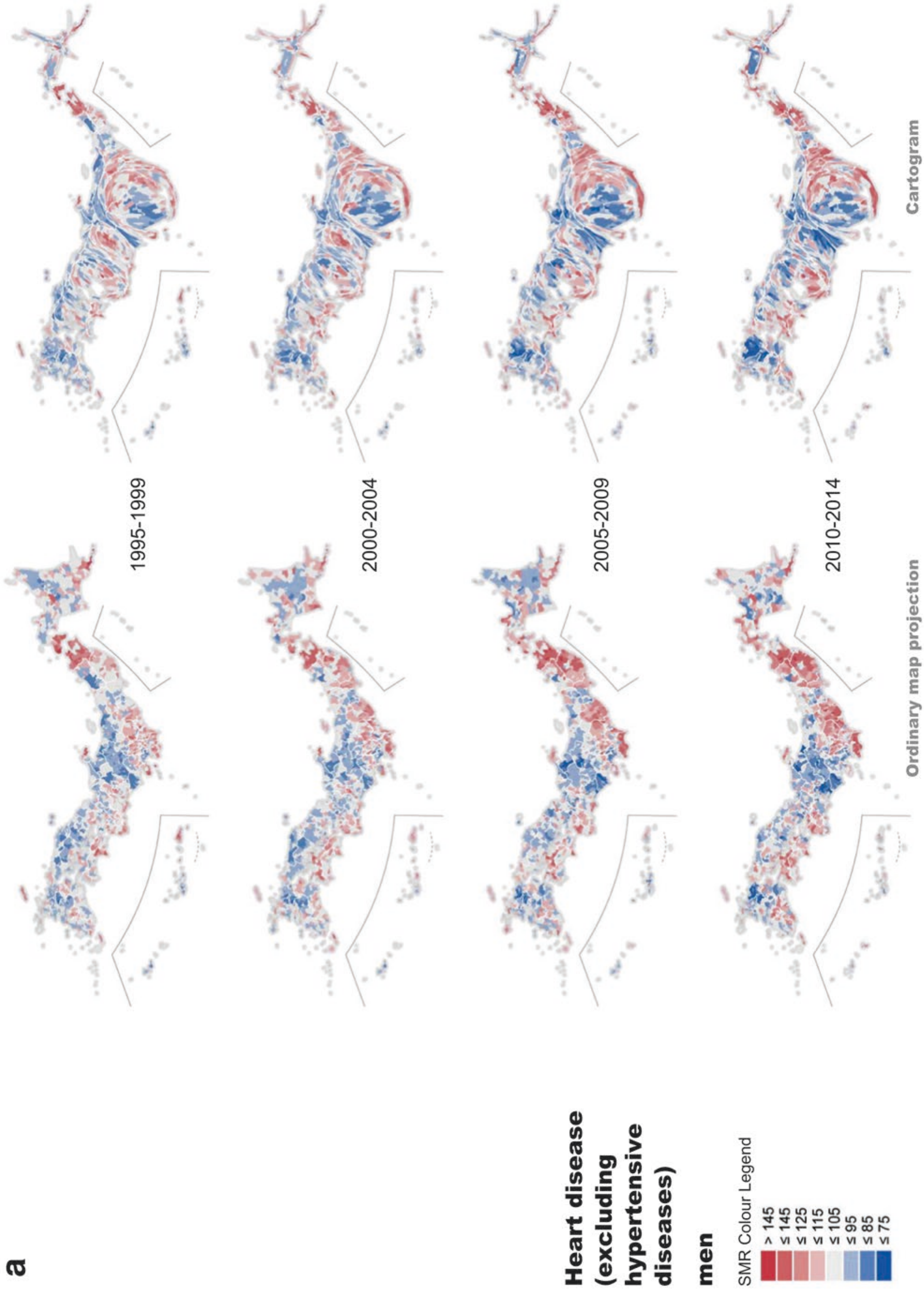


Fig. 5.1 SMR distribution of heart disease (excluding hypertensive diseases), 2010–2014. (**a**) Men. (**b**) Women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Heart disease (excluding hypertensive diseases)
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Ordinary map projection
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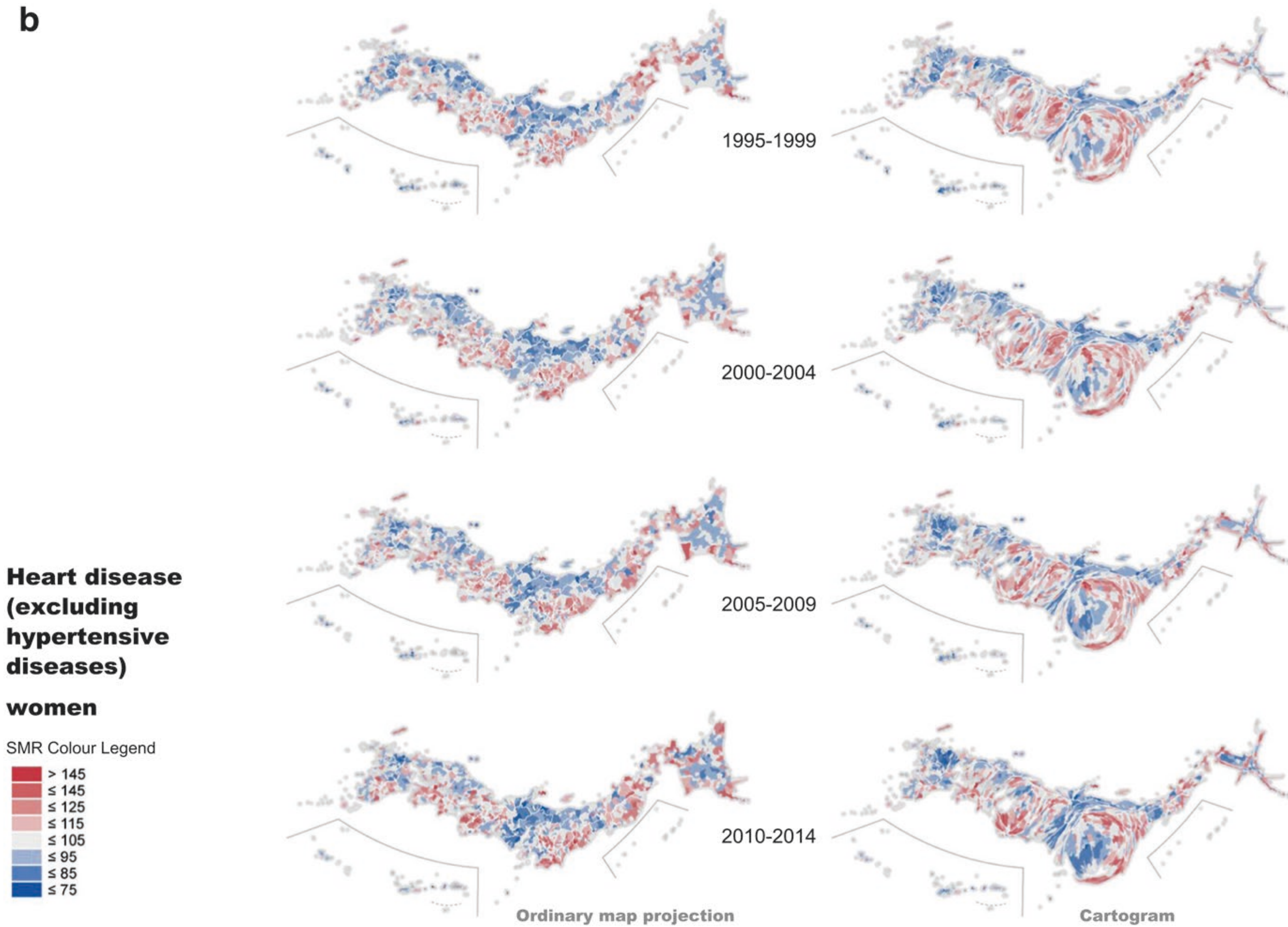


Fig. 5.2 Transition of SMR distribution of heart disease (excluding hypertensive diseases) from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

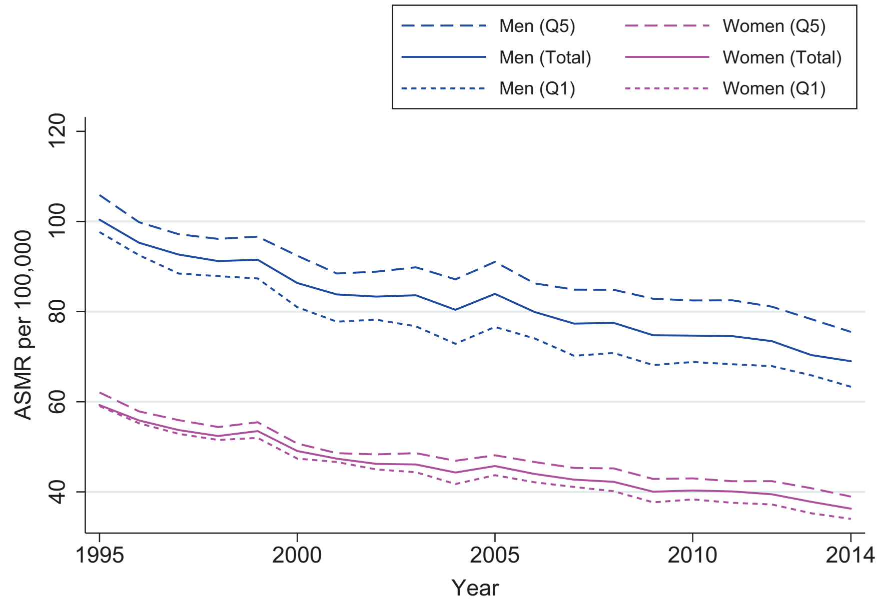


Fig. 5.3 Annual transition in the ASMR of heart disease (excluding hypertensive diseases) from 1995 to 2014

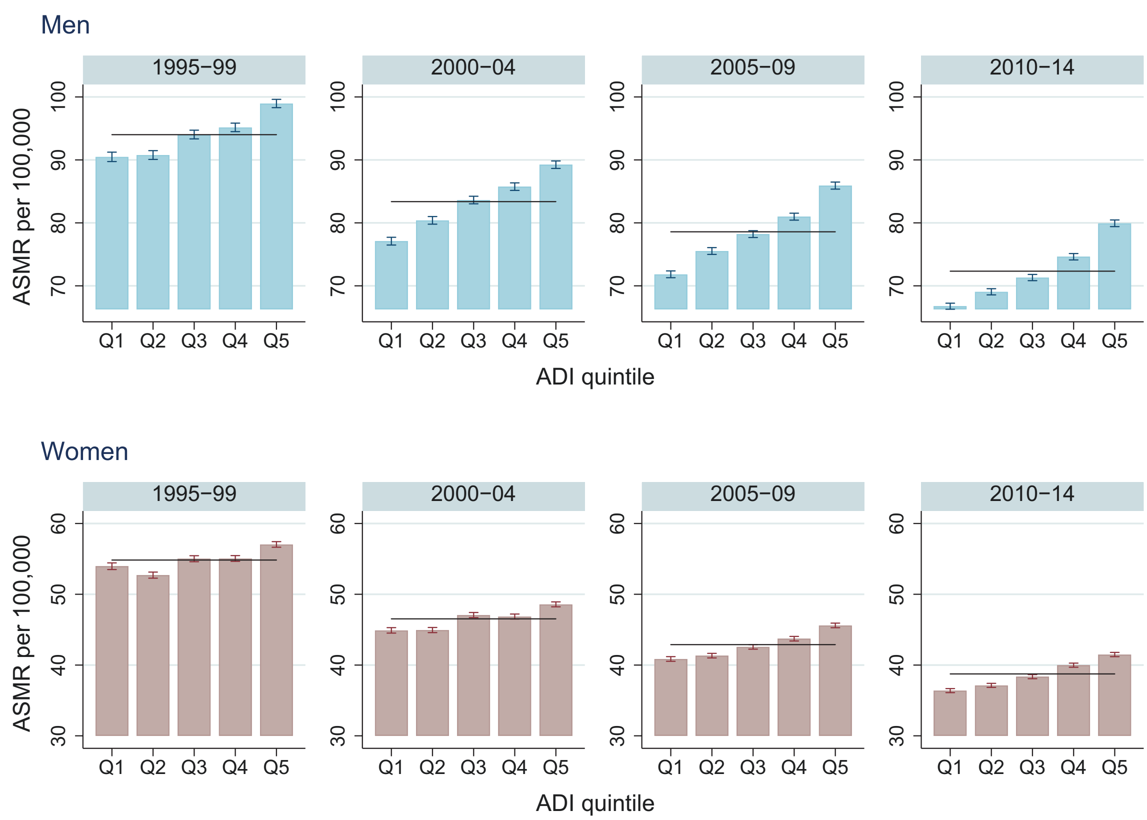


Fig. 5.4 The transition in the ASMR distribution of heart disease (excluding hypertensive diseases) by ADI quintile. (Top: Men, Bottom: Women)

exceptionally drastic change from high SMRs in the period from 1995 to 1999 to low SMRs in that from 2010 to 2014.

The ASMR of heart disease (excluding hypertension) has decreased for both sexes (Fig. 5.3). Higher mortality rates in more deprived areas have been consistent throughout the 20-year period but the socioeconomic disparity is larger for men than women (Fig. 5.4). As can be seen from the temporal trend of RII, the relative socioeconomic inequality has been widened (Fig. 5.5). The absolute socioeconomic inequality measured by SII was also larger in the latest period from 2010 to 2014 than in the earliest period from 1995 to 1999.

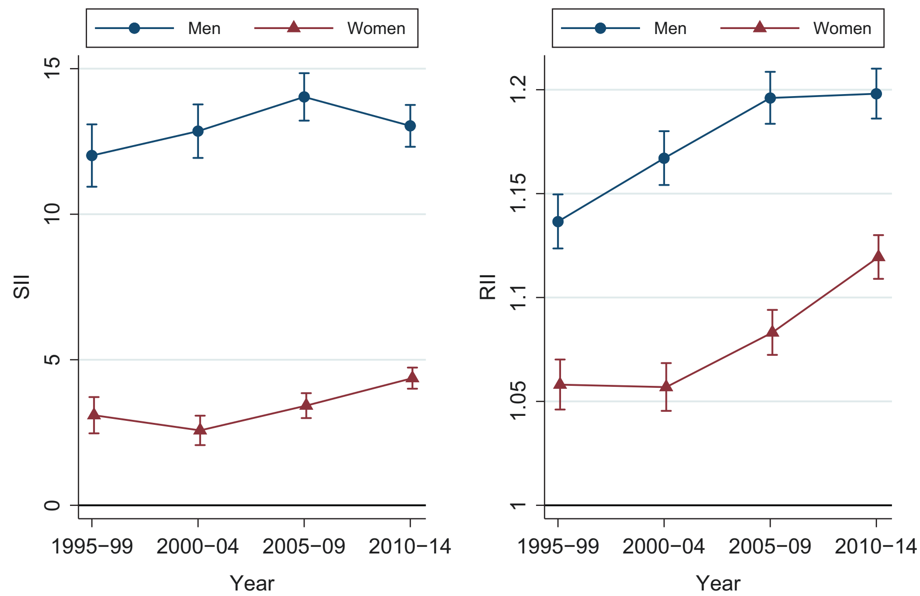


Fig. 5.5 Transition in SII and RII of heart disease (excluding hypertensive diseases) from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.2 Acute Myocardial Infarction (ICD10: I21): A Consistent Burden for Rural Areas

Shigeru Inoue and Hiroyuki Kikuchi

Overview

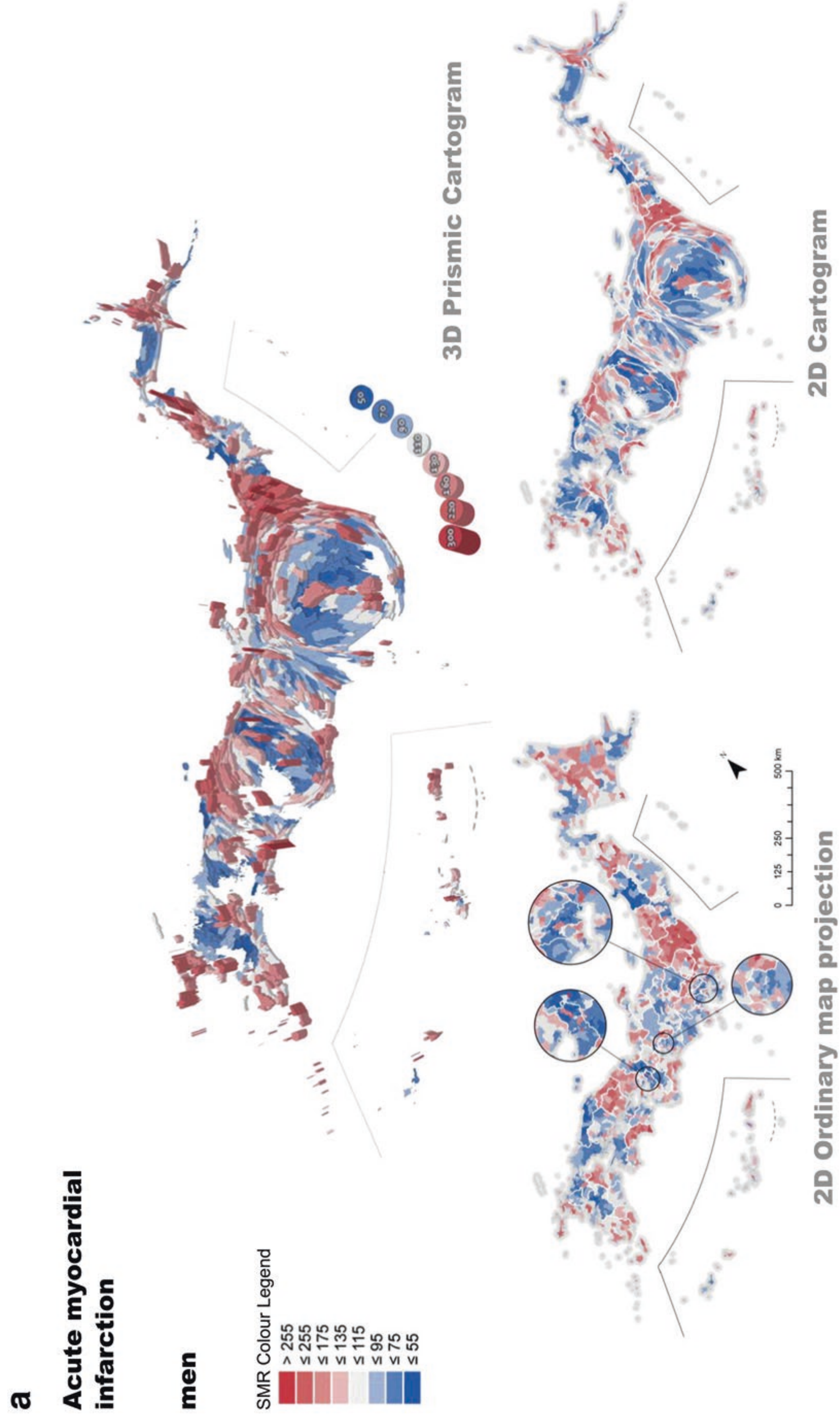
This category of deaths includes acute myocardial infarction and recurrent myocardial infarction. The disease is known to have lifestyle and atherosclerotic risk factors which could be common in deprived regions. When rescued during the acute phase, other categories of death (e.g. old myocardial infarction, heart failure) might ultimately be the cause of death instead of acute myocardial infarction. Thus, the geographical variation in the mortality of the disease may be associated with the level of acute-phase care, including the emergency medical system. Namely, in regions with well-established medical systems, deaths during the acute phase of myocardial infarction may be suppressed, resulting that deaths due to other categories of heart disease, such as heart failure and chronic ischemic heart disease, may increase.

While SMRs are high in various rural areas, including Aomori, Fukushima, Tottori, and Kochi Prefectures, SMR tends to be quite low in metropolitan areas (Fig. 5.6). Differences in health care supply systems, particularly access to emergency medicine, may contribute to this regional disparity.

Transitions in the Study Period

For both men and women, areas with high SMR and areas with low SMR have become easier to distinguish from 1995 to 2014, indicating a widening trend of relative regional mortality risk across Japan (Fig. 5.7). An increase of SMR in Fukushima Prefecture has been observed since before the Great East Japan Earthquake disaster in 2011, but the SMR in the prefecture has been even higher in the period from 2010 to 2014. In contrast, Iwate Prefecture, which also suffered severely from the disaster, shows a downward trend of SMR. The cartogram-based SMR maps make it easier to visualize the temporal changes of SMRs in metropolitan regions with large populations. Reviewing at changes in such areas, the decline in SMR is particularly noticeable in western Tokyo and Osaka Prefecture.

The ASMR of acute myocardial infarction shows a downward trend for both sexes (Fig. 5.8). The high mortality rate in deprived regions has been consistent throughout the 20-year period (Fig. 5.9). As can be seen from the temporal trend of RII, the relative socioeconomic inequality has slightly widened since around 2000 for women (Fig. 5.10). The socioeconomic disparity in mortality was previously greater for men compared to women, but recently the difference between men and women has been diminished.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Acute myocardial infarction
men
SMR Colour Legend
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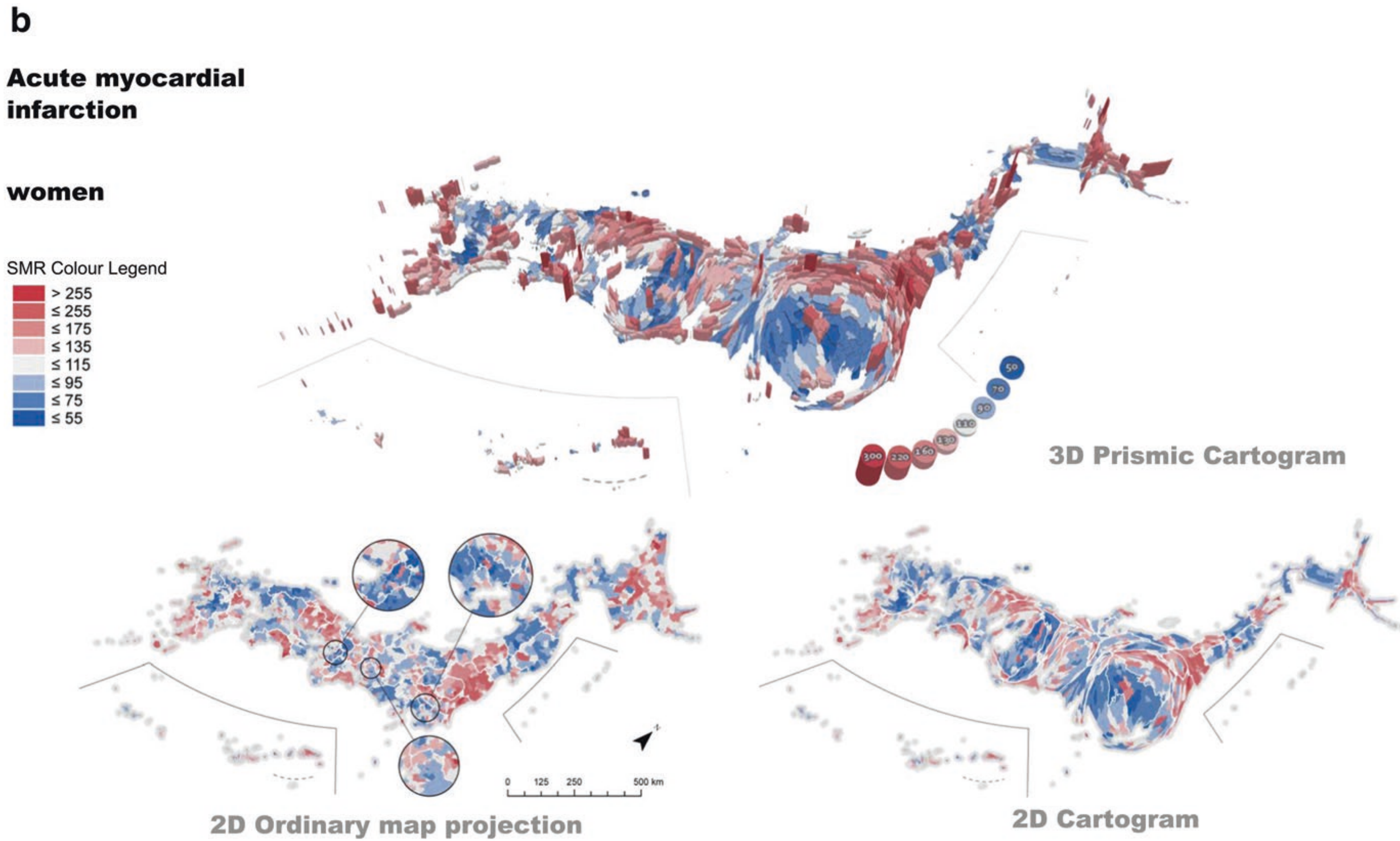
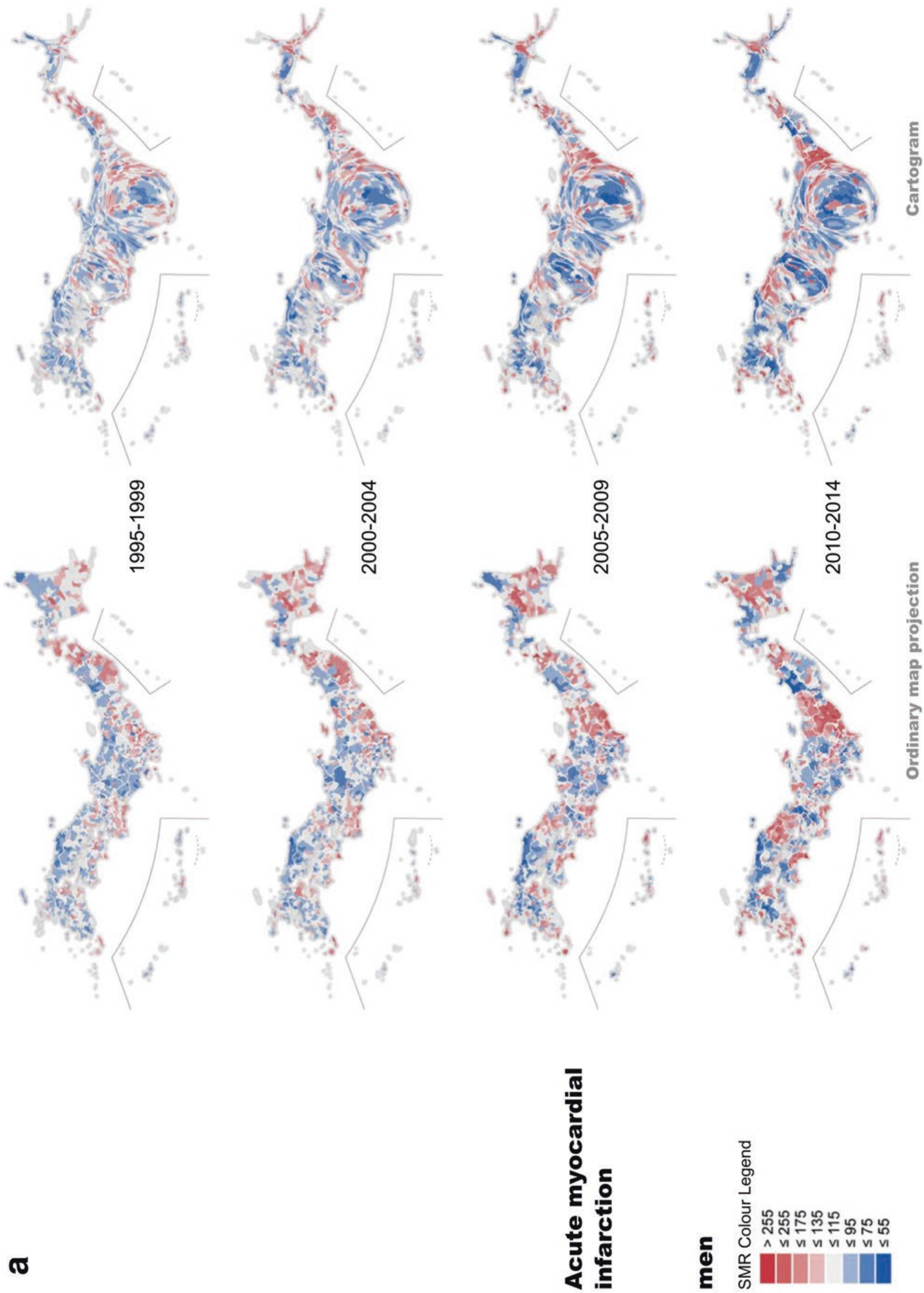


Fig. 5.6 SMR distribution of acute myocardial infarction, 2010–2014. (**a**) Men. (**b**) Women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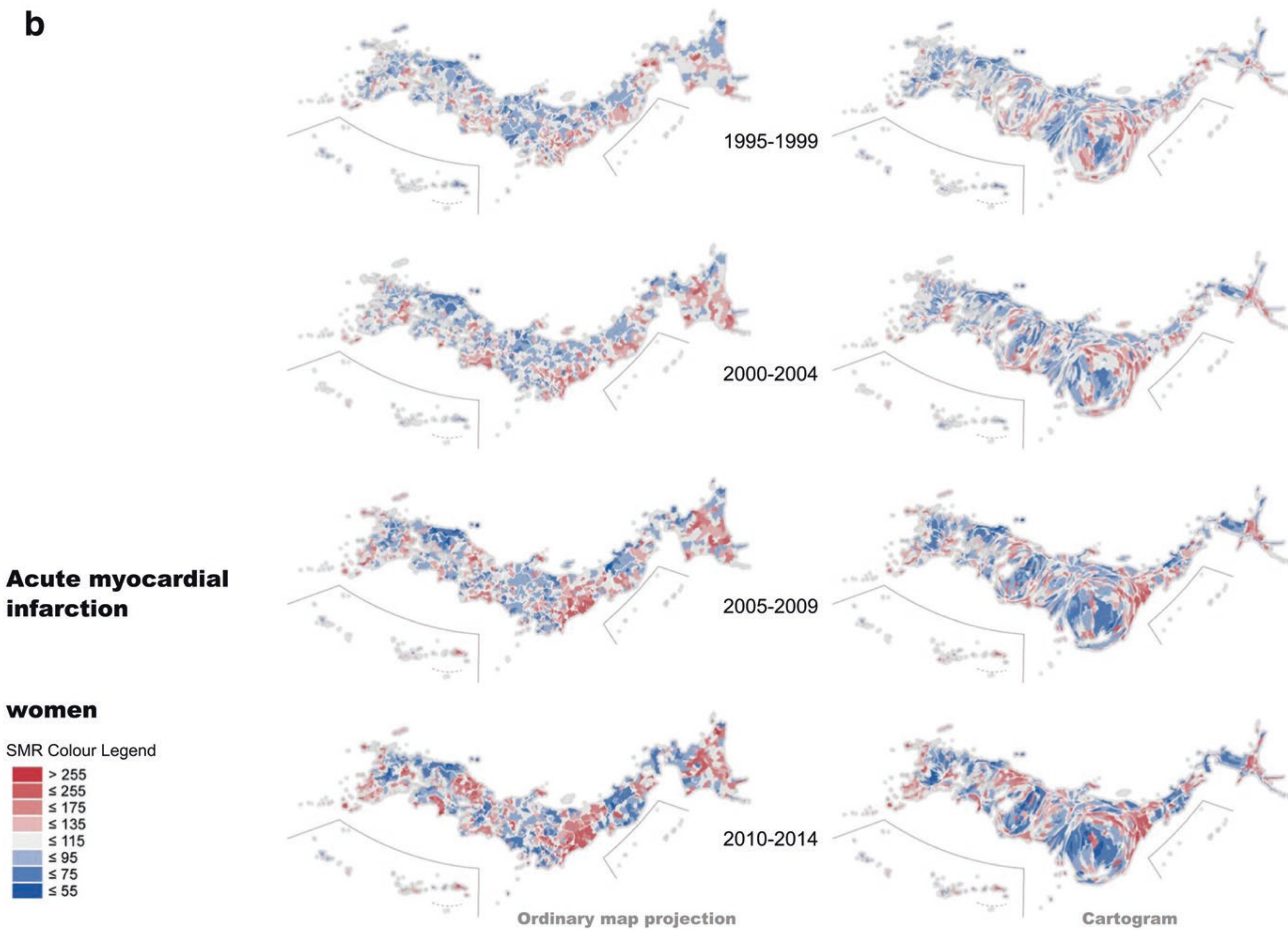
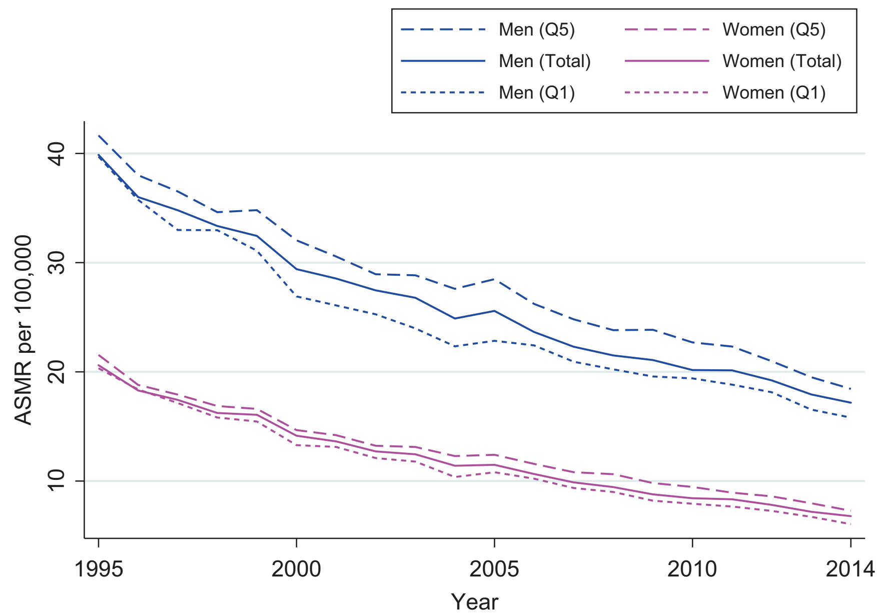


Fig. 5.7 Transition of SMR distribution of acute myocardial infarction from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.8 Annual transition in the ASMR of acute myocardial infarction from 1995 to 2014



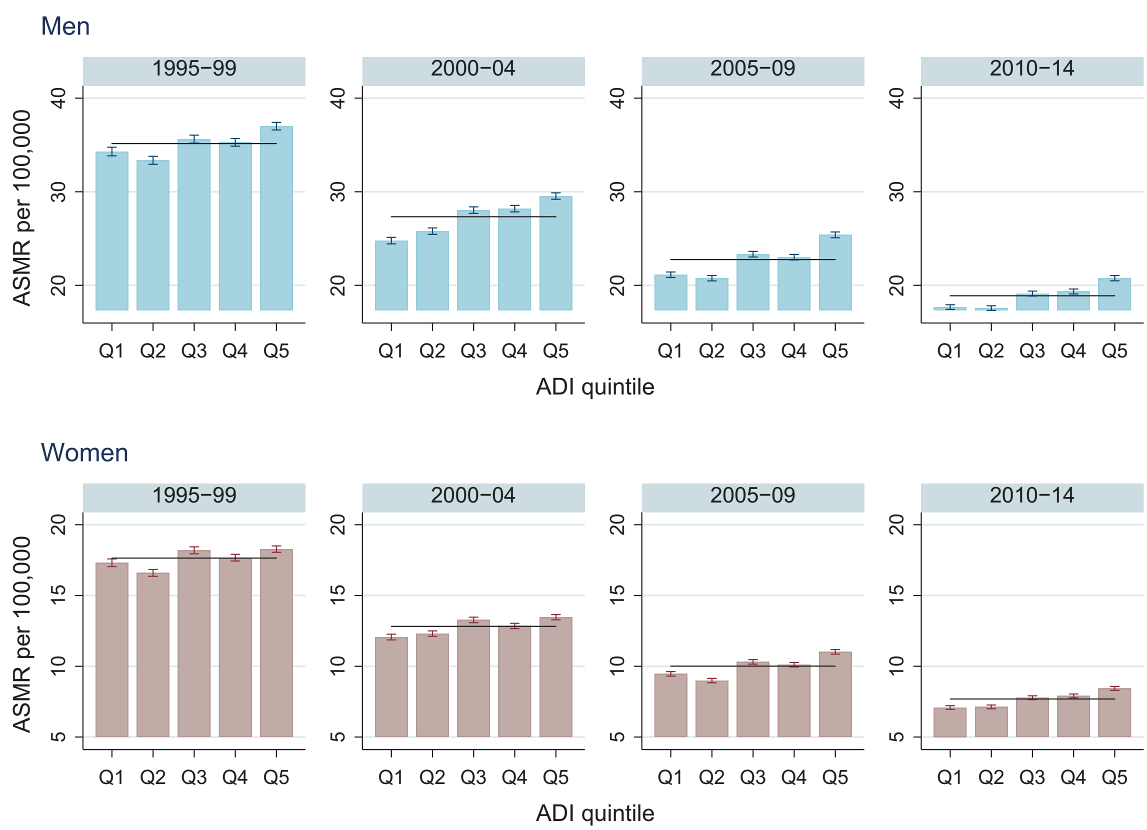


Fig. 5.9 The transition in the ASMR distribution of acute myocardial infarction by ADI quintile. (Top: Men, Bottom: Women)

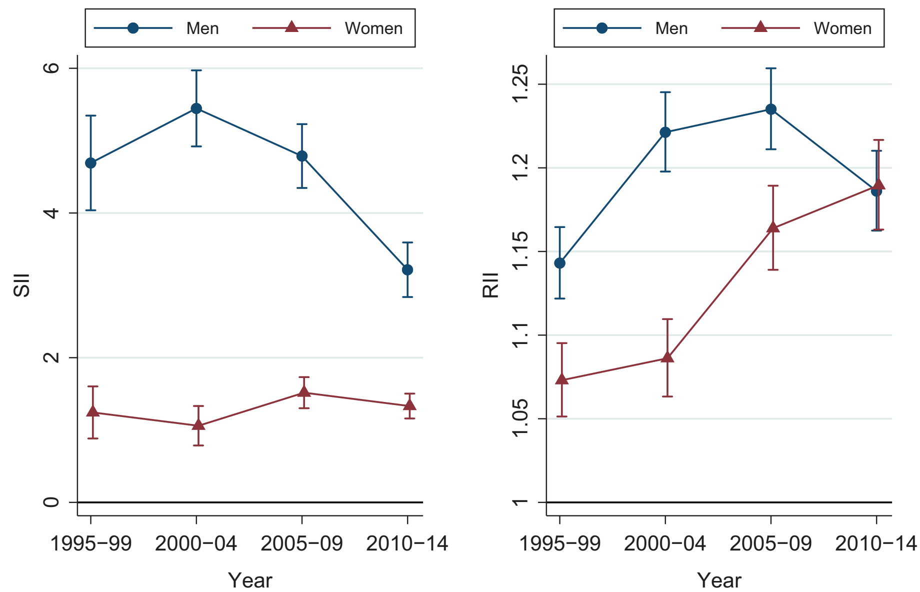


Fig. 5.10 Transition in SII and RII of acute myocardial infarction from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.3 Other Ischemic Heart Diseases (ICD10: I20, I22-I25): Deaths of Survivors from Acute Myocardial Infarction?

Shigeru Inoue and Hiroyuki Kikuchi

Overview

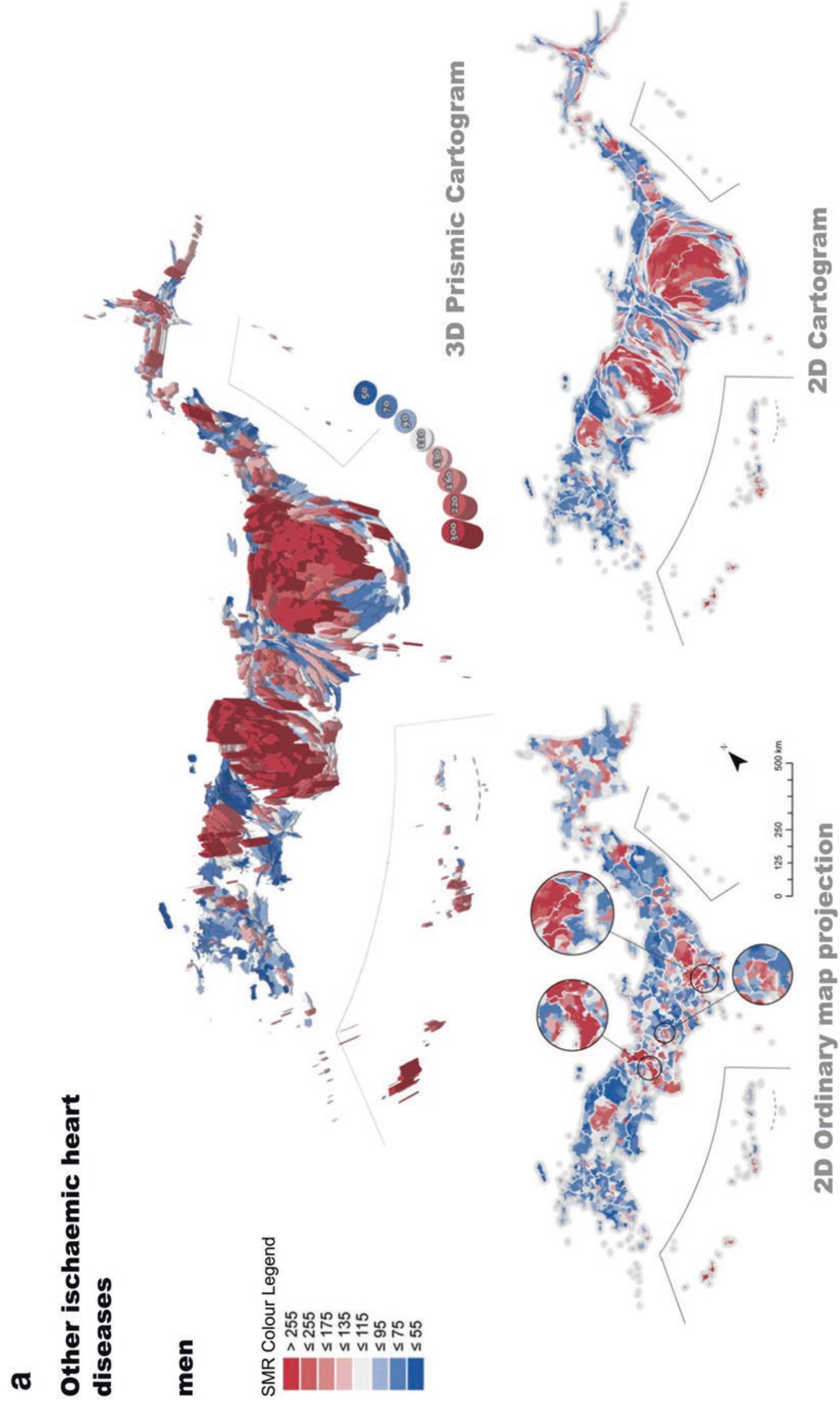
This category of mortality includes ischemic heart diseases other than acute myocardial infarction, i.e. angina pectoris, acute myocardial infarction sequelae, other acute ischemic heart diseases, and chronic ischemic heart disease (e.g. old myocardial infarction). The number of deaths for this disease is comparable to that of acute myocardial infarction. Similar to acute myocardial infarction, lifestyle and atherosclerotic risk factors are expected to be associated with the rate of mortality for this disease. In addition, transition from myocardial infarction to chronic ischemic heart disease after successful emergency treatment during the acute phase of myocardial infarction may lead to fatal ailments in this category.

The regional distribution of SMR shown in Fig. 5.11 is distinctively different than or even more aptly, the reverse of that of acute myocardial infarction. SMR is high in major cities and their surrounding areas including the Tokyo, Nagoya/Chukyo, and Osaka/Keihanshin metropolitan areas as well as regional core cities such as Sendai and Hiroshima cities. The distribution is similar for both men and women.

Transitions in the Study Period

There is no major change in the distribution of SMR as a whole during the 20 years from 1995 to 2014, but SMRs have decreased in several urbanized areas, particularly in Aichi, Kanagawa, and Fukuoka Prefectures (Fig. 5.12).

The temporal trend of the ASMR of this disease has been almost constant for men and slightly declining for women (Fig. 5.13). In the decades (1995–2014), higher mortality rates have been observed in less deprived areas (Figs. 5.14 and 5.15), particularly in urbanized regions. Although the reason for the reverse socioeconomic gradient in the mortality is unknown, the high SMR of the disease may reflect good regional medical care capable of efficiently rescuing patients in the acute phase of myocardial infarction as mentioned before.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Other ischaemic heart diseases
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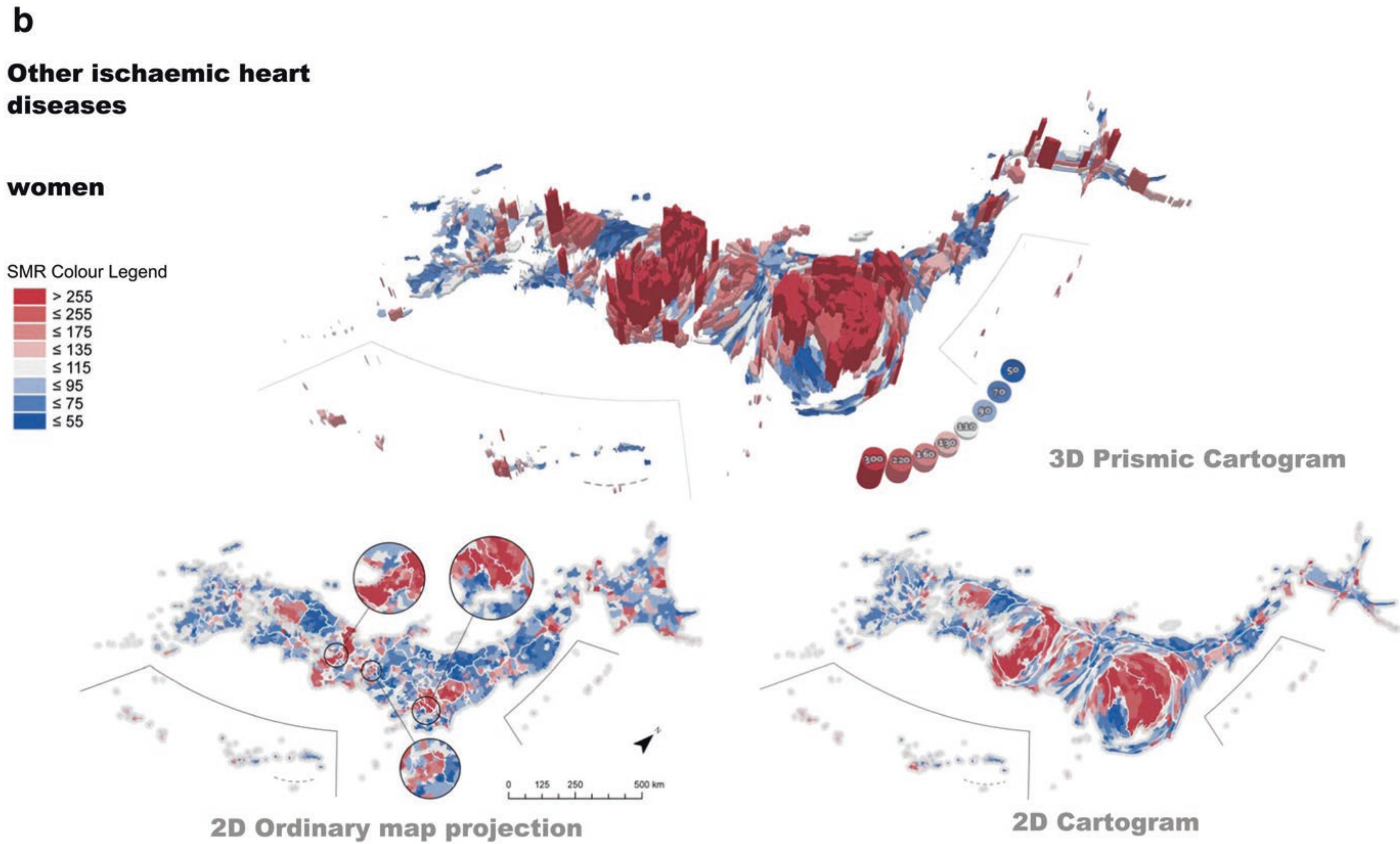
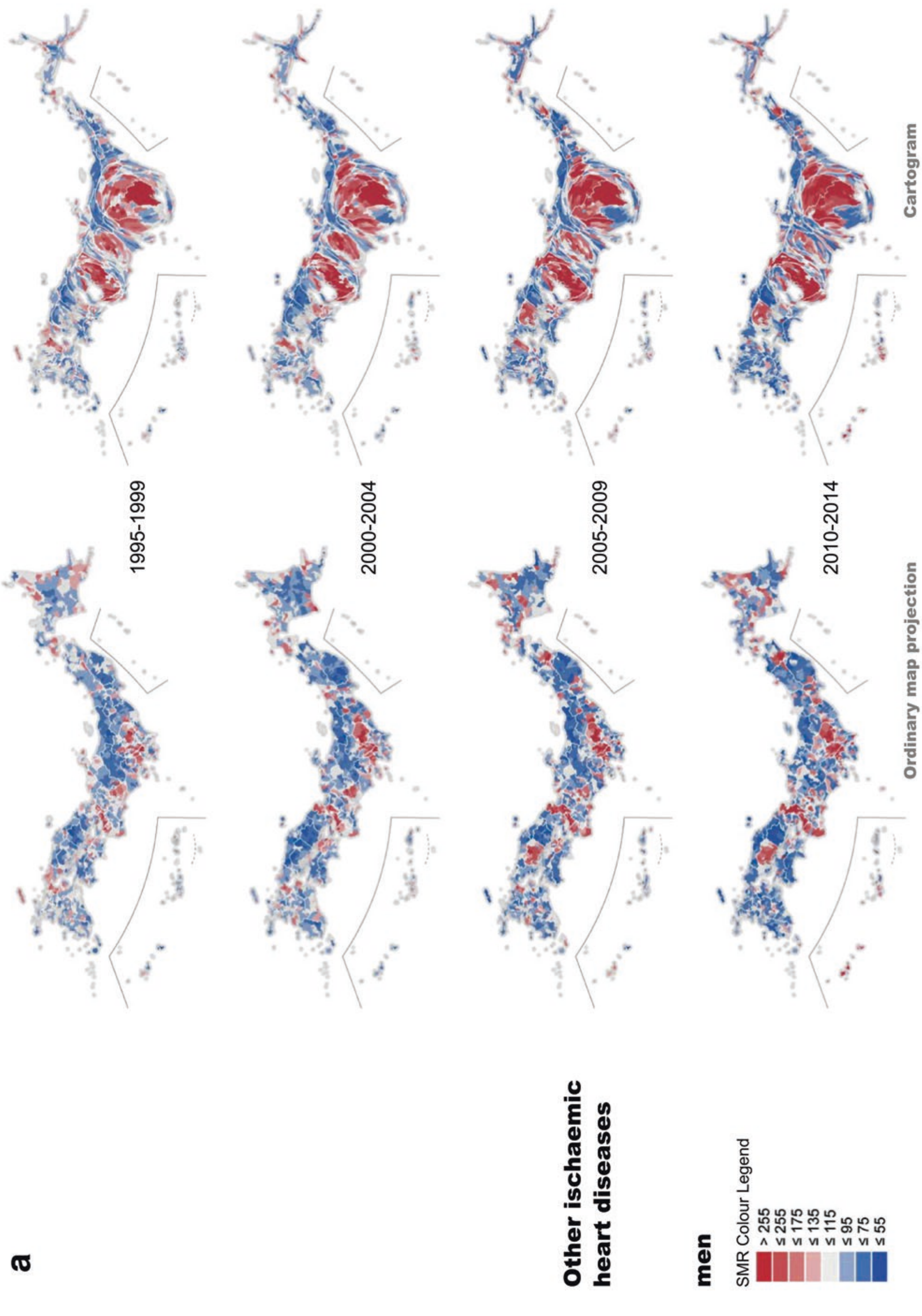


Fig. 5.11 SMR distribution of other ischaemic heart diseases, 2010–2014. (**a**) Men. (**b**) Women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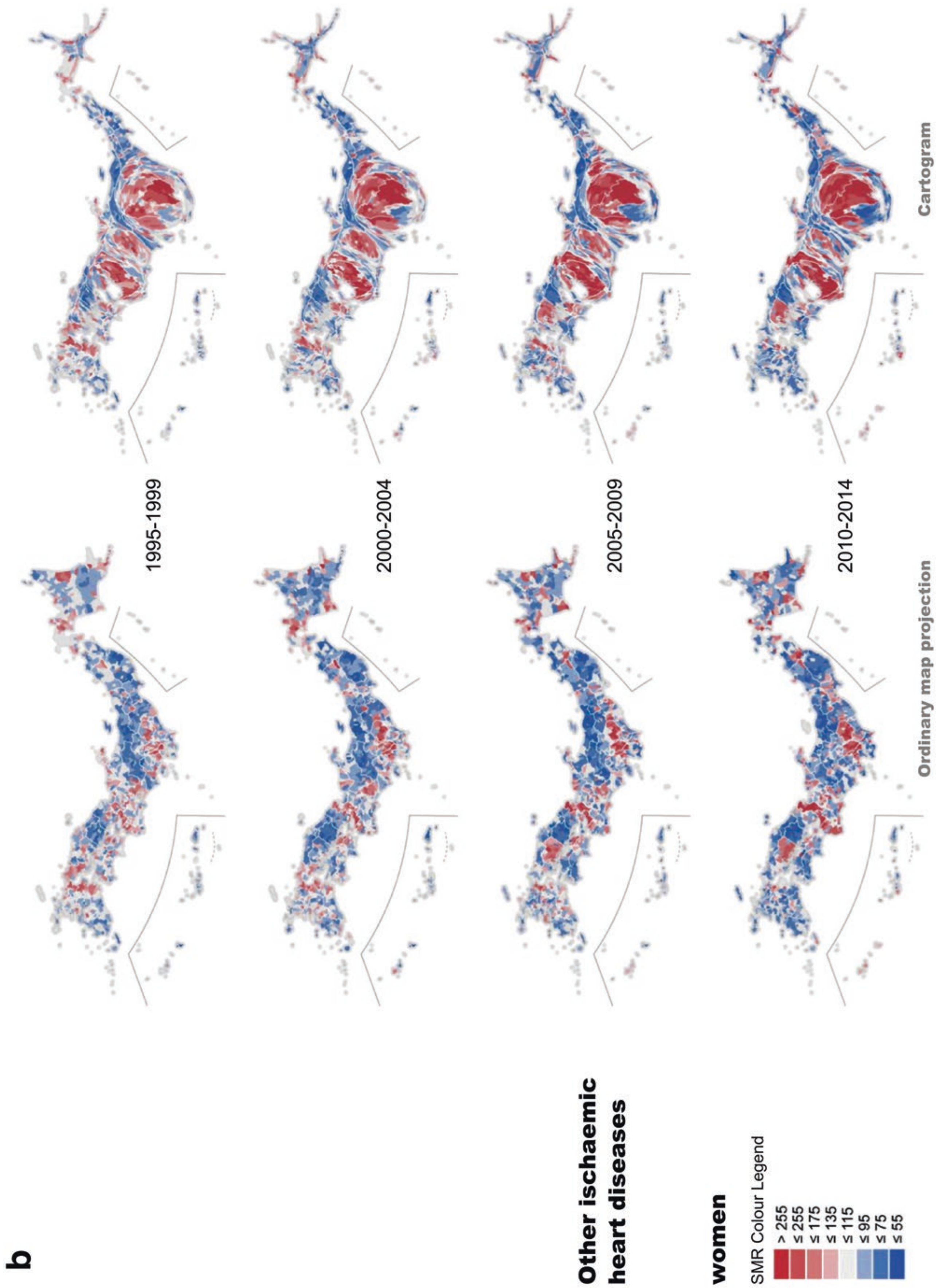


Fig. 5.12 Transition of SMR distribution of other ischaemic heart diseases from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

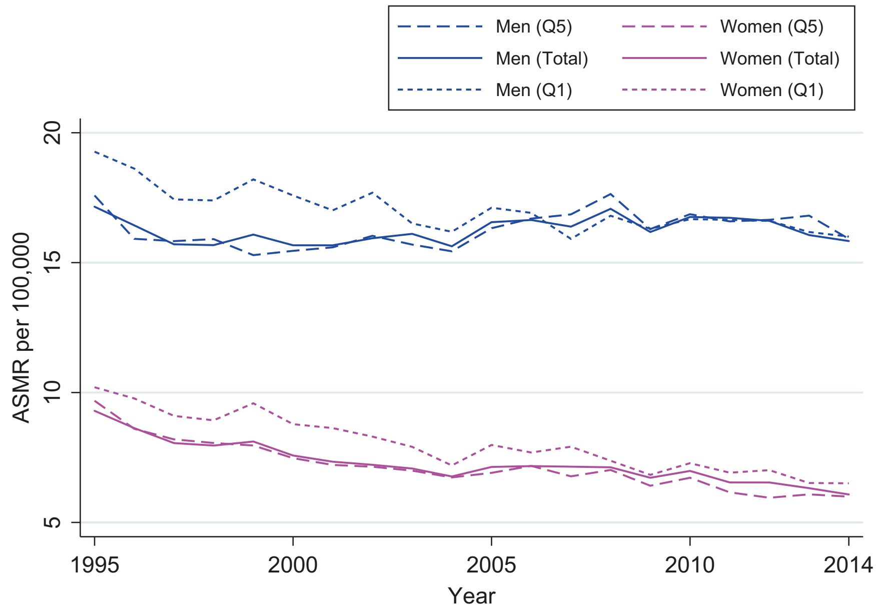


Fig. 5.13 Annual transition in the ASMR of other ischaemic heart diseases from 1995 to 2014

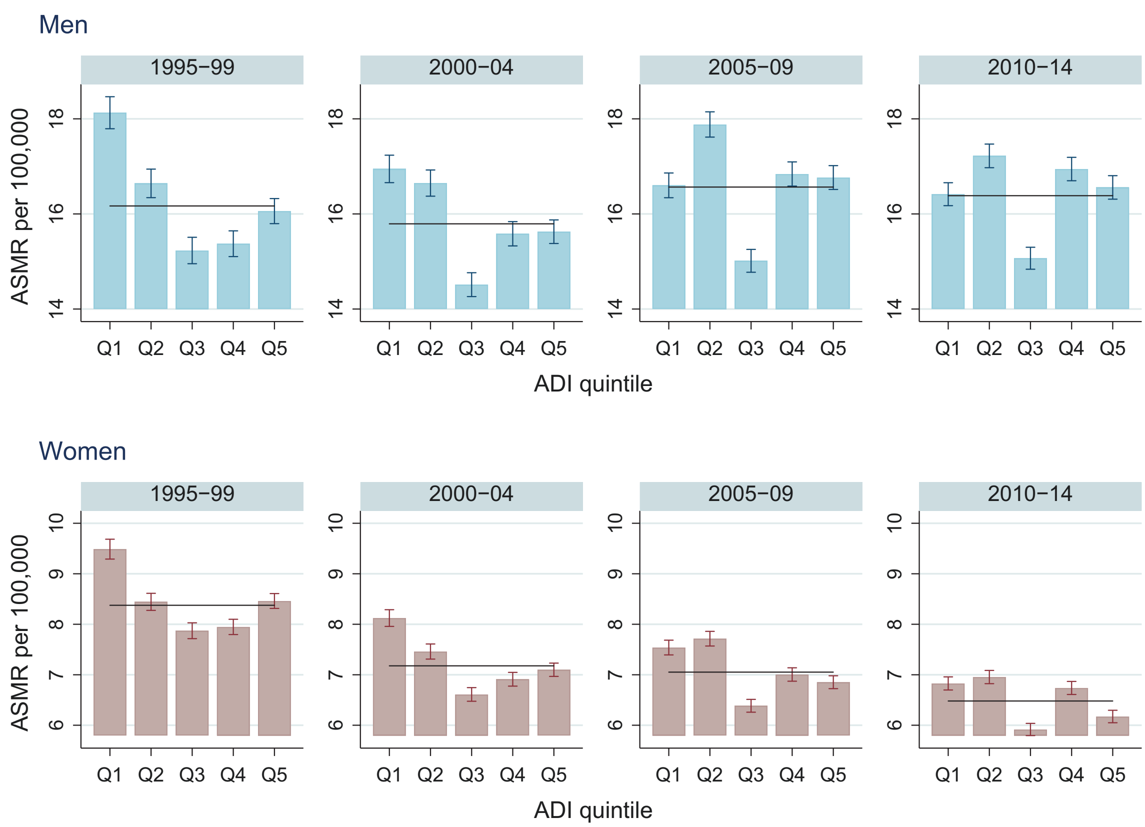


Fig. 5.14 The transition in the ASMR distribution of other ischaemic heart diseases by ADI quintile. (Top: Men, Bottom: Women)

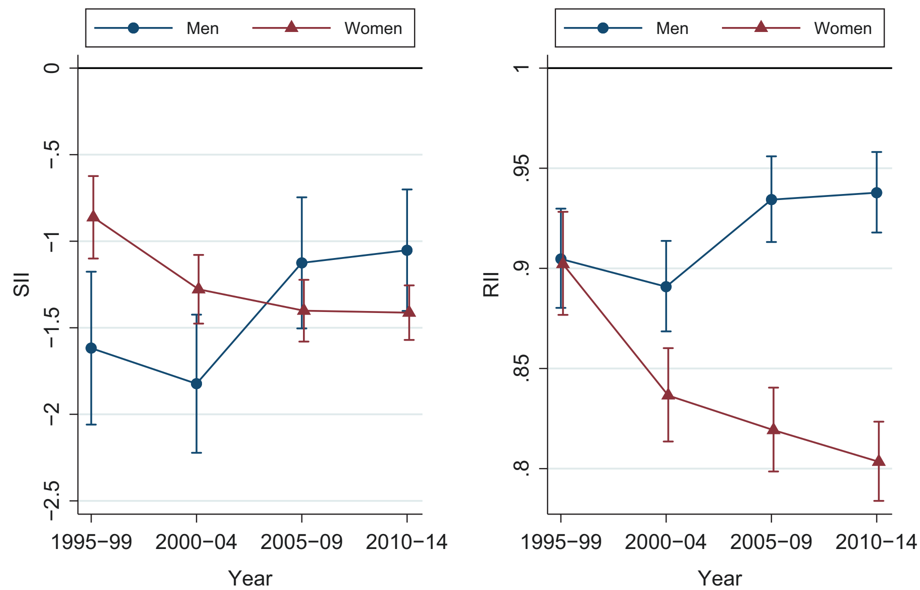


Fig. 5.15 Transition in SII and RII of other ischaemic heart diseases from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.4 Cardiac Arrhythmias and Conduction Disturbances (ICD10: I44-I49): Urban–Rural Disparities Related to Access to Medical Care?

Shigeru Inoue and Hiroyuki Kikuchi

Overview

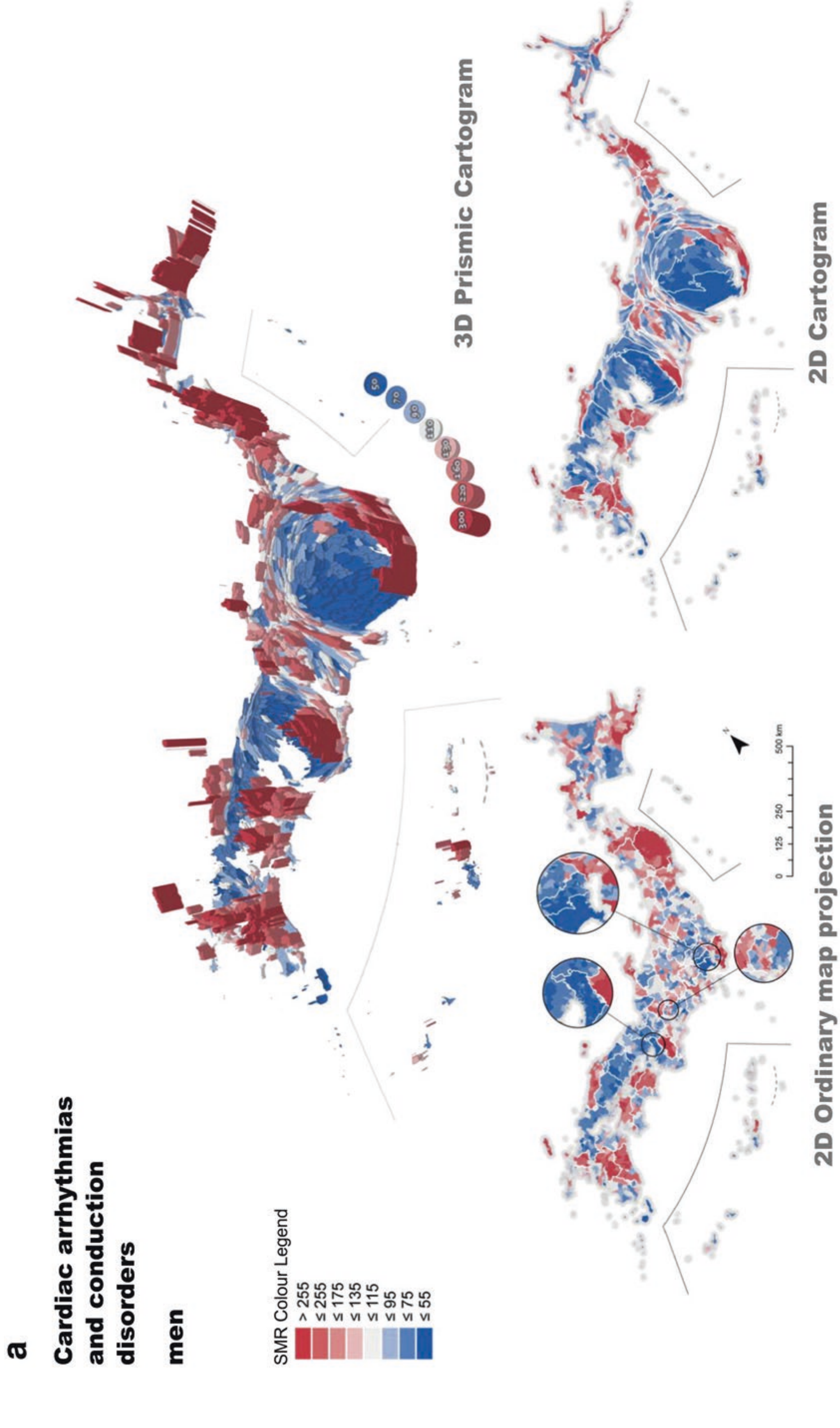
This category of mortality includes ventricular fibrillation, cardiac arrest, and other arrhythmias. Since fatal arrhythmias require immediate emergency and critical care, the regional distribution of the mortality of the disease is expected to be associated with the quality of emergency medical systems.

The areas with high SMR are scattered throughout the country, mainly in non-metropolitan areas (Fig. 5.16). Features of regional distribution are similar in men and women. Examples of regions with high SMR include the Tohoku region and surrounding or peripheral parts of large metropolitan areas. There are many high SMR clusters on several peninsulas, some of which are remote from major cities. Large urban areas generally have low SMRs. The distribution of high SMR regions can be explained by low access to medical care, since emergency care can be crucial to saving lives from the disease.

Transitions and Socioeconomic Disparities

SMRs have largely been reduced in urbanized areas, particularly along Taiheiyo (pacific) belt from the Tokyo metropolitan area to the northern Kyusyu region (Fig. 5.17). This region includes many industrial cities, such as Nagoya, Osaka, Kobe, and Hiroshima. As a result, the disparity of the mortality between urban and rural has generally widened.

The ASMR of arrhythmias and conduction disorders is characterized by a gentle upward trend (Fig. 5.18), particularly in areas with low socioeconomic conditions and especially deprived rural areas. The high mortality rate in more deprived areas has been consistent throughout the 20 years from 1995 to 2014 (Fig. 5.19). As can be seen from the temporal trend of RII and SII, the socioeconomic inequalities in the mortality tend to widen with urban–rural disparities, particularly for men (Fig. 5.20).


a
Cardiac arrhythmias and conduction disorders
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
≤ 95
≤ 75
≤ 55
3D Prismic Cartogram
50
70
90
110
130
160
220
300
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

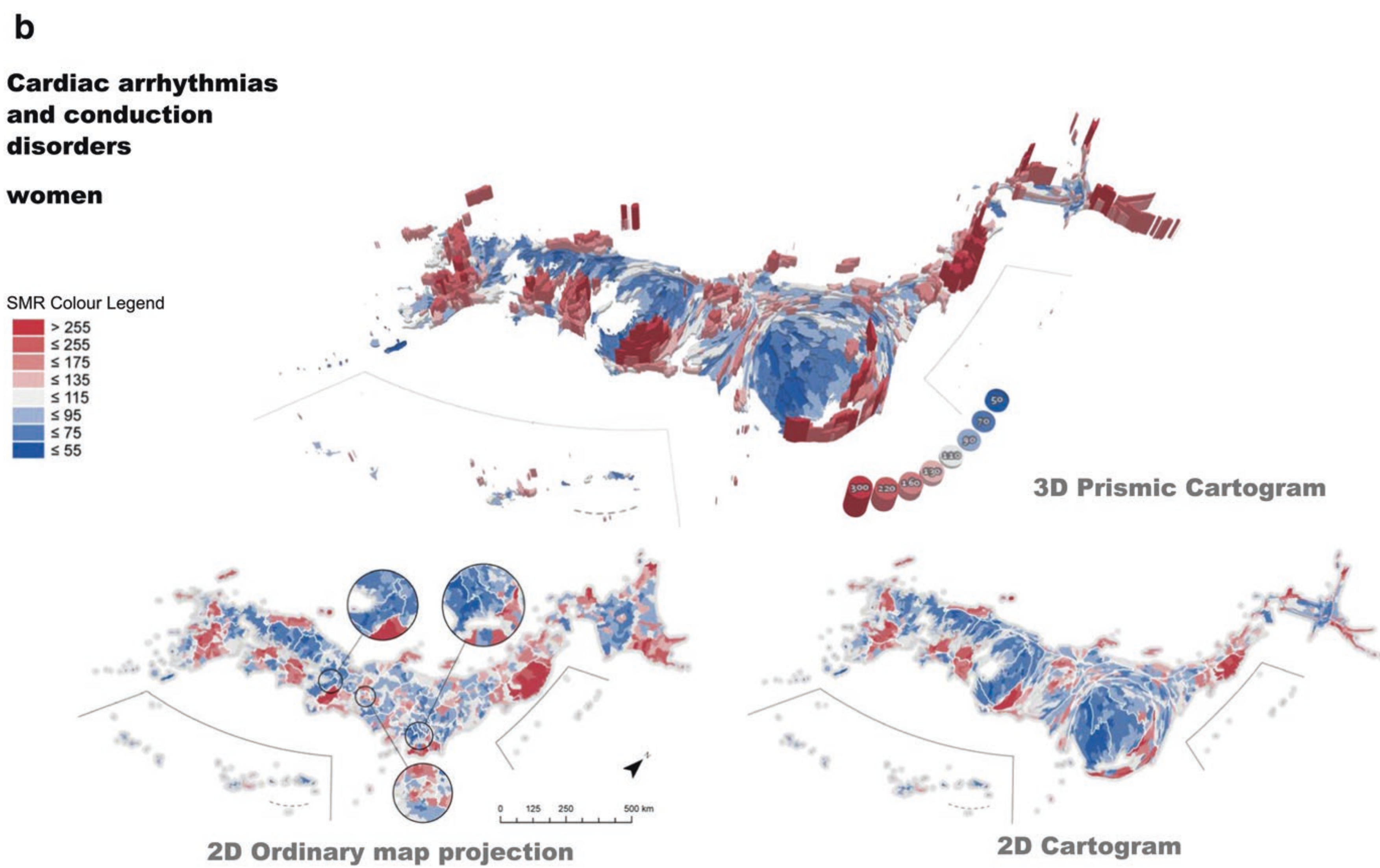
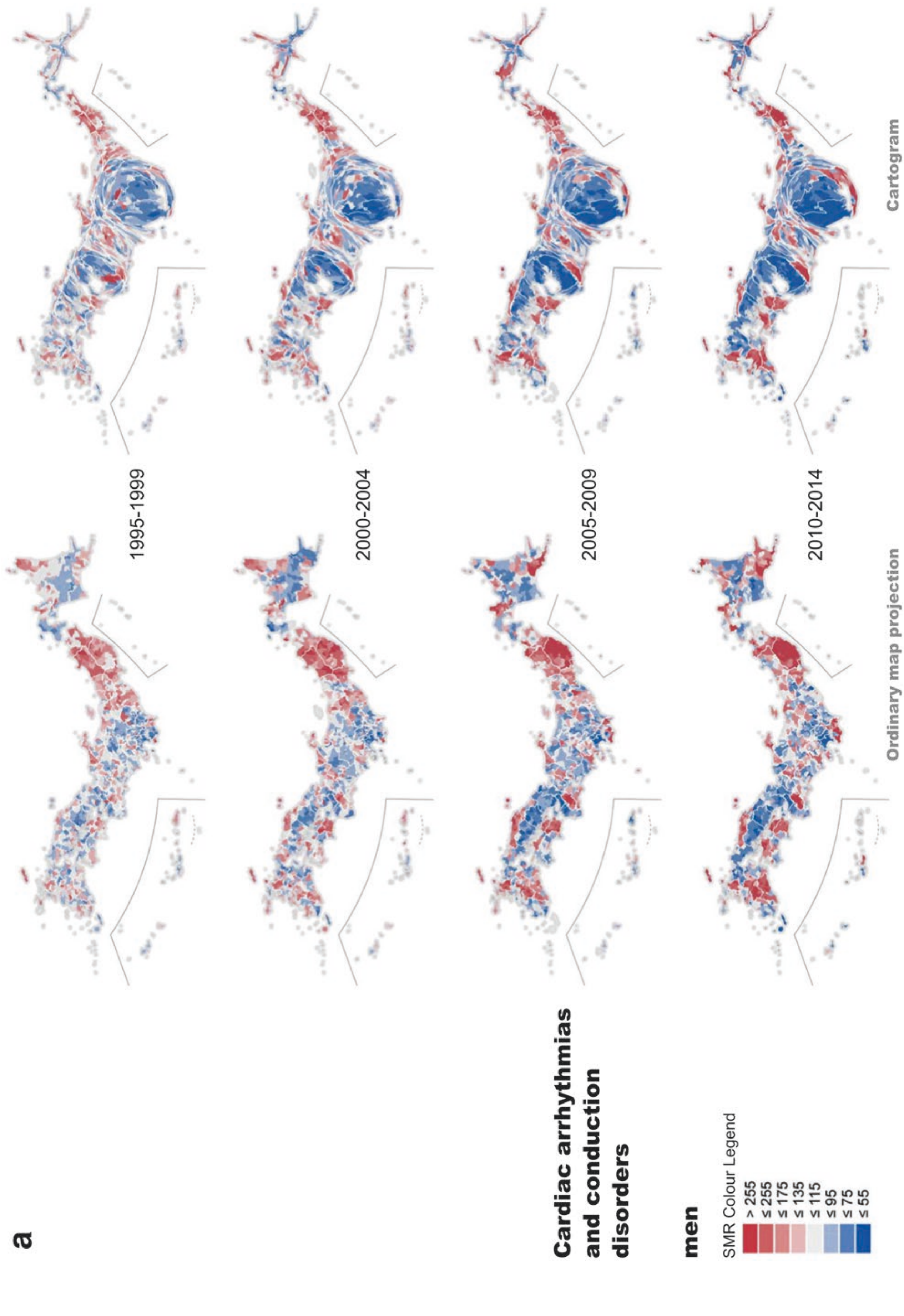


Fig. 5.16 SMR distribution of cardiac arrhythmias and conduction disorders, 2010–2014. (**a**) Men. (**b**) Women


a
Cardiac arrhythmias and conduction disorders
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
≤ 95
≤ 75
≤ 55
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

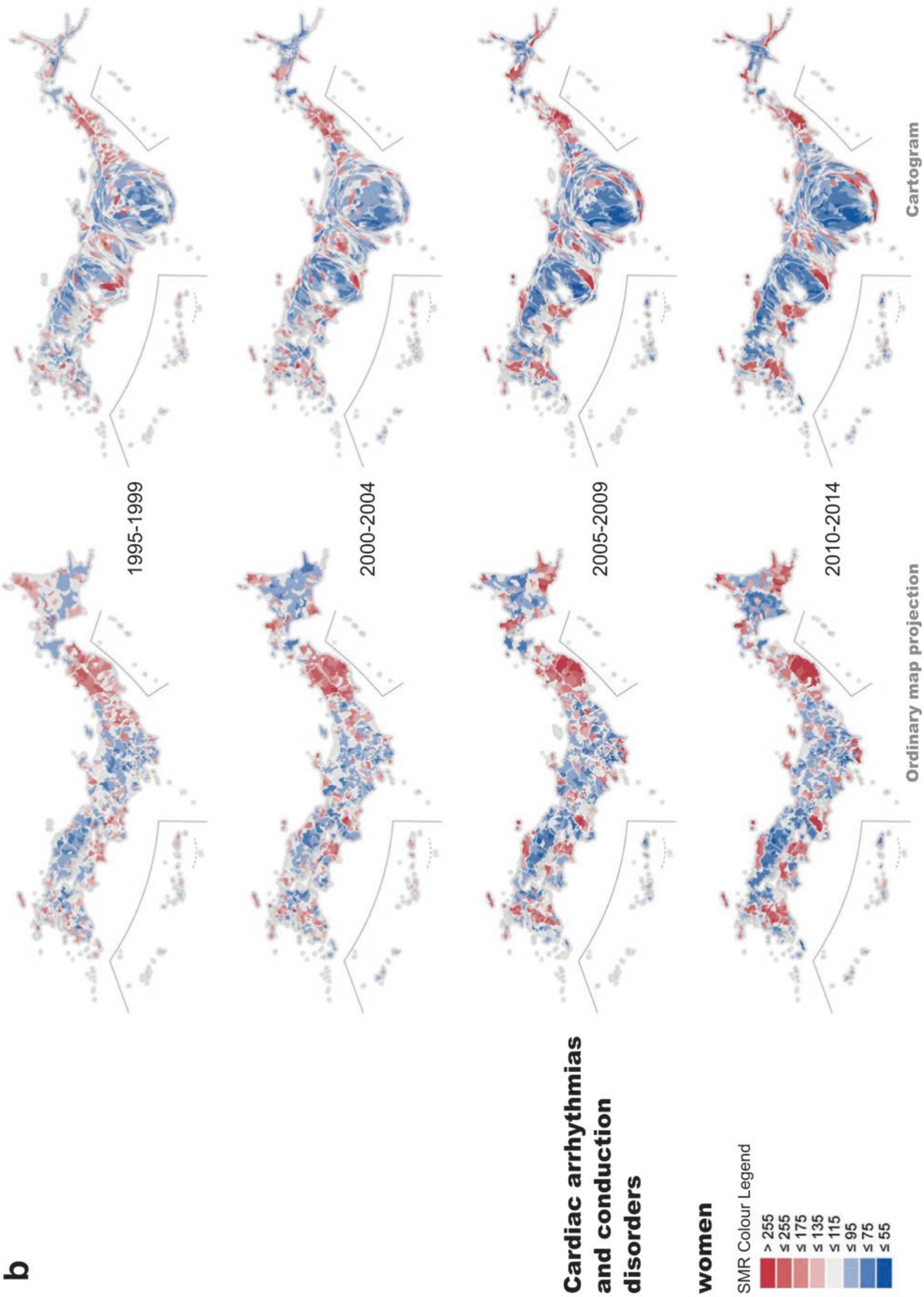


Fig. 5.17 Transition of SMR distribution of cardiac arrhythmias and conduction disorders from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.18 Annual transition in the ASMR of cardiac arrhythmias and conduction disorders from 1995 to 2014

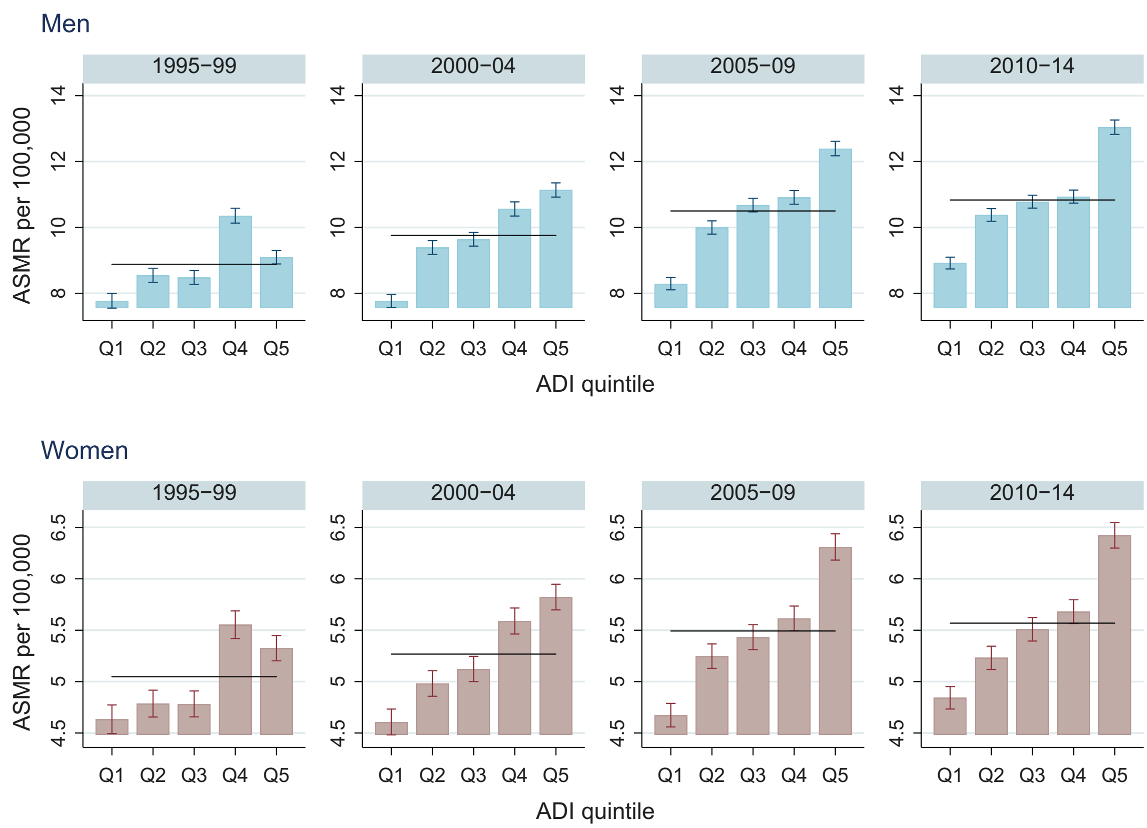


Fig. 5.19 The transition in the ASMR distribution of cardiac arrhythmias and conduction disorders by ADI quintile. (Top: Men, Bottom: Women)

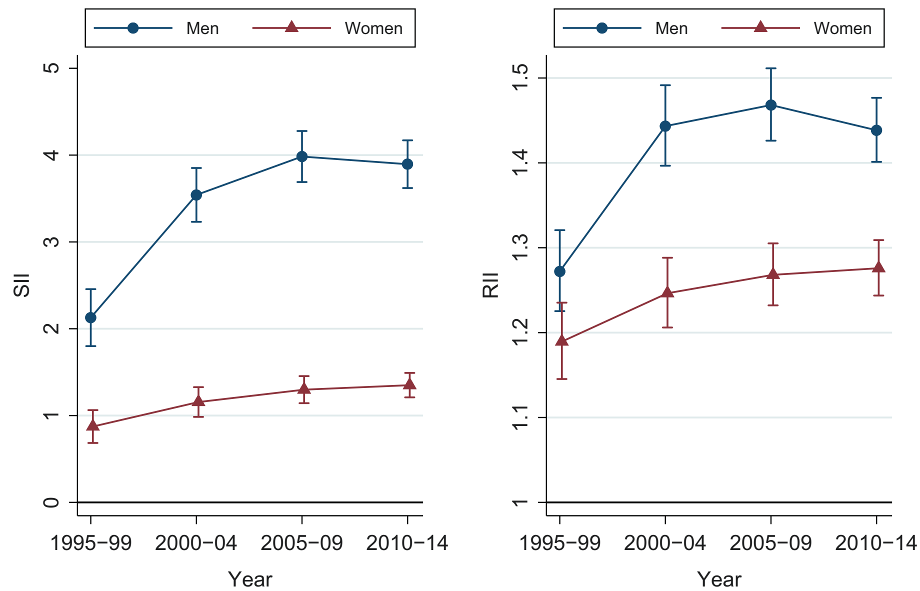


Fig. 5.20 Transition in SII and RII of cardiac arrhythmias and conduction disorders from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.5 Heart Failure (ICD10: I50): Low Burden in Big Cities

Shigeru Inoue and Hiroyuki Kikuchi

Overview

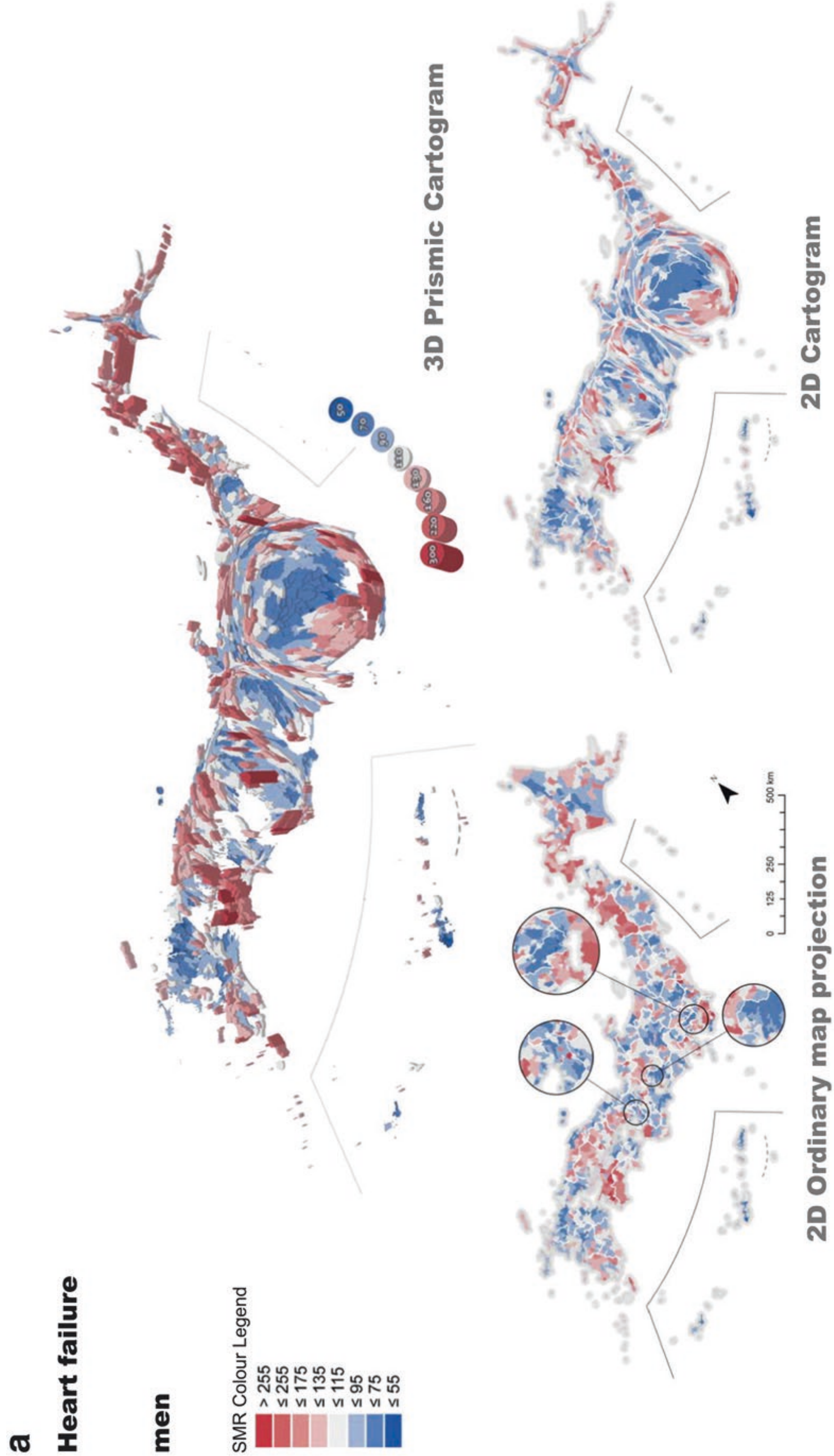
Deaths from chronic heart failure, such as congestive heart failure, fall into this category of mortality. Although the disease state causing heart failure and the breakdown of the primary disease are unknown, it is believed that lifestyle habits, such as smoking, alcohol consumption, salt intake, and physical activity, may be associated with the mortality of the disease.

The regions with high SMR of heart failure are found in many non-metropolitan areas (Fig. 5.21). Within the Tokyo metropolitan areas, SMRs tend to be high in the outer suburbs of Chiba, Saitama, and Kanagawa Prefectures. This geographical tendency might reflect the migration tendency of older populations with the disease to areas with more facilities for the older adults, including chronic care hospitals in the regions neighbouring the core part of the metropolitan areas.

Transitions and Socioeconomic Disparities

According to the series of SMR maps based on an ordinary map projection for the last four periods (Fig. 5.22), there is overall no noticeable changes in the SMR distribution except the rise of SMR in Akita Prefecture. The series of cartogram-based SMR maps (Fig. 5.22) highlights increasing SMRs in some suburbs of metropolitan regions, particularly Kanagawa Prefecture next to Tokyo. Meanwhile, these also highlight decreasing SMRs in Aichi Prefecture of the Nagoya/Chukyo metropolitan area.

The ASMR of heart failure is declining for both sexes (Fig. 5.23). The high mortality rate in more deprived regions has been consistent throughout the 20-year period from 1995 to 2014 (Fig. 5.24). As can be seen from the temporal trend of SII and RII, the socioeconomic inequality in the mortality was reduced in the early 2000s but tends to widen since around 2010 (Fig. 5.25).


a
Heart failure
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
≤ 95
≤ 75
≤ 55
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

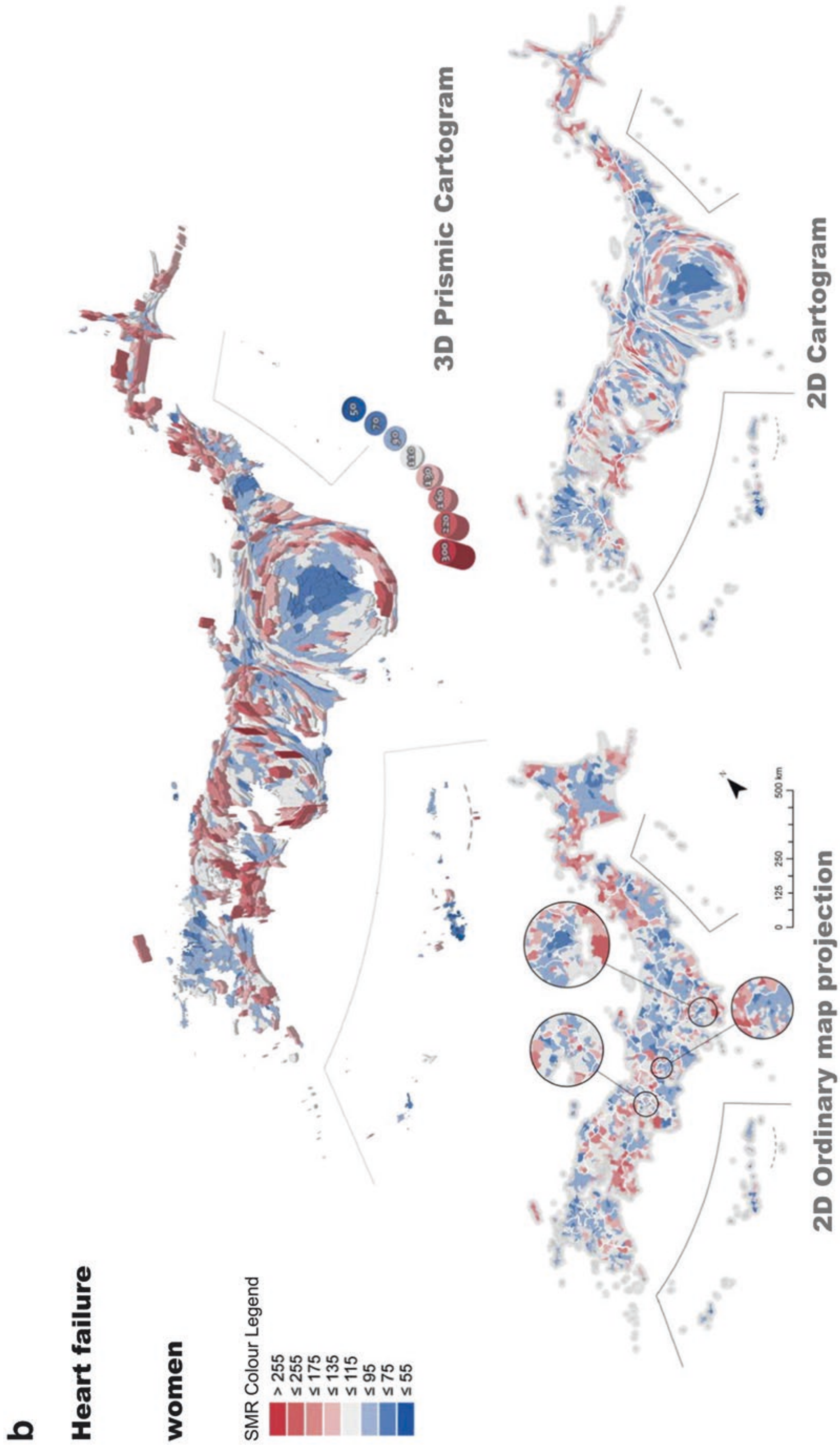
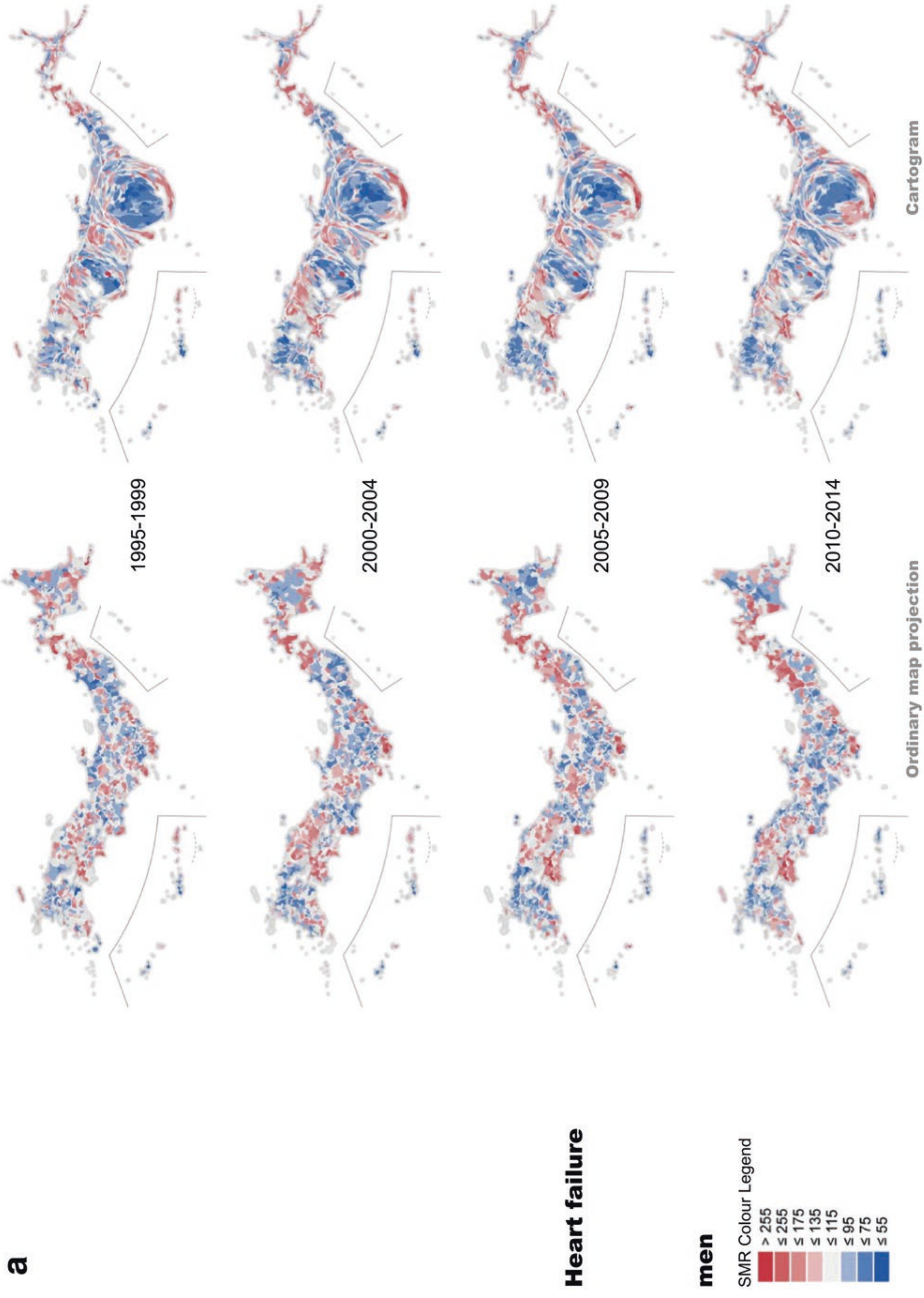


Fig. 5.21 SMR distribution of heart failure, 2010–2014. (**a**) Men. (**b**) Women


a
Heart failure
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
≤ 95
≤ 75
≤ 55
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

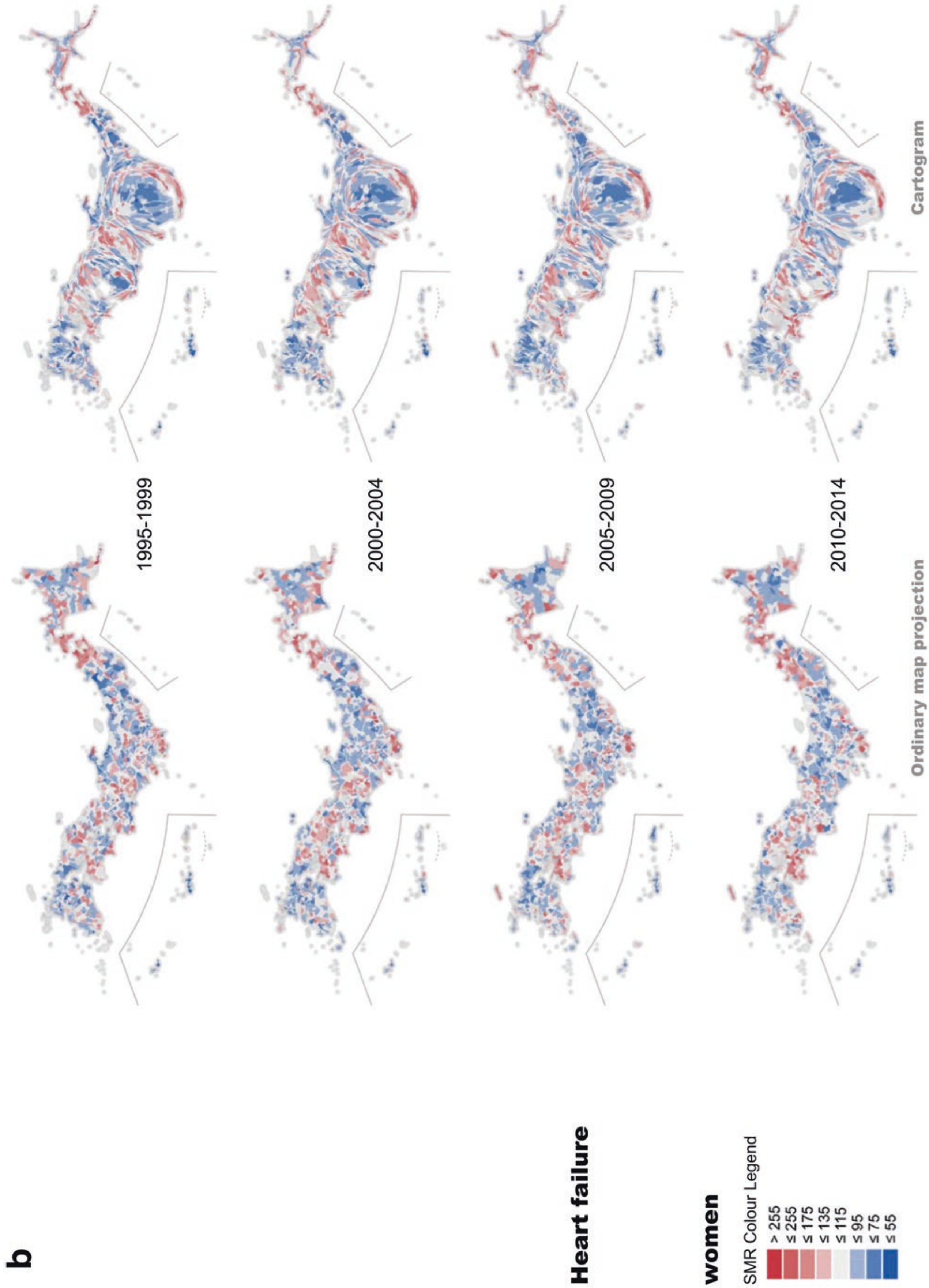


Fig. 5.22 Transition of SMR distribution of heart failure from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

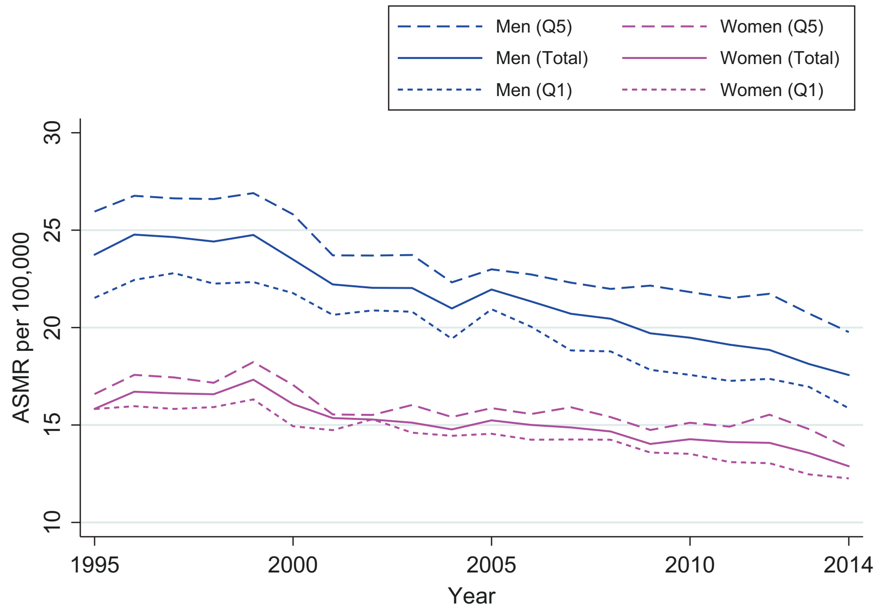


Fig. 5.23 Annual transition in the ASMR of heart failure from 1995 to 2014

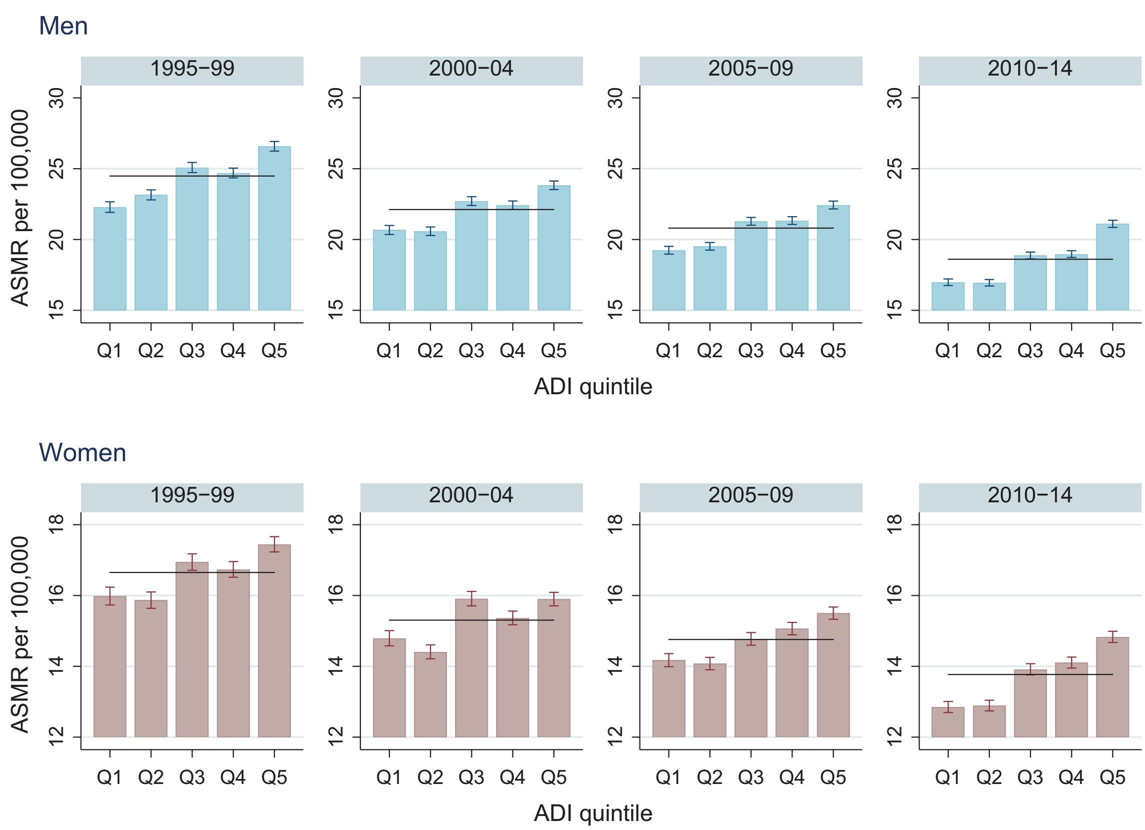


Fig. 5.24 The transition in the ASMR distribution of heart failure by ADI quintile. (Top: Men, Bottom: Women)

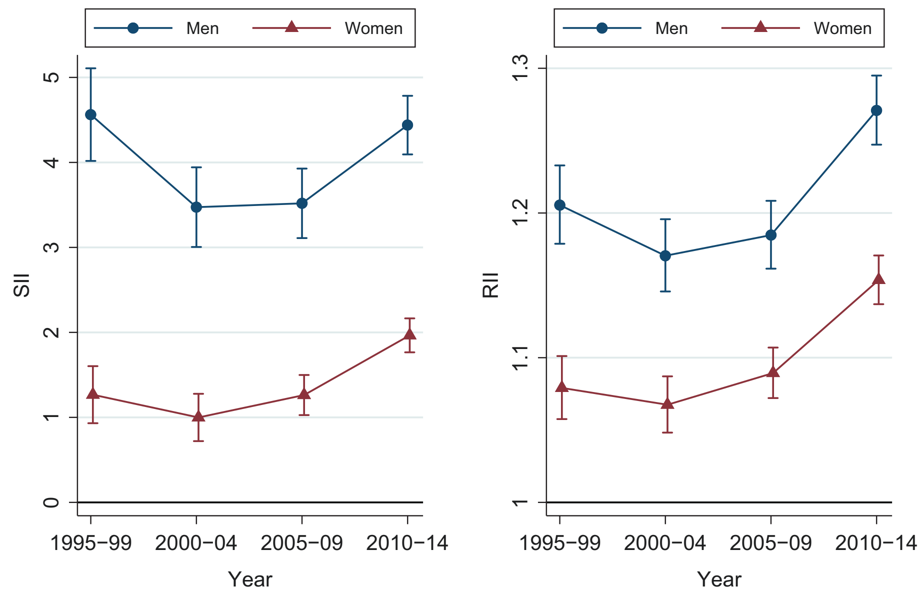


Fig. 5.25 Transition in SII and RII of heart failure from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.6 Cerebrovascular Disease (All) (ICD10: I60-I69): Disease in Cold Regions?

Ryozo Matsuda

Overview

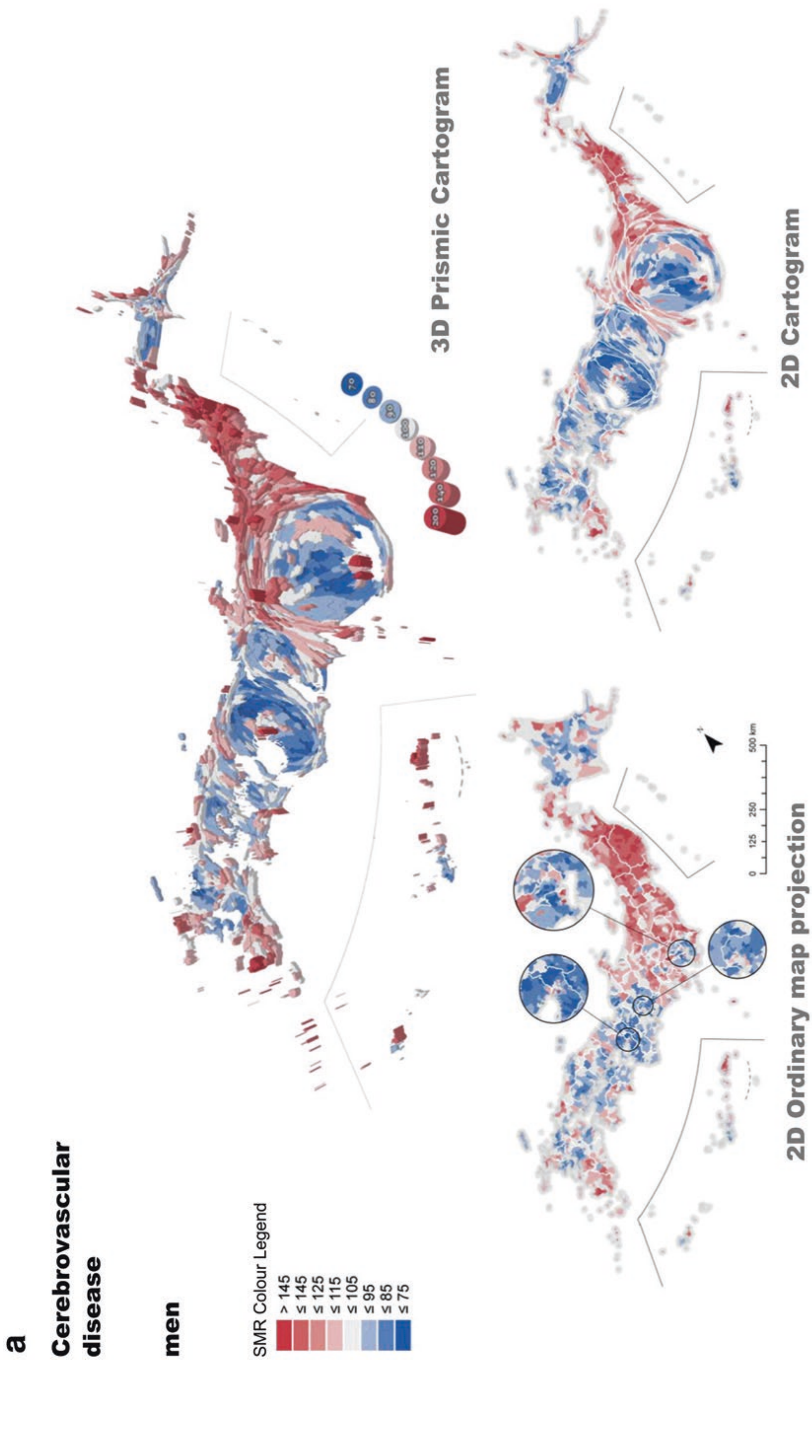
Cerebrovascular disease was the most common cause of death until the 1980s and is still the fourth most common cause of death after cancer, heart disease, and pneumonia. The proportions of the major three types of cerebrovascular disease—subarachnoid haemorrhage, intracerebral haemorrhage, and cerebral infarction—among the total number of cerebrovascular disease deaths are roughly 10%, 30%, and 60%, respectively.

Although SMRs for cerebrovascular disease are high in colder regions, particularly the Tohoku region among both men and women, SMRs in Hokkaido, the most northern region in Japan, are low in general (Fig. 5.26). A study suggests that large temperature differences inside traditional Japanese houses in winter season has an effect on increased incidence of cerebrovascular disease in northern Japan, while housing with more westernized heating systems in Hokkaido, developed mainly after the modernization of Japan, may mitigate its incidence (Kagami 1983). SMRs are also high in several local areas in Chugoku, Kyusyu, and other regions. As the cartogram shows, it tends to be low in urban areas, particularly in the Tokyo and Osaka metropolitan areas. However, SMRs are very high in socioeconomically deprived inner-city parts in urban areas. These regional differences may be attributed to differences in the distribution of population with hypertension, quality of housing, and delivering of timely quality care to cerebrovascular disease patients.

Transitions and Socioeconomic Disparities

Over the 2 decades (1995–2014), the SMR distribution has not changed considerably and has generally been similar among different periods (Fig. 5.27). Some areas are changing, but the map using the ordinary projection demonstrates no clear geographical trends. However, the series of cartogram-based SMR maps shows that in the last 20 years there has been a decrease in SMRs in affluent suburbs of metropolitan areas. The decrease may be attributed to improvement of delivery in such health services as emergency care.

ASMR of all cerebrovascular diseases continues to decrease (Fig. 5.28). The socioeconomic disparity, or deprivation gap, in mortality rates is consistently observed and marked in males (Fig. 5.29). Data from two recent periods—2005–2009 and 2010–2014—indicate that the socioeconomic gradient in mortality is getting steeper. The ASMR of the deprivation index by quintile indicates that the socioeconomic disparities have become remarkable in both males and females in the last 10 years, 2005–2014. This is also shown by the growing trend of RII (Fig. 5.30).


a
Cerebrovascular disease
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

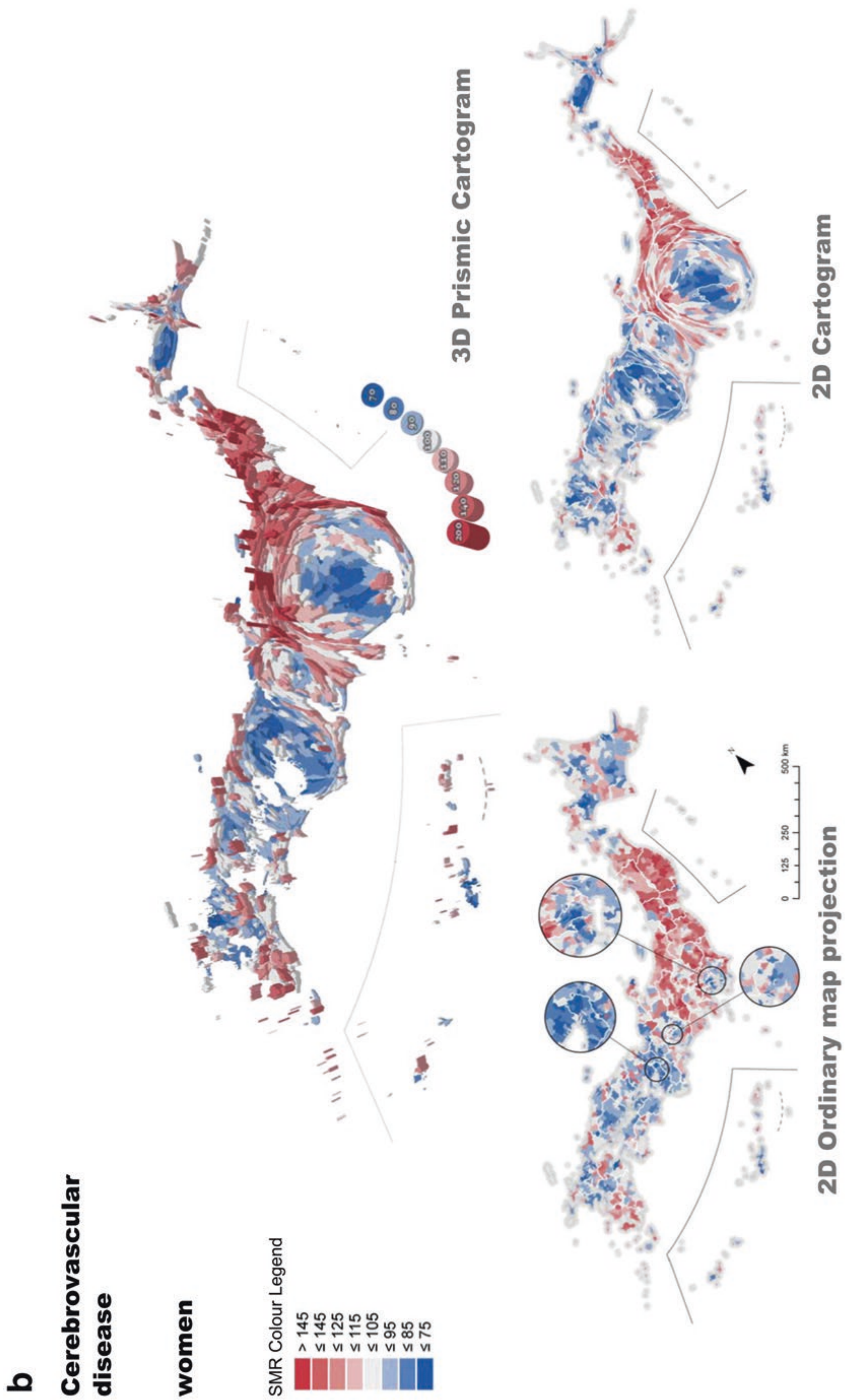
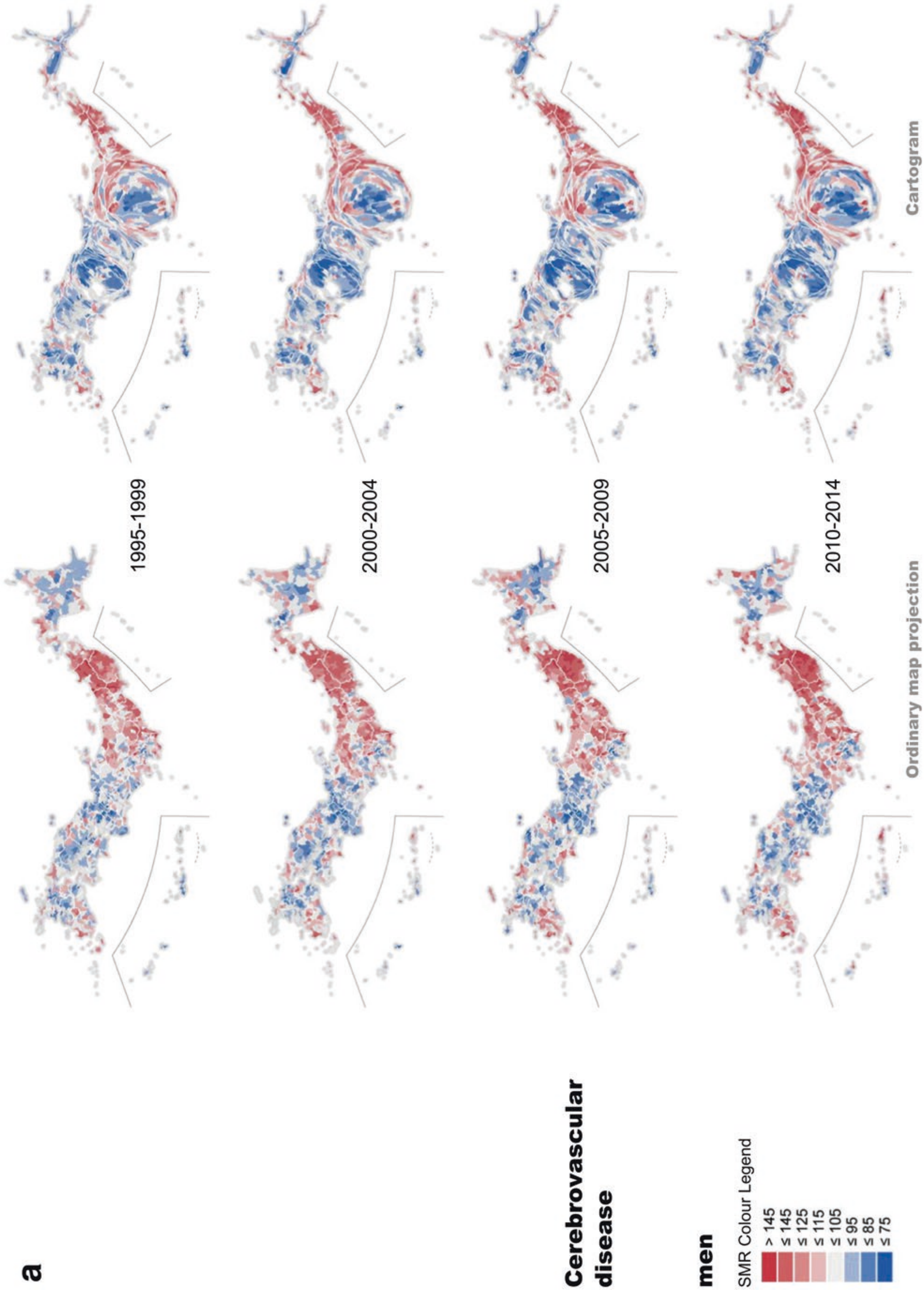


Fig. 5.26 SMR distribution of cerebrovascular disease, 2010–2014. (**a**) Men. (**b**) Women


a
Cerebrovascular disease
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

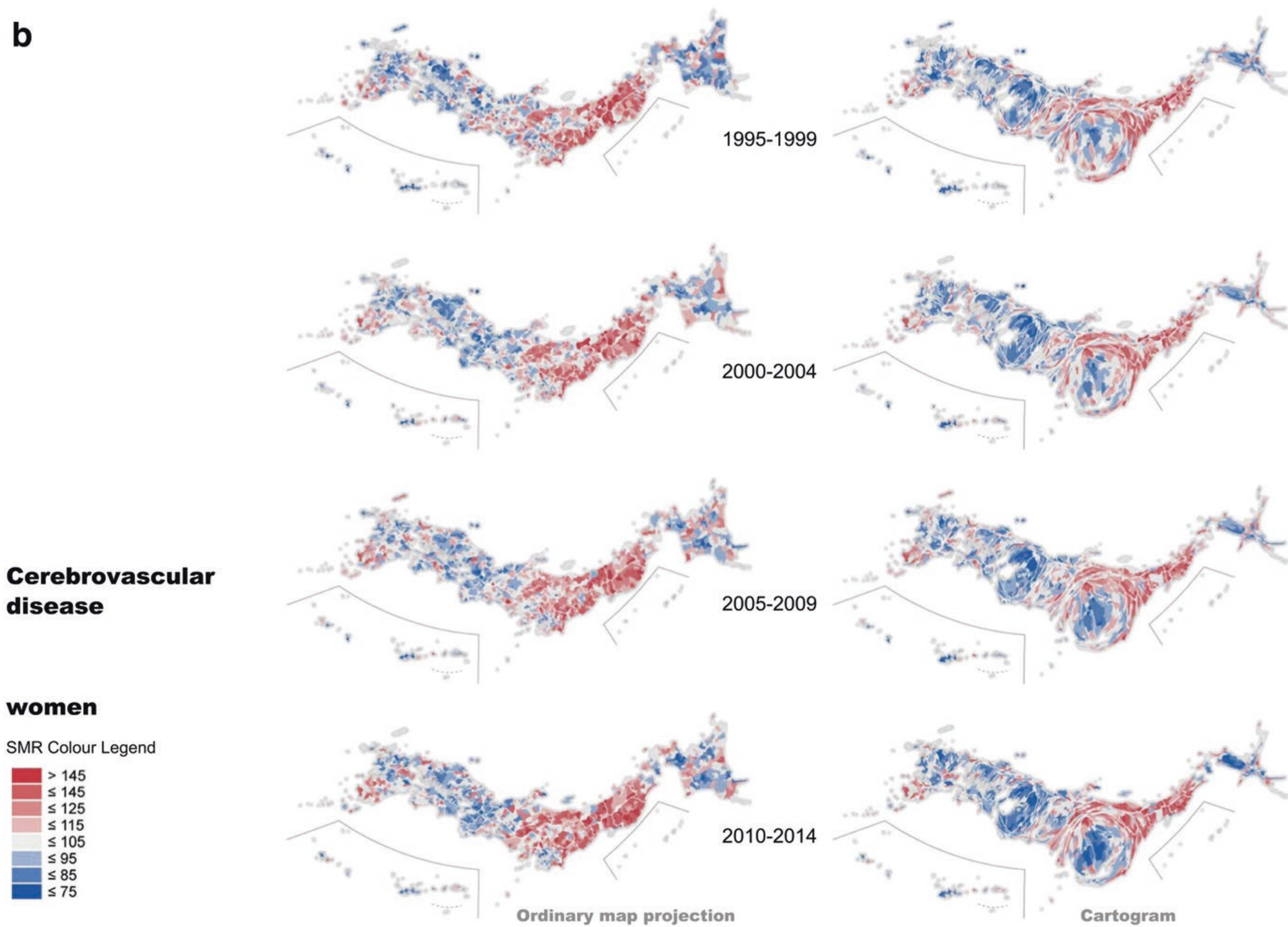
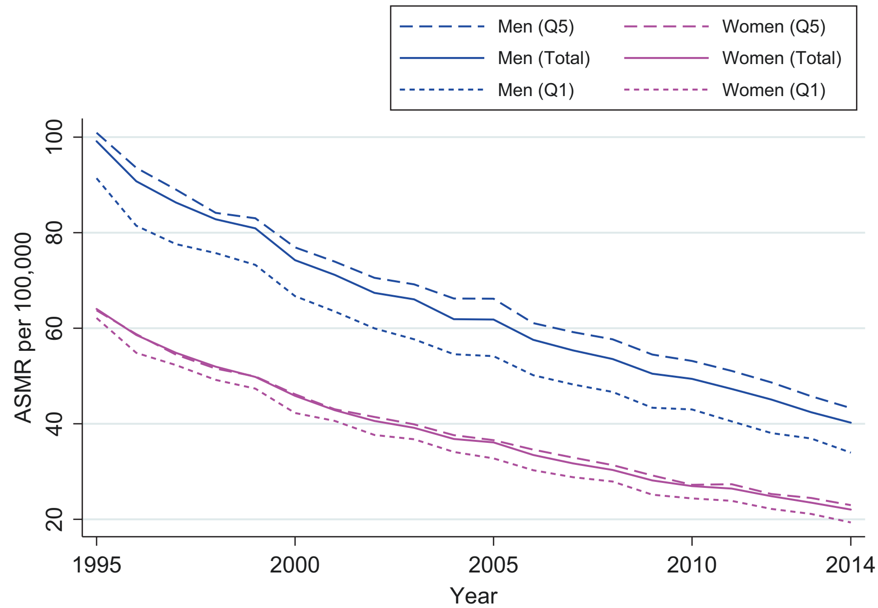


Fig. 5.27 Transition of SMR distribution of cerebrovascular disease from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.28 Annual transition in the ASMR of cerebrovascular disease from 1995 to 2014



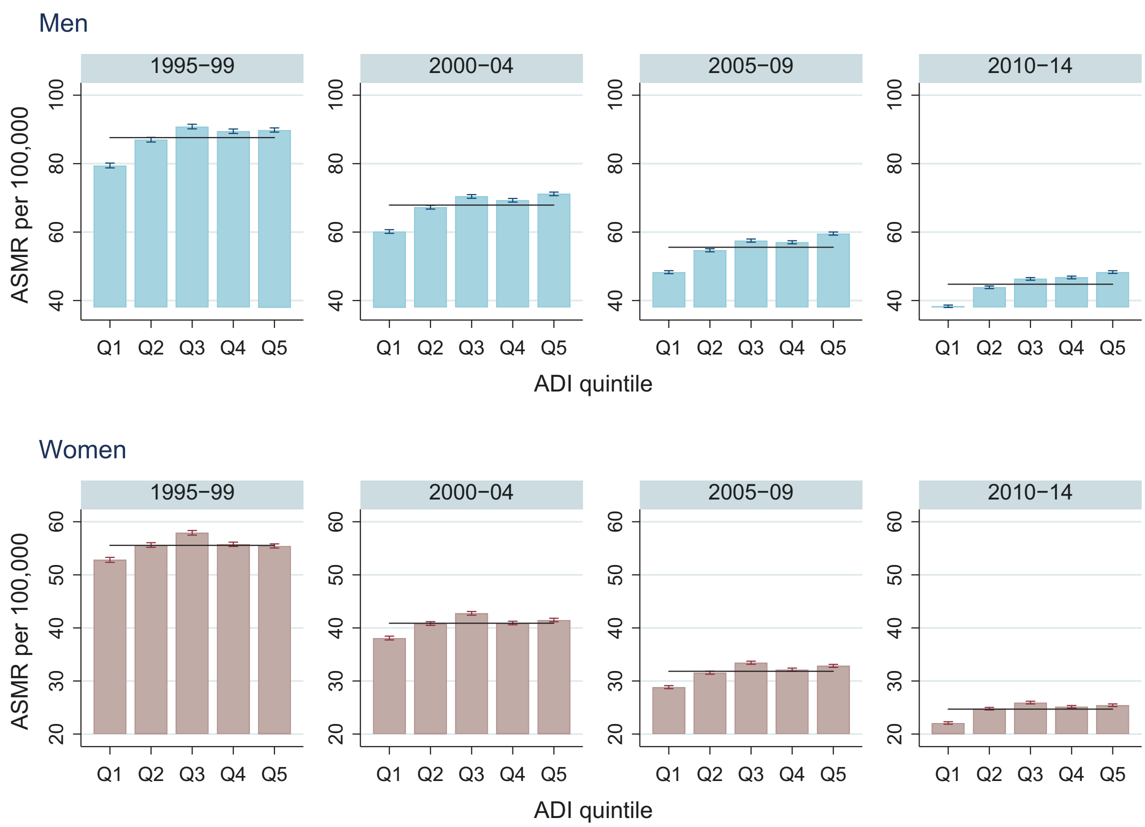


Fig. 5.29 The transition in the ASMR distribution of cerebrovascular disease by ADI quintile. (Top: Men, Bottom: Women)

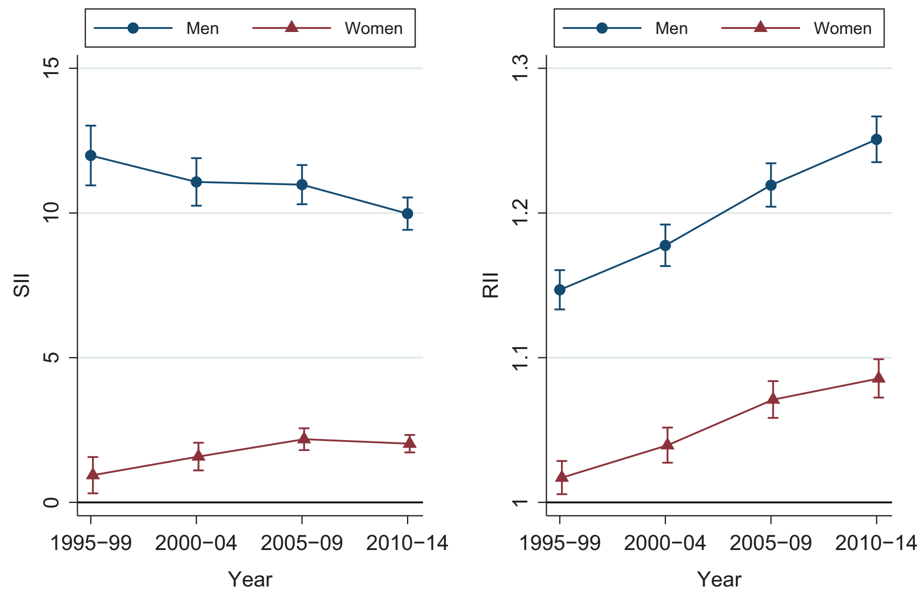


Fig. 5.30 Transition in SII and RII of cerebrovascular disease from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.7 Subarachnoid Haemorrhage (ICD10: I600-I609, I690): Widening Gap Between Metropolitan and Non-metropolitan Areas

Ryozo Matsuda

Overview

Subarachnoid haemorrhage is one of the most devastating types of stroke. Deaths from subarachnoid haemorrhage geographically differ at various scales, and WHO-based studies show that the mortality rate is as high in Japan as in Finland (Ingall et al. 2000).

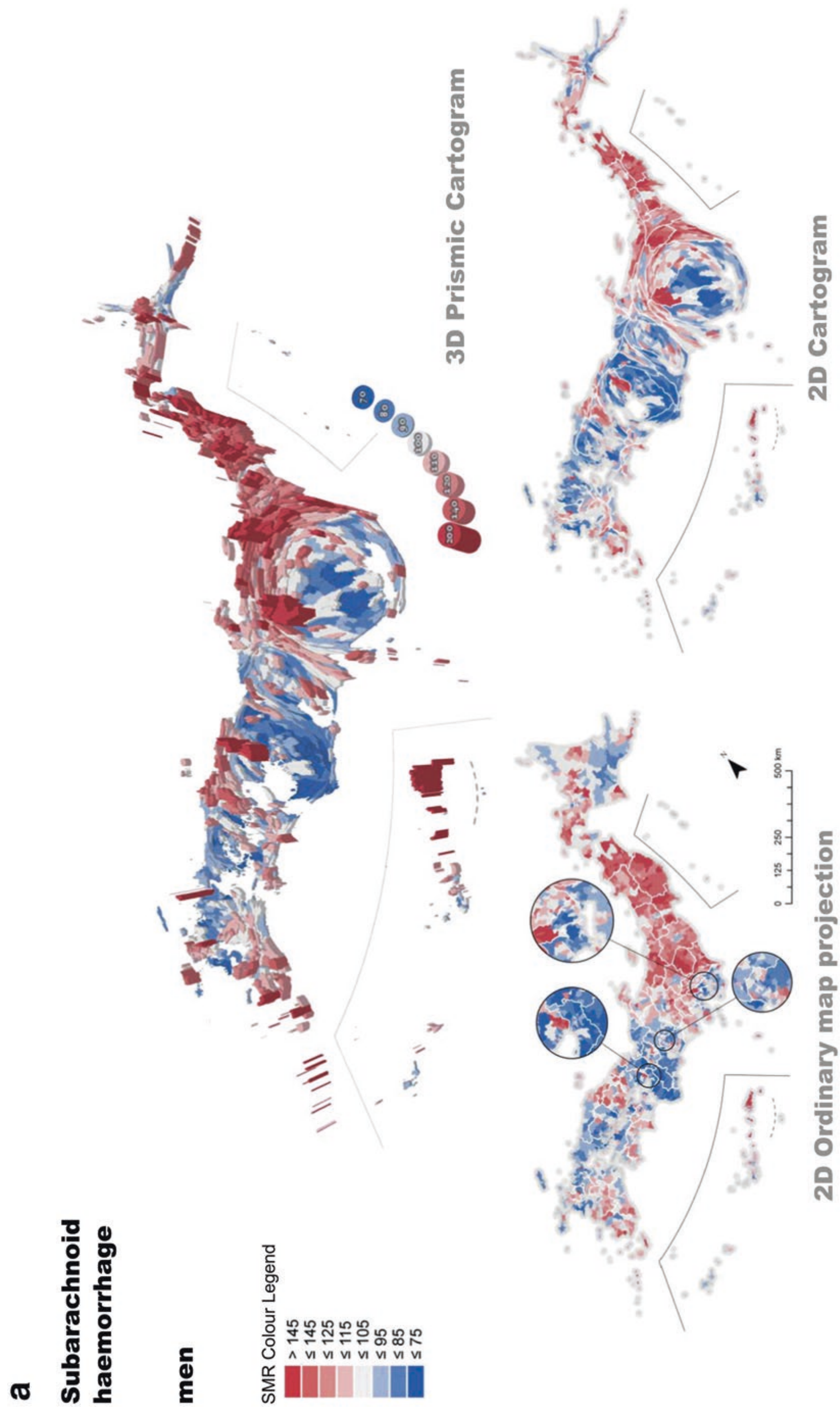
The SMR of subarachnoid haemorrhage is generally high in both sexes in eastern Japan, particularly the Tohoku and northern Kanto regions (Fig. 5.31). The SMRs in Hokkaido, located to the north of Tohoku region, vary considerably. There are, however, also areas with high male SMRs in western Japan as well as eastern Chugoku and southern Kyushu regions. Chugoku and eastern Shikoku regions have low SMRs among women. The cartogram shows that the SMR tends to be low in urban areas, e.g. in the Tokyo and Keihanshin/Osaka metropolitan areas. These regional differences may be attributed to different distributions of population of hypertensives and smoking and differences in access to emergency care (van Gijn and Rinkel 2001).

Transitions and Socioeconomic Disparities

The overall pattern that the eastern Japan has higher SMR of subarachnoid haemorrhage than the rest of the country has not changed considerably between 1995 and 2014 (Fig. 5.32). The southern Kyusyu areas have continuously higher SMRs, while the Kinki region has recorded lower SMRs. The cartogram-based SMR maps, however, clearly shows that SMRs decreased in some urban areas over the last 20 years, particularly in the Tokyo metropolitan areas. In addition, northern Kyusyu has lower SMRs in the period from 2010 to 2014 than those in the period from 2000 to 2004. Reasons for the change are not clear but may include changed urban lifestyle and improvements in emergency medical care.

The ASMR of subarachnoid haemorrhage continues to decrease and the gap between sexes became small since around 2005 (Fig. 5.33).

There have been high mortality rates in areas with low socioeconomic indices during the period observed. The gap of ASMR between areas with low and high ADI has widened since the middle of the 2000s (Fig. 5.34). The ASMR by ADI quintile indicates that socioeconomic disparities have become remarkable in both males and females in the last 10 years, 2005–2014. The growth of both SII and RII also shows the same trend (Fig. 5.35).


a
Subarachnoid haemorrhage
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
0 125 250 500 km
N

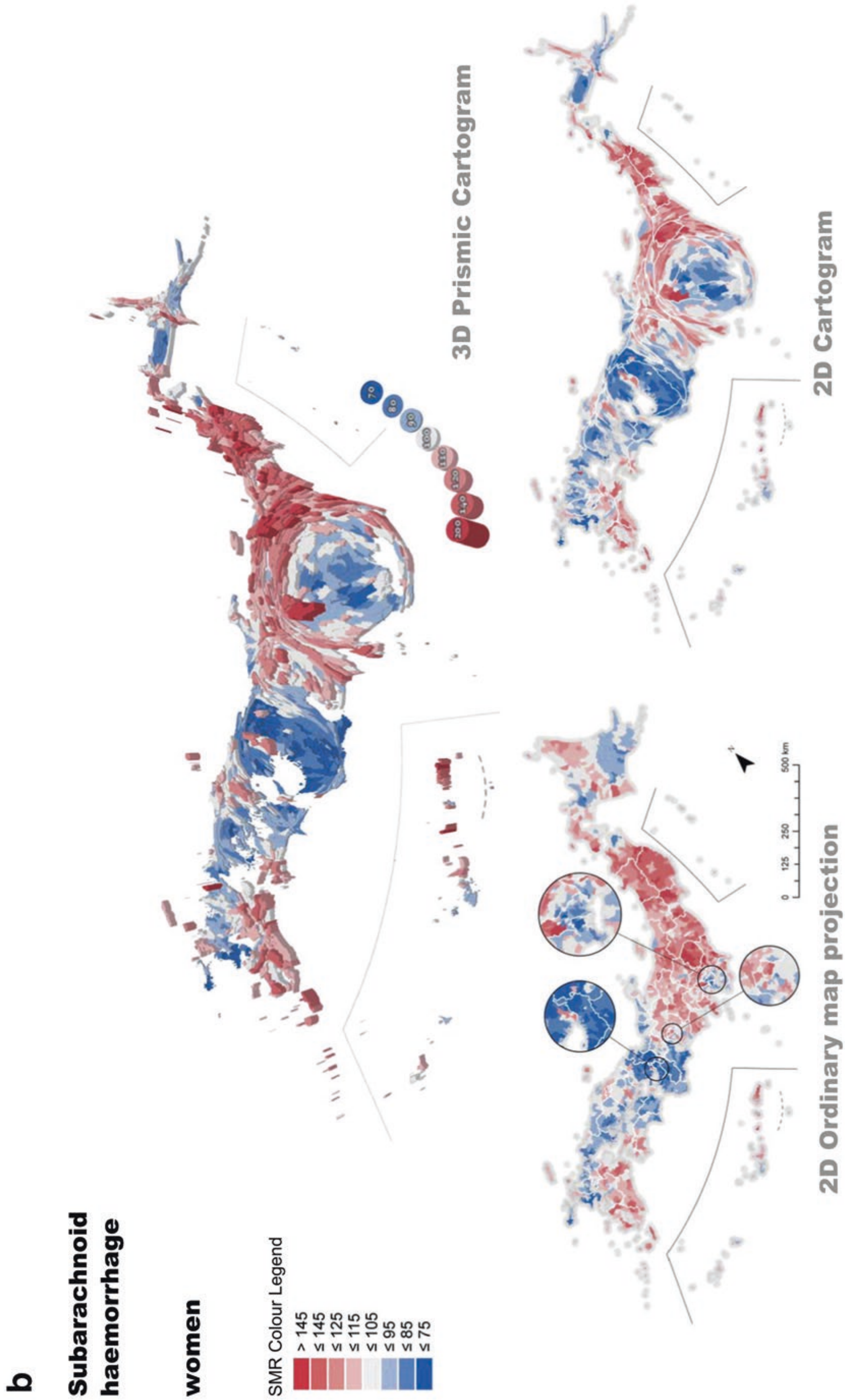
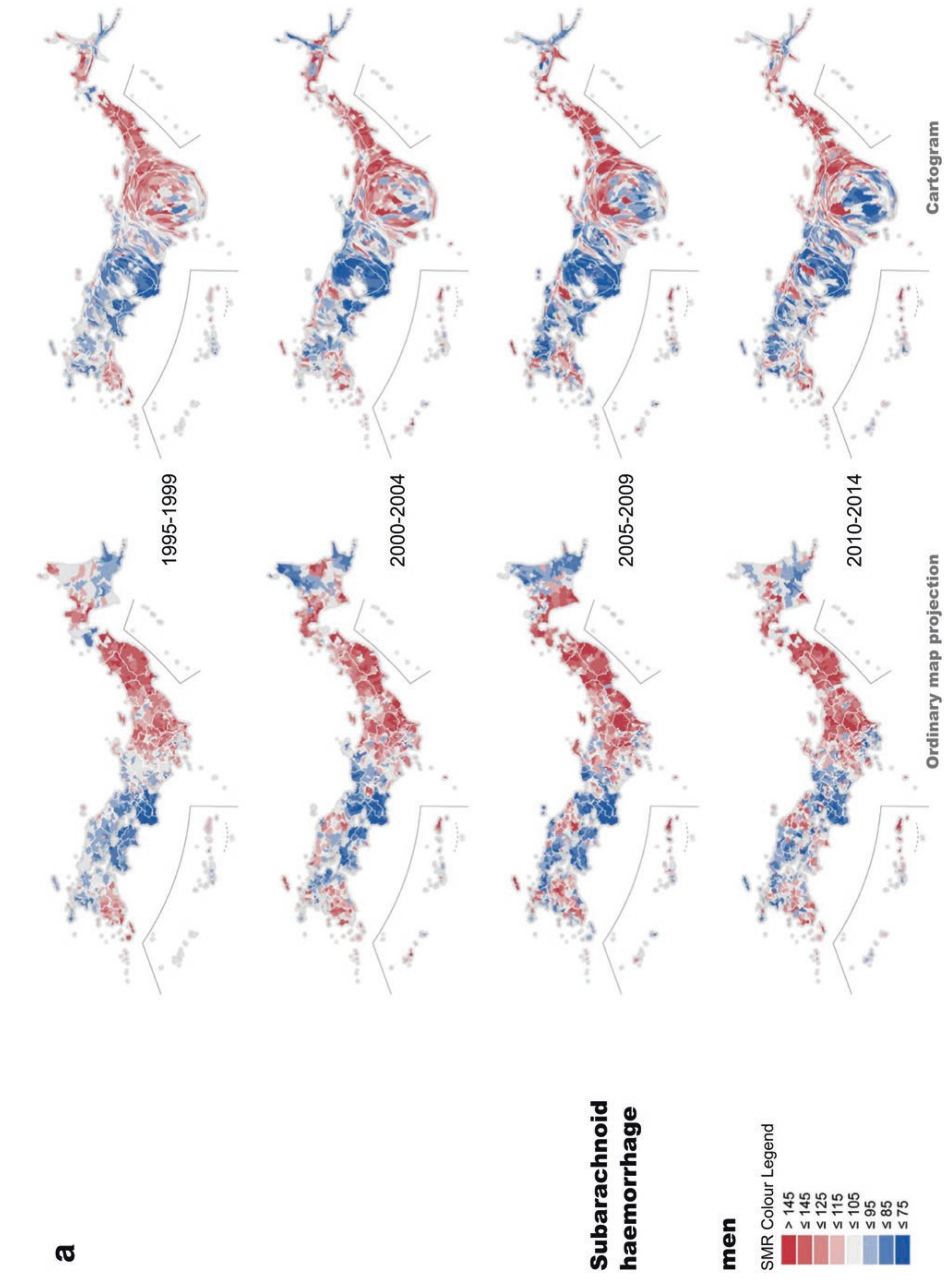


Fig. 5.31 SMR distribution of subarachnoid haemorrhage, 2010–2014. (**a**) Men. (**b**) Women


a
Subarachnoid haemorrhage
men
SMR Colour Legend
> 145
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1995-1999
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2010-2014
Ordinary map projection
Cartogram

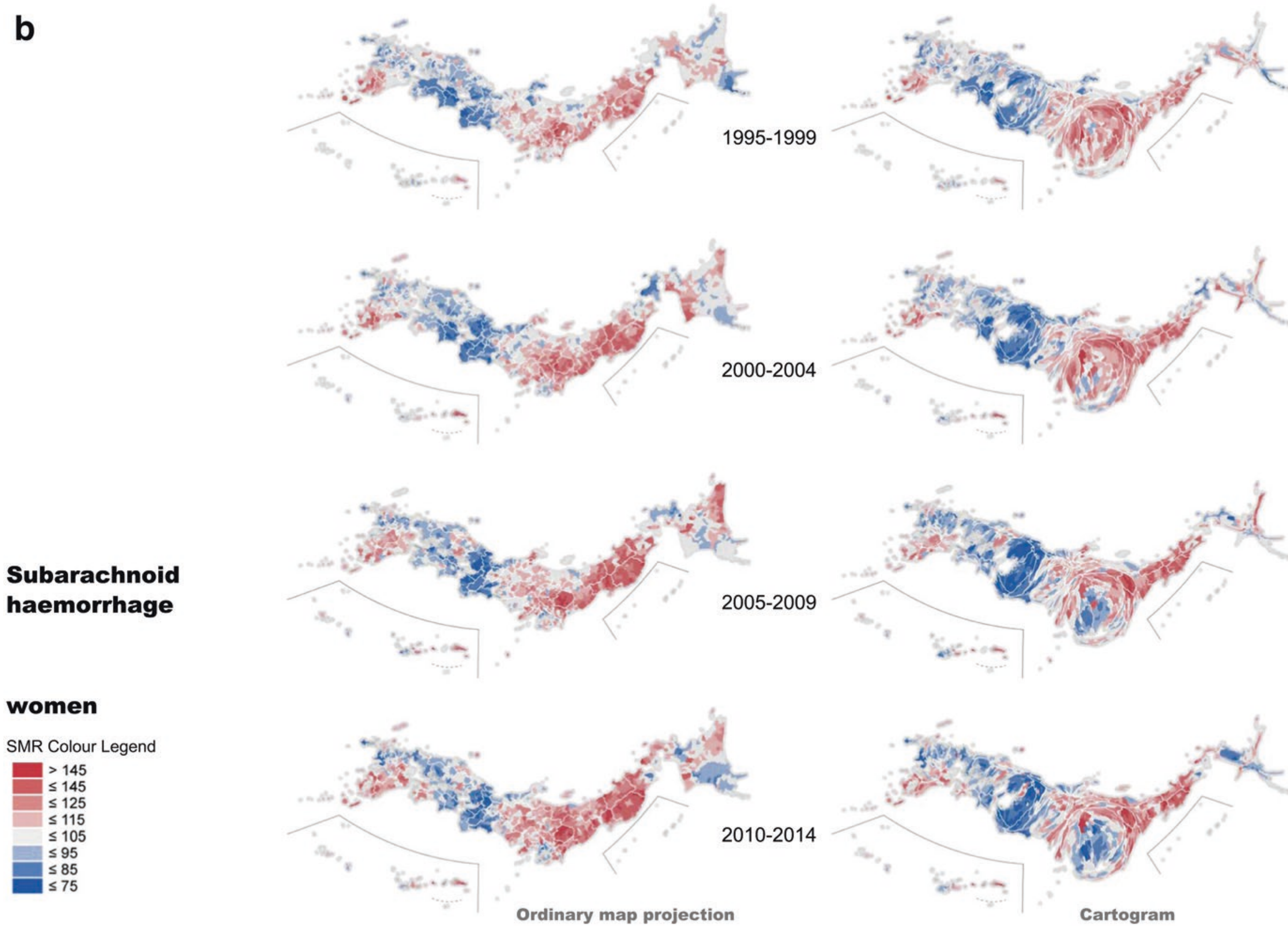
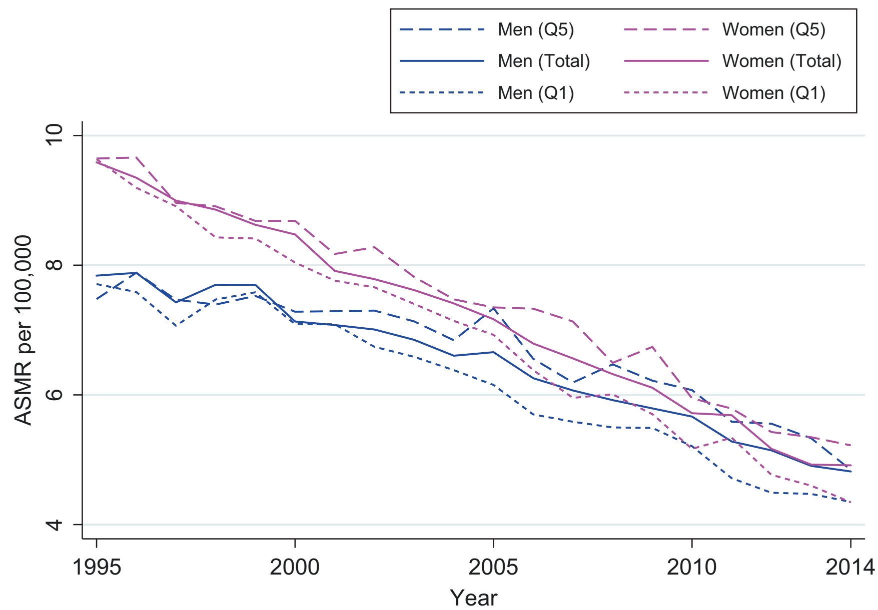


Fig. 5.32 Transition of SMR distribution of subarachnoid haemorrhage from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.33 Annual transition in the ASMR of subarachnoid haemorrhage from 1995 to 2014



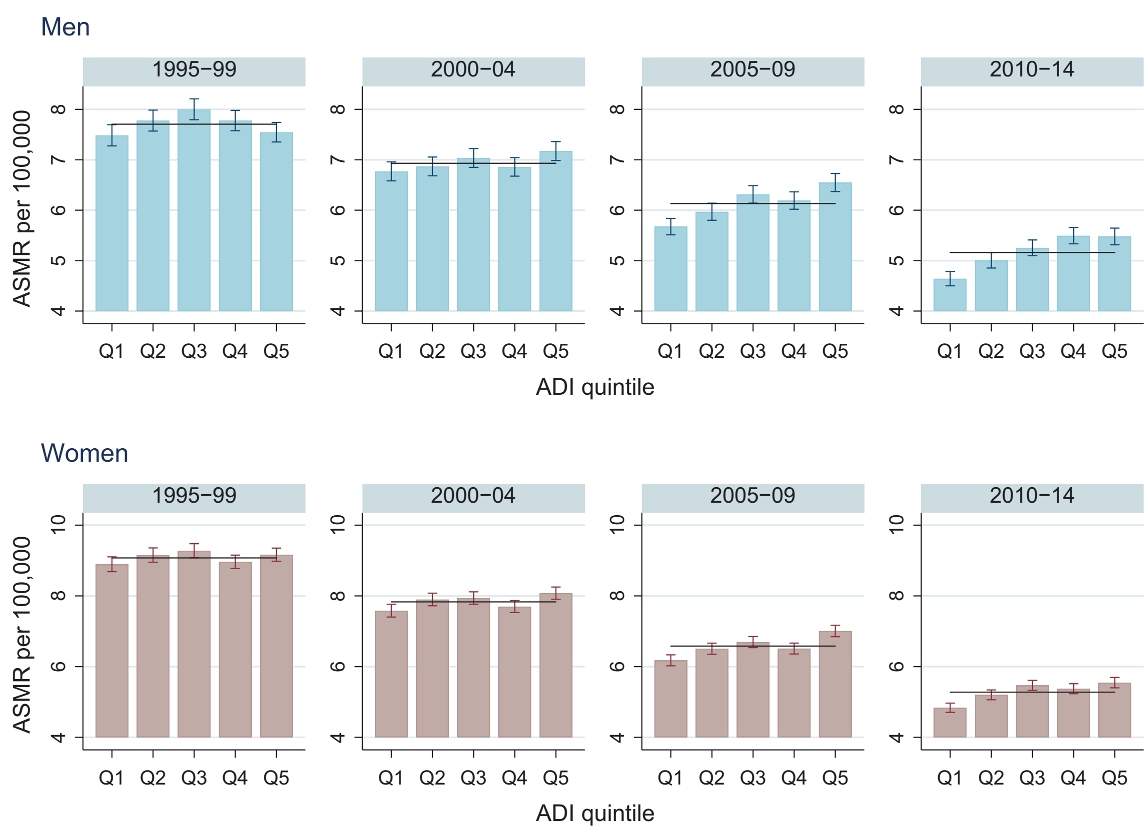


Fig. 5.34 The transition in the ASMR distribution of subarachnoid haemorrhage by ADI quintile. (Top: Men, Bottom: Women)

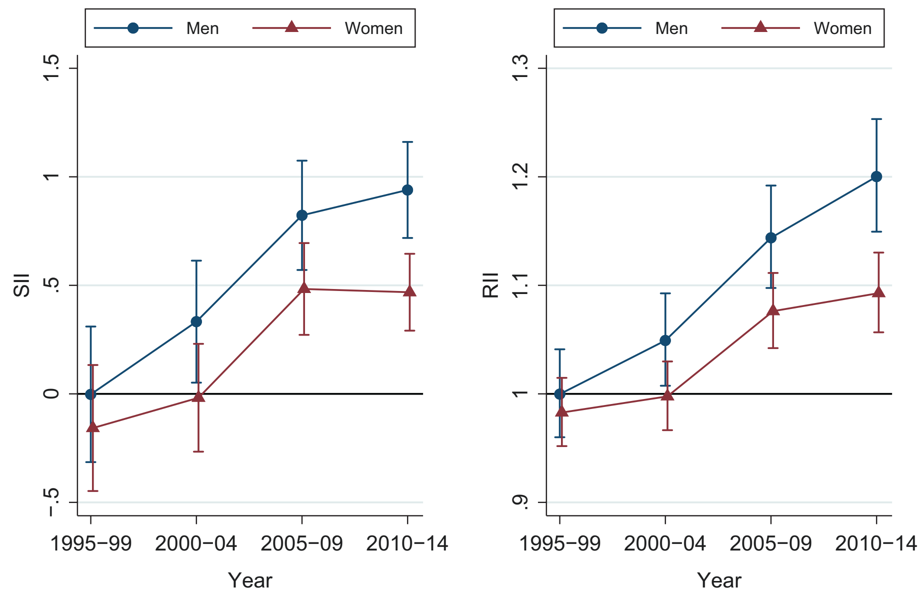


Fig. 5.35 Transition in SII and RII of subarachnoid haemorrhage from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.8 Intracerebral Haemorrhage (ICD10: I610-I619, I691): An Old National Disease Related to Hypertension

Ryozo Matsuda

Overview

The stroke mortality rate in Japan was extremely high by international standards in the 1960s, attributed to the particularly high mortality rate of cerebral haemorrhages. Since then, cerebral haemorrhage mortality has greatly decreased due to widespread hypertension treatment and improvements in diet. Around the mid-1980s, the mortality rate became similar to that of Western societies (Levi et al. 2002).

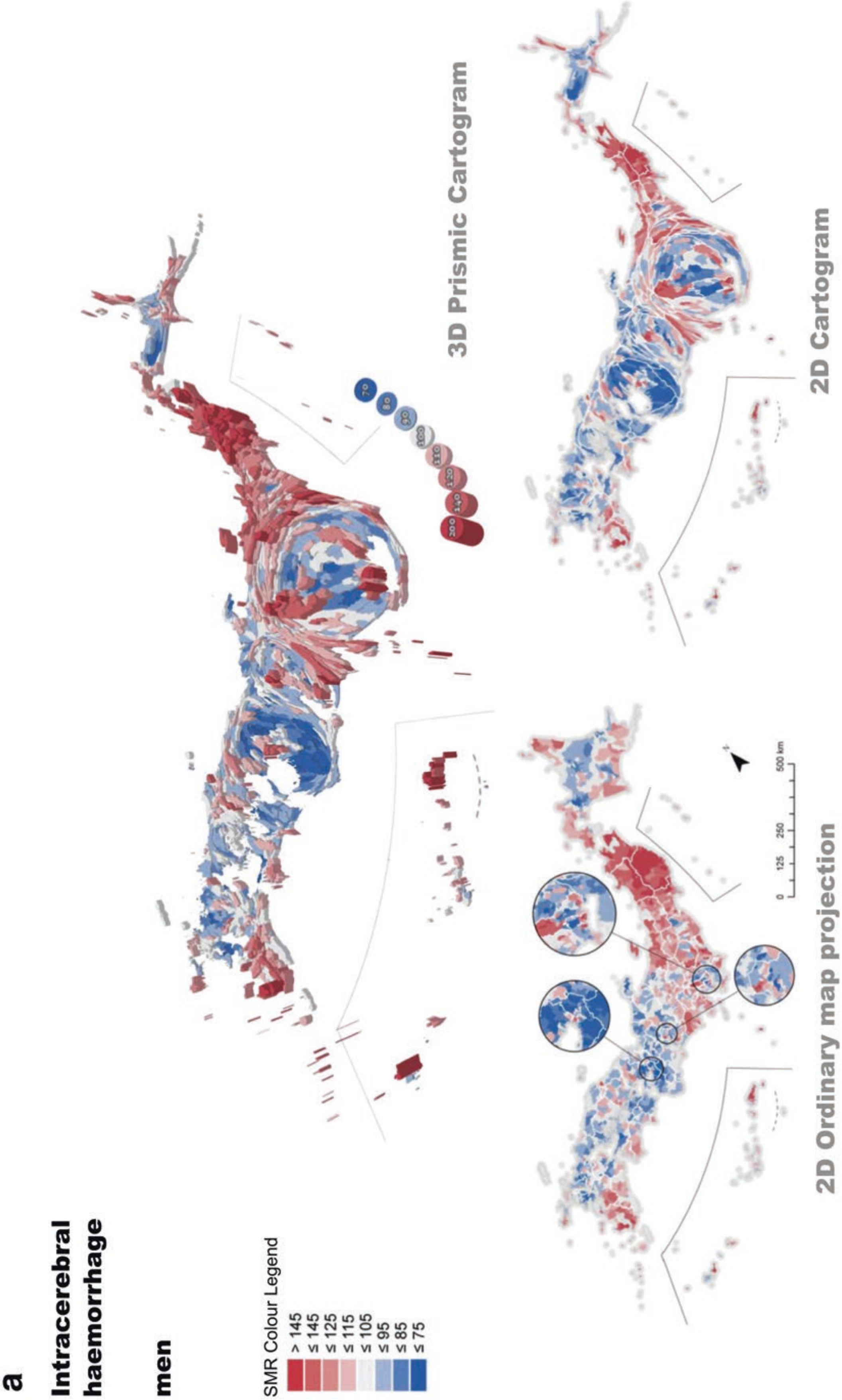
Regional variations in this disease's mortality may reflect variations in the major risk factors of the disease: hypertension related to various life habits, such as high salt intake, smoking, and insufficient physical activity.

SMRs of intracerebral haemorrhage are high in the Tohoku region for both sexes, but there are also areas with high SMRs in the Hokuriku, Tokai, Southern Kyushu, Okinawa, and Hokkaido regions (Fig. 5.36). The cartogram-based SMR maps shows that SMRs tend to be low in urban areas, mainly in the Tokyo and Osaka metropolitan areas, but that there are high SMR areas corresponding to inner-city parts within the metropolitan areas.

Transitions and Socioeconomic Disparities

It appears that the difference between the Tohoku region and the rest of the country has grown for both males and females over the 2 decades from 1995 to 2014 (Fig. 5.37). However, there seems to be no major change in the overall geographical trend. The series of cartogram-based SMR maps (Fig. 5.37) clearly shows that there have continuously been significant disparities in the SMRs between urban areas: the Kinki region has lower mortality rates than the Tokyo metropolitan area in general. The disparities between them could be attributed to higher health care density in the region and to different food cultures. It also shows that areas with high SMR in men continue to exist in some urban areas, including inner-city parts of central Osaka and industrial areas around Kawasaki city in the Tokyo metropolitan area.

The ASMR of intracerebral haemorrhage has continued to decrease (Fig. 5.38). The socioeconomic disparity in mortality is larger for men than women. Although ASMRs decreased across the ADI quintiles, it appears that the magnitude of the disparity has been similar during the period from 1995 to 2014 (Fig. 5.39). There have been continuously clear associations between ASMRs and ADI quintiles in men, but not in women. The disparity of intracerebral haemorrhages in females has been lower than that in males during the 2 decades covered in this study. While the SII decreased for men, the SII for women and the RII for both sexes indicate stable trends of the mortality inequality of the disease (Fig. 5.40).


a
Intracerebral haemorrhage
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

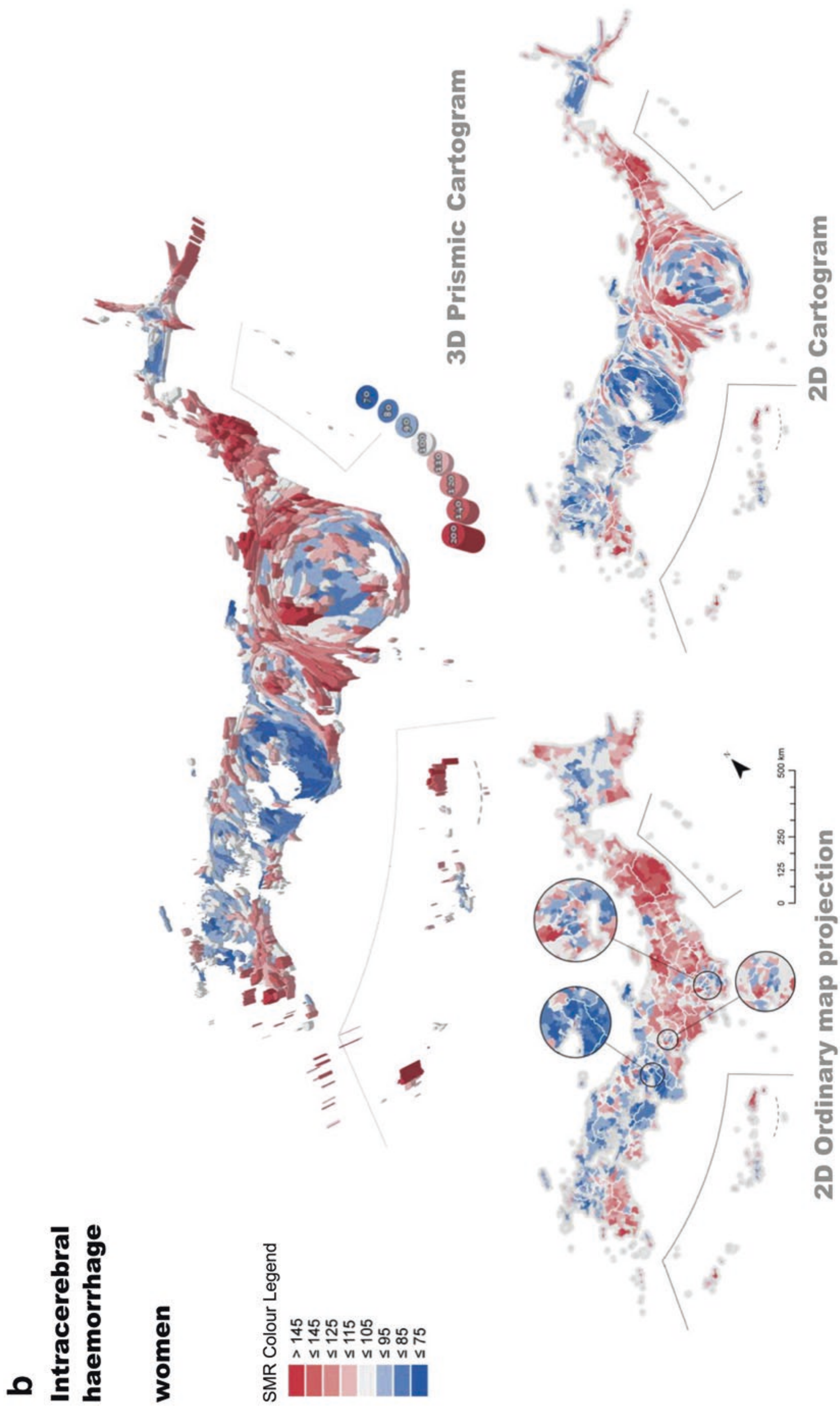
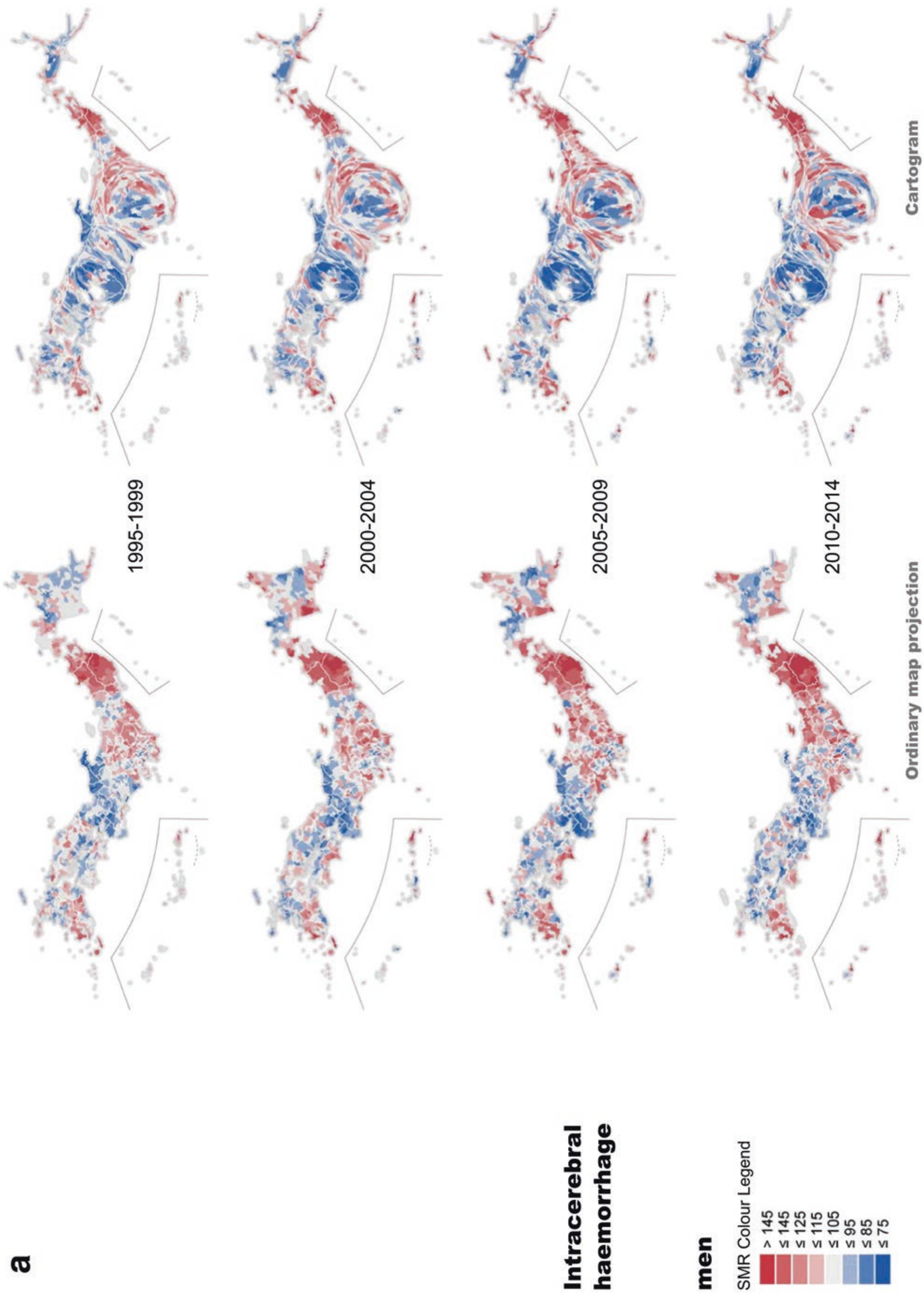


Fig. 5.36 SMR distribution of intracerebral haemorrhage, 2010–2014. (**a**) Men. (**b**) Women


a
Intracerebral haemorrhage
men
SMR Colour Legend
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≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

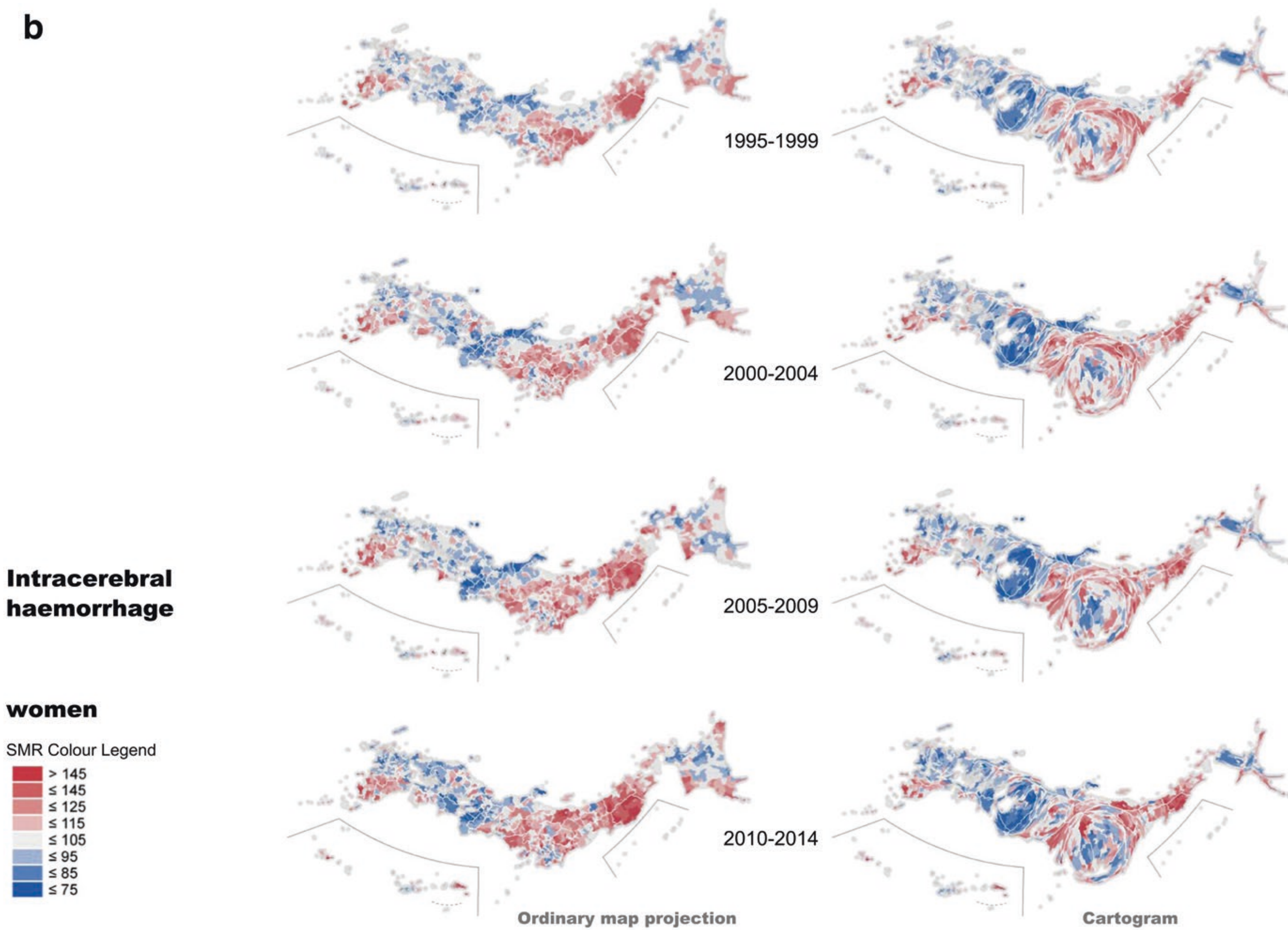
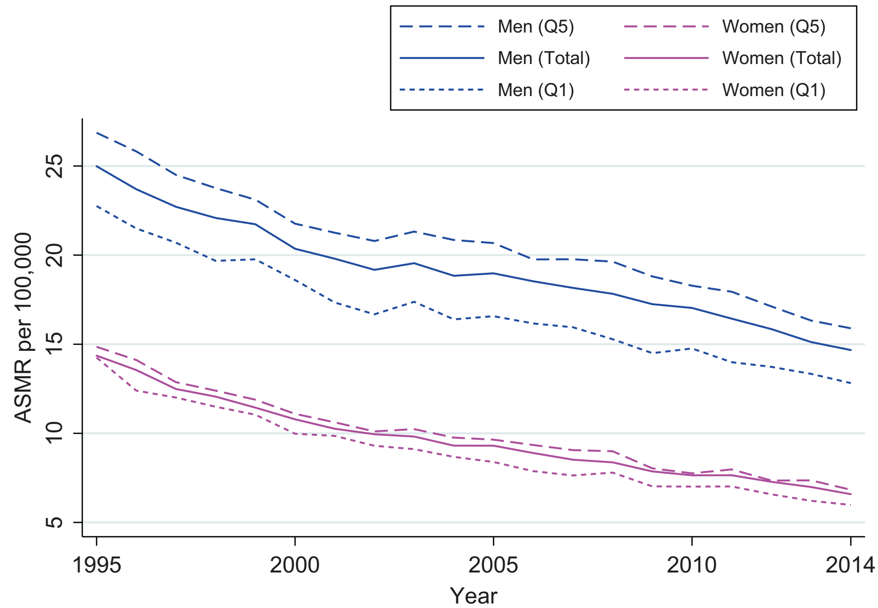


Fig. 5.37 Transition of SMR distribution of intracerebral haemorrhage from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.38 Annual transition in the ASMR of intracerebral haemorrhage from 1995 to 2014



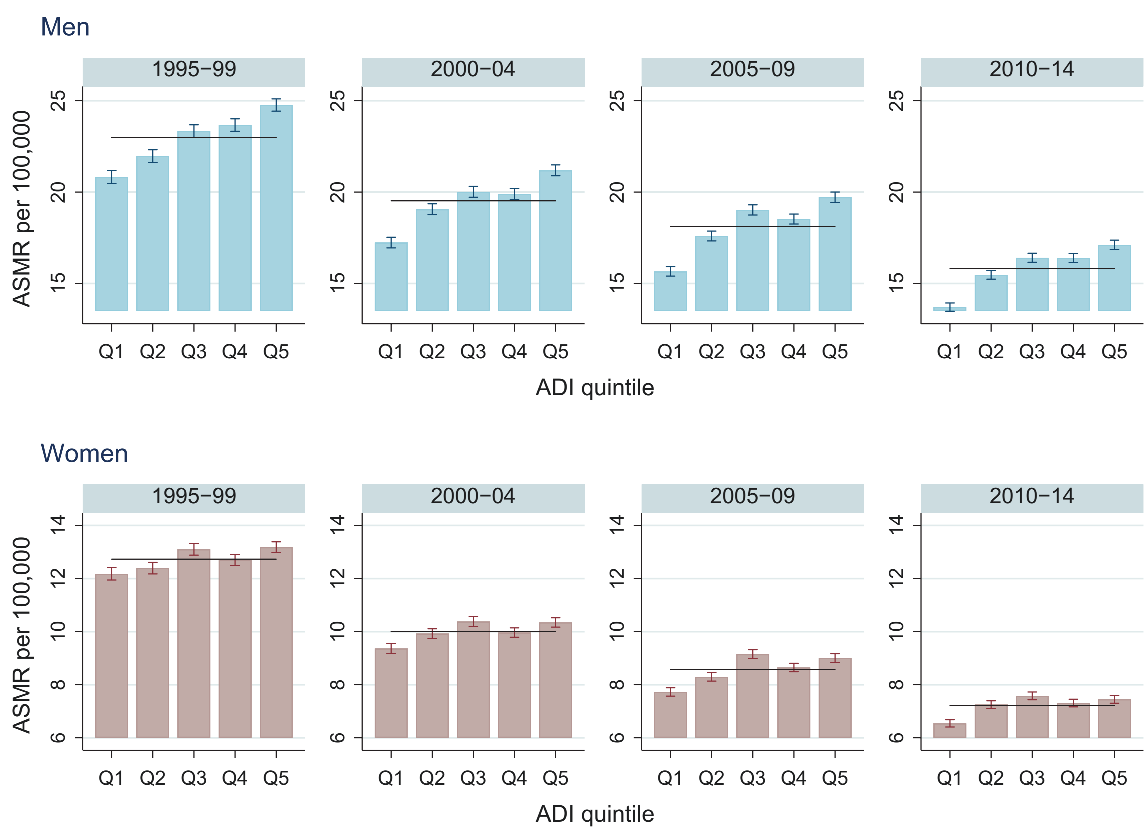


Fig. 5.39 The transition in the ASMR distribution of intracerebral haemorrhage by ADI quintile. (Top: Men, Bottom: Women)

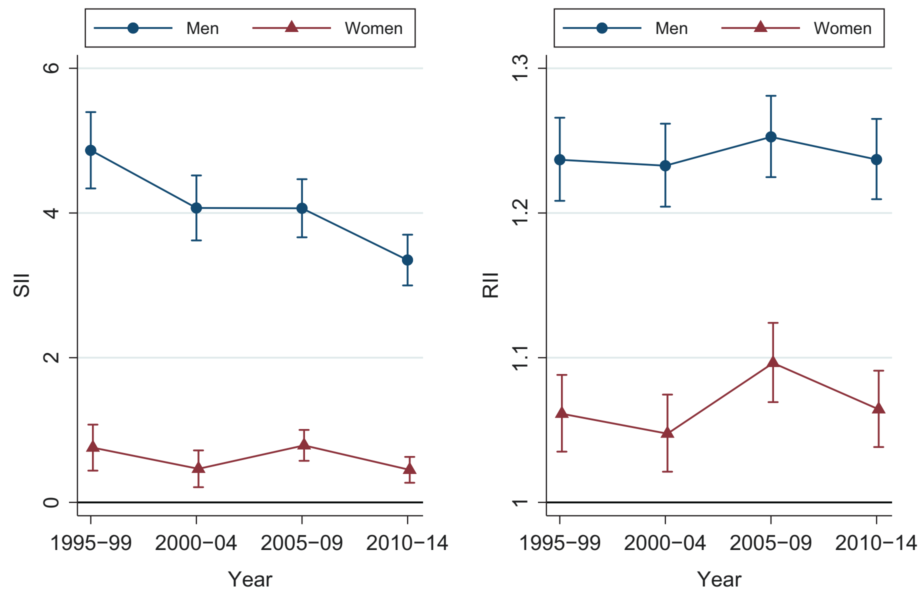


Fig. 5.40 Transition in SII and RII of intracerebral haemorrhage from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.9 Cerebral Infarction (ICD10: I630-I639, I693): Widening Gap Between the Tohoku Region and the Rest

Ryozo Matsuda

Overview

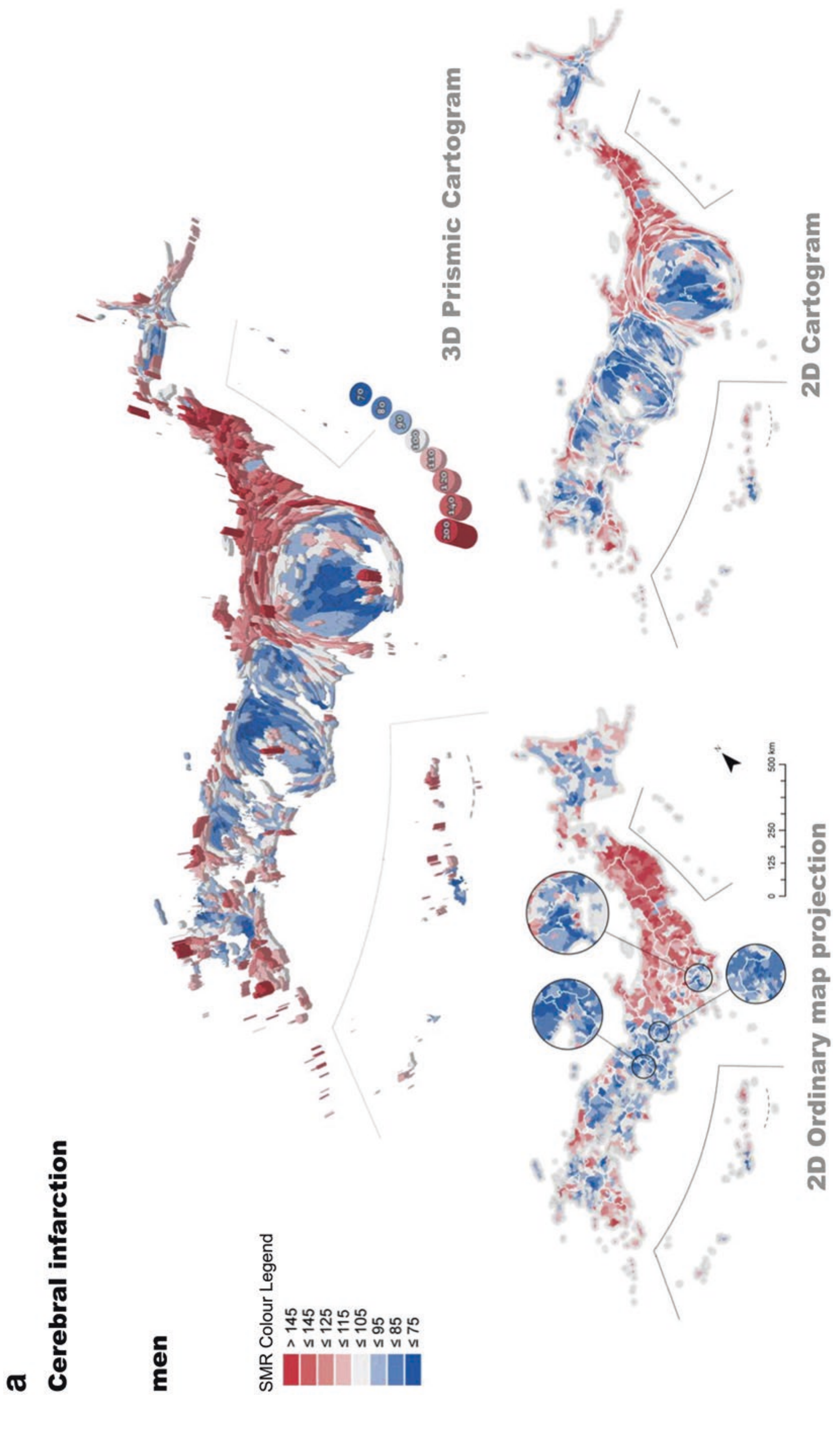
The most common cause of stroke fatalities in Japan used to be intracerebral haemorrhage. Since around 1980, however, it has shifted to cerebral infarction. Health care seems to increasingly have a larger impact on mortality for cerebral infarction. Resources for advanced management of acute cerebral infarction differ between areas and, therefore, may contribute to geographical mortality differences. New strategies of stroke prevention, including detection of atrial fibrillation and utilization of anticoagulants to prevent cardioembolic stroke, may also have increasing impacts on the incidence and morality of stroke.

Areas with high SMRs of cerebral infarction are concentrated in the Tohoku and Hokuriku regions for both men and women, but there are also high SMR areas in the Chubu, Chugoku, and Kyushu regions (Fig. 5.41). As shown by the prismic cartogram-based maps, the SMR tends to be low in urban areas, mainly in the Tokyo and Osaka metropolitan areas. Several inner-city parts within those areas, however, have high SMRs, particularly for men. For women, areas with large SMRs are scattered in several rural areas throughout the country.

Transitions and Socioeconomic Disparities

Over the last 20 years from 1995 to 2014, it appears that the difference between the Tohoku region and the rest of the country is growing for both males and females (Fig. 5.42). It is difficult to identify other clear trends; the SMRs for cerebral infarction have increased in some areas and decreased in others. The series of cartogram-based maps, however, shows that there has been a continuing trend toward lower SMRs in affluent metropolitan areas. This trend may be partly attributed to improved access to quality emergency care. In contrast, inner-city areas with higher SMRs in the first period, 1995–1999, still had higher SMRs in the last period, 2010–2014.

The ASMRs of cerebral infarction in both sexes have continued to decrease (Fig. 5.43). The age-standardized mortality by ADI quintile groups in the third and last period shows clear gradients in male ASMRs by the ADI quintile (Fig. 5.44). It is difficult to detect such gradients in female ASMRs, although since 2000 the least deprived areas consistently had the smallest female ASMRs. In general, the socioeconomic disparity in mortality has been more pronounced in men than in women. The RII trend shows that the socioeconomic disparity in mortality has been widening in both sexes during the observation period, 1995–2014 (Fig. 5.45).


a
Cerebral infarction
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

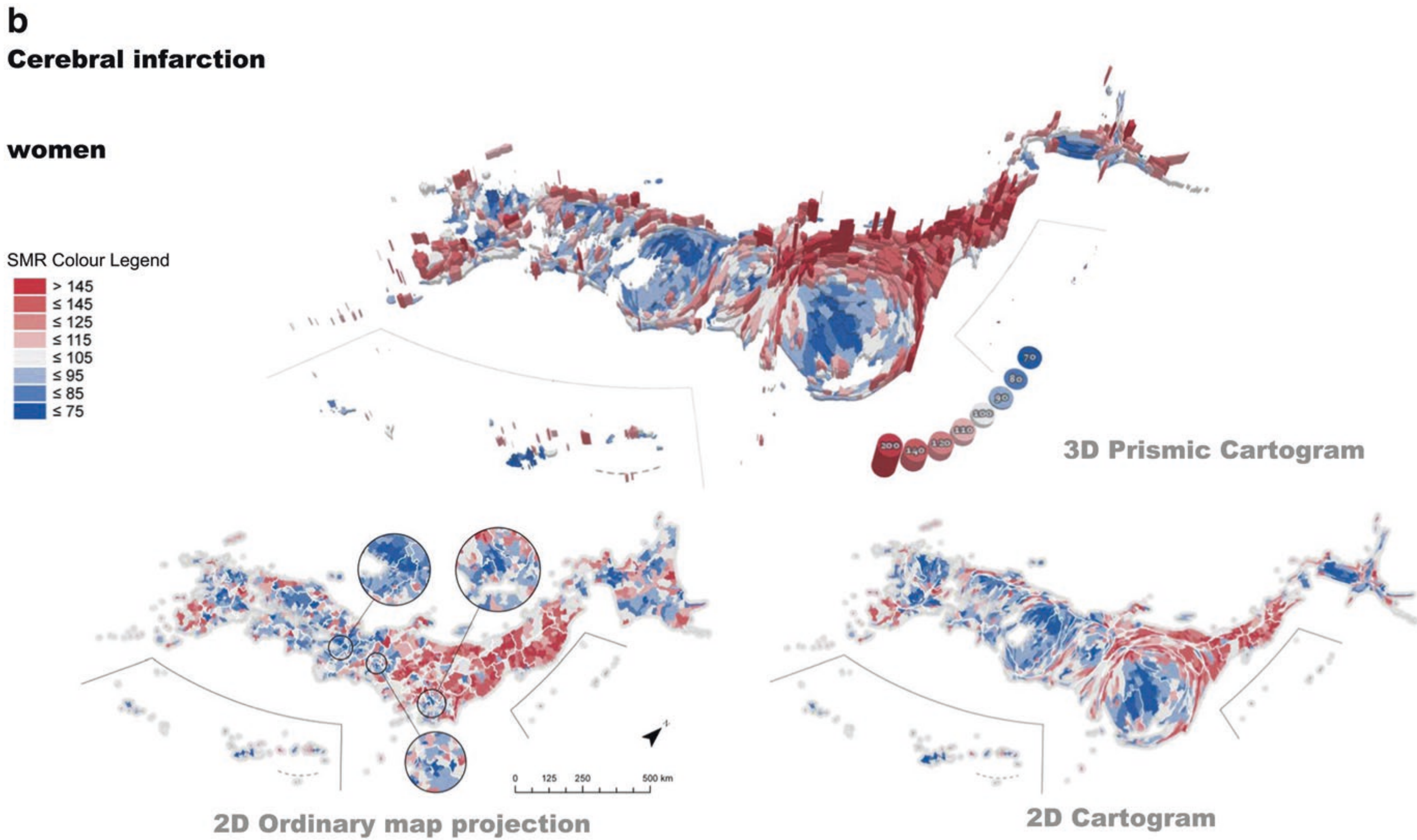
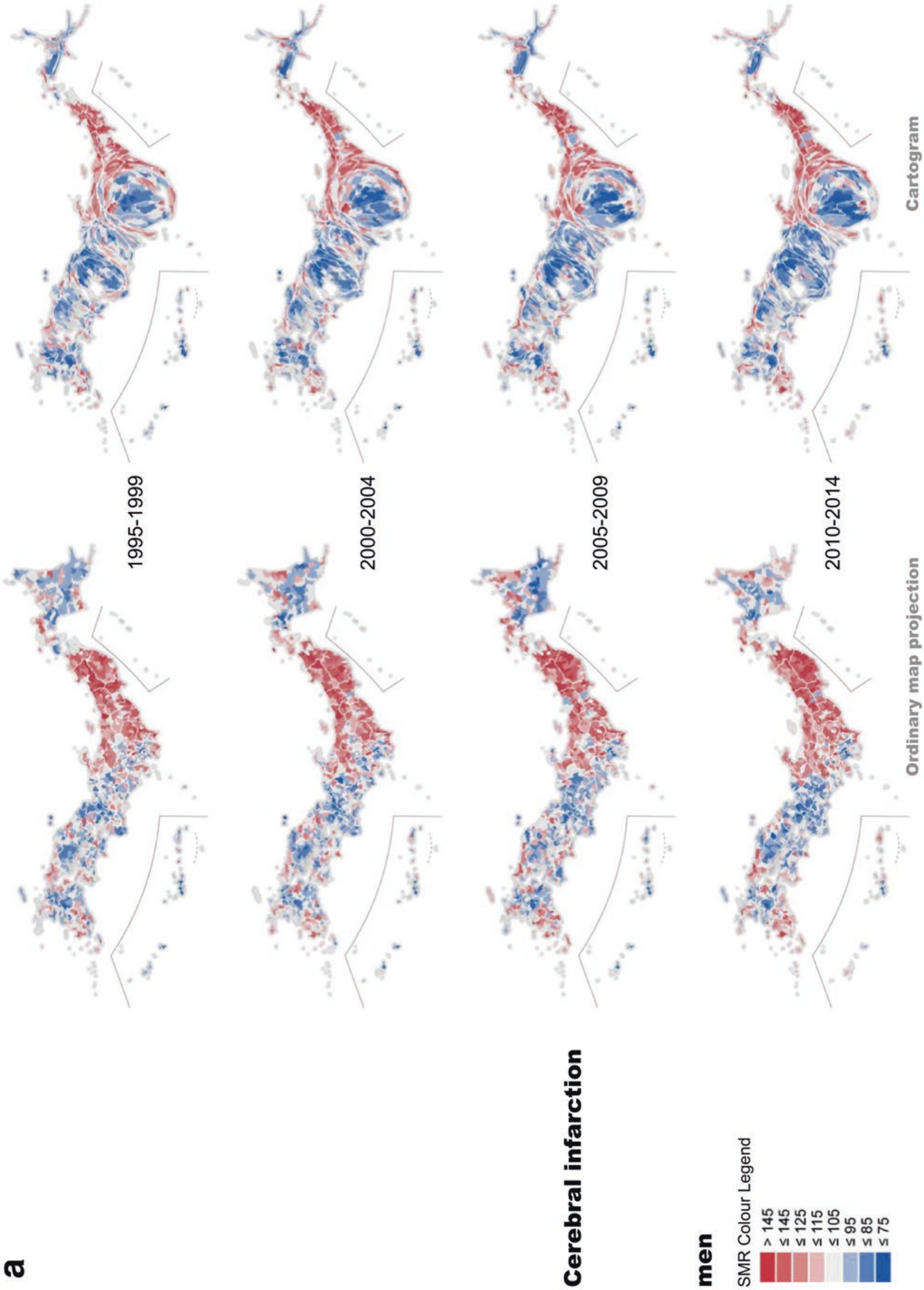


Fig. 5.41 SMR distribution of cerebral infarction, 2010–2014. (**a**) Men. (**b**) Women


a
Cerebral infarction
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

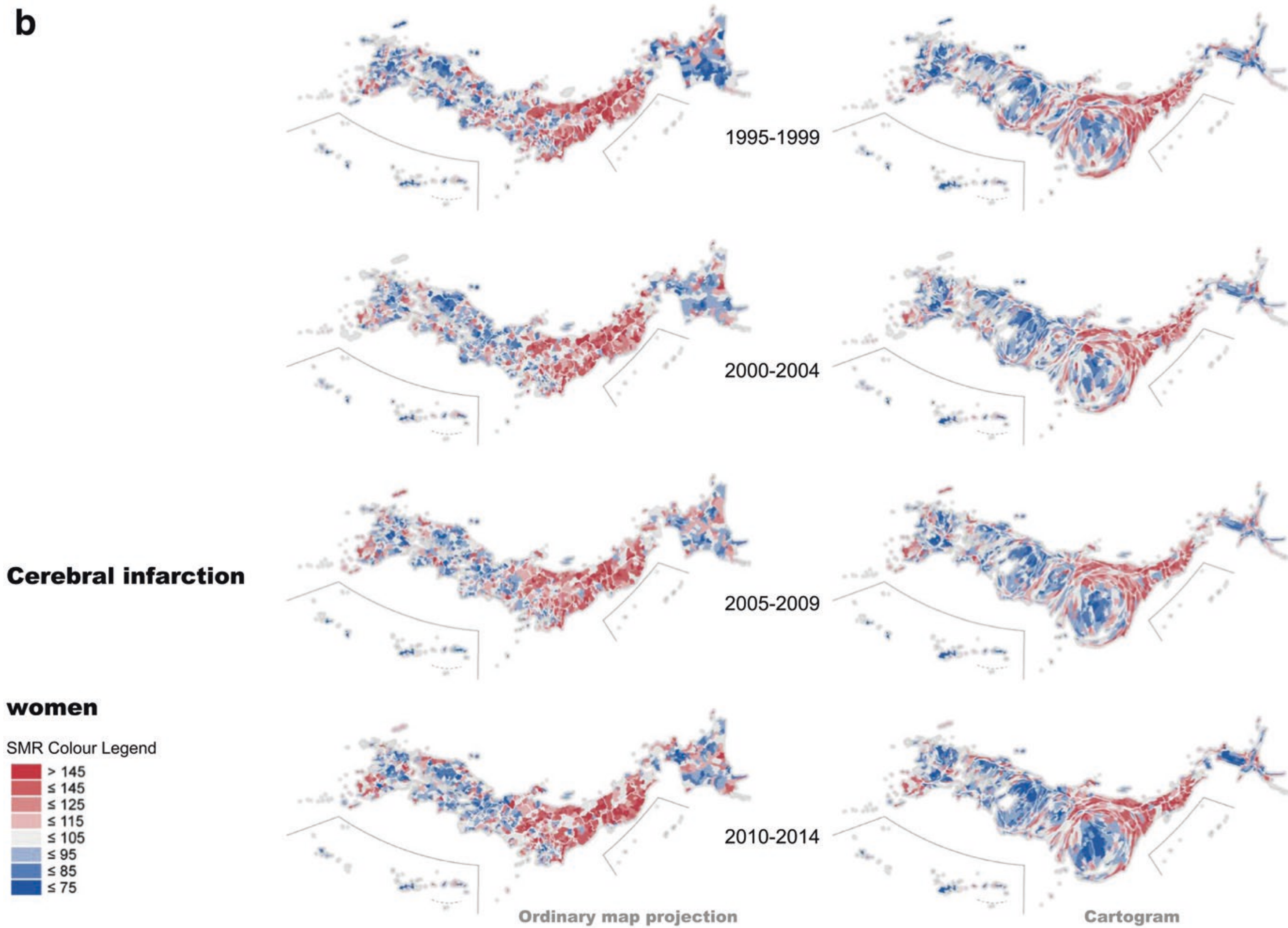


Fig. 5.42 Transition of SMR distribution of cerebral infarction from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

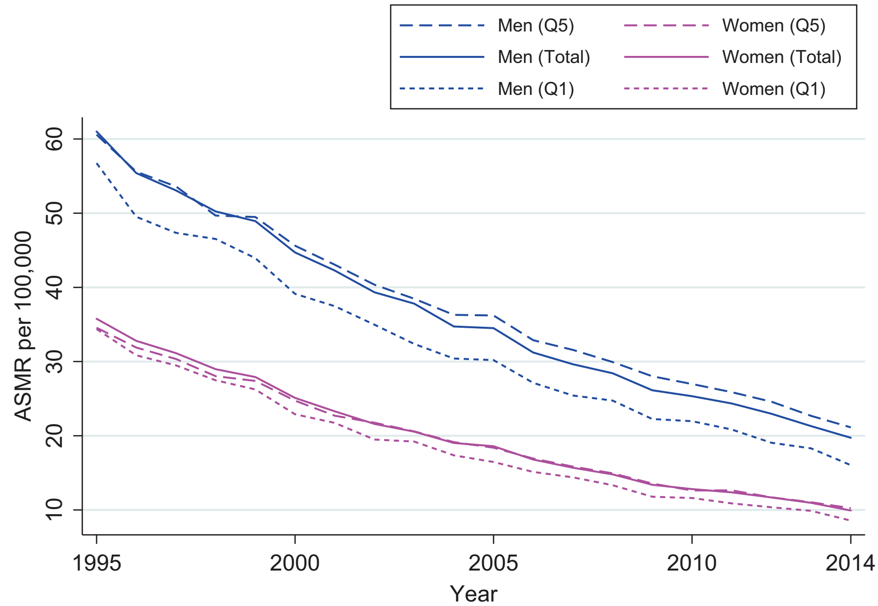


Fig. 5.43 Annual transition in the ASMR of cerebral infarction from 1995 to 2014

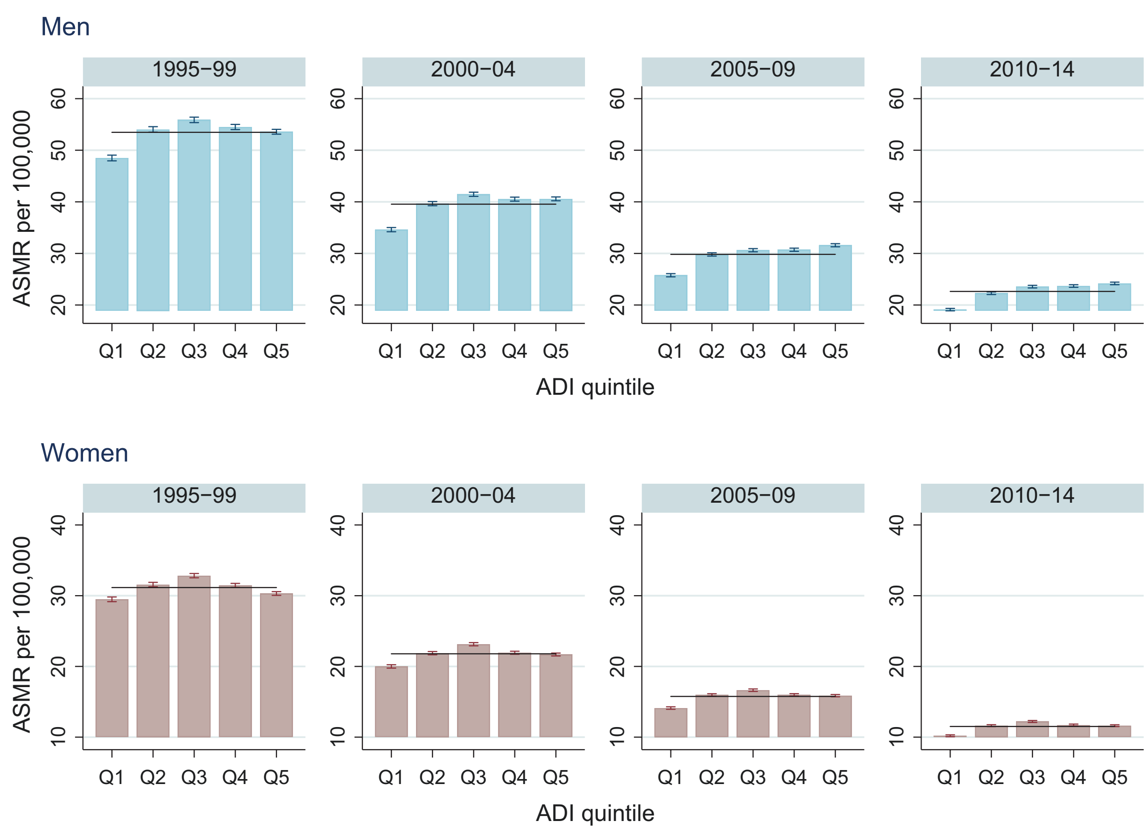


Fig. 5.44 The transition in the ASMR distribution of cerebral infarction by ADI quintile. (Top: Men, Bottom: Women)

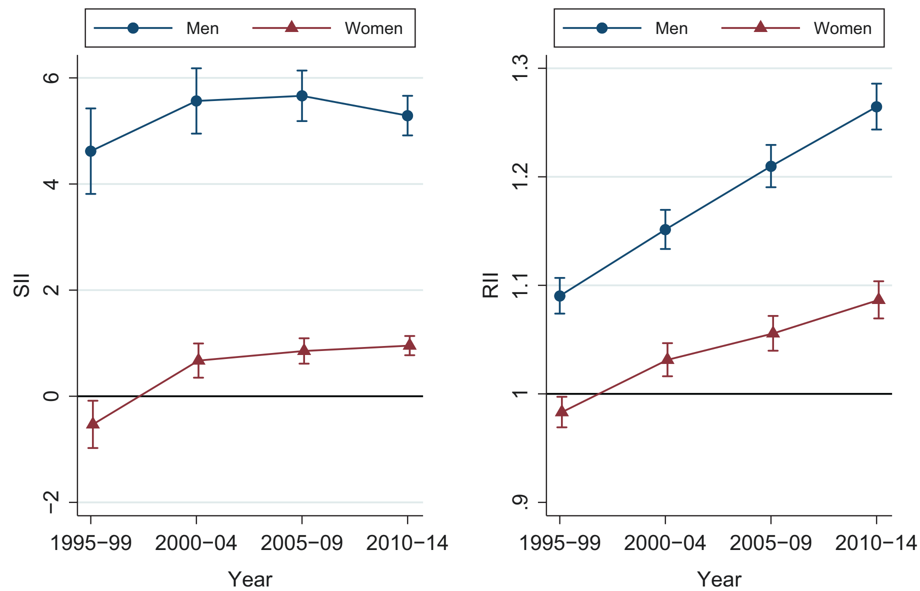


Fig. 5.45 Transition in SII and RII of cerebral infarction from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.10 Hypertensive Diseases (ICD10: I10-I15): Osaka Disease?

Shigeru Inoue and Hiroyuki Kikuchi

Overview

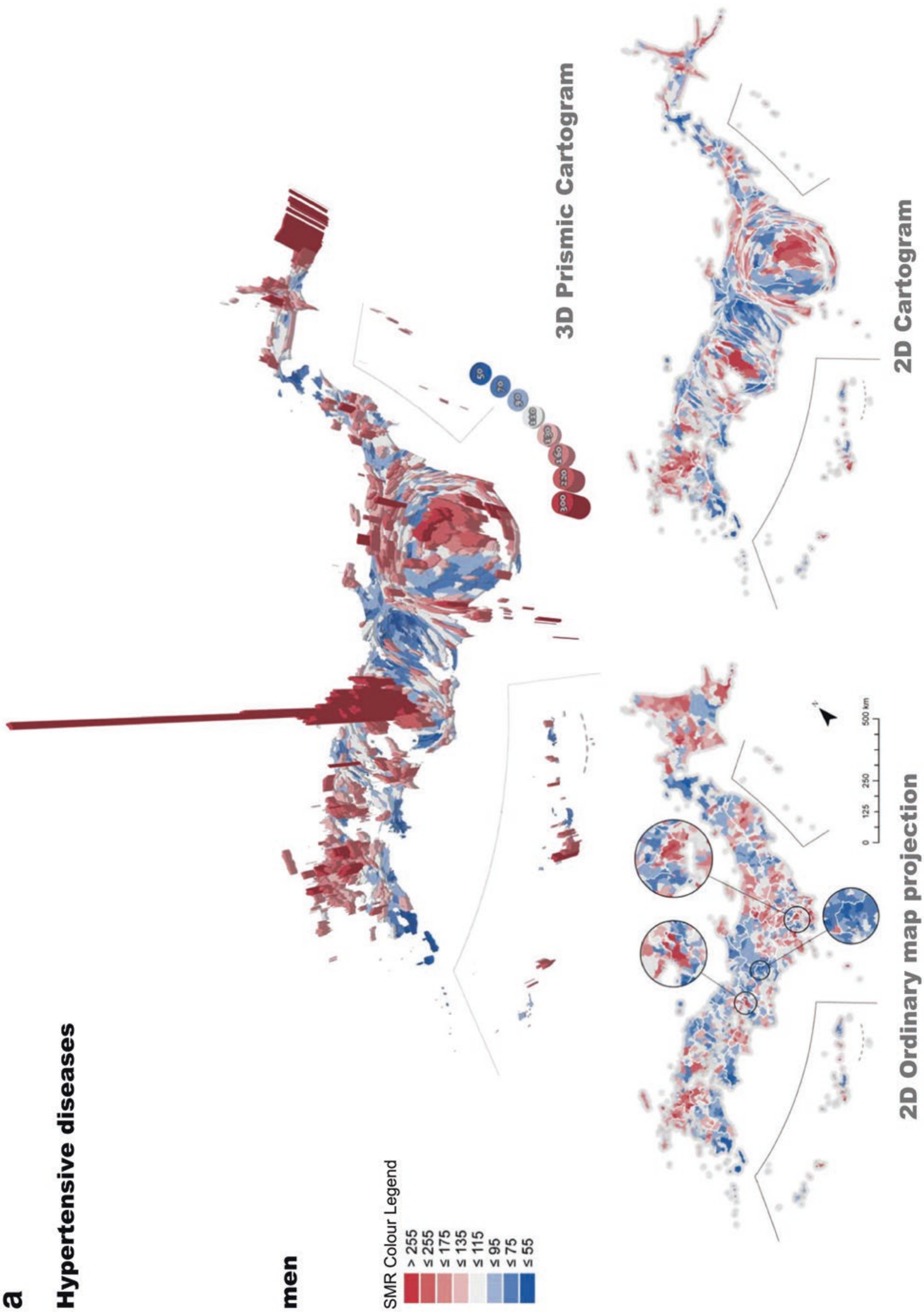
This category of death includes fatal cases of essential hypertension, hypertensive heart failure, and hypertensive renal failure but does not include other cardiovascular diseases, such as ischemic heart disease, cerebrovascular disease, and dissecting aortic aneurysm.

Salt intake, alcohol consumption, and obesity are known risk factors of hypertension. Aomori and Akita Prefectures in the Tohoku region, where salt intake and stroke are considered to be common, have rather low SMRs. In the areas with such lifestyle habits, deaths from ischemic heart disease and cerebrovascular disease caused by hypertension may increase, so that SMR of hypertensive disease may not be high. The extremely high SMRs are observed in the Osaka city, the second largest metropolitan core with highly deprived inner-city areas (Fig. 5.46). In the Tokyo metropolitan area, the eastern and northern side of the core region tends to have high SMRs and the western and southern affluent suburbs tend to have quite low SMRs. Overall, the geographical variation in the SMR is huge. The geographical distribution is similar for both men and women.

Transitions and Socioeconomic Disparities

Overall, the distributional pattern of SMR has been similar over the period from 1995 to 2014. However, according to the cartogram-based maps, the SMRs in the core areas, particularly the eastern side of the Tokyo metropolitan areas have substantially increased over the period (Fig. 5.47).

The ASMR of hypertensive diseases has declined regardless of gender (Fig. 5.48) and areal deprivation in the observation periods. High mortality rates in more deprived areas have been consistent throughout the 20-year period, 1995–2014 (Fig. 5.49). Especially in Q5, the most deprived quintile group of areas, the mortality rate has been consistently highest. According to the transition of RII, the deprivation-based regional relative inequality in the mortality has widened, particularly for men (Fig. 5.50).


a
Hypertensive diseases
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
≤ 95
≤ 75
≤ 55
3D Prismic Cartogram
50
70
90
110
130
160
220
300
2D Cartogram
2D Ordinary map projection
0
125
250
500 km

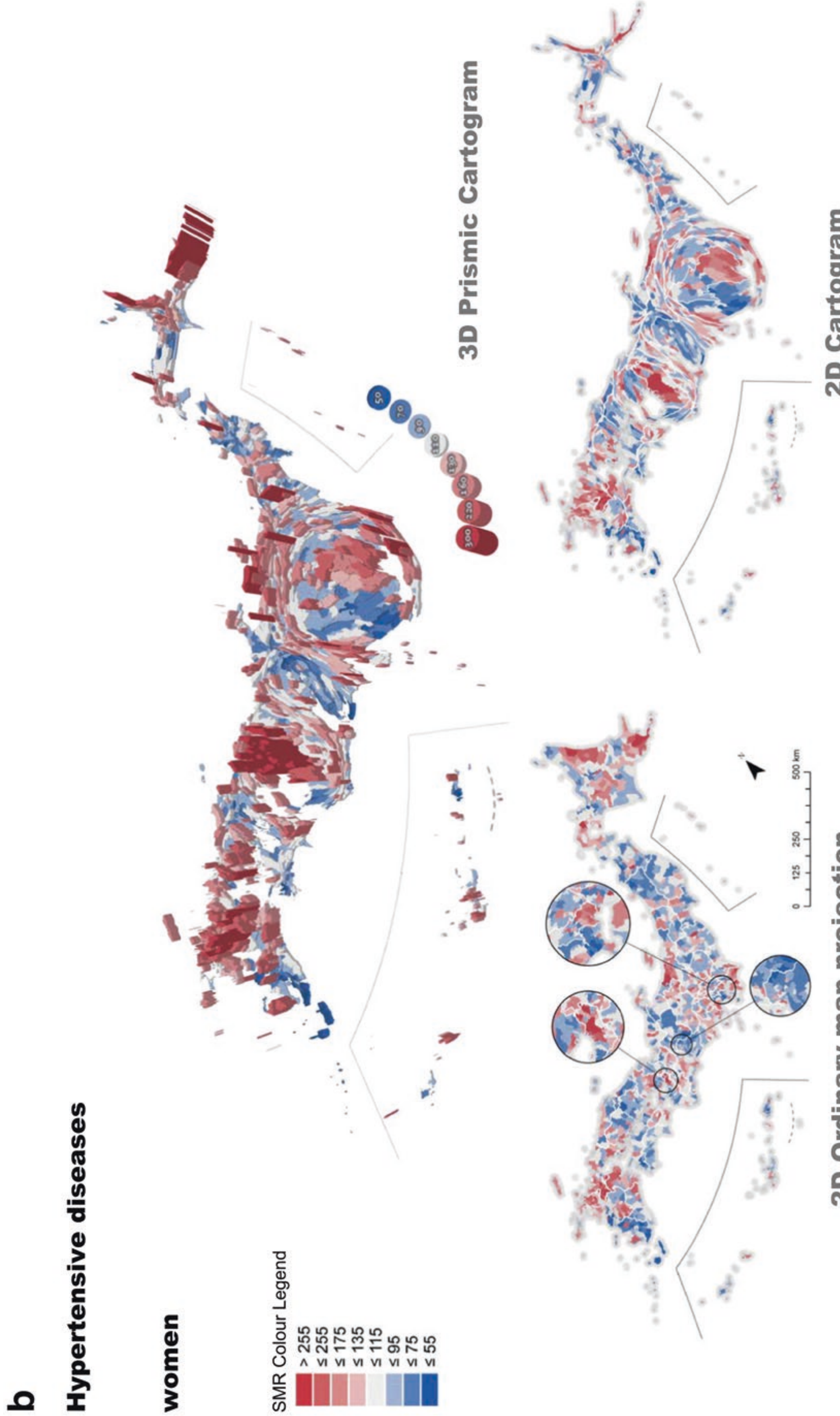
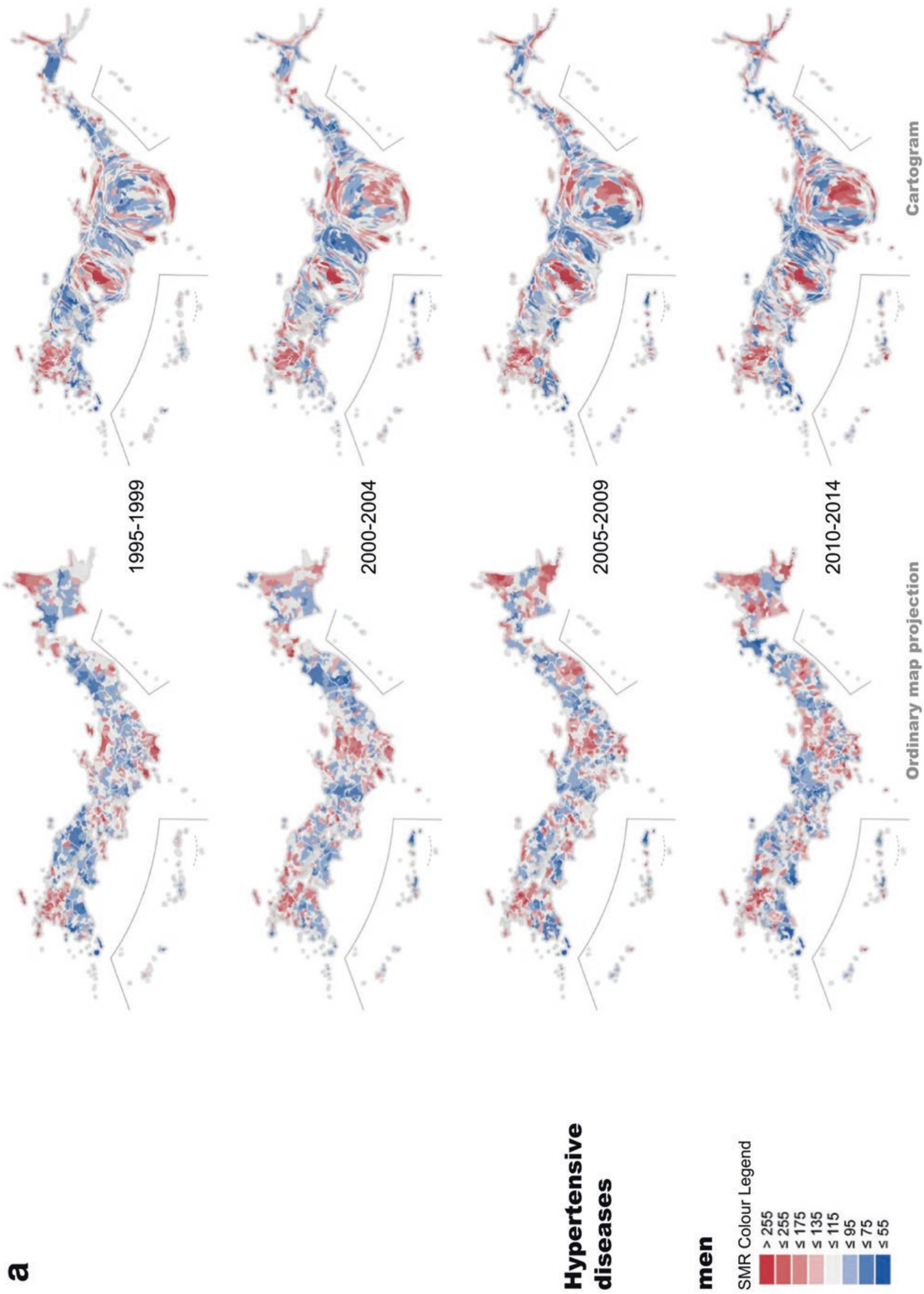


Fig. 5.46 SMR distribution of hypertensive diseases, 2010–2014. (**a**) Men. (**b**) Women


a
Hypertensive diseases
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
≤ 115
≤ 95
≤ 75
≤ 55
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

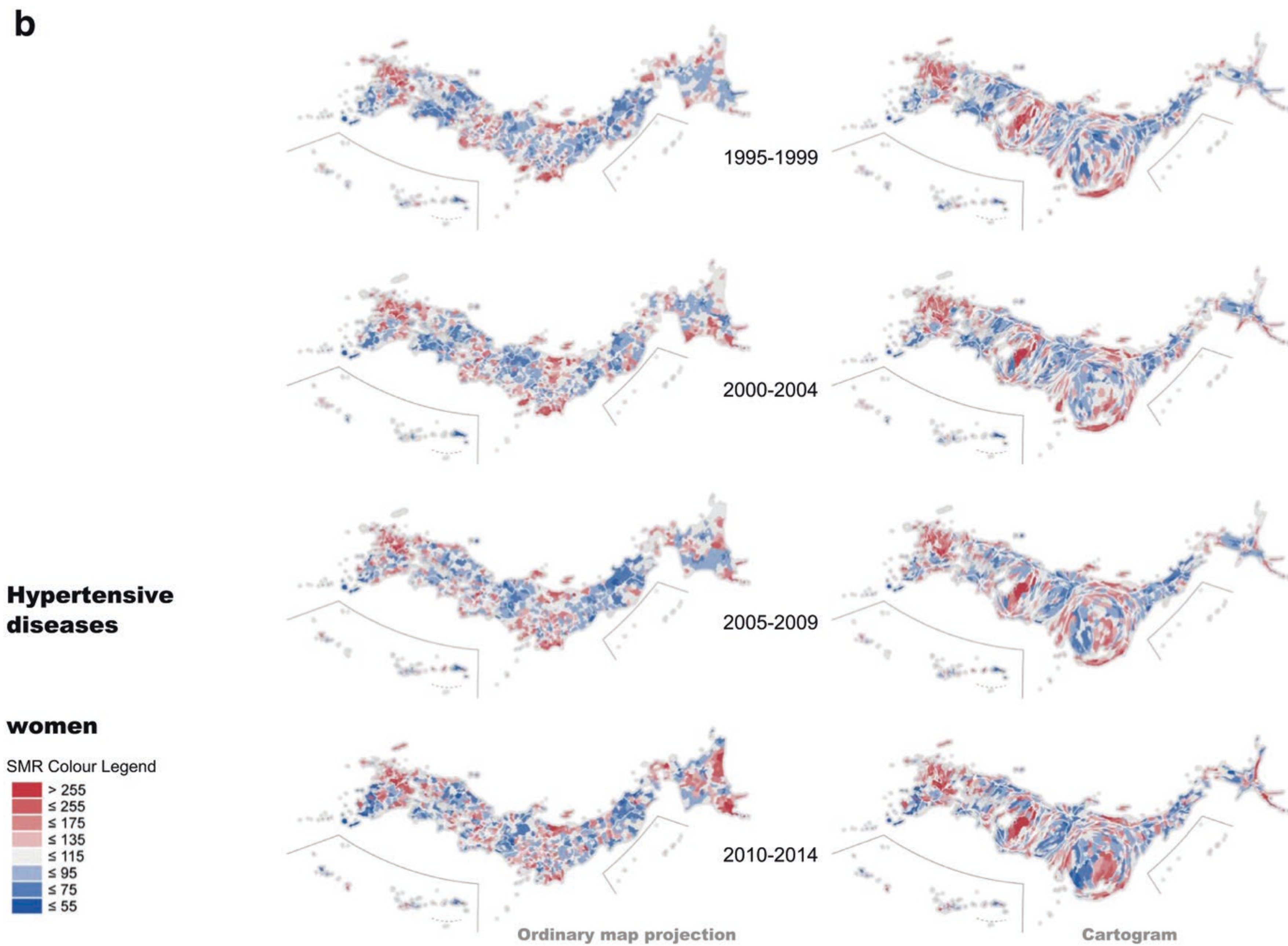


Fig. 5.47 Transition of SMR distribution of hypertensive diseases from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

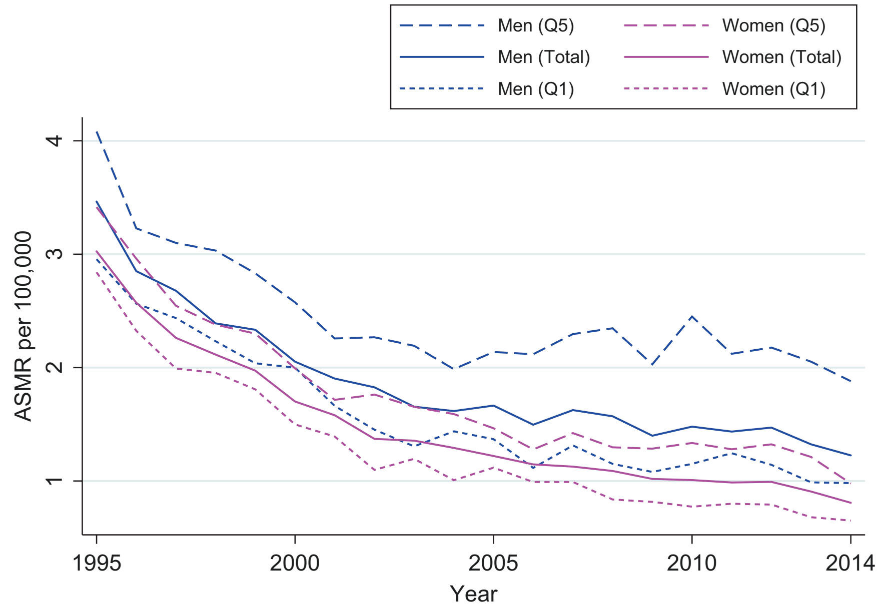


Fig. 5.48 Annual transition in the ASMR of hypertensive diseases from 1995 to 2014

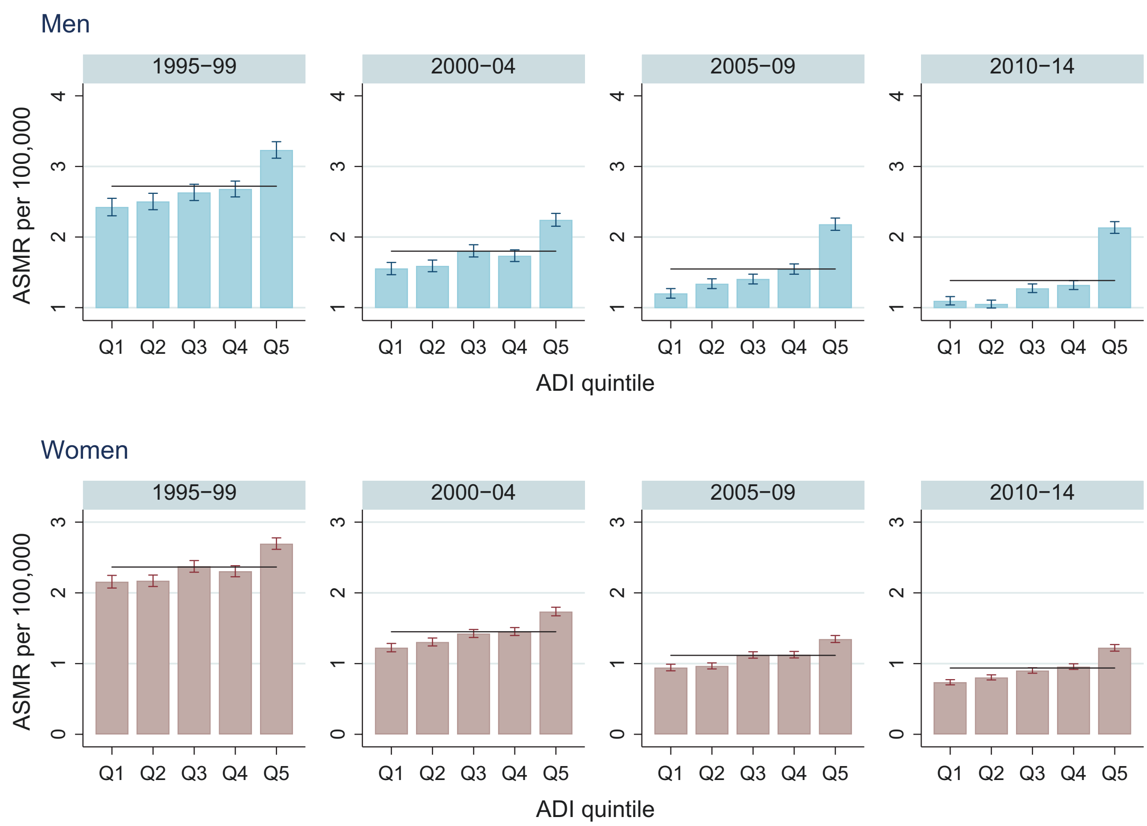


Fig. 5.49 The transition in the ASMR distribution of hypertensive diseases by ADI quintile. (Top: Men, Bottom: Women)

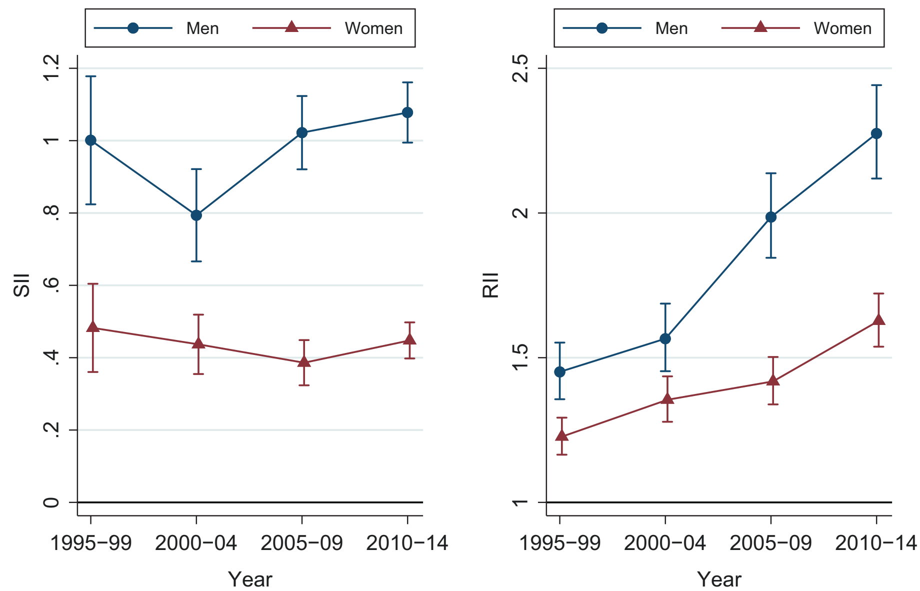


Fig. 5.50 Transition in SII and RII of hypertensive diseases from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.11 Aortic Aneurysm and Dissection (ICD10: I71): Diseases Which Are More Likely to Be Diagnosed in Urban Areas?

Ryozo Matsuda

Overview

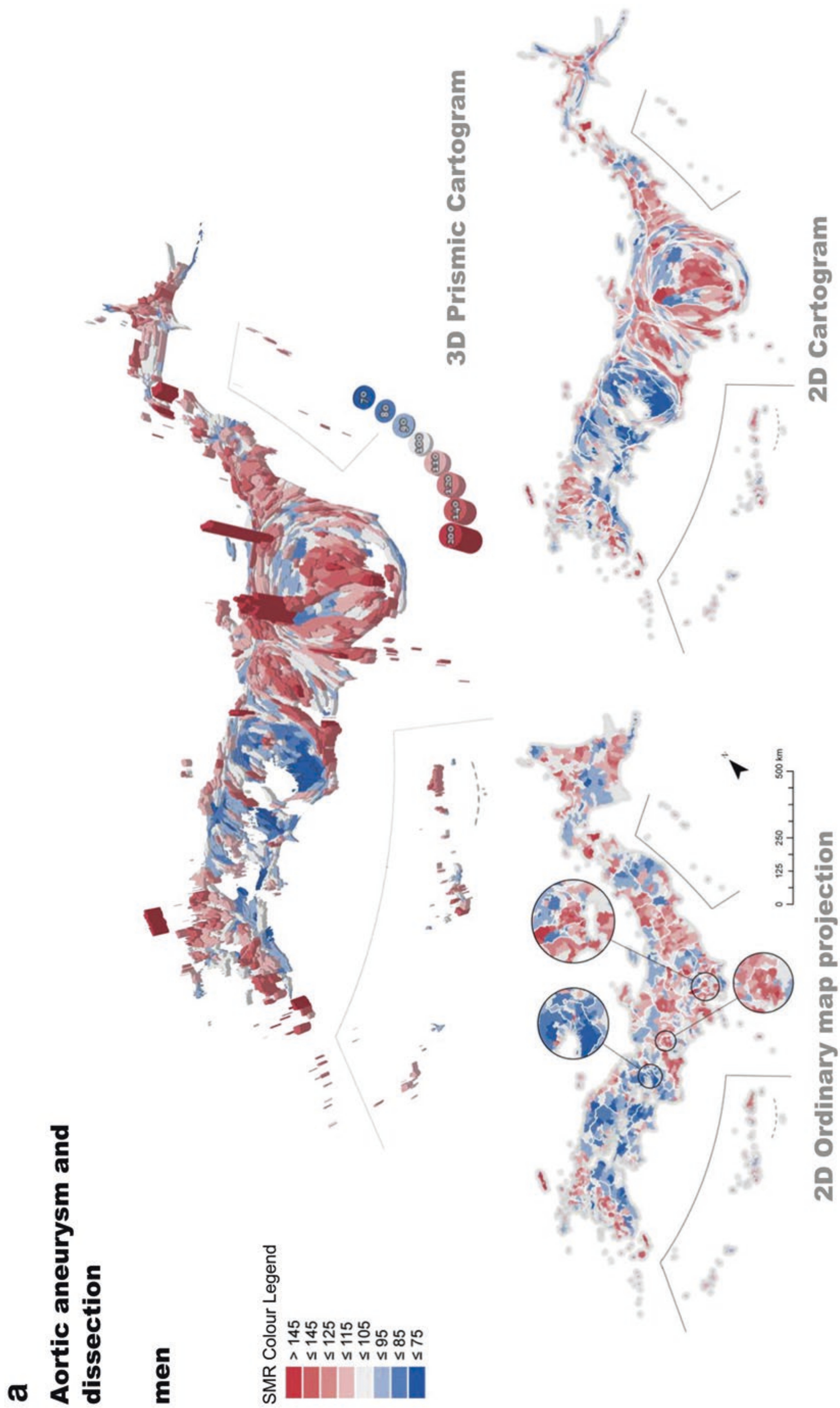
The high SMR for aortic aneurysm and dissection does not concentrate in the Tohoku nor Hokuriku areas like other cerebrovascular diseases. Areas with higher SMRs include selected areas of the Chubu region (i.e. Aichi, Mie, and Nagano Prefectures), the Tokyo metropolitan areas, and southern Kyushu (Fig. 5.51). There are also several rural areas with distinctively high SMR. These differences may be attributed not only to differences in the incidence of aortic aneurysms and dissection, but also to differences in therapeutic and diagnostic procedures within the existing medical system. For example, in Tokyo Prefecture, there is a clinical network on aortic aneurysms and dissection, so that the diagnosability of the disease may be higher there (Yoshino et al. 2013). A higher autopsy rate after unexplained deaths in Tokyo and Hyogo Prefecture, compared to other regions, may partly explain the difference, because it presumably increases the number of detected deaths from aortic diseases (Hori 2010). The SMRs appear to be high in urban areas, except in Osaka, as shown by the cartogram.

Transitions and Socioeconomic Disparities

It is difficult to find general trends in the geographical distribution of the SMRs based on the ordinary map projection (Fig. 5.52). The SMRs increased in some areas or decreased in others, while they moved in other direction in the following set of periods. It appears, however, that the SMRs in the Chubu region have been consistently high.

The cartogram-based maps (Fig. 5.52) show a decrease in SMR in such urban areas as the Tokyo metropolitan area and the Kinki region. The SMR in Kinki region clearly decreased in the 2 decades covered in this study. In the first period, the SMR for aortic disease was very high all over Tokyo; the SMR in the last period remained high but appears to vary among areas.

The ASMR of aortic aneurysms and dissections has continued to increase (Fig. 5.53) but has levelled off since 2010. There seems to be no considerable socioeconomic inequalities in the mortality from aortic diseases as indicated by ASMR by ADI quintiles (Fig. 5.54) and both SII and RII (Fig. 5.55), though a socioeconomic gradient in ASMR is observed among women in the latest period from 2010 to 2014 (Fig. 5.54).


a
Aortic aneurysm and dissection
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0
125
250
500 km

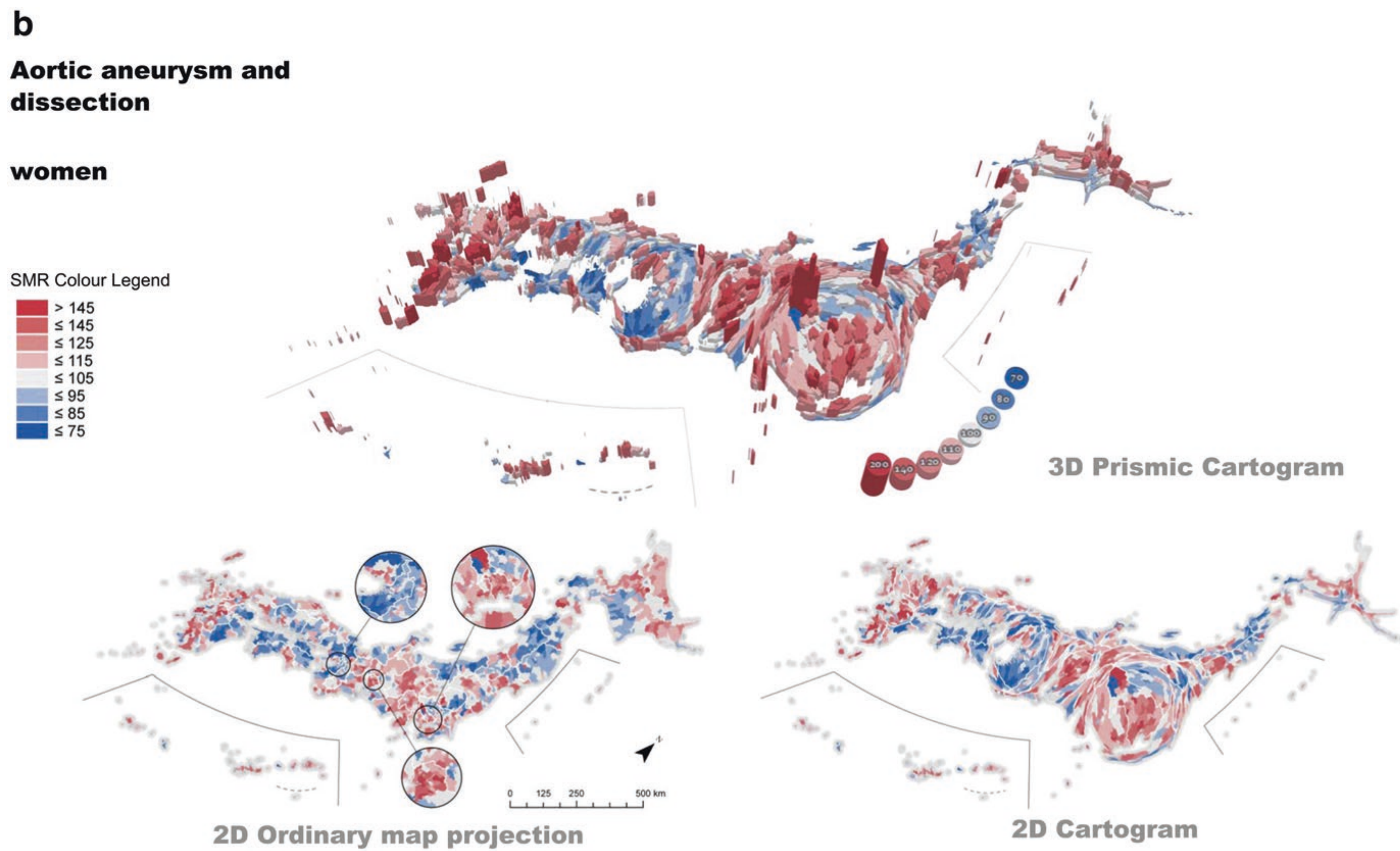
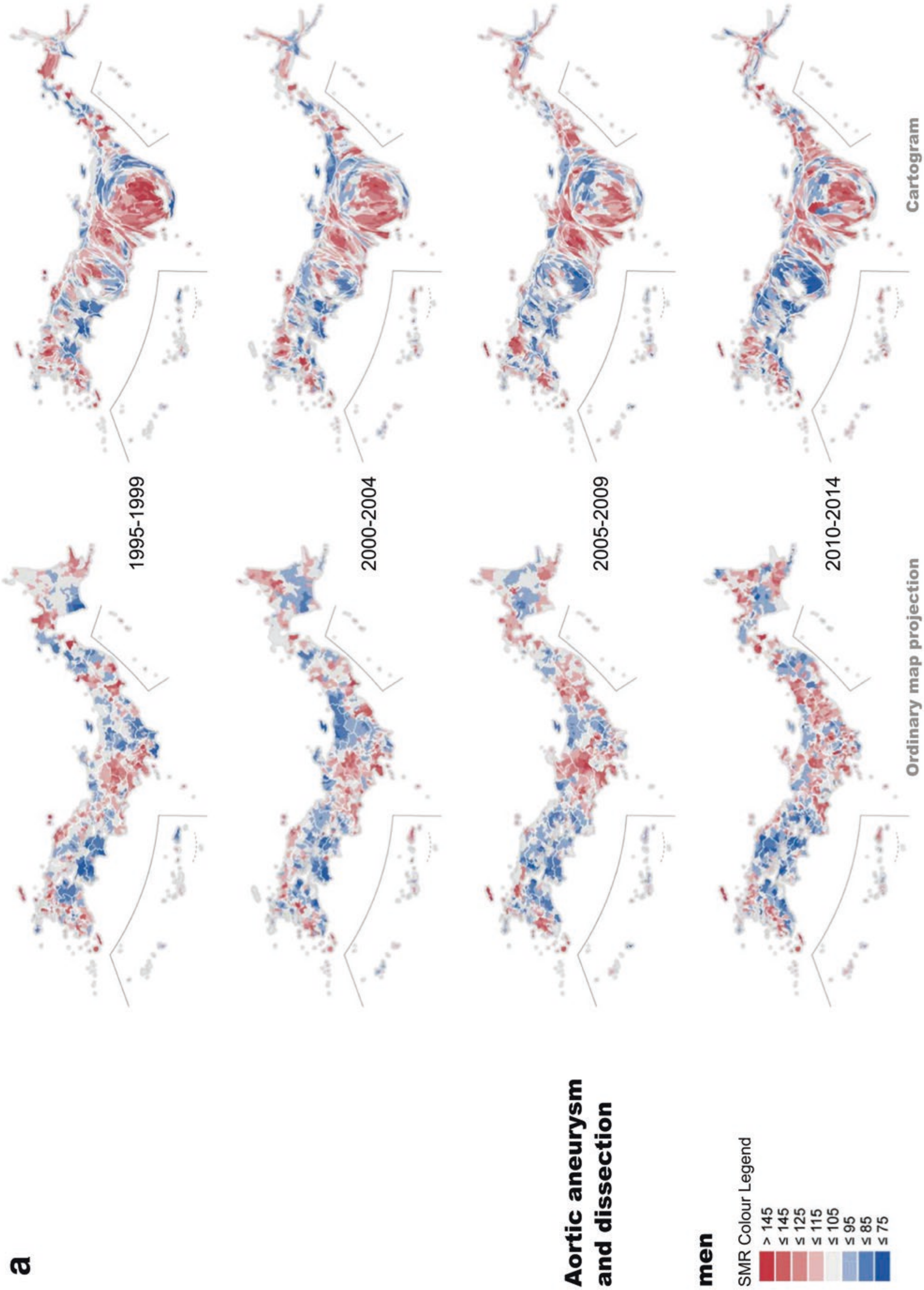


Fig. 5.51 SMR distribution of aortic aneurysm and dissection, 2010–2014. (**a**) Men. (**b**) Women


a
Aortic aneurysm and dissection
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

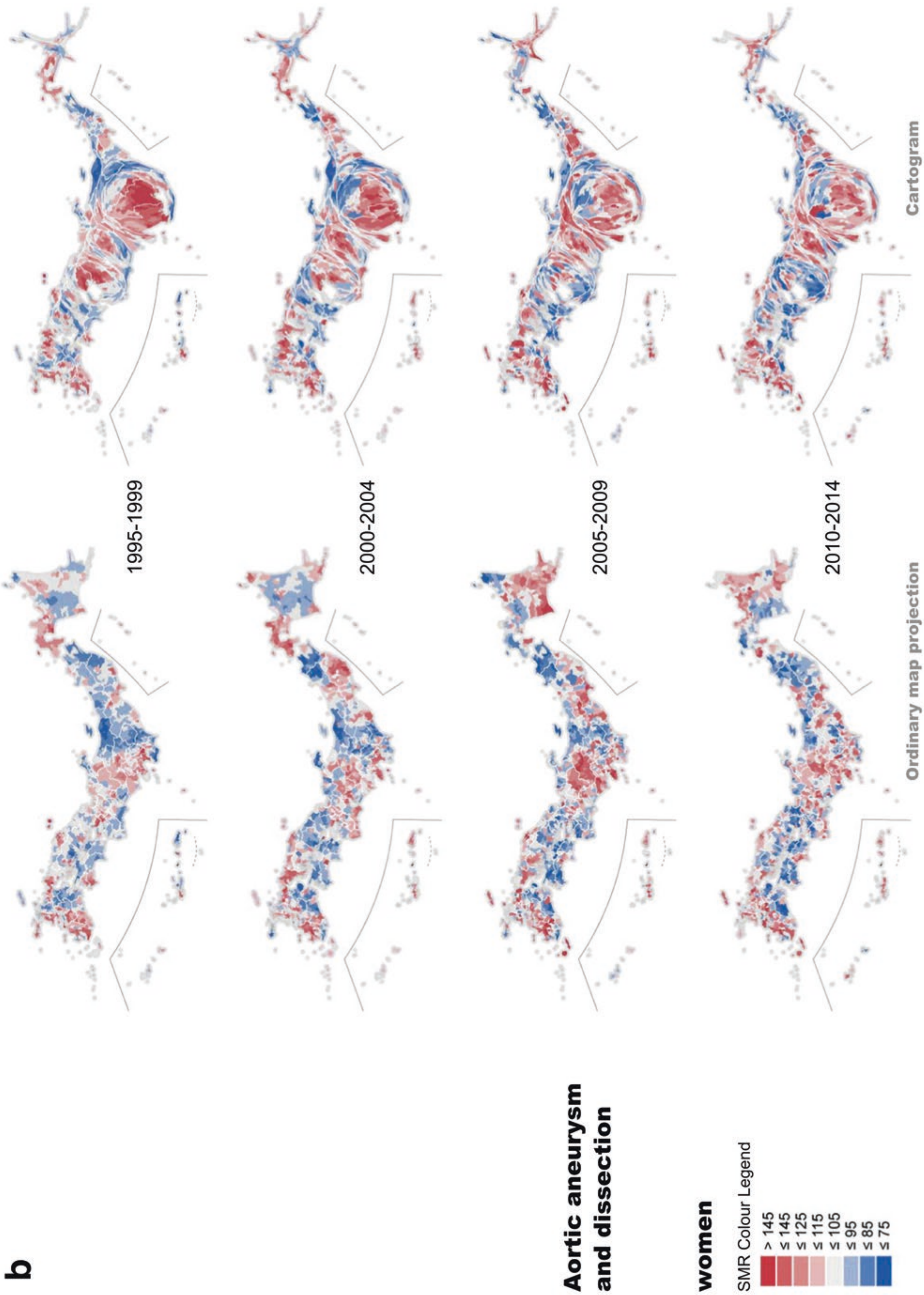


Fig. 5.52 Transition of SMR distribution of aortic aneurysm and dissection from 1995 to 2014 by 5-year period. **(a)** Men. **(b)** Women

Fig. 5.53 Annual transition in the ASMR of aortic aneurysm and dissection from 1995 to 2014

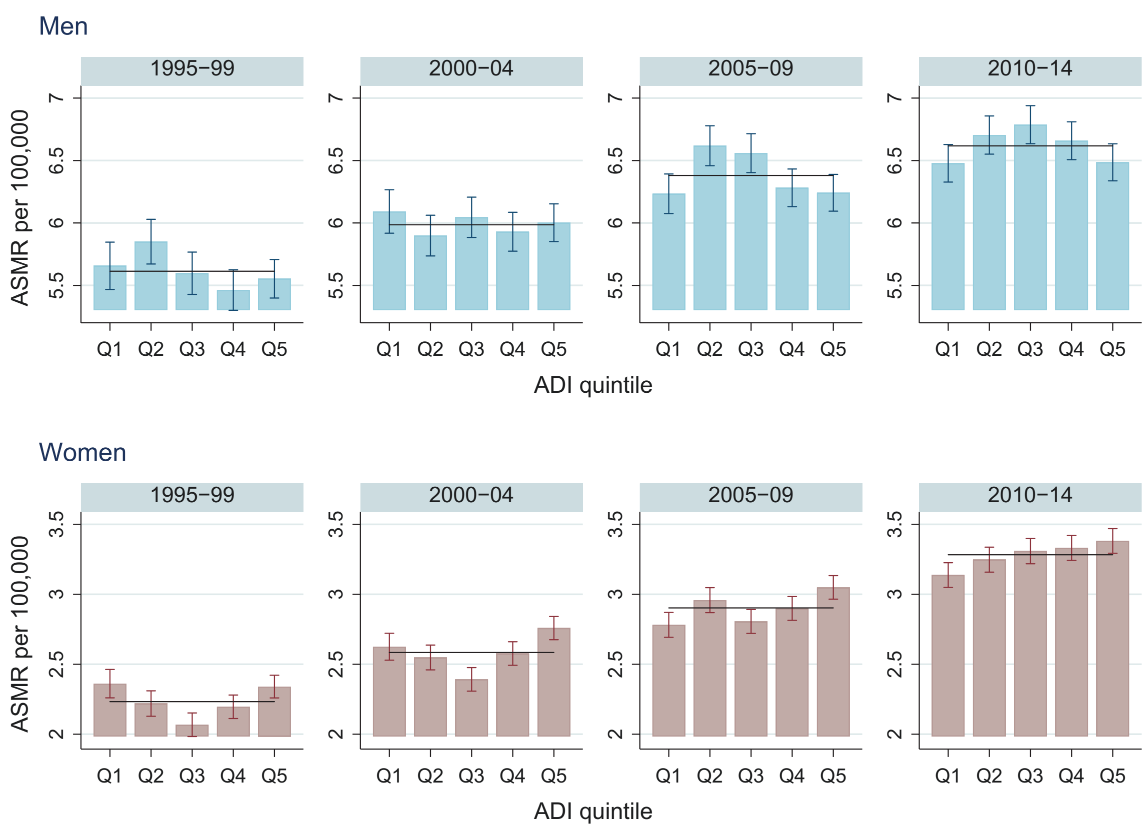


Fig. 5.54 The transition in the ASMR distribution of aortic aneurysm and dissection by ADI quintile. (Top: Men, Bottom: Women)

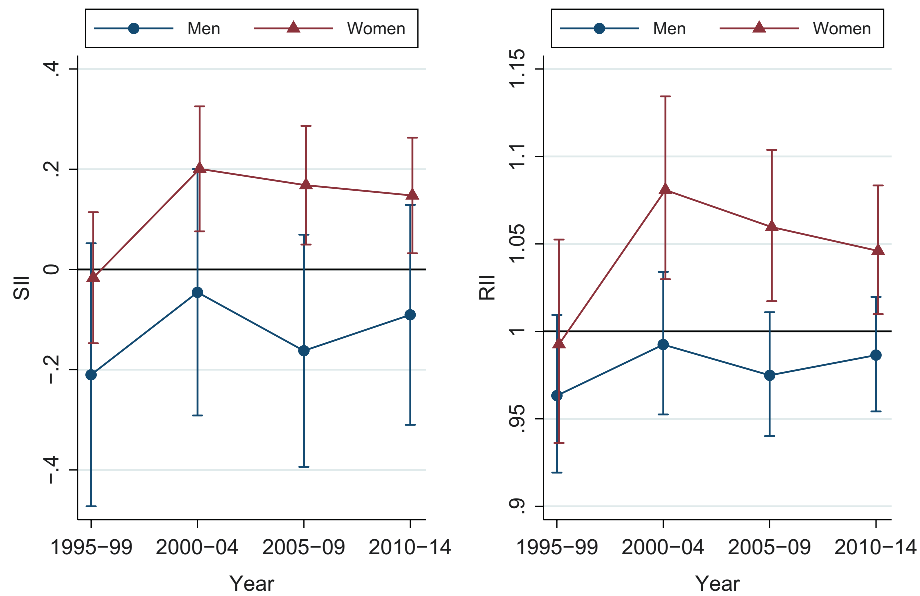


Fig. 5.55 Transition in SII and RII of aortic aneurysm and dissection from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.12 Diabetes Mellitus (ICD10: E10-E14): A Lifestyle Disease Widening Socioeconomic Disparity

Shigeru Inoue and Hiroyuki Kikuchi

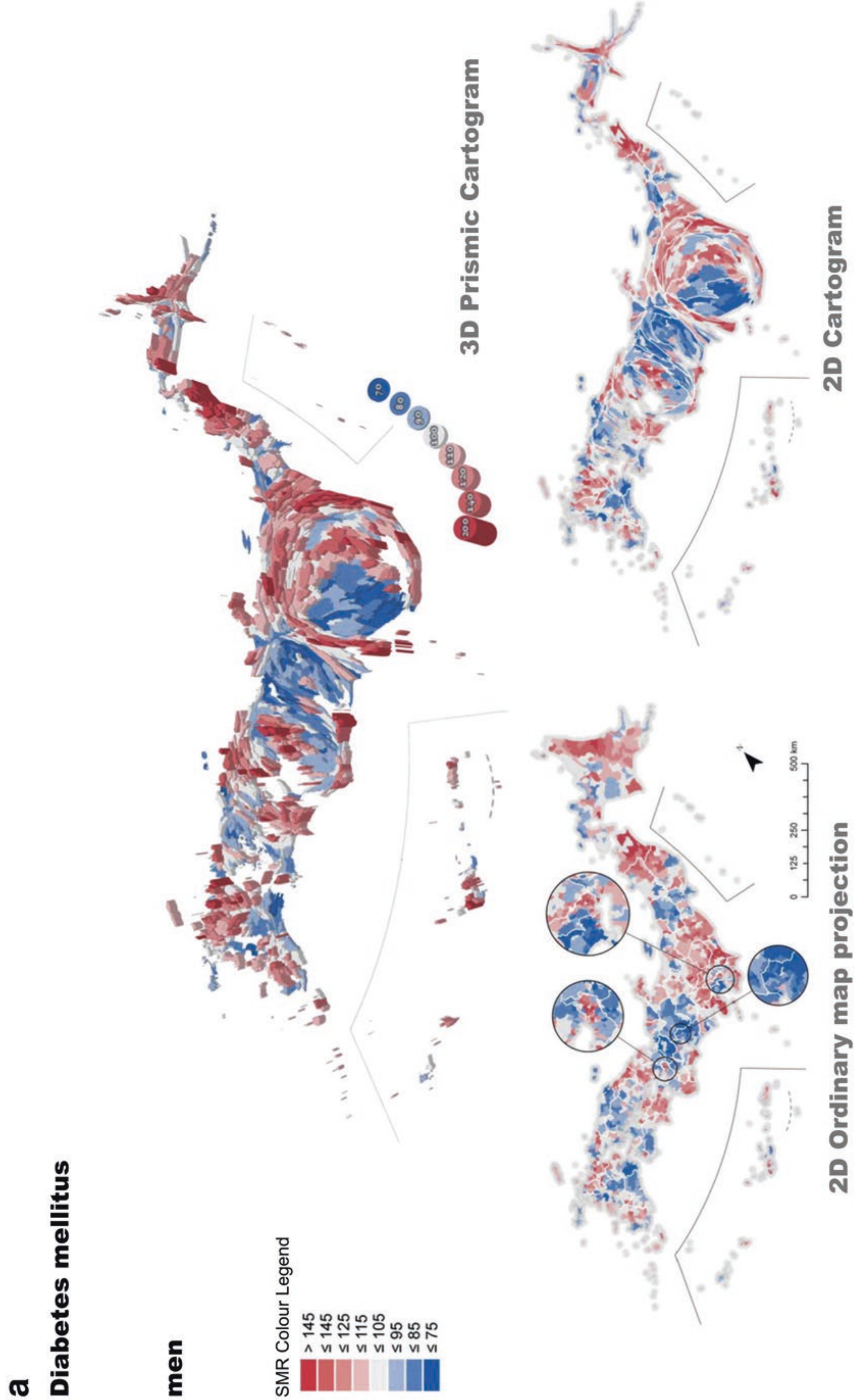
Overview

The geographical distribution of diabetes is expected to be related to local lifestyles including diet, physical activity, exercise, and smoking habit. Since these lifestyles are often associated with socioeconomic factors, the geographical distribution of diabetes may also be expected to be associated with such factors. The areas with high SMR for diabetes are scattered throughout the country, particularly in rural areas such as Hokkaido, the northern part of the Tohoku region, the northern part of the Kanto region, the eastern part of the Shikoku region, and so on (Fig. 5.56). Within the Tokyo metropolitan areas, SMR is higher in the east (old downtown or inner-city like areas) and lower in the west (affluent suburbs), indicating socioeconomic disparities of diabetes mortality. Overall the geographical variations of SMRs are larger for men compared to women.

Distributional Transitions and Socioeconomic Disparities

Although there is no noticeable change for SMR maps based on the ordinary map projection, SMR tends to rise slightly for men in the northern coastal area of Hokkaido and for women in Kagoshima Prefecture. However, by using the cartogram-based SMR maps shows that within the Tokyo metropolitan area, disparities between more deprived inner-city parts and affluent western suburbs are becoming more salient, as the blue-red contrast is becoming clearer in the later period (Fig. 5.57). This indicates a widening trend of socioeconomic disparities of mortality in those areas.

The ASMR of diabetes mellitus tends to decline regardless of gender (Fig. 5.58). The high mortality rate in regions with low socioeconomic status/high deprivation has been consistent throughout the last 20 years, 1995–2014 (Fig. 5.59), but as can be seen from the temporal trend of both SII and RII, the socioeconomic inequality in the mortality tends to widen (Fig. 5.60).


a
Diabetes mellitus
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

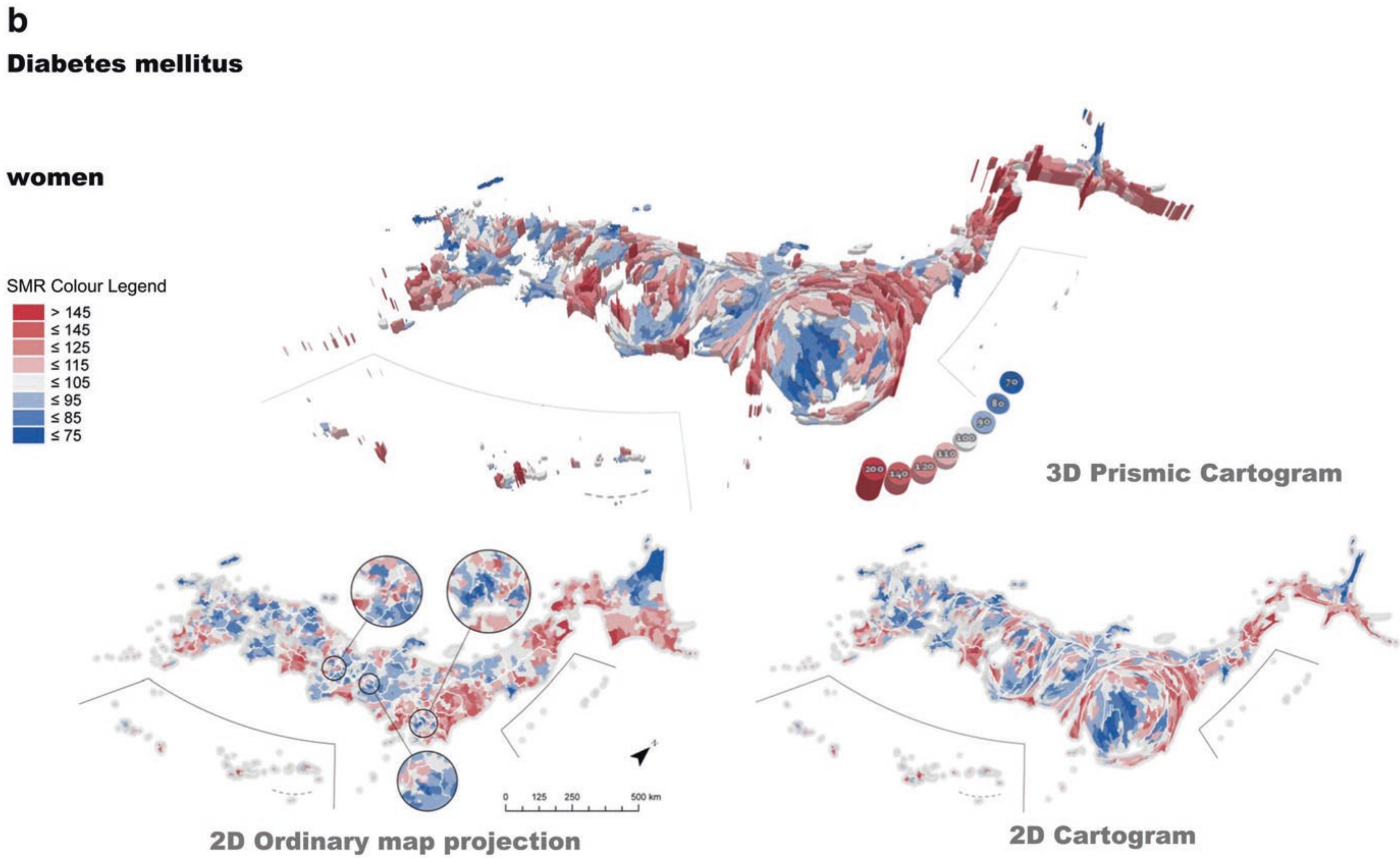
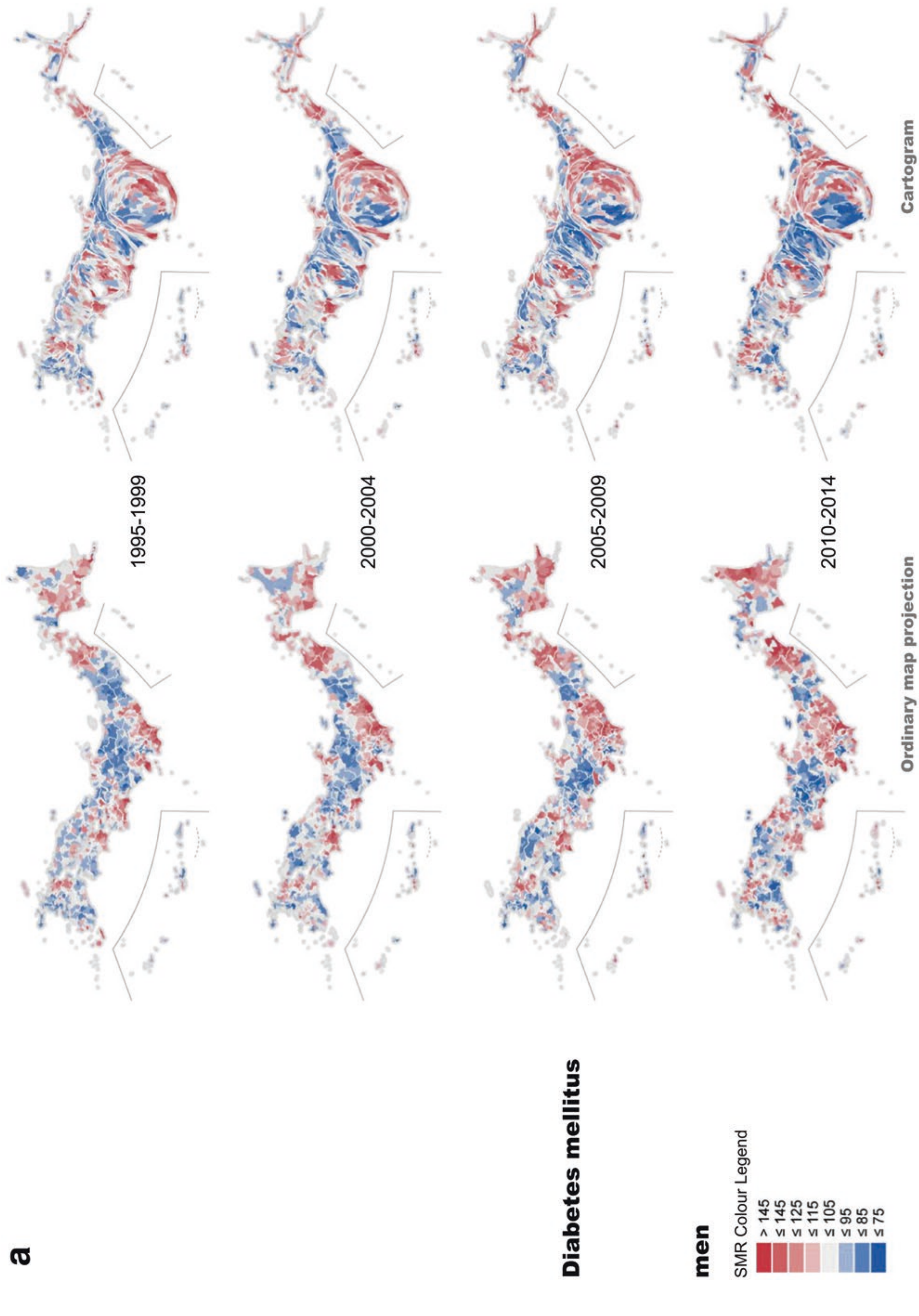


Fig. 5.56 SMR distribution of diabetes mellitus, 2010–2014. (**a**) Men. (**b**) Women


a
Diabetes mellitus
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

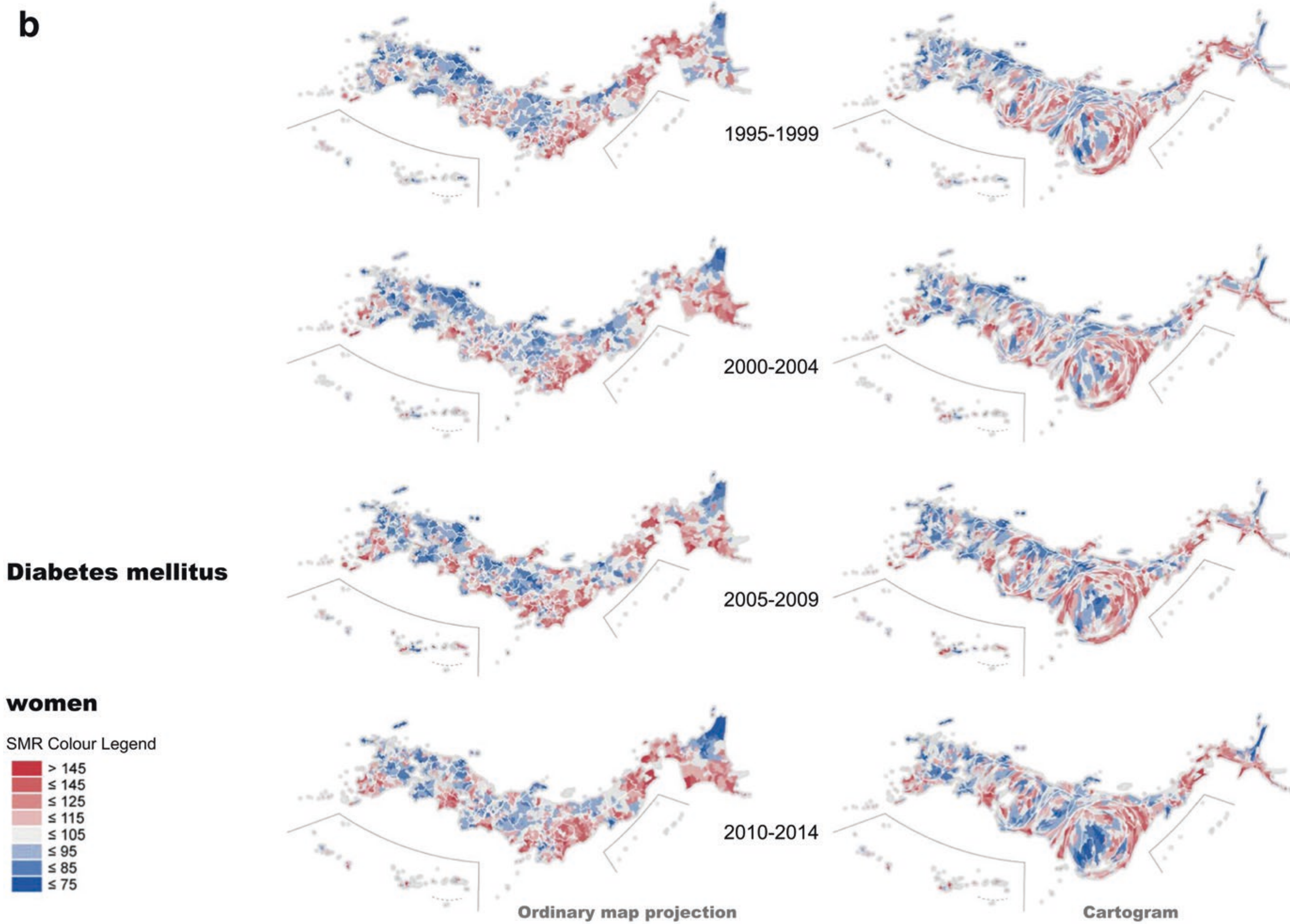
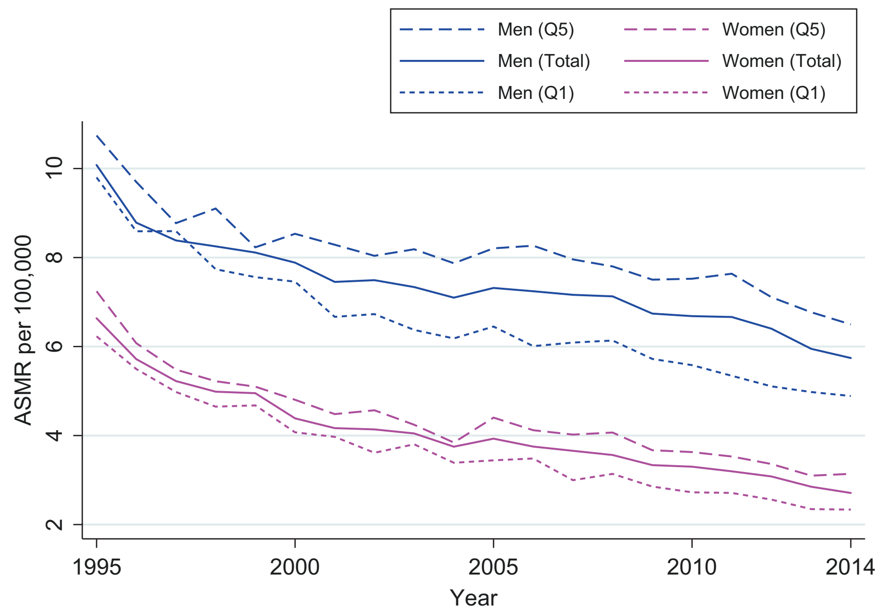


Fig. 5.57 Transition of SMR distribution of diabetes mellitus from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.58 Annual transition in the ASMR of diabetes mellitus from 1995 to 2014



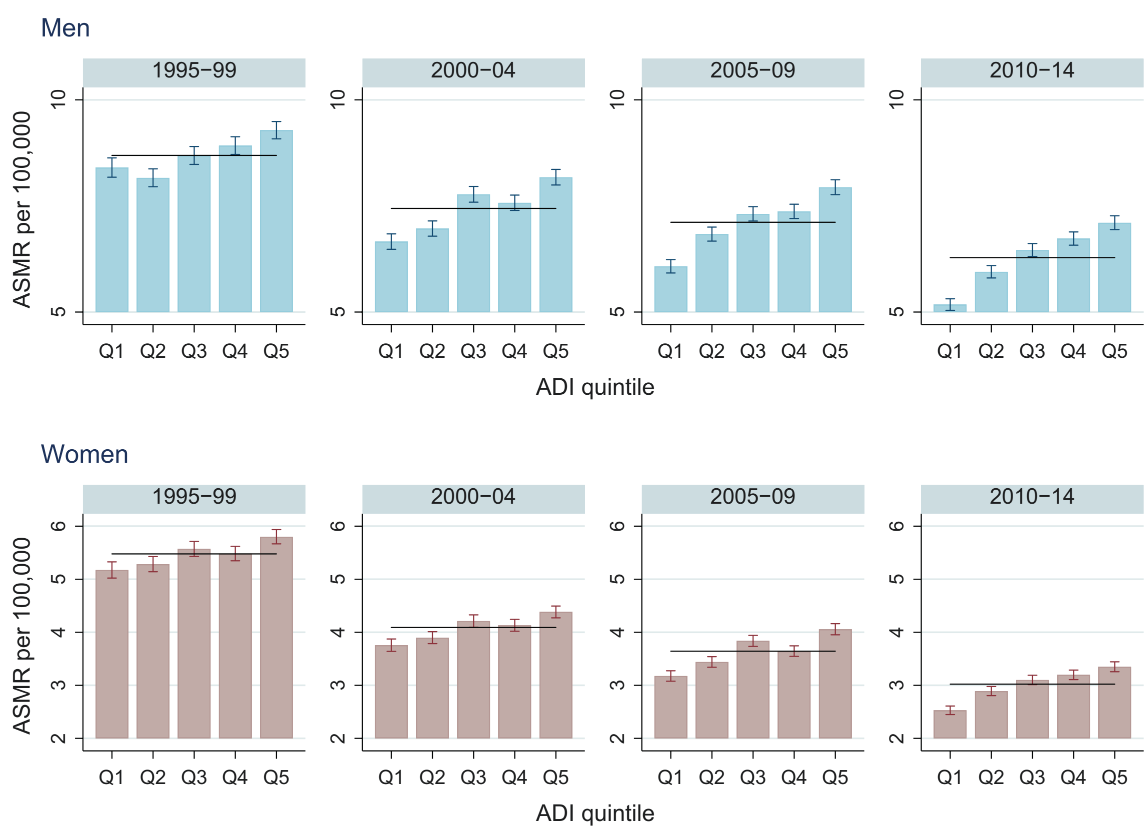


Fig. 5.59 The transition in the ASMR distribution of diabetes mellitus by ADI quintile. (Top: Men, Bottom: Women)

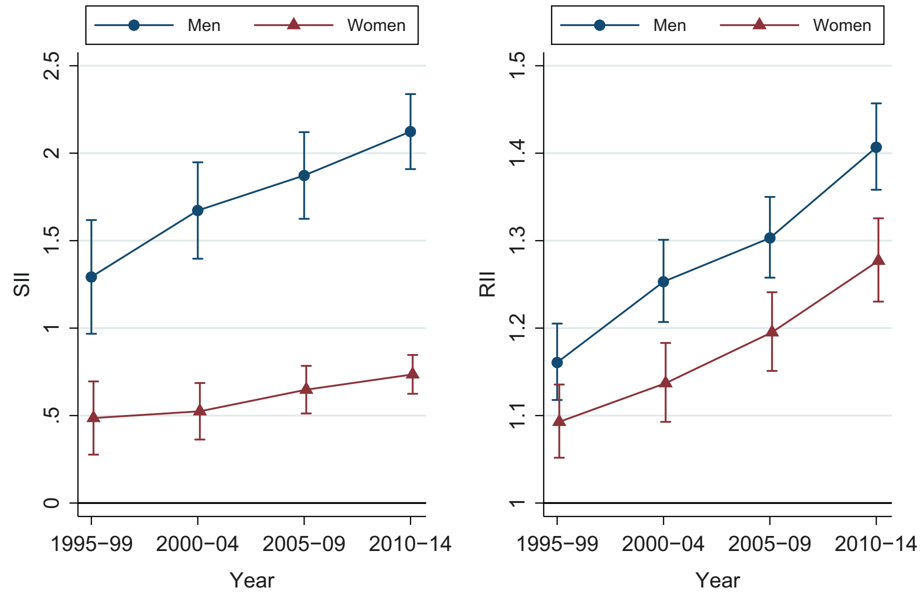


Fig. 5.60 Transition in SII and RII of diabetes mellitus from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.13 Liver Diseases (ICD10: K70-K77): Alcohol-Related Disease

Yuri Ito

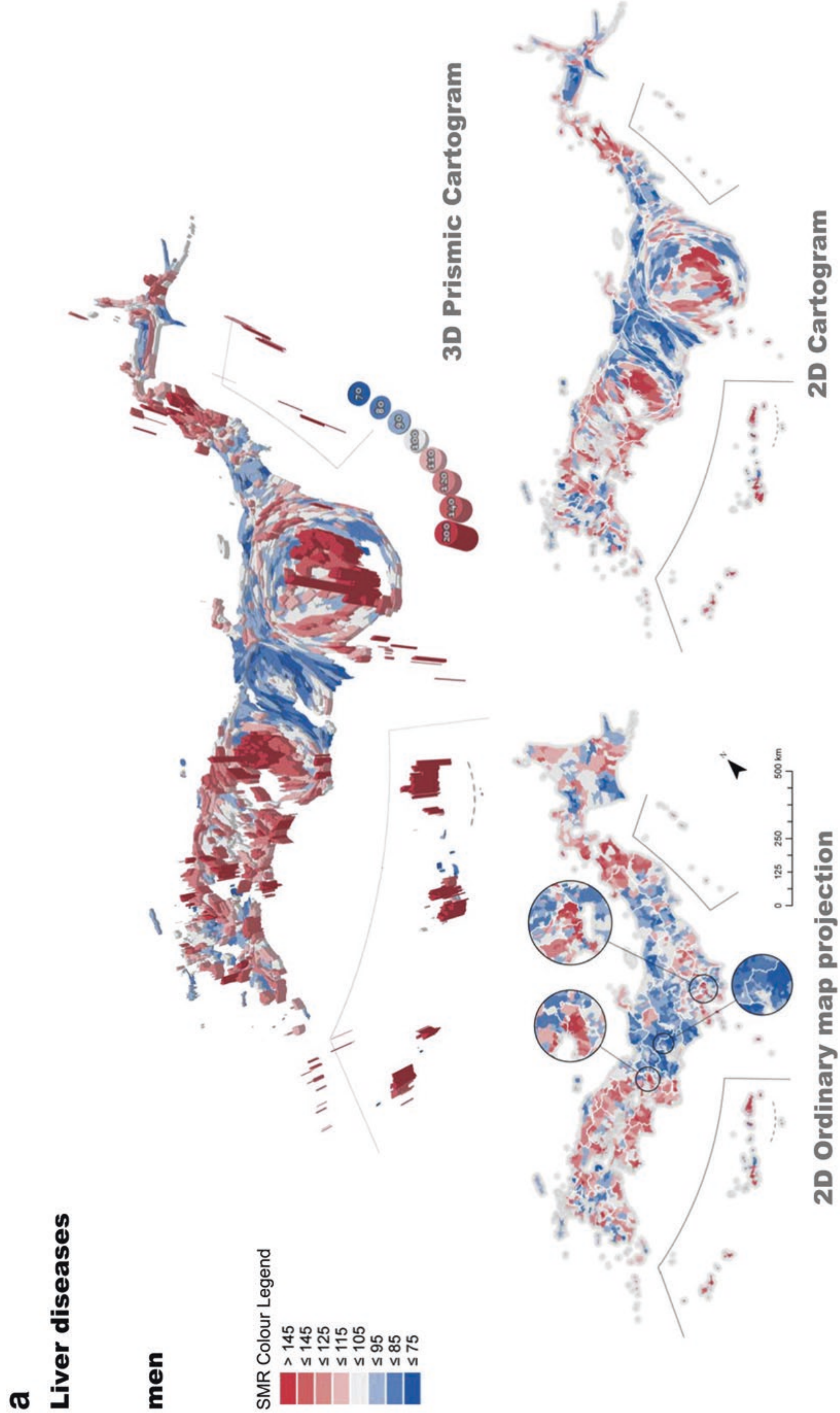
Overview

Fatal liver diseases are related to heavy alcohol intake as well as HBV/HCV infection. High SMR (over 150) areas were observed in the eastern part of Tokyo and Osaka cities, the South of Hokkaido, Aomori Prefectures in the Tohoku region, the eastern part of Shikoku region, and Okinawa Prefecture (Fig. 5.61). For women, higher SMRs were observed in Saitama Prefecture than in Tokyo Metropolis/Prefecture. It is interesting to note that the areas with high SMR for liver disease in the Tokyo metropolitan area have a different distribution than those of liver cancer.

Distributional Transitions and Socioeconomic Disparities

For men, there has been no noticeable change in the distribution of SMR for the disease during the last 20 years from 1995 to 2014. For women, high SMR in Fukuoka Prefecture disappeared after 2000 (Fig. 5.62).

Although the ASMR of liver diseases has decreased a lot through the last 20 years for both sexes (Fig. 5.63), the absolute and relative inequalities of the mortality by ADI quintiles are still very large, particularly for men (Fig. 5.64). While the absolute socioeconomic inequalities of ASMR shown by the transition of SII has declined gradually, the relative one shown by that of RII has been roughly unchanged (Fig. 5.65). The observed wide socioeconomic disparities of the disease measured by ADI might be related to poor accessibility to adequate treatment for the HBV/HCV carriers as well as high prevalence of heavy alcohol intake in the deprived areas.


a
Liver diseases
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
0 125 250 500 km

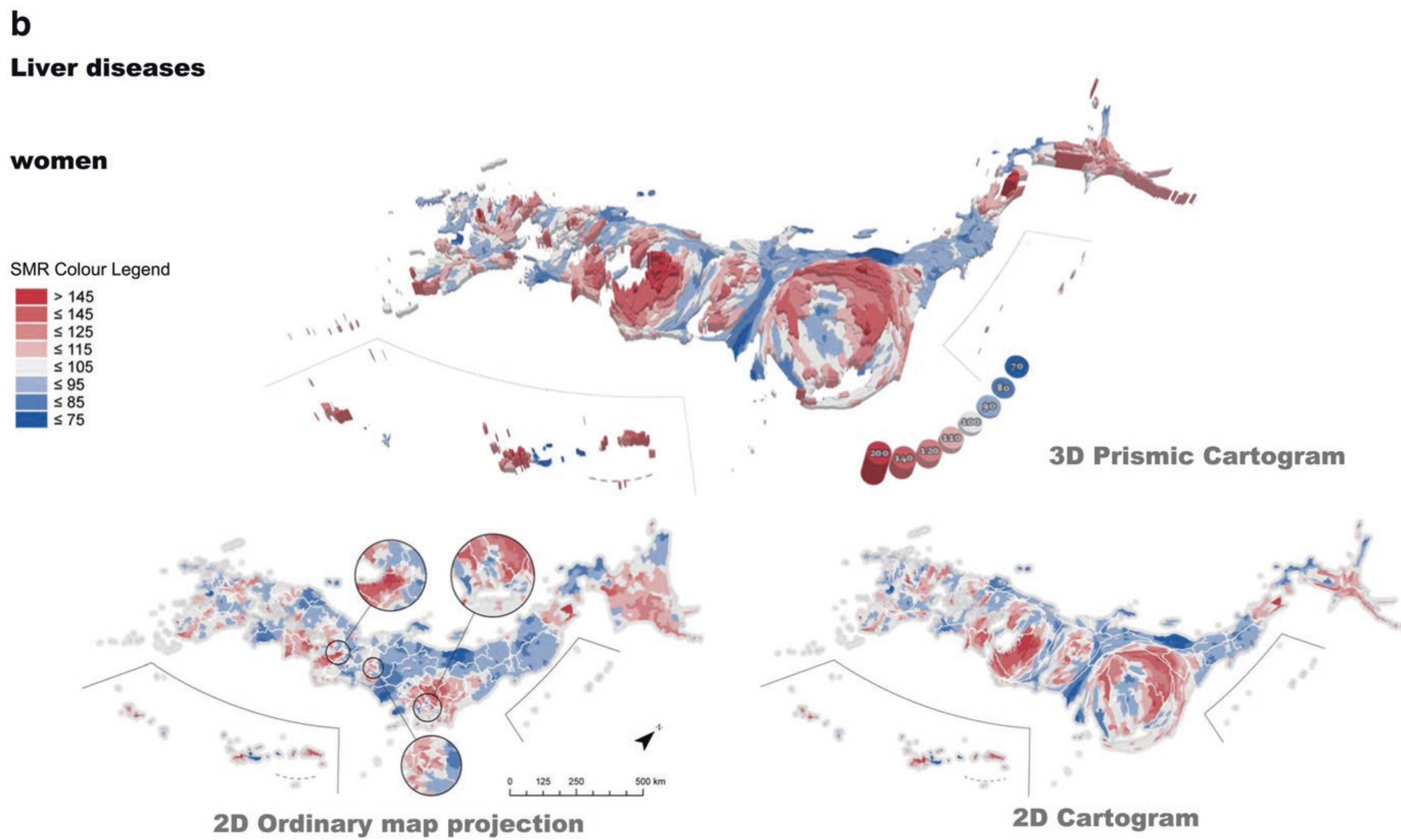
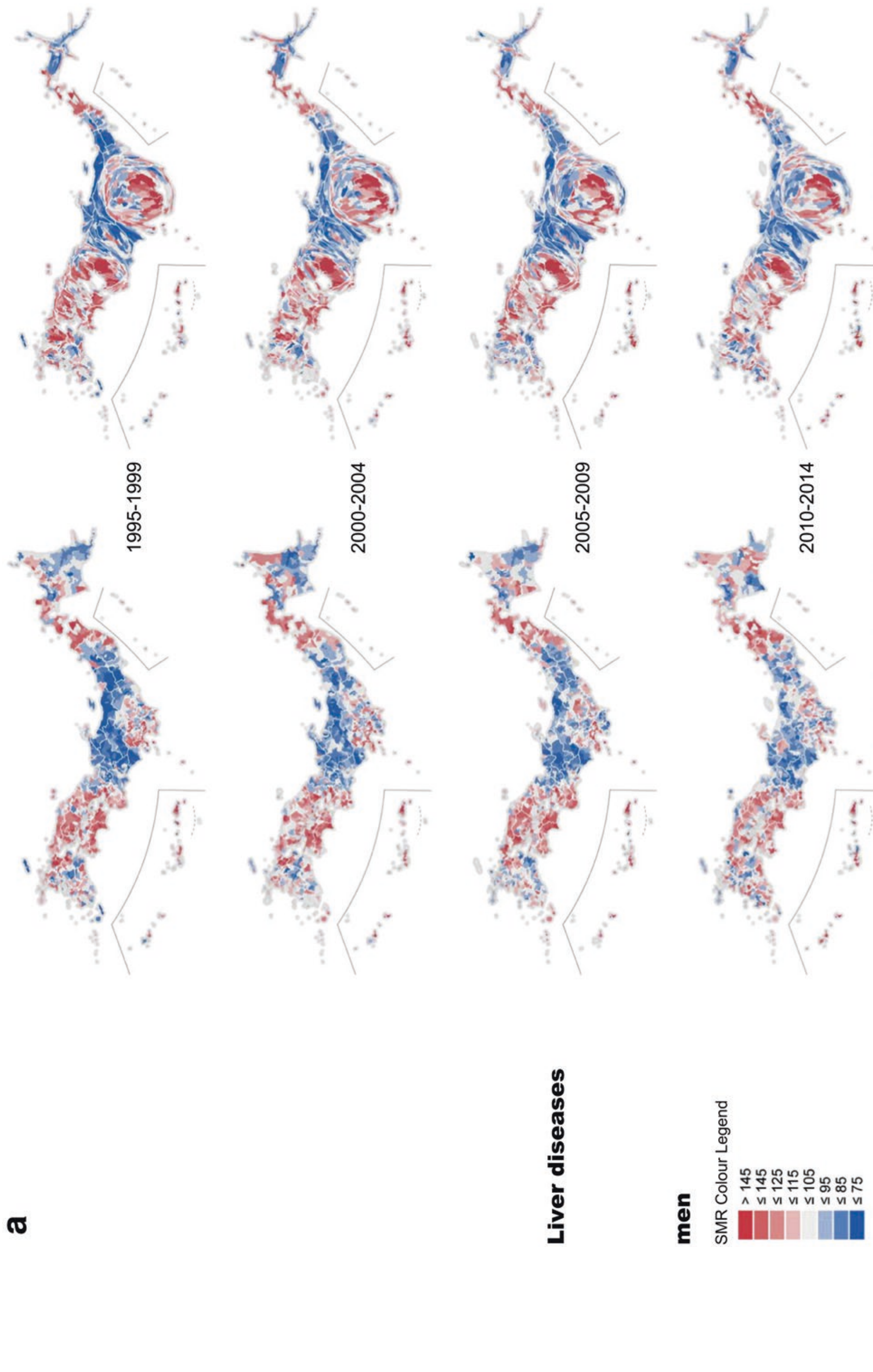


Fig. 5.61 SMR distribution of liver diseases, 2010–2014. (**a**) Men. (**b**) Women


a
Liver diseases
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
1995-1999
2000-2004
2005-2009
2010-2014
Ordinary map projection
Cartogram

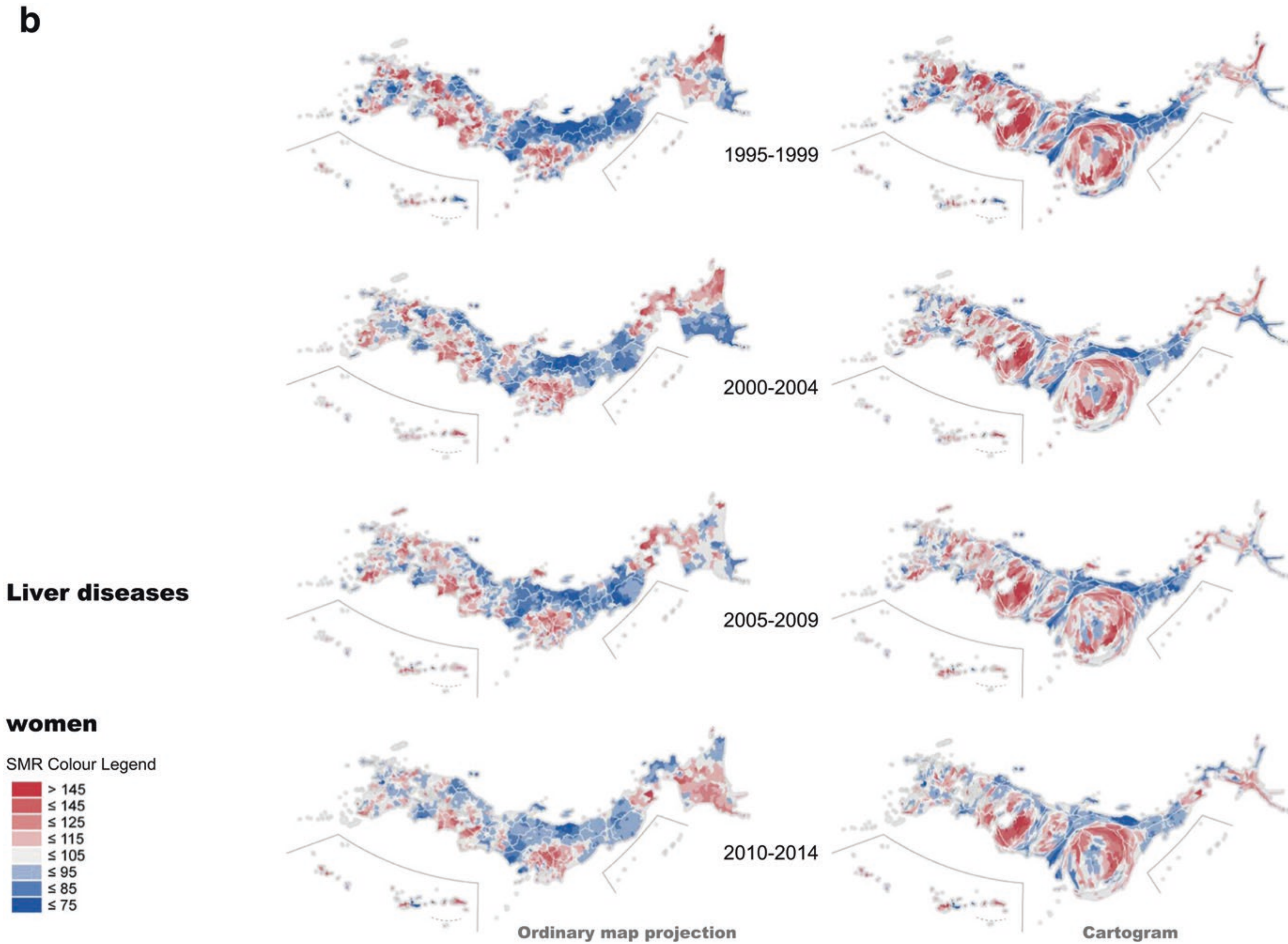
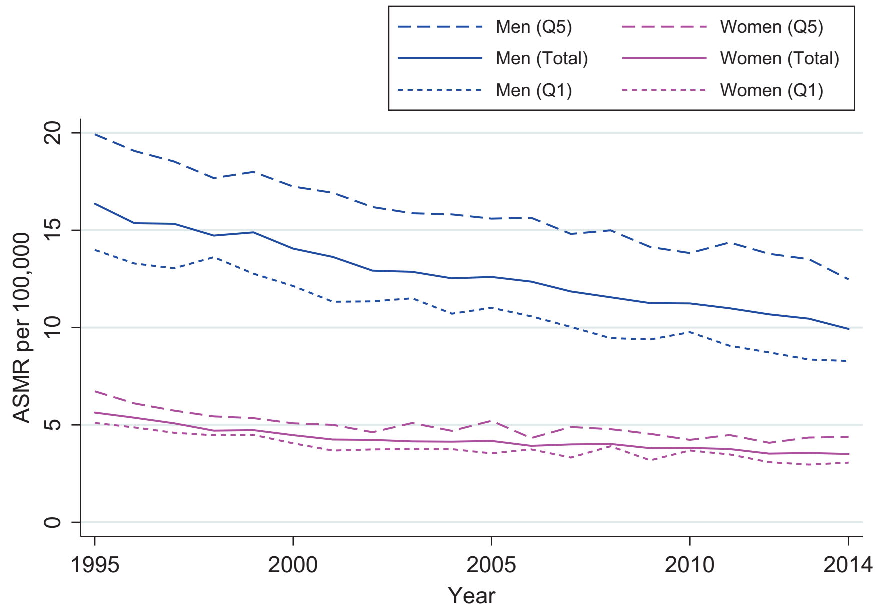


Fig. 5.62 Transition of SMR distribution of liver diseases from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.63 Annual transition in the ASMR of liver diseases from 1995 to 2014



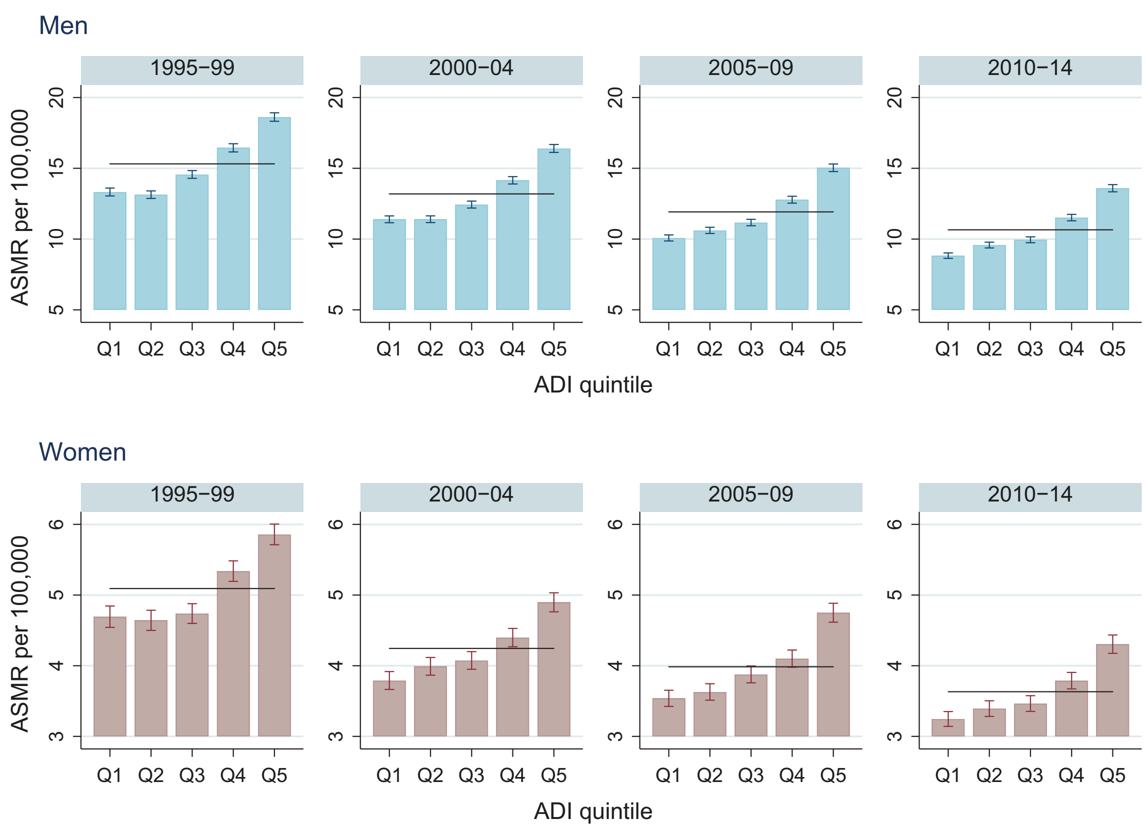


Fig. 5.64 The transition in the ASMR distribution of liver diseases by ADI quintile. (Top: Men, Bottom: Women)

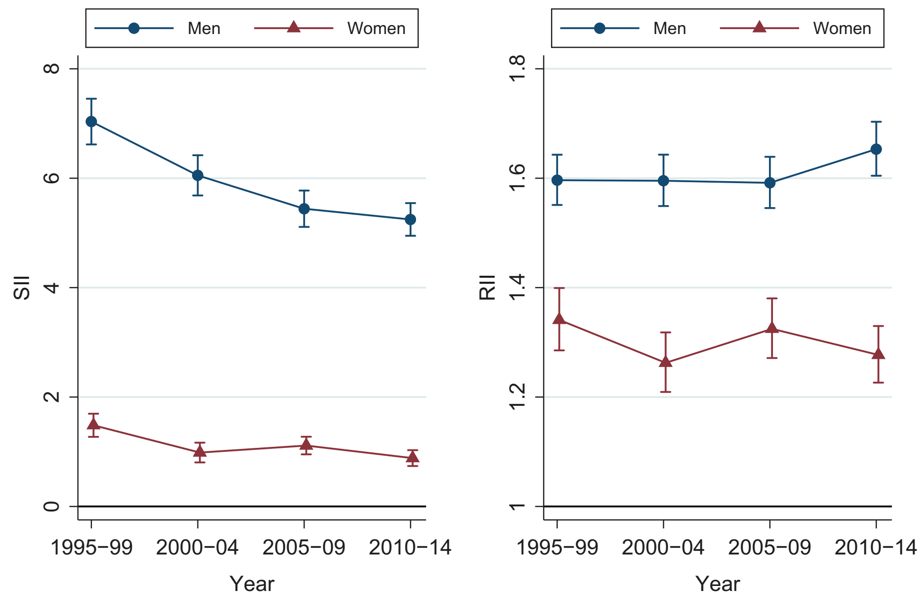


Fig. 5.65 Transition in SII and RII of liver diseases from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

5.14 Renal Failure (ICD10: N17-N19): Distributional Similarity to Diabetes Mellitus

Shigeru Inoue and Hiroyuki Kikuchi

Overview

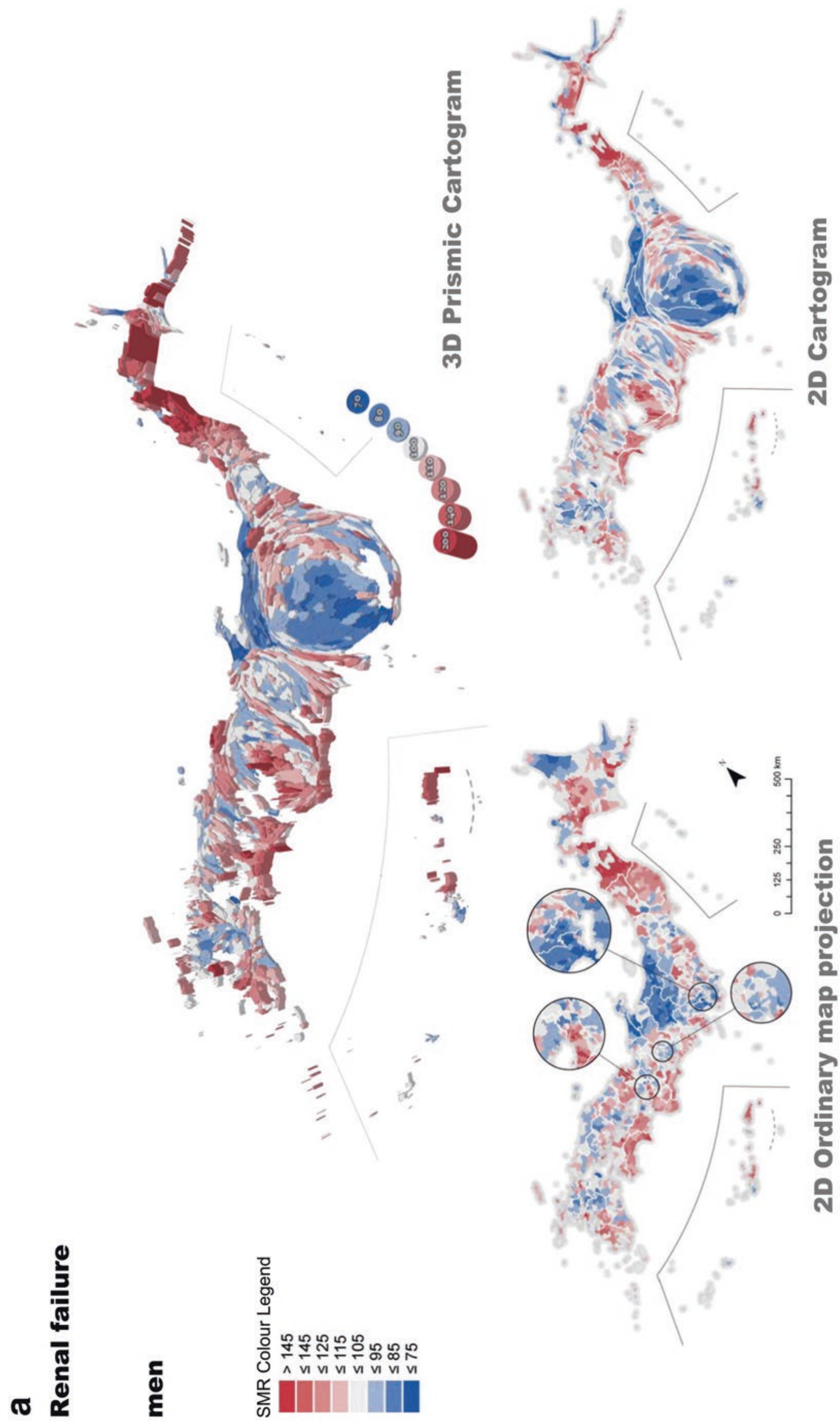
Both acute and chronic renal failures are included in this category. Of the causes of death due to renal failure, acute renal failure accounted only for 13.8% of the total in 2016. Thus, the mortality in this category mainly reflects geographical trends of chronic renal failure. In 2015, the major primary diseases for introducing dialytic treatment were diabetes nephropathy (38.4%), chronic glomerulonephritis (29.8%), and nephrosclerosis (9.5%) (Masakane et al. 2018). Thus, the distribution of renal failure SMR may be related to the regional differences in management of diabetes mellitus and hypertension.

The geographical distribution of SMR for this category (Fig. 5.66) has a certain similarity to diabetes mellitus. Areas with high SMR for renal failure are found in non-metropolitan areas, such as the northern part of Tohoku region, some parts of the Shikoku Region, and the southmost part of the Kyusyu region. Also, some urbanized areas have high SMRs, particularly in Osaka Prefecture and the eastern and northern part of Tokyo city. Low SMRs are found in the affluent suburbs of major metropolitan areas as well as some non-metropolitan areas including the Hokuriku and Chubu regions, and the Sea of Japan side of Chugoku region. Geographical distributions are similar for both men and women.

Distributional Transitions and Socioeconomic Disparities

Although the overall geographical pattern of the SMR has been unchanged, the regional gaps between high and low SMR regions have been slightly reduced over the 20 years from 1995 to 2014. The cartogram-based SMR maps show that SMRs in suburbs in the Osaka metropolitan area have gradually declined, and the regional disparity between high and low SMR areas is becoming salient within the Tokyo metropolitan area for the 20 years period (Fig. 5.67).

The ASMR of renal failure is decreasing for both sexes (Fig. 5.68). High mortality rates in more deprived areas have been consistent throughout the 20-year period from 1995 to 2014 (Fig. 5.69). As can be seen from the temporal trend of RII, the relative socioeconomic inequality in the mortality tends to gradually widen (Fig. 5.70).


a
Renal failure
men
SMR Colour Legend
> 145
≤ 145
≤ 125
≤ 115
≤ 105
≤ 95
≤ 85
≤ 75
3D Prismic Cartogram
70
80
90
100
110
120
140
200
2D Cartogram
2D Ordinary map projection
0
125
250
500 km

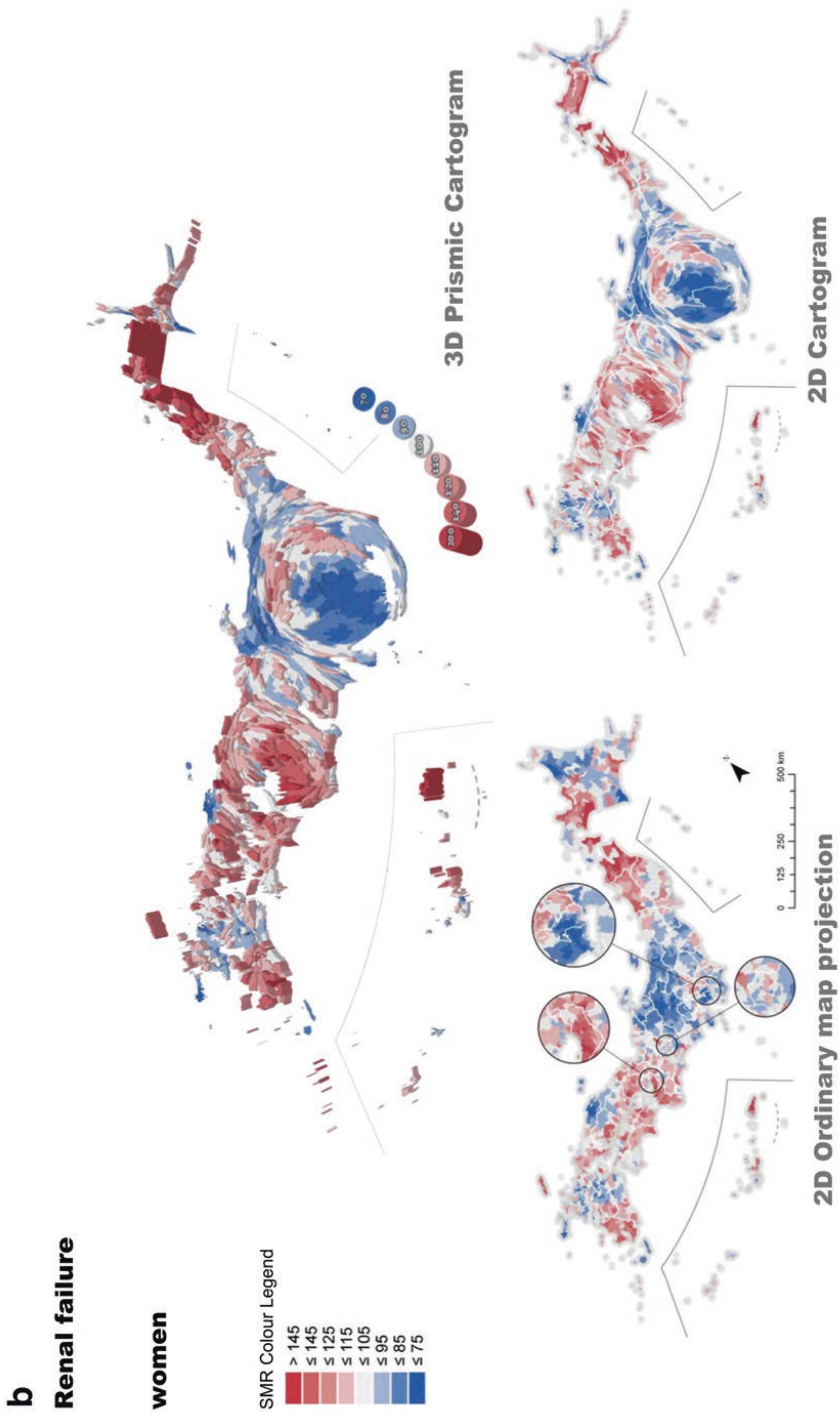
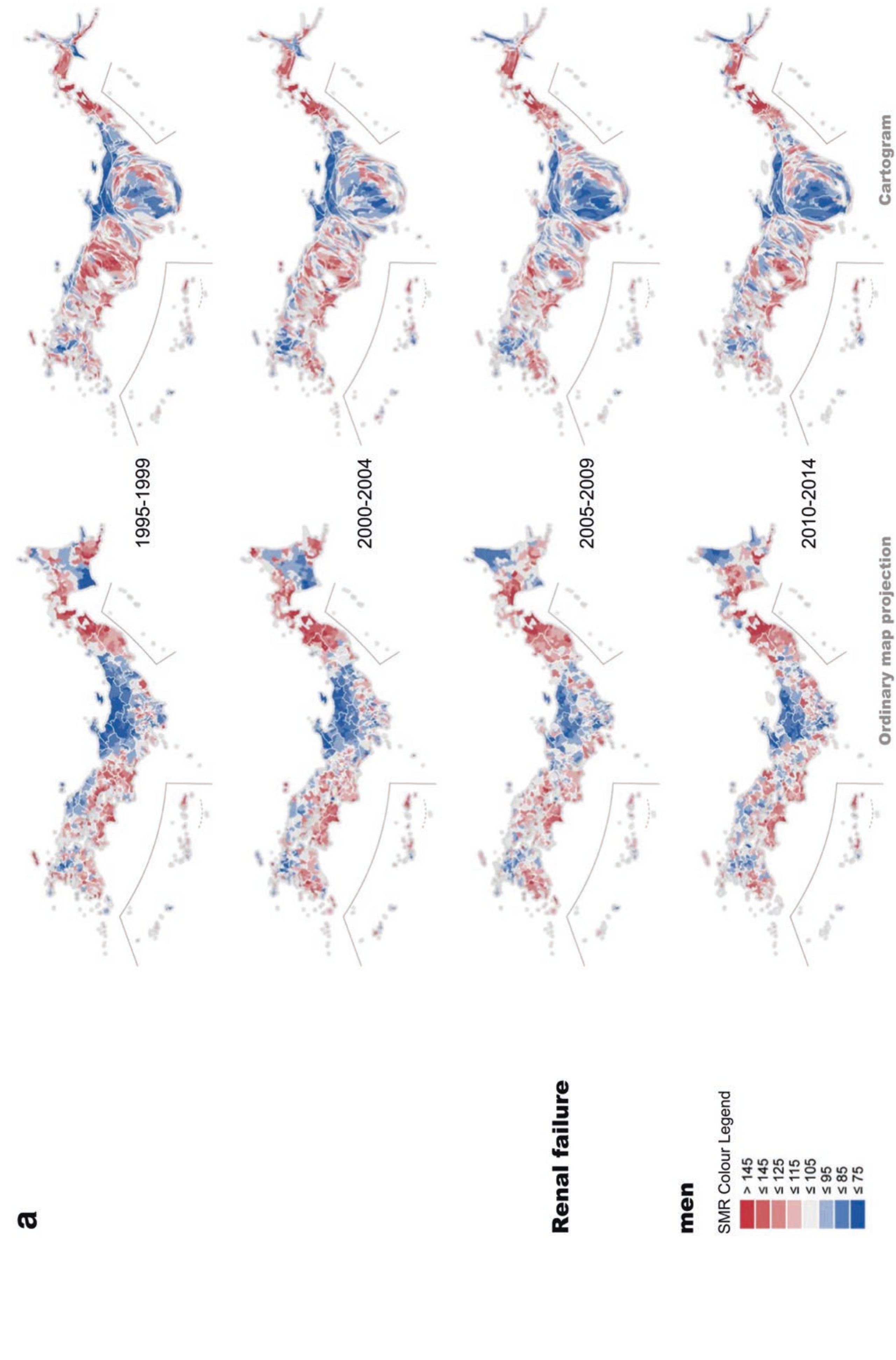


Fig. 5.66 SMR distribution of renal failure, 2010–2014. (**a**) Men. (**b**) Women


a
Renal failure
men
SMR Colour Legend
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Ordinary map projection
Cartogram

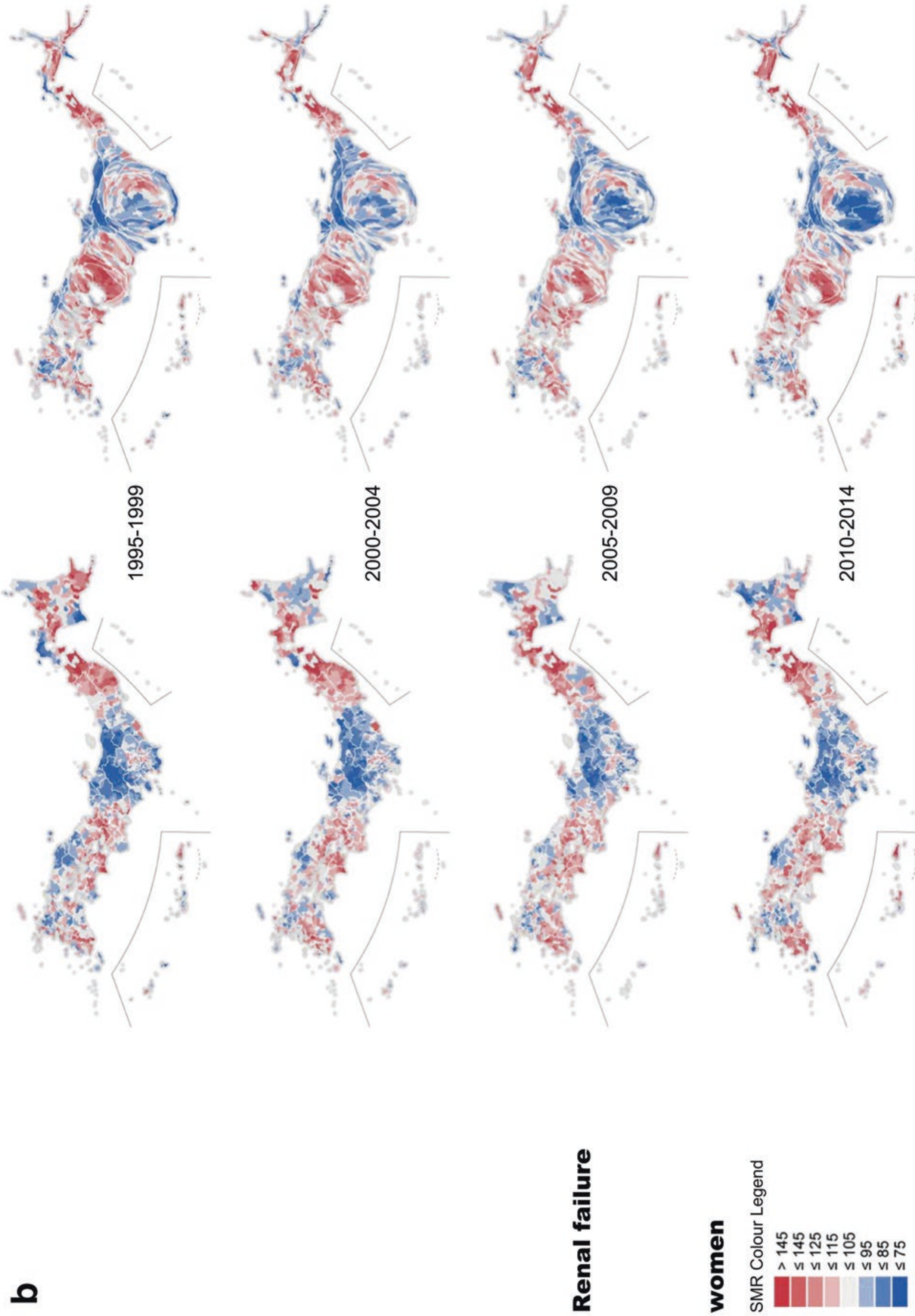

Fig. 5.67 Transition of SMR distribution of renal failure from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 5.68 Annual transition in the ASMR of renal failure from 1995 to 2014

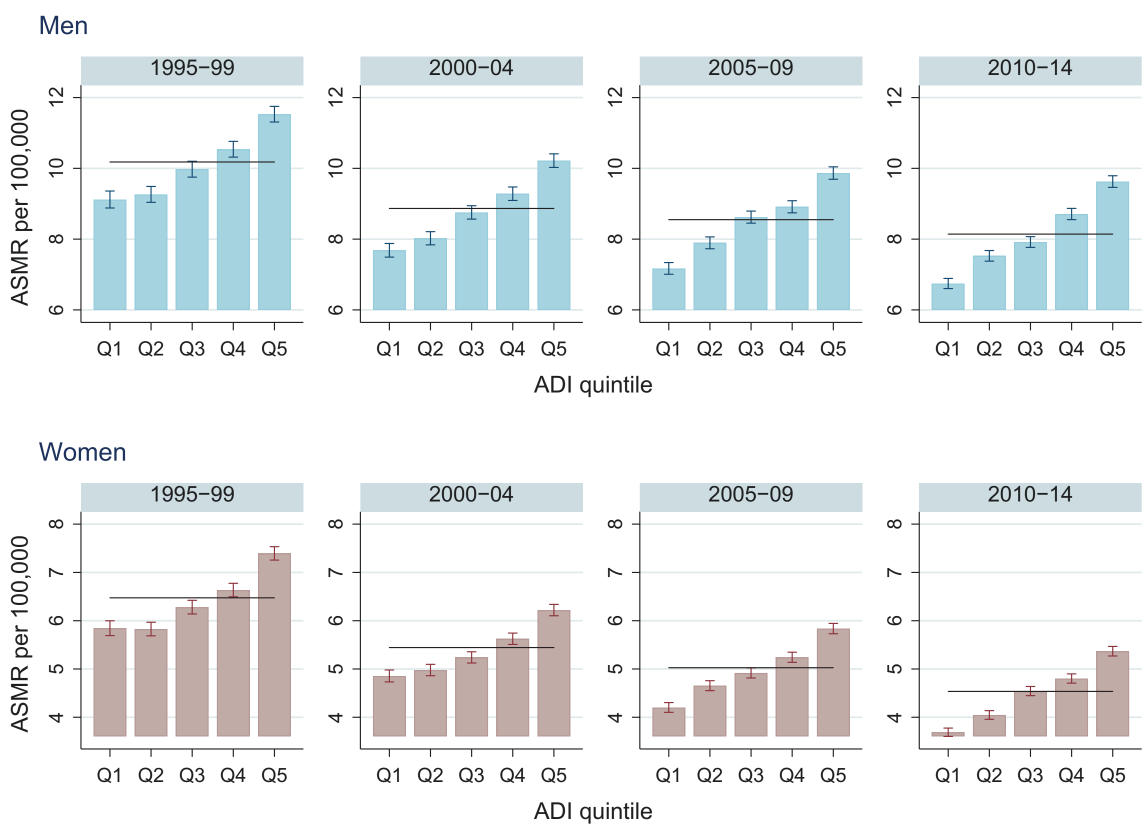

Fig. 5.69 The transition in the ASMR distribution of renal failure by ADI quintile. (Top: Men, Bottom: Women)

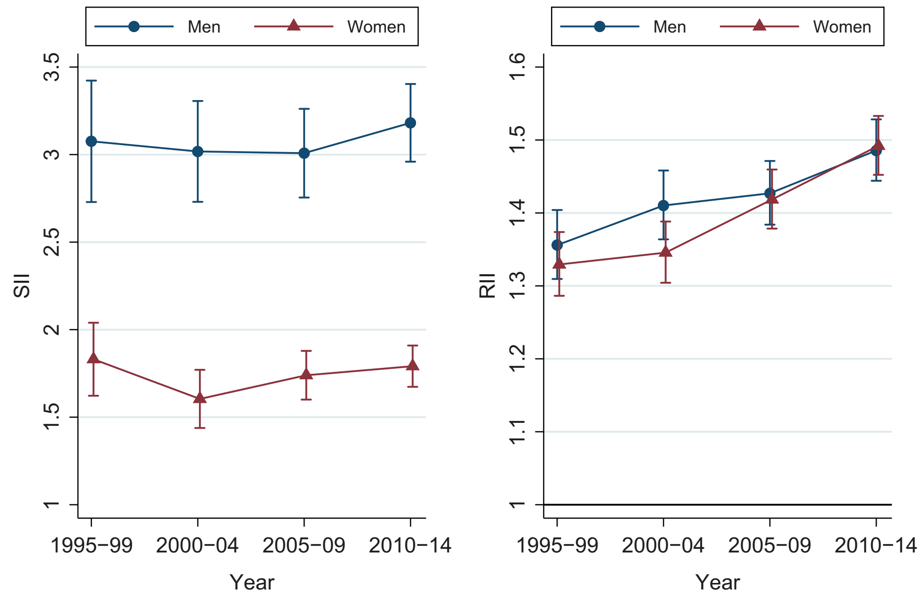

Fig. 5.70 Transition in SII and RII of renal failure from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

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6 Other Major Causes of Death

Takahiro Tabuchi, Mayuko Yonejima, Tomoya Hanibuchi, and Tomoki Nakaya

This chapter contains maps of standardized mortality ratios (SMRs) of major causes of death other than cancer and circulatory diseases in Japan from 1995 to 2014. This group contains a wide variety of diseases including tuberculosis, pneumonia, chronic obstructive pulmonary disease (COPD), asthma, senility, accidents (total and transport-related), and suicide. Despite the large variety of causes of death, most show socioeconomic inequalities based on the areal deprivation index (ADI), and some, such as pneumonia, show clear diverging trends, meaning people are increasingly more likely to die from certain diseases in relatively deprived regions. An obvious exception is senility, a natural death due to the weakness with aging and now a common type of death for Japanese (the fifth leading cause of death) with an inverse socioeconomic disparity. This discrepancy may reflect regional differences in attitudes toward dying and the terminal care of aged people. Suicide was known as an important cause of death with large socioeconomic disparity, but the inequalities indices decreased in the last period from 2010 to 2014.

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6.1 Tuberculosis (ICD10: A15-A19): Legacy of Urban Poverty

Takahiro Tabuchi

Overview

During the 1920s, tuberculosis (TB) was the leading cause of death in Japan, though it rapidly declined with the improvement of Japanese social, environment, and nutritional conditions (see Chap. 2, Sect. 2.1). However, outbreaks of tuberculosis still occur in Japan. Tuberculosis is by no means a problem of the past. Large differences in tuberculosis rates among regions have been identified. The maps presented here (Fig. 6.1) also show that the mortality rates are particularly high in urban areas such as Tokyo and Osaka. A remarkably high mortality rate was observed in the inner-city area of Osaka city, particularly among men. The prismic cartograms clearly showed that deaths from tuberculosis were strongly concentrated in limited parts of metropolitan areas. These regional disparities may be attributed to the spread of TB from person to person through droplet transmission which is common among populations living in densely inhabited communities, particularly in deprived urban areas with high-risk populations of TB infection, such as concentrations of homeless persons (Tabuchi et al. 2011).

Distributional Transitions and Socioeconomic Disparities

There has been no significant change in the distribution of SMR over the 20 years from 1995 to 2014 (Fig. 6.2). Although a certain number of TB-related deaths have been observed nationwide since the decline in the rate of

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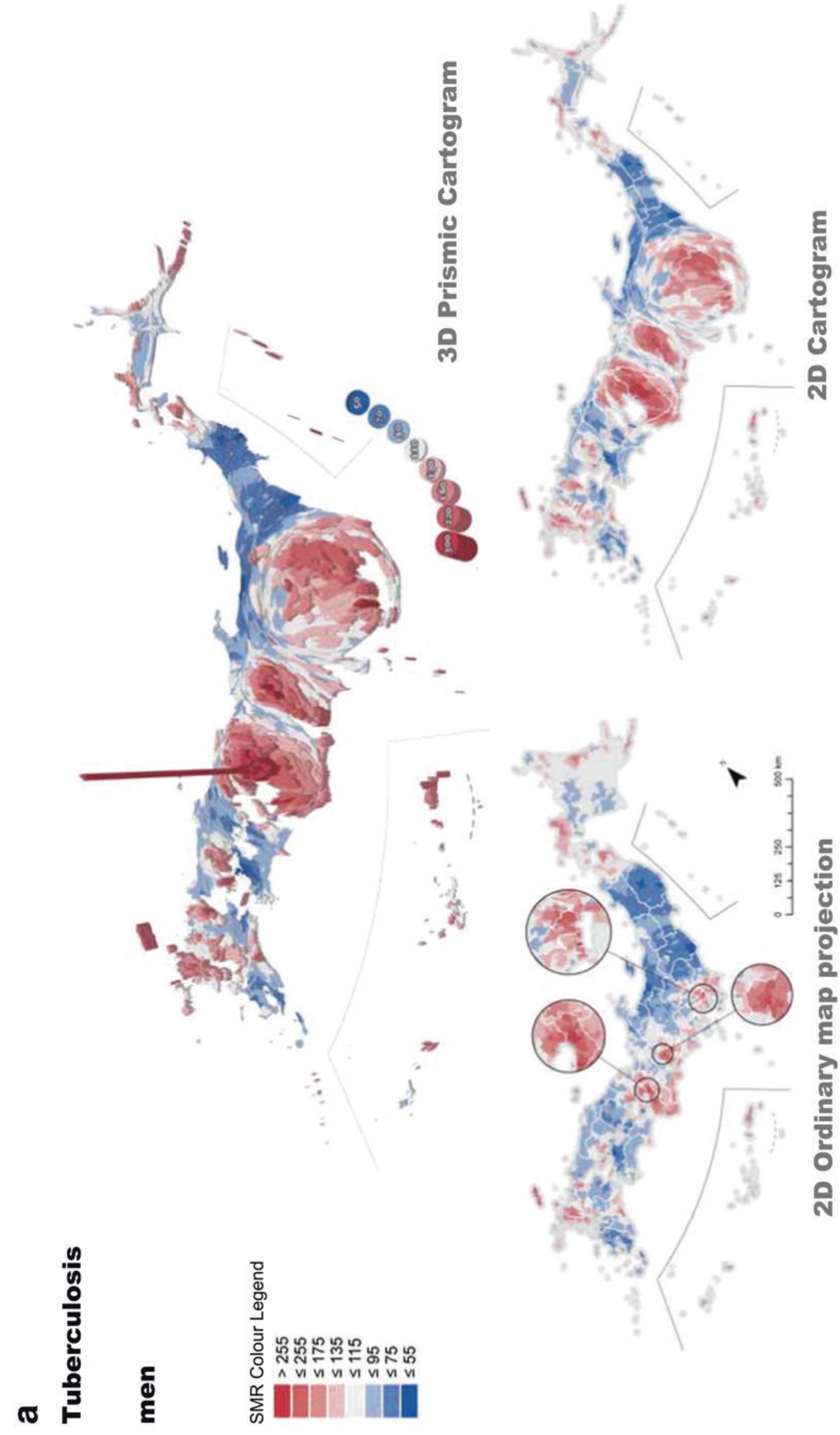
https://doi.org/10.1007/978-3-030-22707-4_6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Tuberculosis
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SMR Colour Legend
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2D Ordinary map projection
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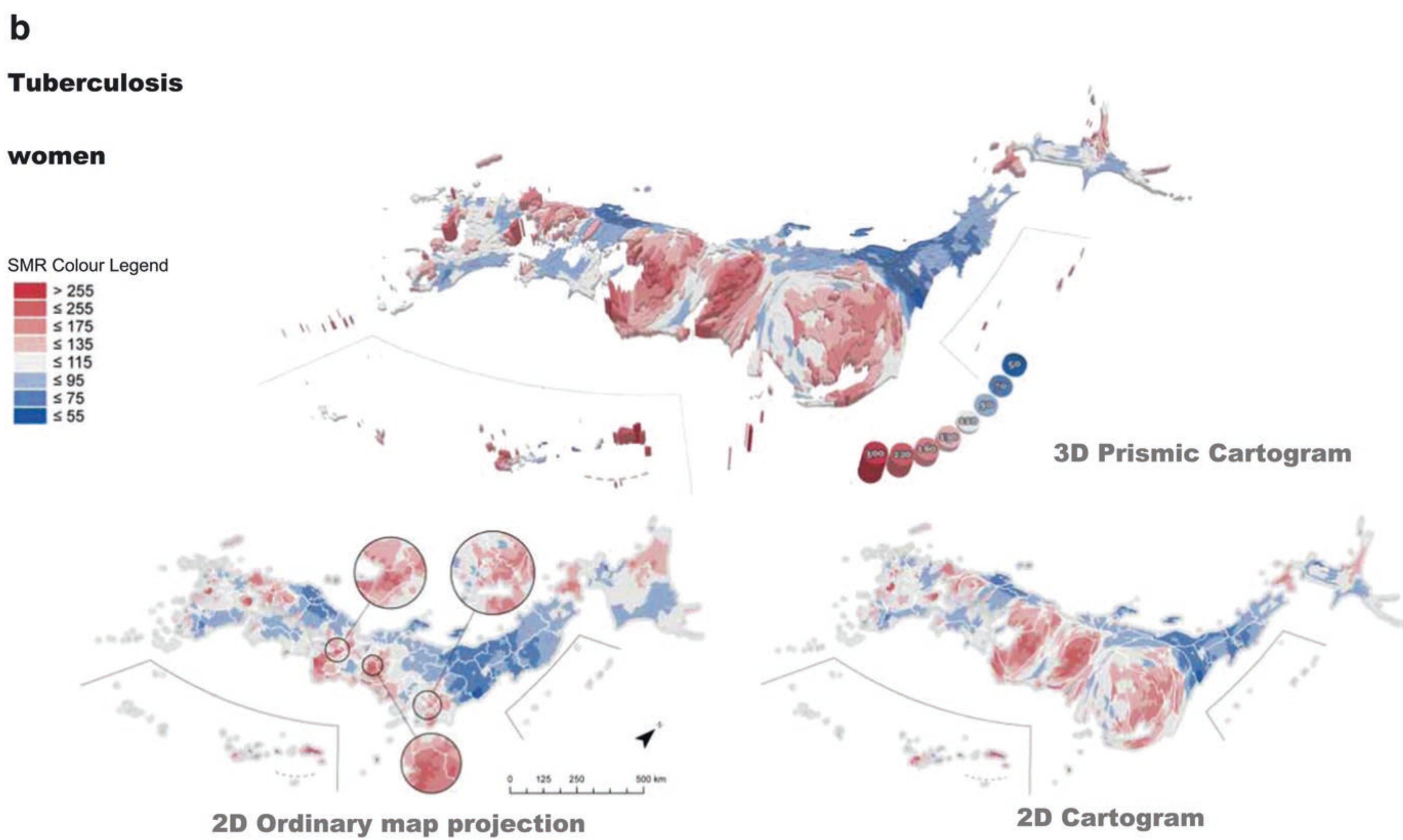
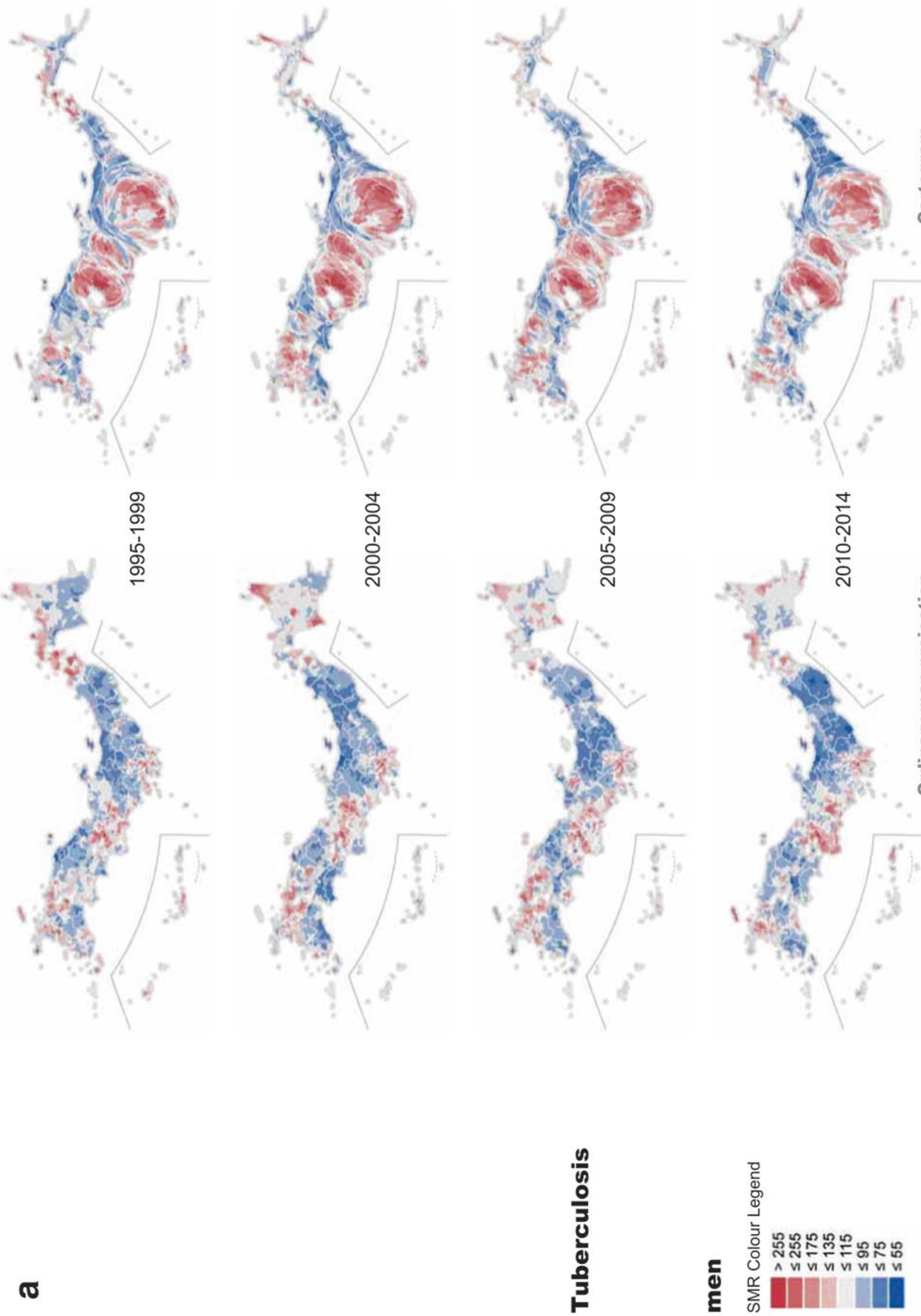


Fig. 6.1 SMR distribution of tuberculosis, 2010–2014. (**a**) Men. (**b**) Women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SMR Colour Legend
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Ordinary map projection
Cartogram

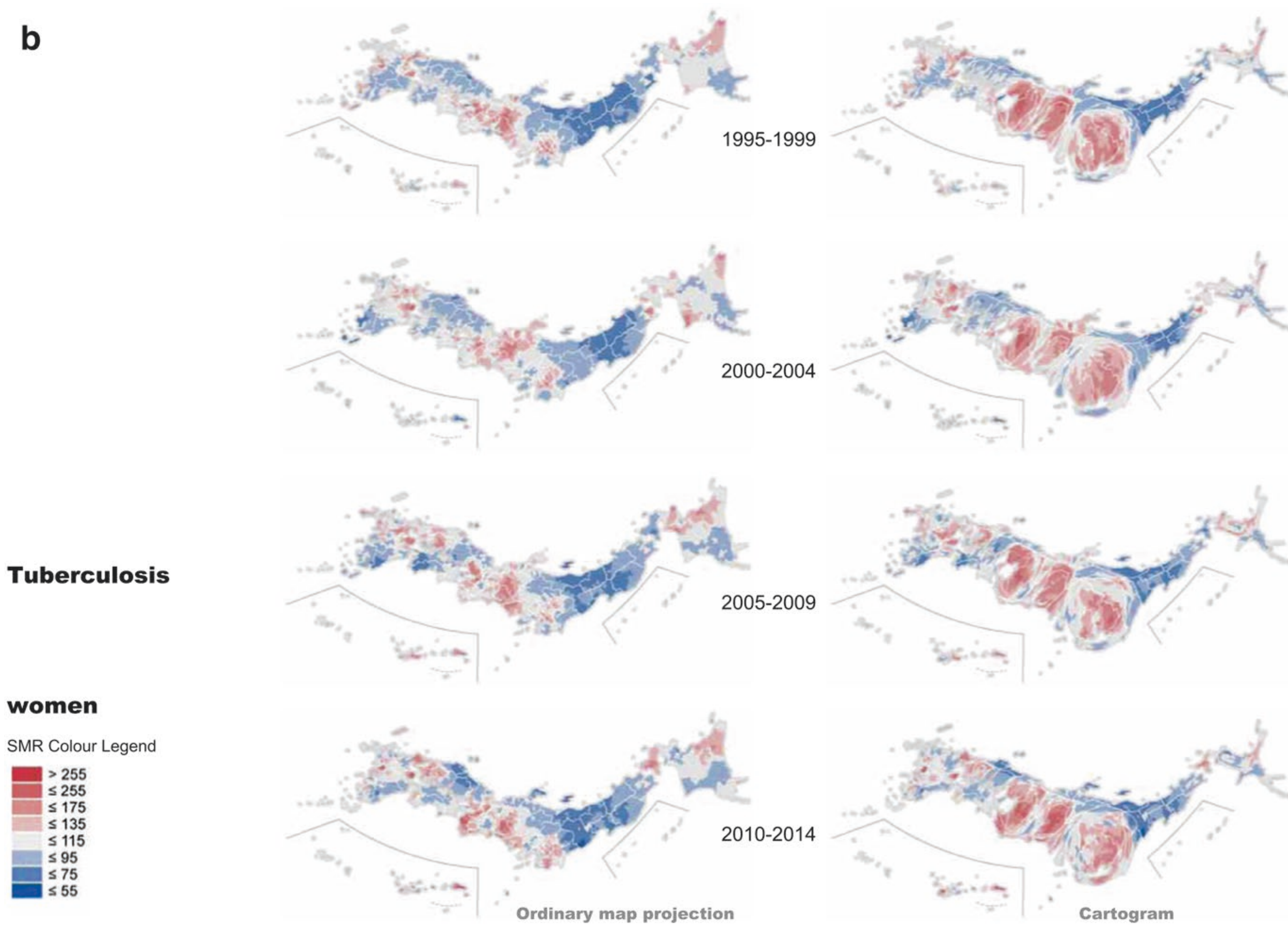


Fig. 6.2 Transition of SMR distribution of tuberculosis from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

TB-related mortality, they have mostly occurred in urban areas.

The age standardized mortality rate (ASMR) of TB has steadily decreased during the period from 1995 to 2014 (Fig. 6.3). High ASMR of TB was observed in areas with the highest area deprivation level (Q5), especially in men in the latest period from 2010 to 2014 (Fig. 6.4). While the SII of TB decreased, the RII increased for both sexes, indicating widening relative inequalities of TB over the 20 years (Fig. 6.5). The socioeconomic disparity of TB mortality by

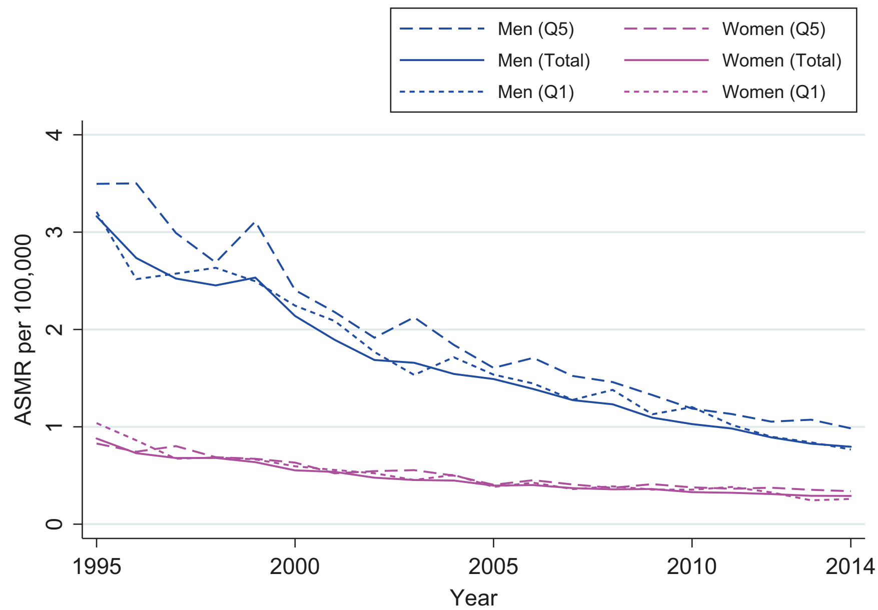


Fig. 6.3 Annual transition in the ASMR of tuberculosis from 1995 to 2014

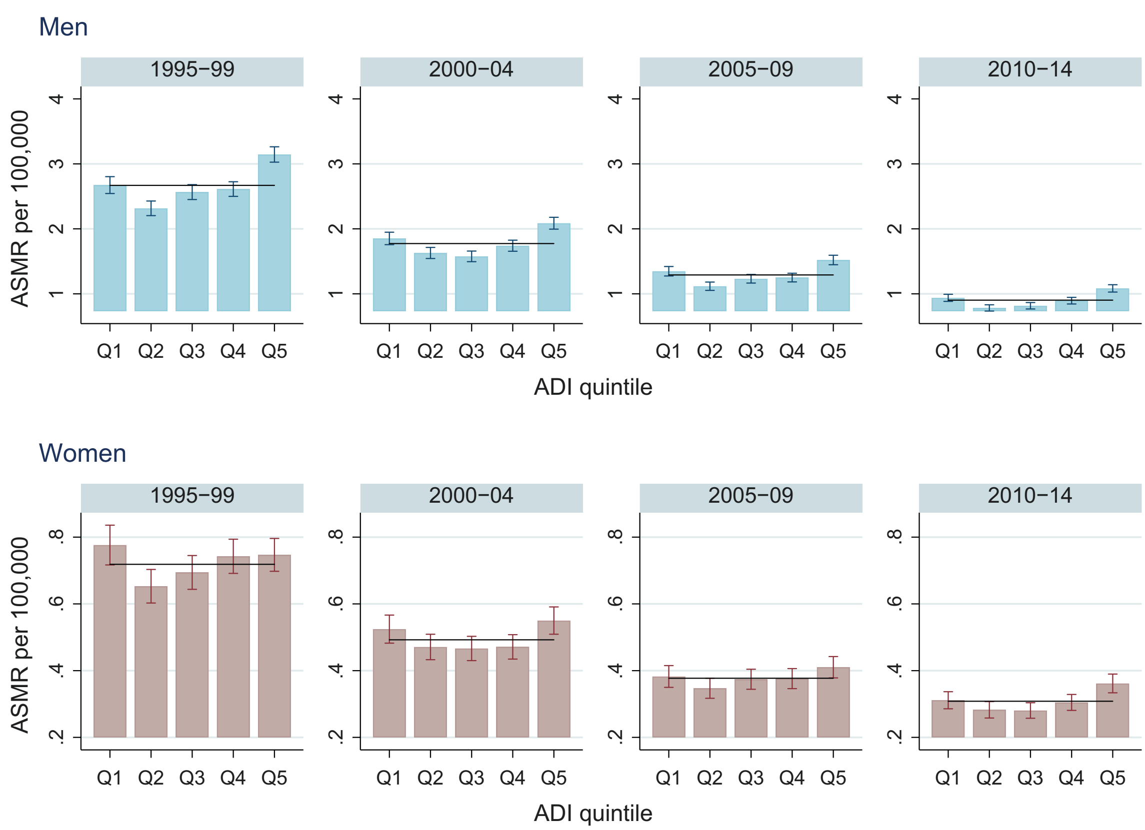


Fig. 6.4 The transition in the ASMR distribution of tuberculosis by ADI quintile. (Top: Men, Bottom: Women)

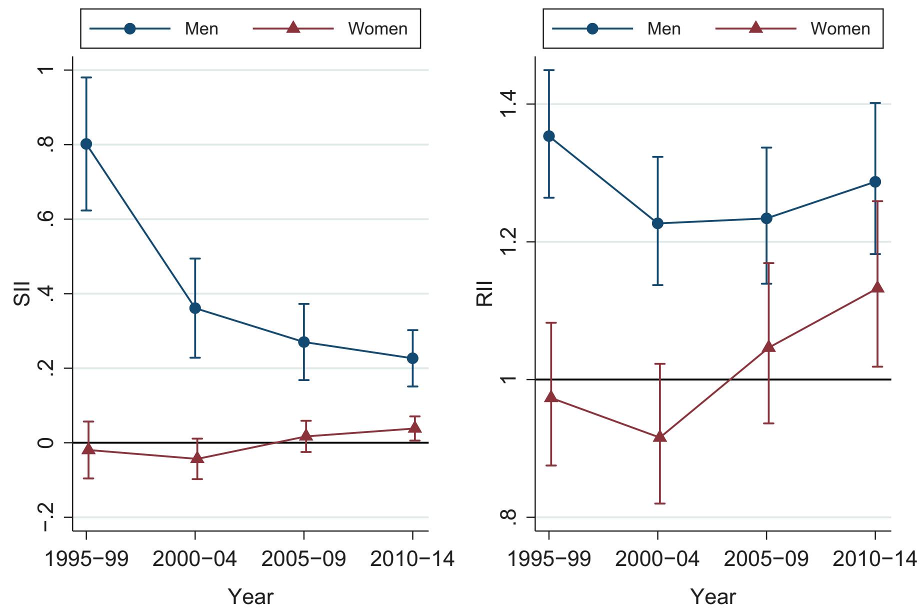


Fig. 6.5 Transition in SII and RII of tuberculosis from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

ADI quintile, however, has showed no clear trend (Fig. 6.4). Rather, a slightly higher mortality of TB was observed in areas with the lowest deprivation index, Q1 compared to Q2 or Q3, which may be related to a higher rate of death from TB in urban centers where deprivation indices are often at lower levels, such as Q1 or Q2. It may indicate that highly deprived persons who suffer from TB are likely to live in the vicinity of urban affluence zones in metropolitan core areas.

6.2 Pneumonia (ICD10: J12-J18): Common Disease in the Super-Aged Society

Takahiro Tabuchi

Overview

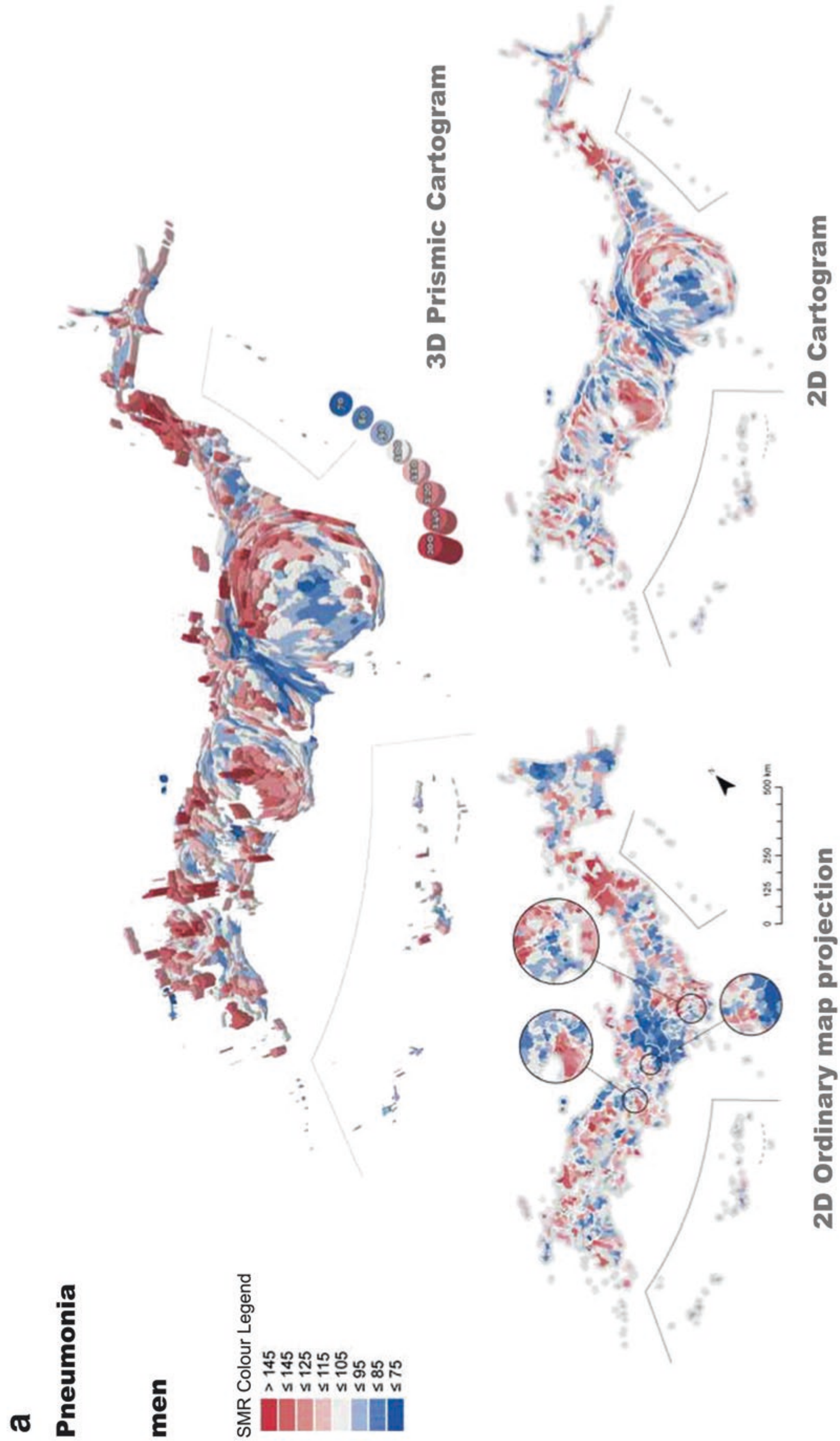
Pneumonia, like tuberculosis, was a fairly common cause of death in the early 1900s (see Chap. 2, Sect. 2.1). Crude mortality rate from pneumonia decreased until around the 1970s and has been increasing since then, reflecting the rapid growth of the older population in Japan. Although deaths from pneumonia vary from region to region, the degree of geographical variation of the disease is moderate. From the prismic cartograms (Fig. 6.6), we can see that for males SMR of pneumonia is high in the Tohoku region, such as Aomori Prefecture, and for females in the northern Kanto and Hokuriku regions, and in the inner-city parts of Osaka Prefecture for both sexes. The cartogram-based maps clarified the differences between the Kanto and Kinki regions; the disease is more common in the periphery of the Kanto region, whereas in the Kinki region it is more common in the central areas.

The mortality rate is low in the Chubu region around Nagano Prefecture and in the affluent suburbs of metropolitan areas. These regional disparities may be attributed to the geographical disparities of general mortality risks for pneumonia reflecting socioeconomic disparities as well as geographical differences of diagnostic practices; physicians in some areas might be more likely to identify pneumonia as a cause of death compared to other areas.

Distributional Transitions and Socioeconomic Disparities

A series of cartogram-based maps (Fig. 6.7) shows that within the Tokyo metropolitan area, SMRs in the affluent suburbs (colored in blue) have been declining, which indicates a widening socioeconomic residential disparity of the disease in the area.

The ASMR of pneumonia decreased during the period from 1995 to 2014 (Fig. 6.8). High ASMR from pneumonia was generally observed in areas with the highest areal deprivation index (Q5) (Fig. 6.9). In the 20 years from 1995 to 2014, the trends of SII and RII indicate that the socioeconomic inequalities in the mortality have widened (Fig. 6.10). It should be noted that the absolute difference of the ASMR between the most and least deprived groups has clearly widened since around 2000.


a
Pneumonia
men
SMR Colour Legend
> 145
≤ 145
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≤ 115
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3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
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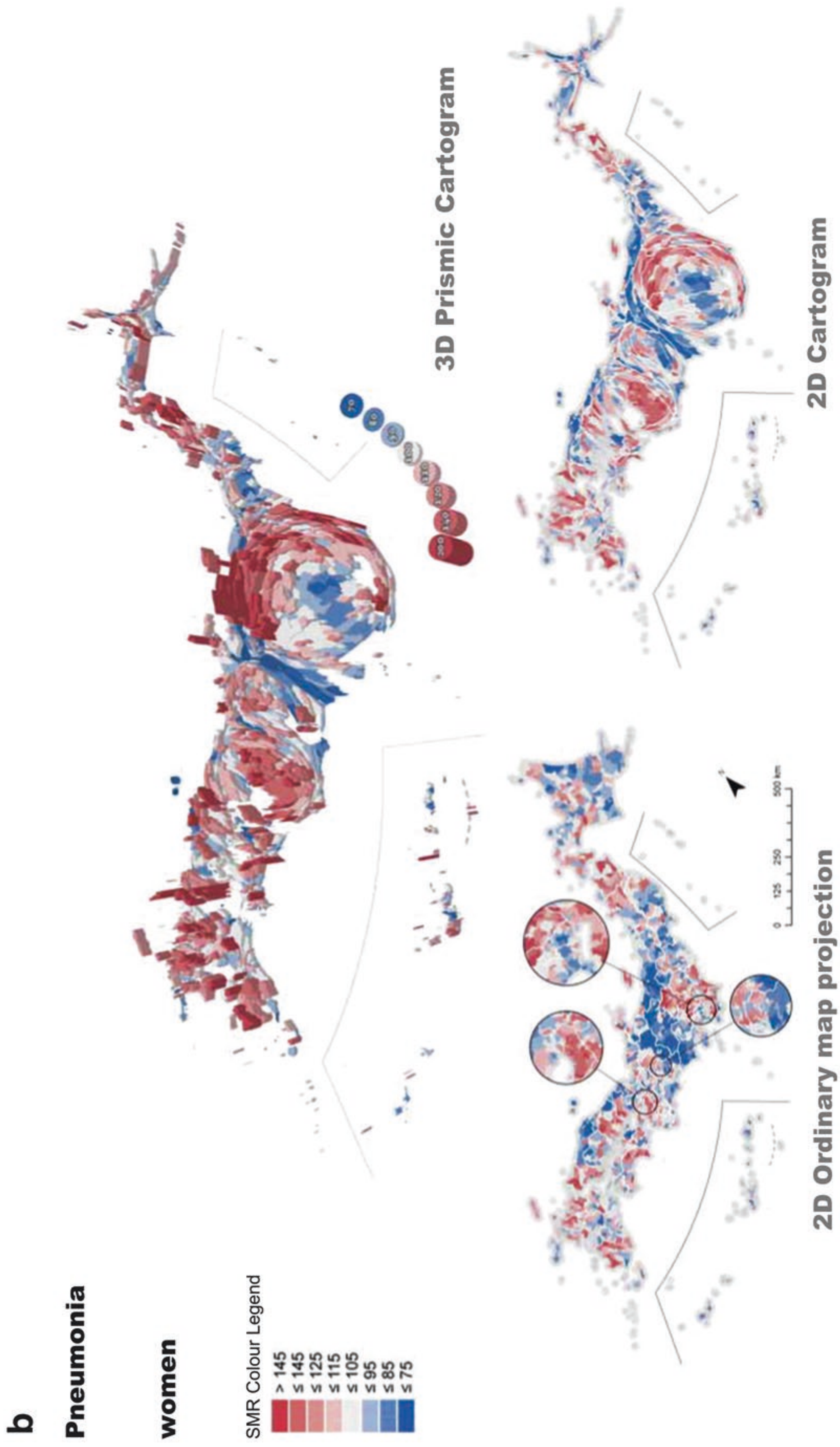
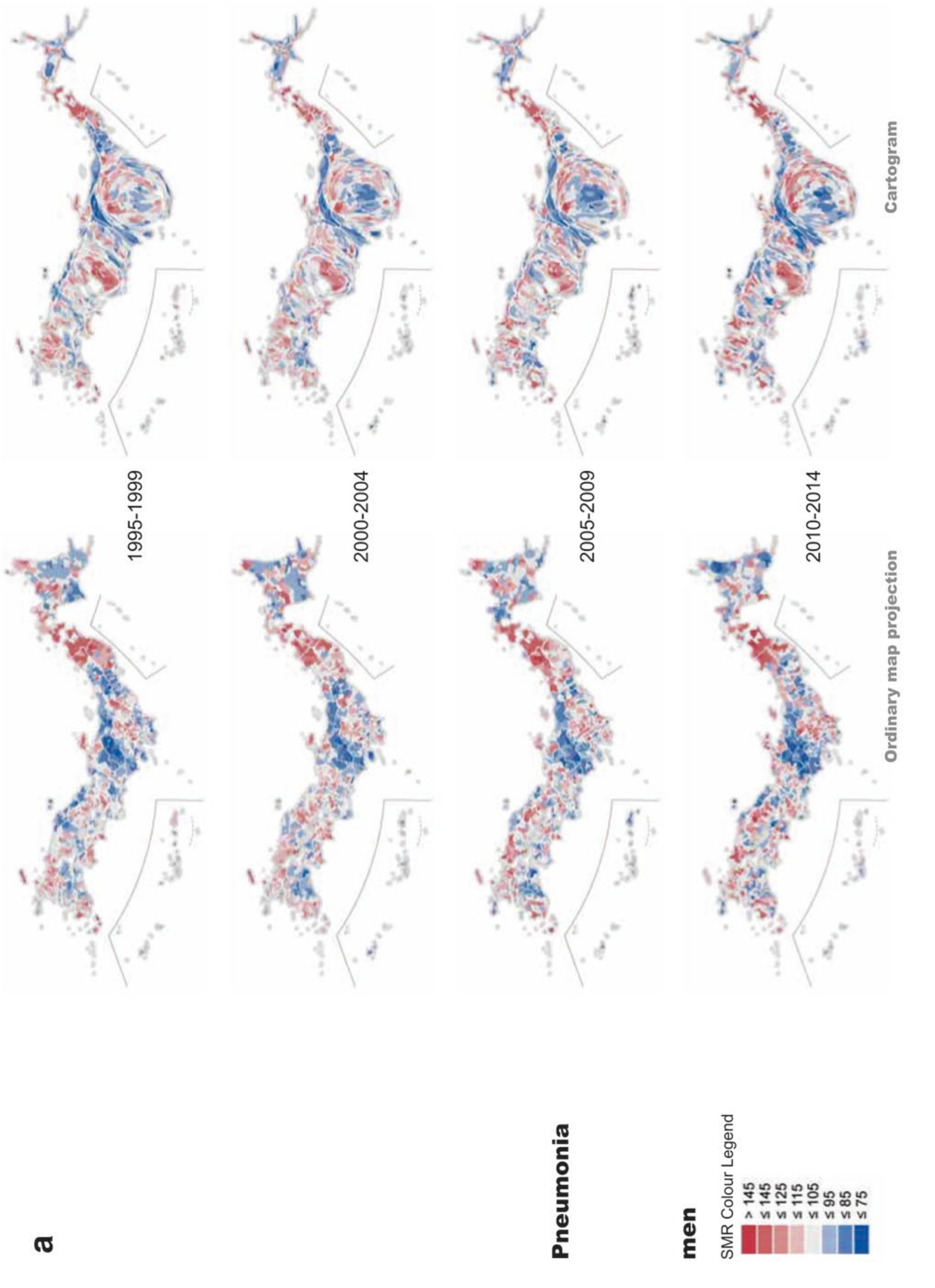


Fig. 6.6 SMR distribution of pneumonia, 2010–2014. (**a**) Men. (**b**) Women


a
Pneumonia
men
SMR Colour Legend
> 145
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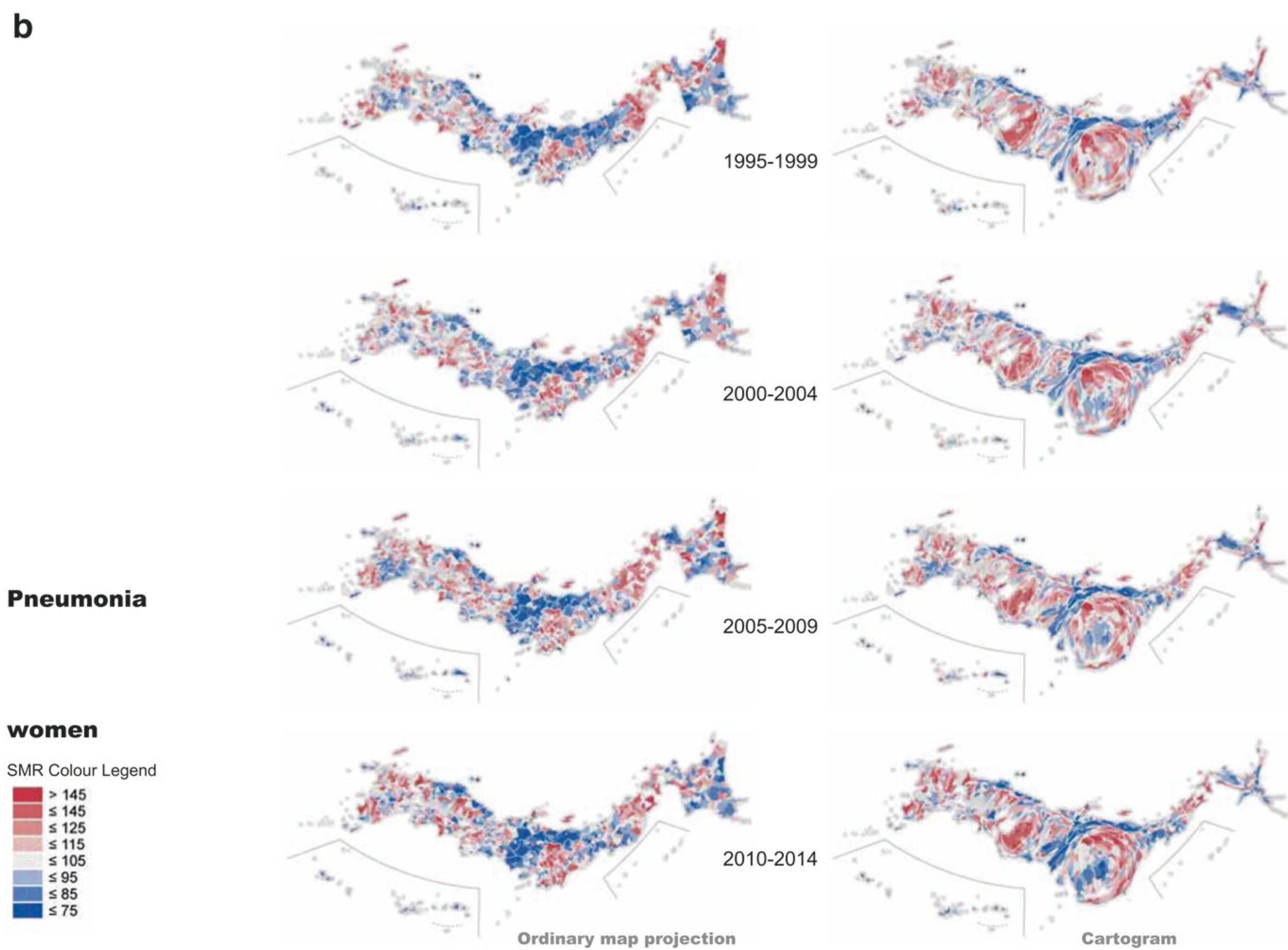
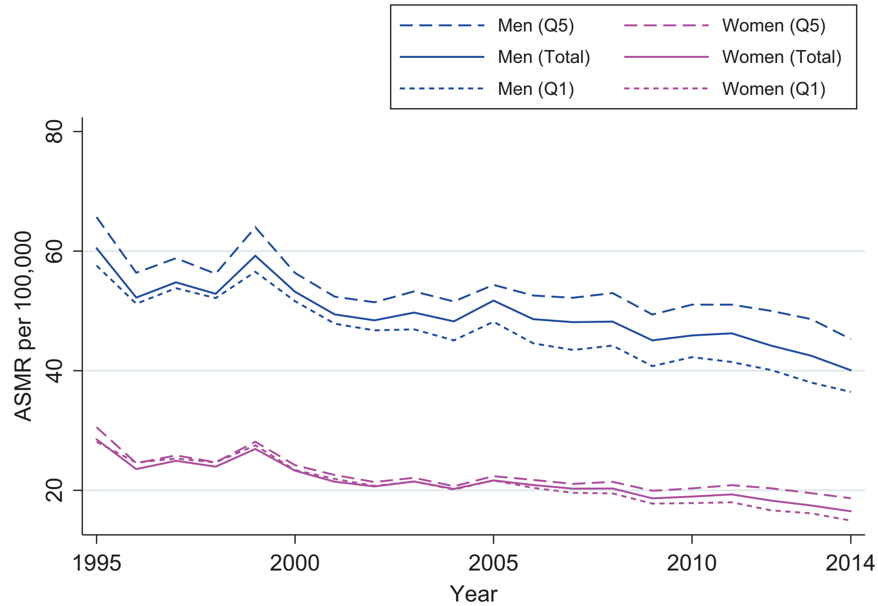


Fig. 6.7 Transition of SMR distribution of pneumonia from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 6.8 Annual transition in the ASMR of pneumonia from 1995 to 2014



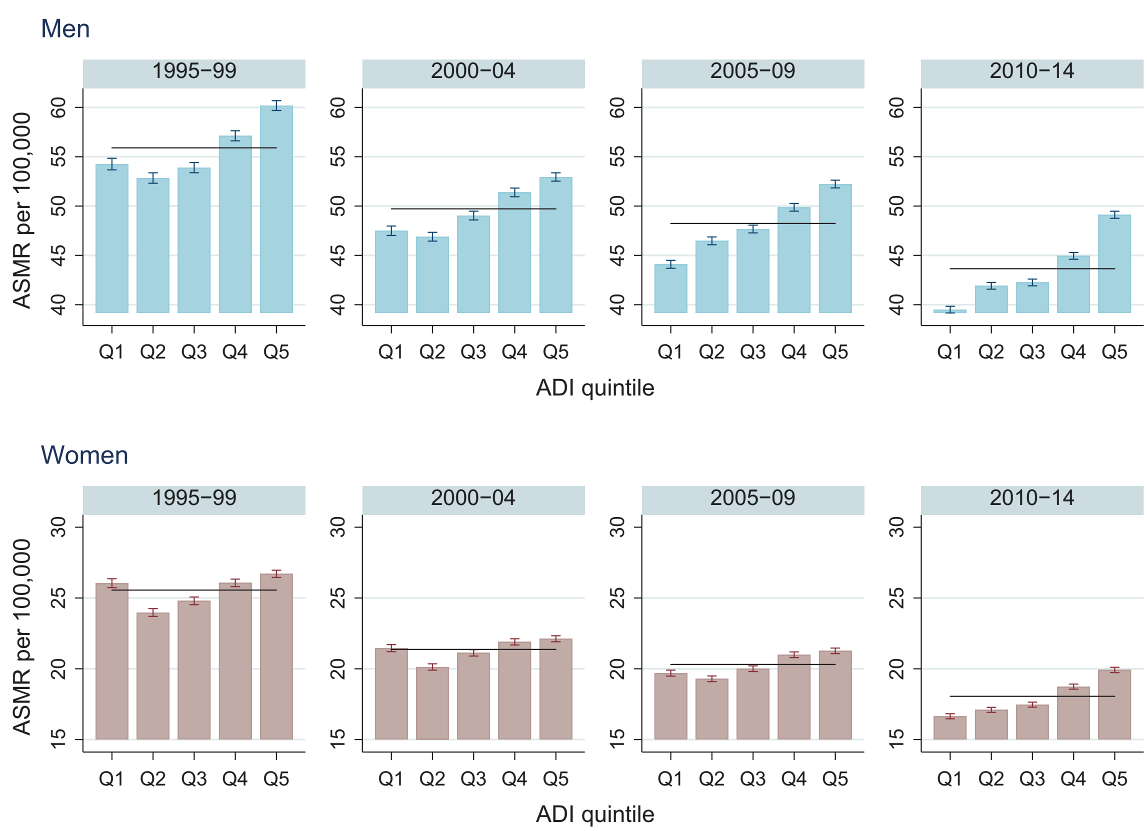


Fig. 6.9 The transition in the ASMR distribution of pneumonia by ADI quintile. (Top: Men, Bottom: Women)

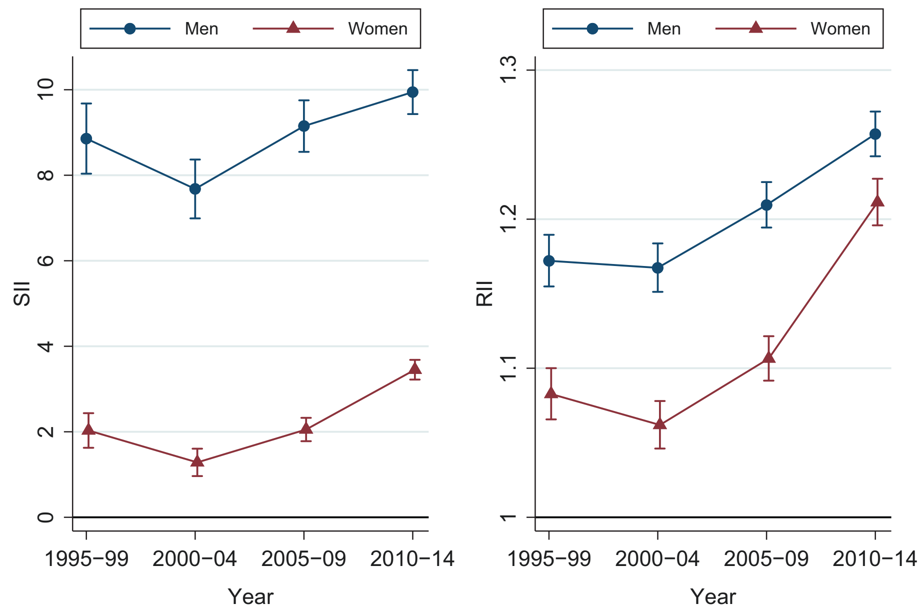


Fig. 6.10 Transition in SII and RII of pneumonia from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

6.3 Chronic Obstructive Pulmonary Disease (ICD10: J41-J44): Disease from Long-Term Smoking

Takahiro Tabuchi

Overview

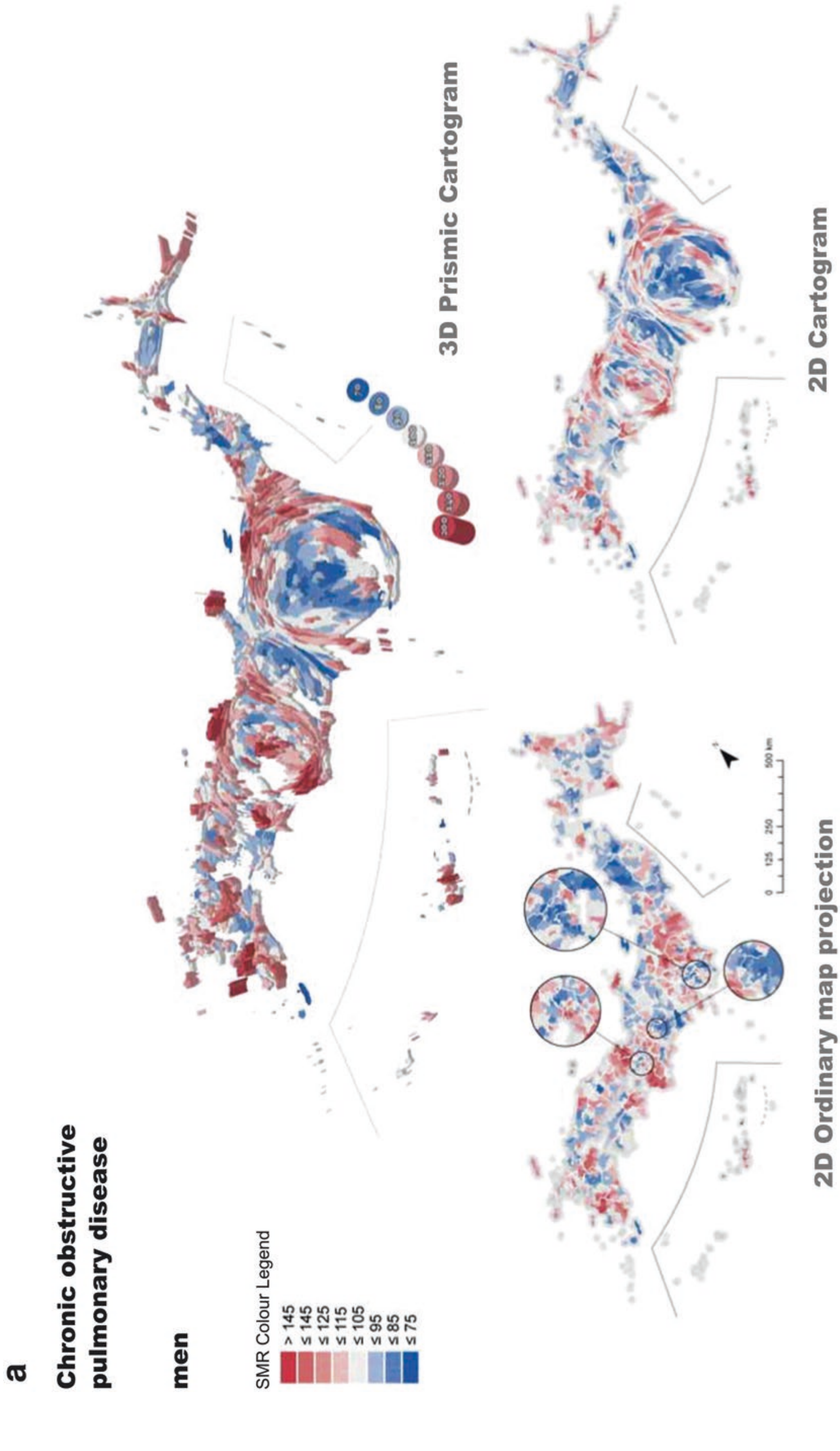
Chronic obstructive pulmonary disease (COPD) is a generic term for diseases conventionally called chronic bronchitis or emphysema. It is an inflammatory disease of the lung caused by long-term inhalation exposure of harmful substances such as tobacco smoke, and it is a lifestyle-related disease which tends to develop during middle old age. Therefore, the regional distribution of deaths from chronic obstructive pulmonary disease may reflect long-term smoking trends in local populations.

The map shows that there is a clear geographical tendency with SMRs of COPD, generally high in urban areas for women while peripheral areas of the metropolitan areas tend to have higher SMR for men (Fig. 6.11). This gender difference in the regional disparities of COPD mortality may be attributed to a higher rate of women smoking and a lower rate of men smoking in urban areas compared to non-urban areas (Fukuda et al. 2005). The estimated municipal smoking prevalence was shown in Chap. 3, Sect. 3.7 (Fig. 3.31).

Distributional Transitions and Socioeconomic Disparities

There has been no significant change in the distribution of SMR over the last 20 years (1995–2014) for either traditional or cartogram-based maps (Fig. 6.12). This stability of this geographical tendency may mean that mortality from COPD reflects long-term smoking trends.

The ASMR of COPD has gradually decreased during the period from 1995 to 2014 (Fig. 6.13). The highest ASMR for the disease has been consistently observed in areas belonging to the most deprived quintile (Q5) for the period (Fig. 6.14). These socioeconomic disparities of the disease seemed to be reasonable as smoking prevalence is associated with socioeconomic status, including area deprivation. In the 20 years, the socioeconomic inequalities in the mortality measured by the difference of ASMR according to quintile groups of ADI and the SII (Fig. 6.15) have increased for men but decreased for women. The RII has increased for both of sexes in the latest period after 2005.


a
Chronic obstructive pulmonary disease
men
SMR Colour Legend
> 145
≤ 145
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3D Prismic Cartogram
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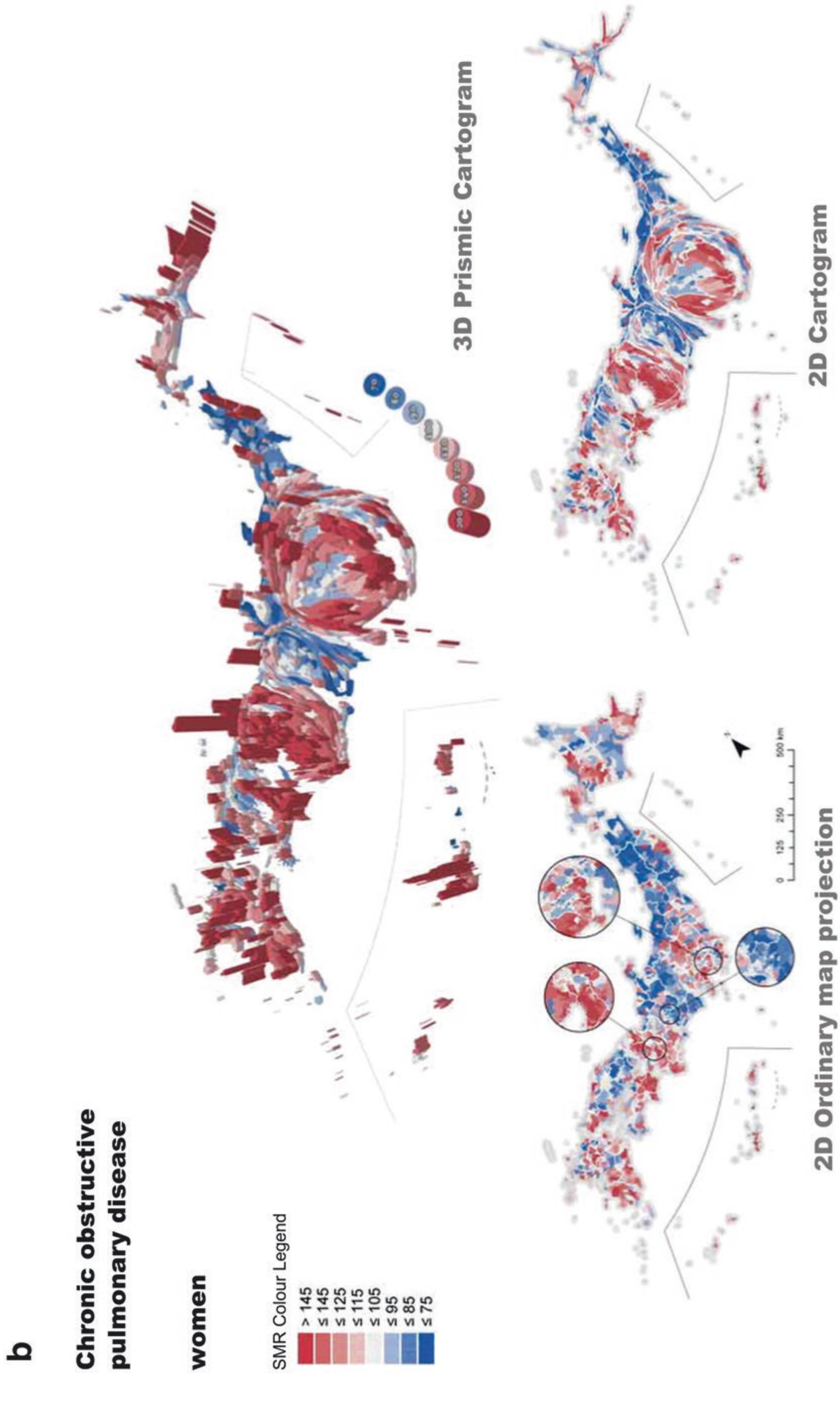
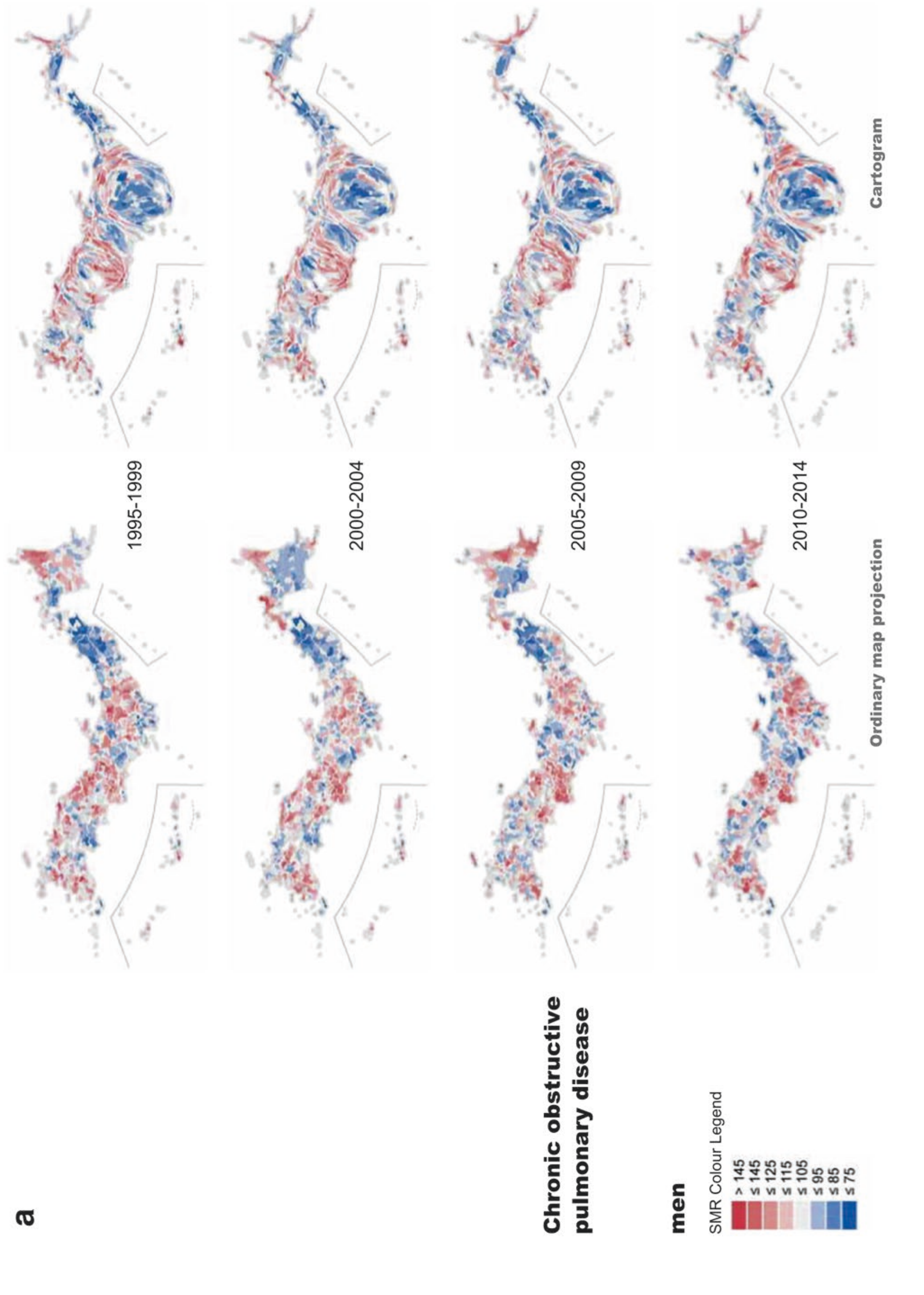


Fig. 6.11 SMR distribution of chronic obstructive pulmonary disease, 2010–2014. (**a**) Men. (**b**) Women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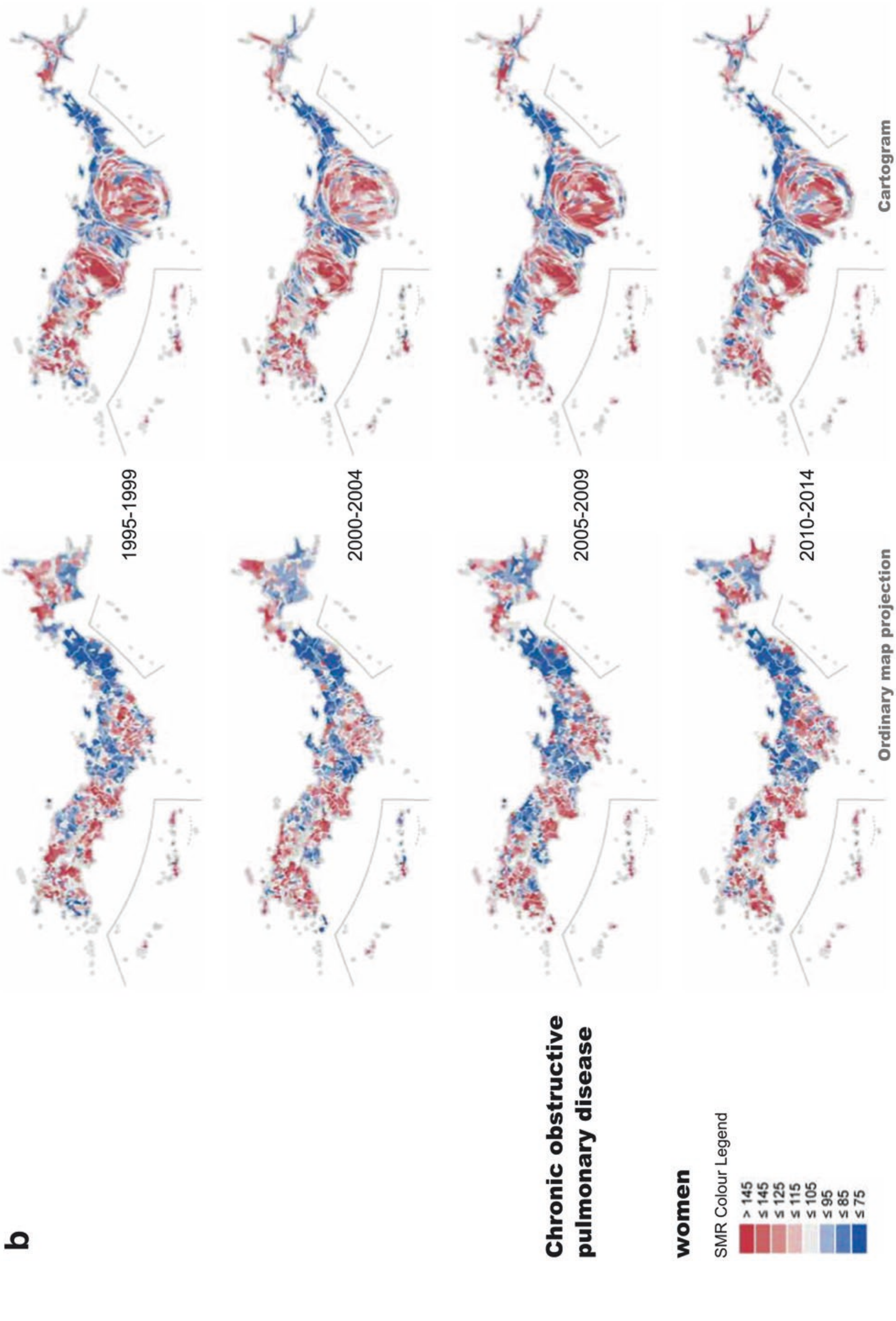
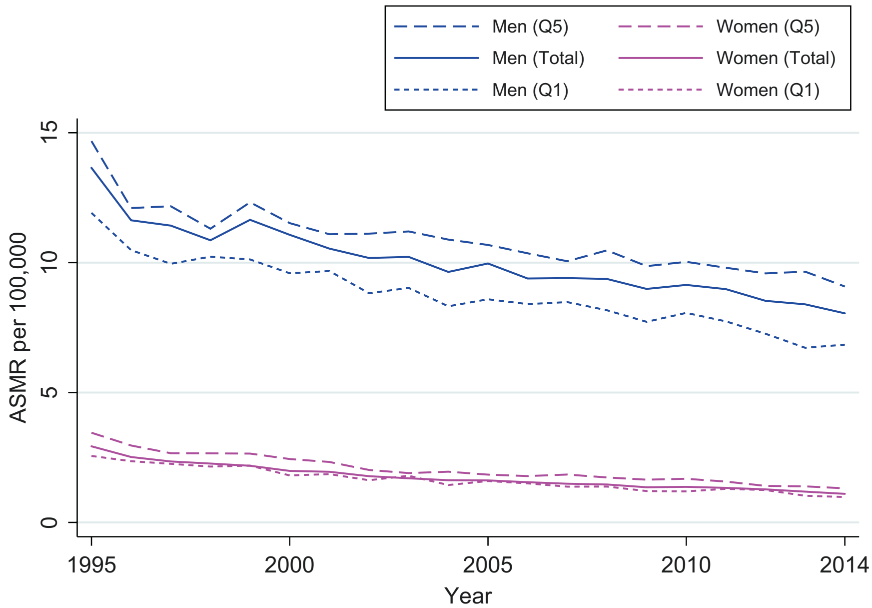


Fig. 6.12 Transition of SMR distribution of chronic obstructive pulmonary disease from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 6.13 Annual transition in the ASMR of chronic obstructive pulmonary disease from 1995 to 2014



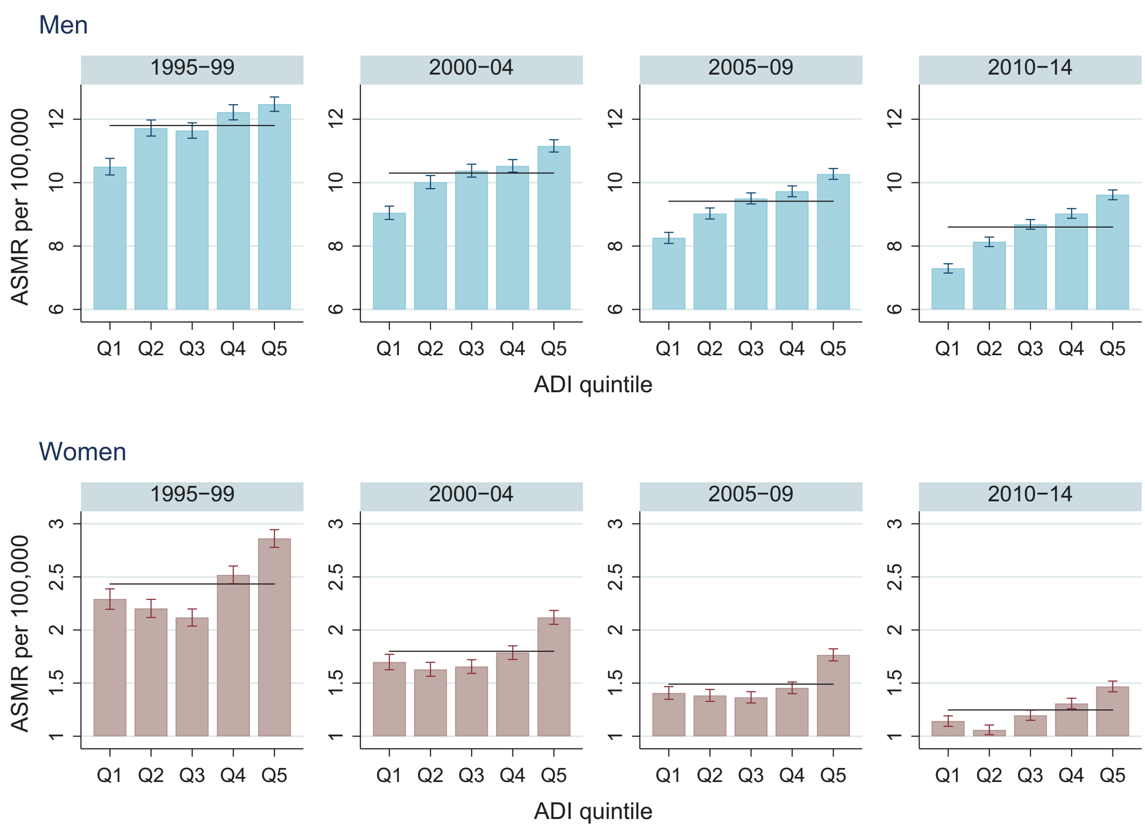


Fig. 6.14 The transition in the ASMR distribution of chronic obstructive pulmonary disease by ADI quintile. (Top: Men, Bottom: Women)

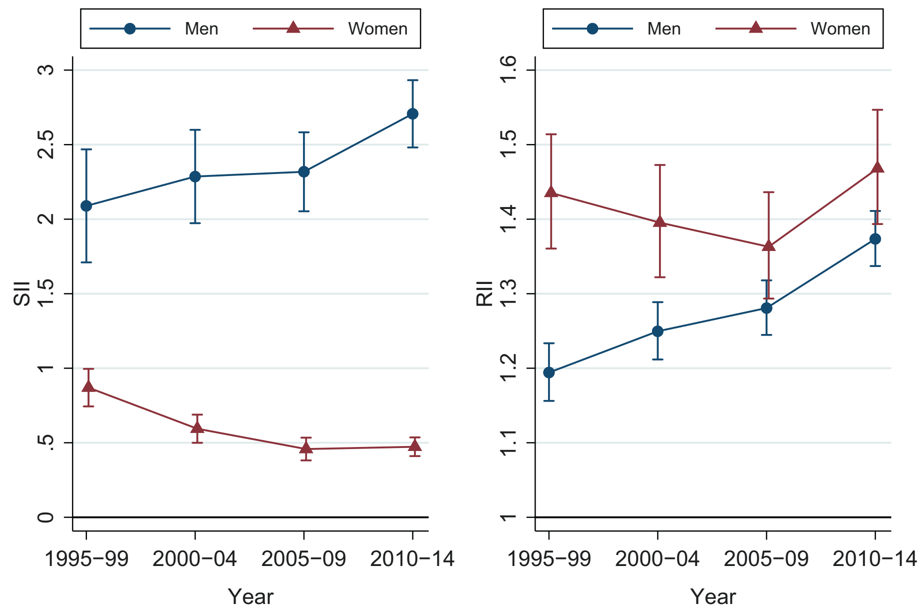


Fig. 6.15 Transition in SII and RII of chronic obstructive pulmonary disease from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

6.4 Asthma (ICD10: J45-J46): Paroxysmal Respiratory Disease by Chronic Inflammation

Takahiro Tabuchi

Overview

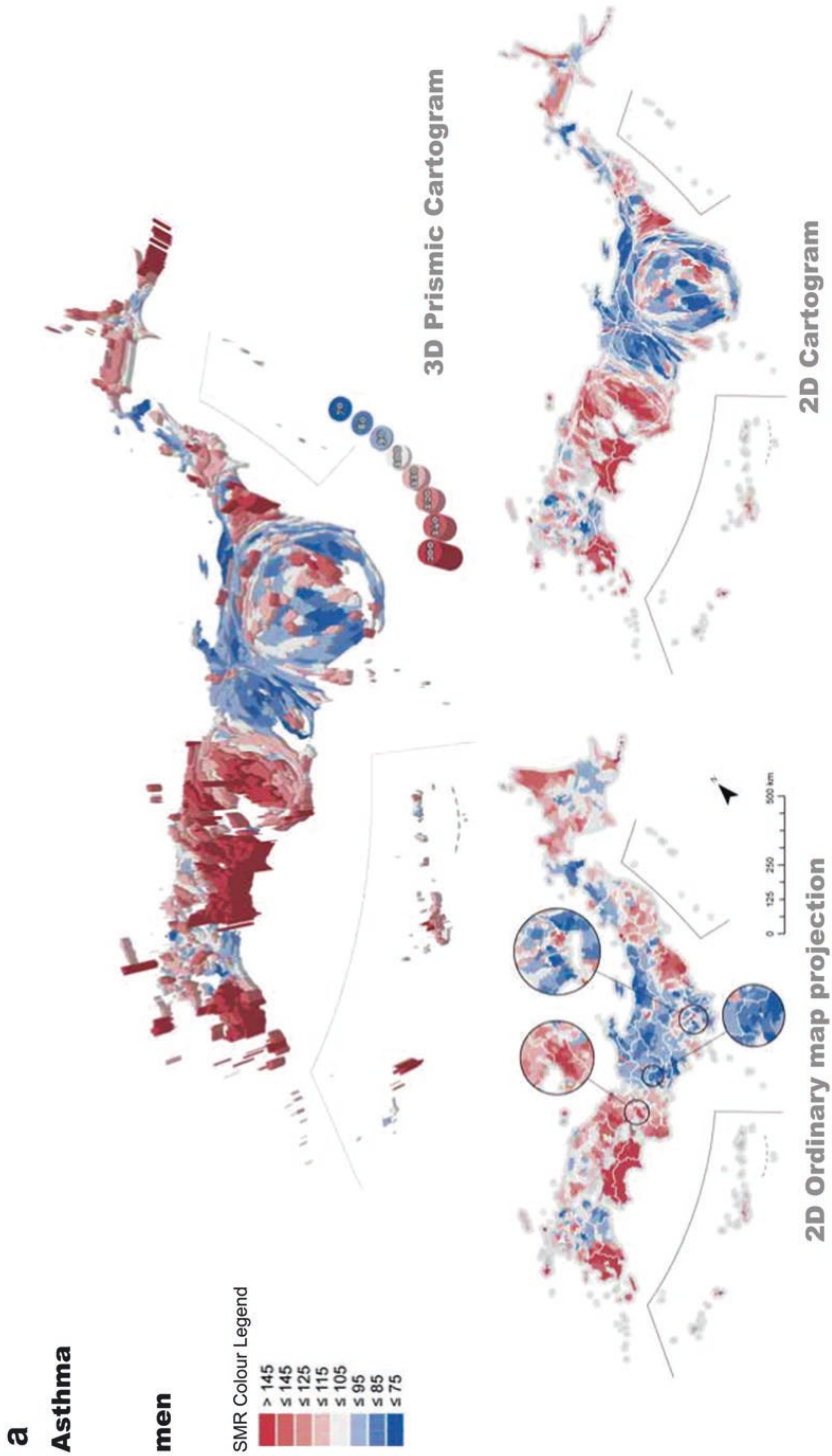
When asthma (generally bronchial asthma) develops, the inflammation of the bronchi becomes chronic due to allergic reactions, and the airways narrow and become hypersensitive to irritation. Thus, episodes of wheezing, coughing, and dyspnea may occur paroxysmally, sometimes leading to death.

Looking at the regional distribution of asthma SMR (Fig. 6.16), we can see that for both sexes SMR is high in western Japan and low in eastern Japan. We can also identify local clusters of high SMR areas in Fukushima Prefecture on the traditional projection map and inner-city parts of the Tokyo metropolitan areas on the cartogram-based map. This trend indicates socioeconomic regional disparity of mortality within metropolitan areas. It is, however, hard to infer the reasons of this geographic distributions of asthma mortality. The context for these regional disparities may be related to the distribution of allergic agents, medical institutions, and respiratory physicians who are likely to diagnose patients with asthma (Kimura et al. 2010).

Distributional Transitions and Socioeconomic Disparities

There has been no remarkable change in the distributional pattern of SMR for this disease over the 20 years, 1995–2014 (Fig. 6.17). This may suggest that the distribution of allergens responsible for asthma has not changed over time. However, the regional variations of SMRs have been getting smaller as we can see from the fact that the number of areas with very high or low SMRs has decreased.

There was a sharp decrease in the ASMR of asthma between 1995 and 2005 (Fig. 6.18). The ASMR tends to be higher for more deprived areas as seen in the bar graphs of ASMR by ADI quintile (Fig. 6.19). In the last 20 years from 1995 to 2014, the socioeconomic inequality of asthma mortality shown by RII has remained almost unchanged (Fig. 6.20). As the overall ASMR has decreased, the absolute inequality in ASMR between the most and least deprived areas (measured by the SII) was diminished for both sexes (Fig. 6.20).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SMR Colour Legend
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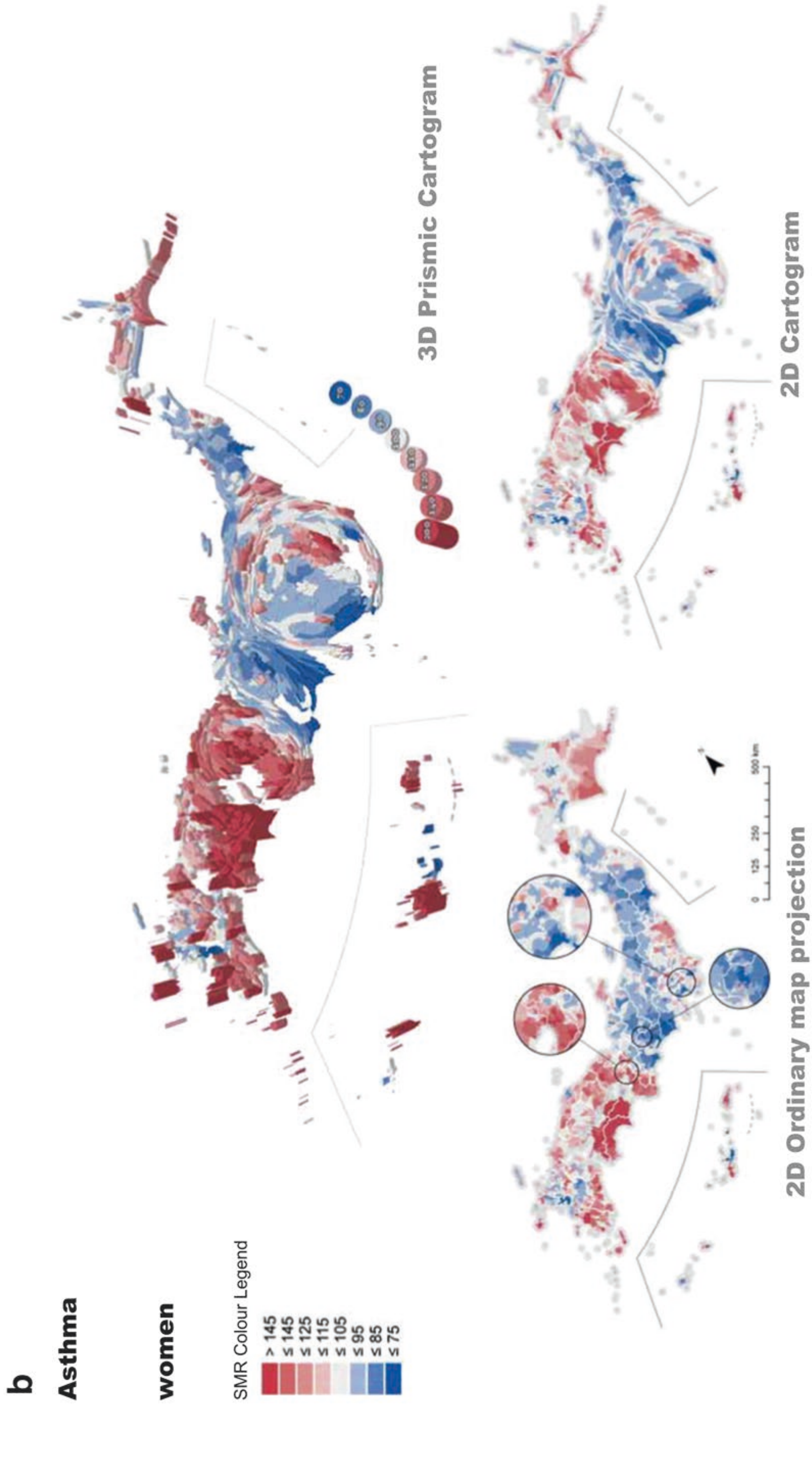
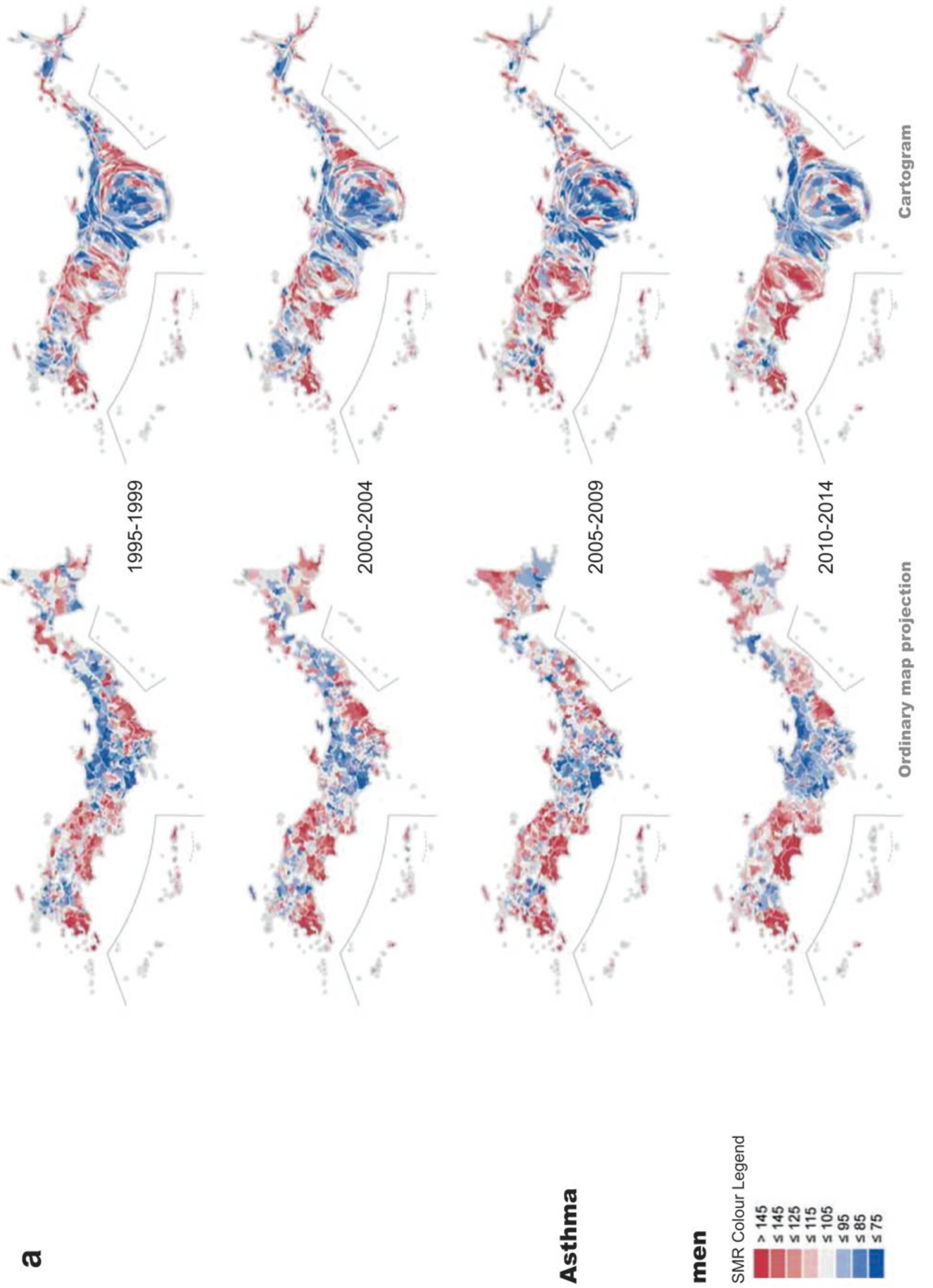


Fig. 6.16 SMR distribution of asthma, 2010–2014. (**a**) Men. (**b**) Women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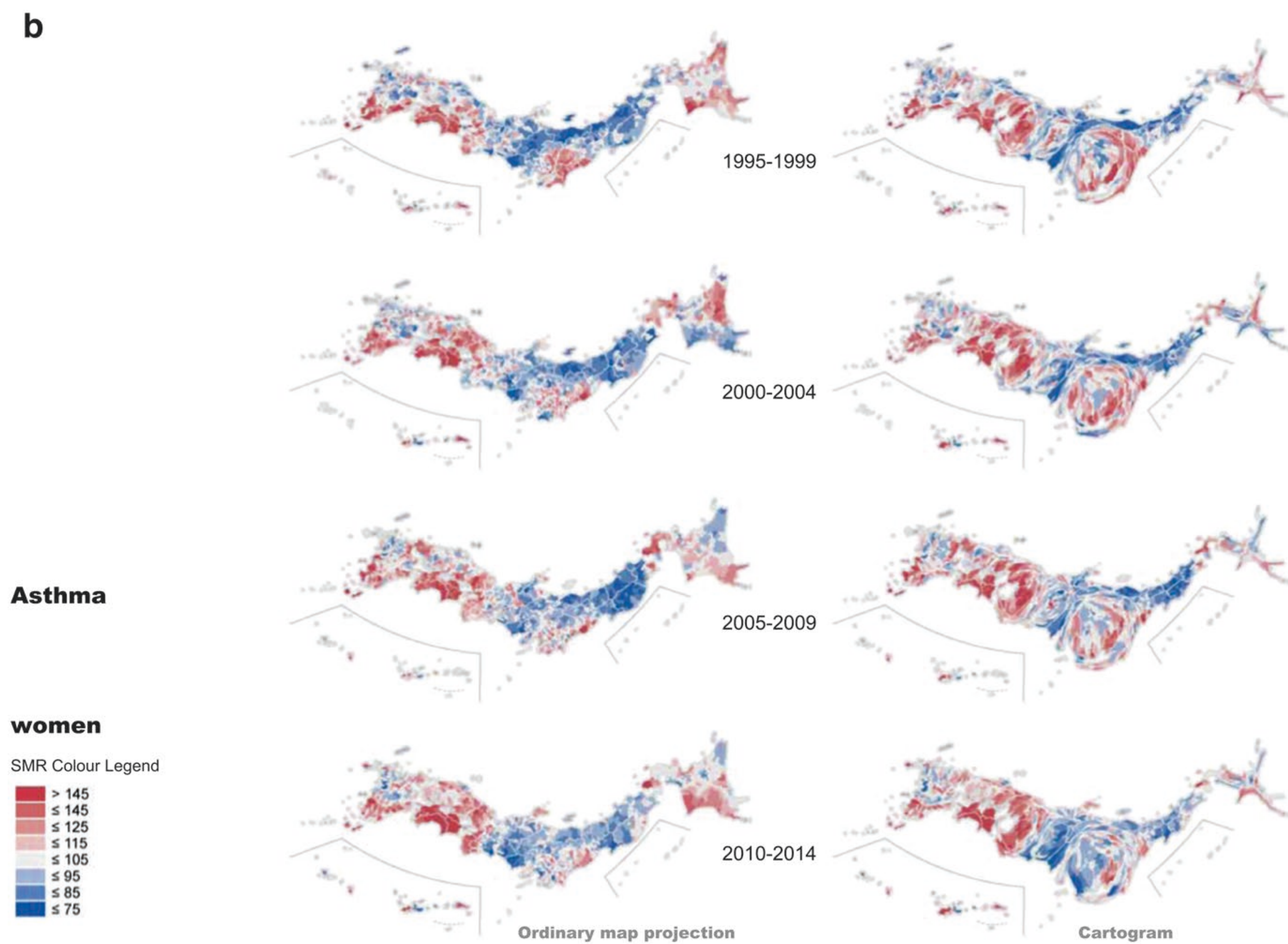
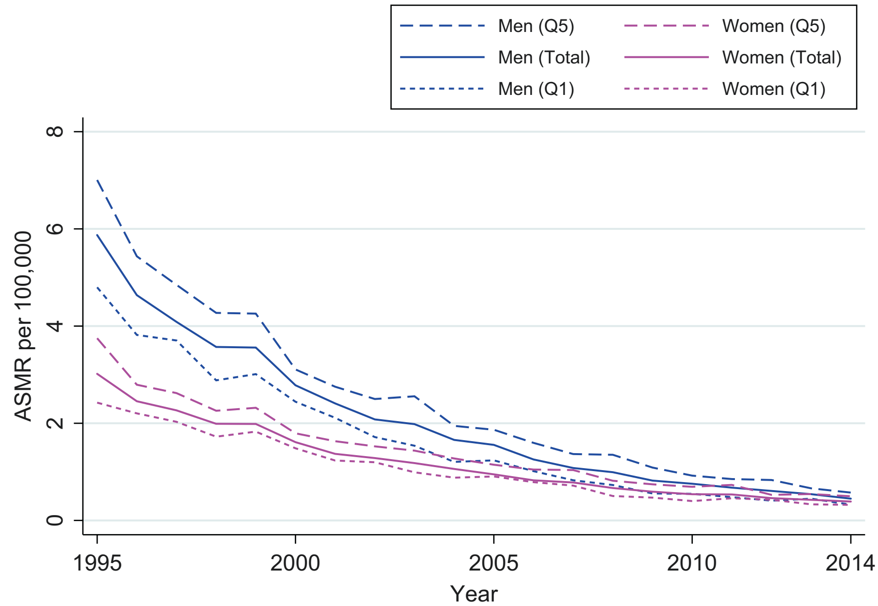


Fig. 6.17 Transition of SMR distribution of asthma from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 6.18 Annual transition in the ASMR of asthma from 1995 to 2014



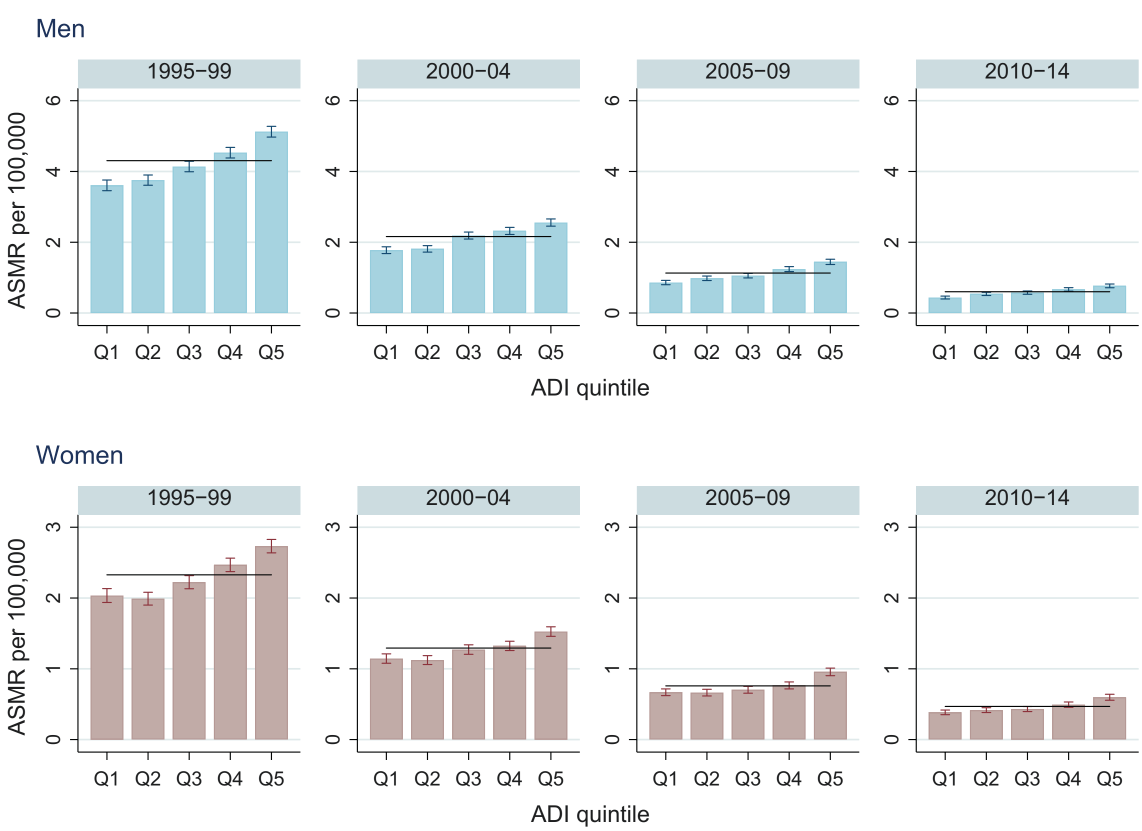


Fig. 6.19 The transition in the ASMR distribution of asthma by ADI quintile. (Top: Men, Bottom: Women)

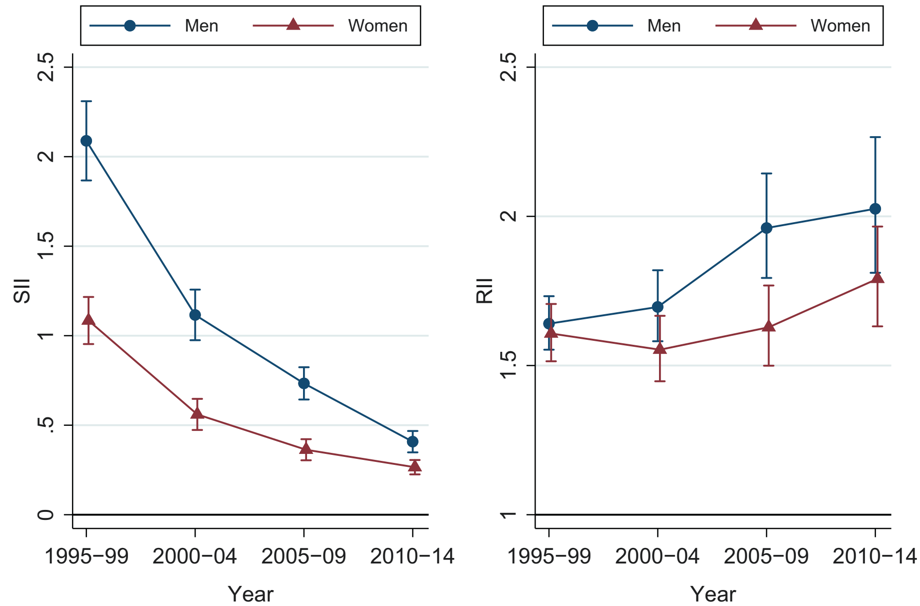


Fig. 6.20 Transition in SII and RII of asthma from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

6.5 Senility (ICD10: R54): Well-Dying?

Tomoki Nakaya

Overview

Senility results in a natural death due to the weakness of aging. In a Japanese society in which aging is advancing, senility deaths have increased, and it is the fifth cause of death at present. Regional disparities in senility mortality are large; particularly evident in the prismic cartograms (Fig. 6.21). While high senility SMRs are mainly observed outside metropolitan areas, several metropolitan regions such as the Osaka area have distinctively low SMRs.

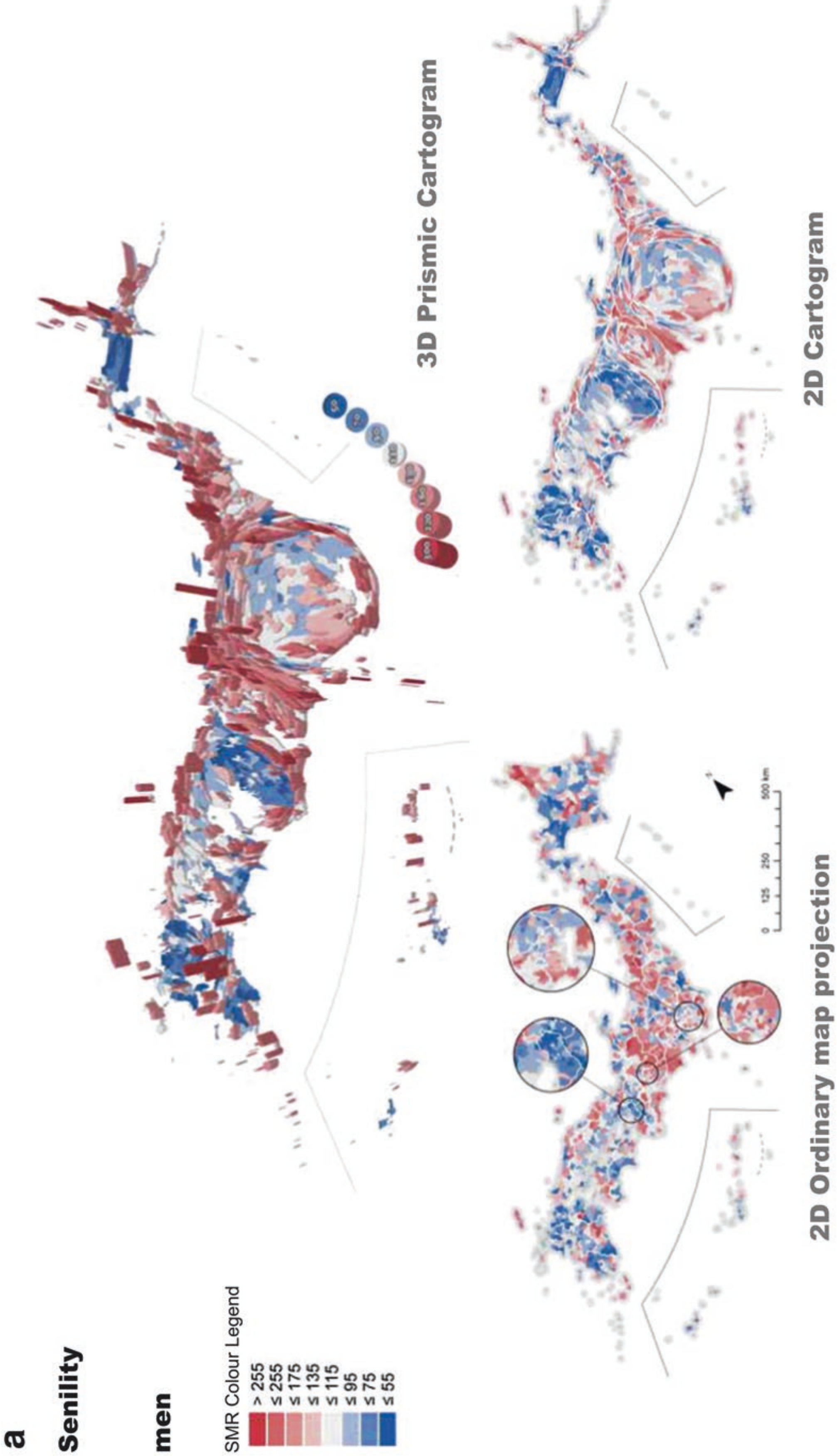
If senility death means mild deaths associated with aging, unlike other deaths caused by diseases or injuries, in an area with a high mortality of senility, aged people are likely to be "well-dying." If so, unlike other 3D maps of mortality, the higher the mountains here, the more pleasant is the passing of the old adults.

However, there may be several factors causing regional disparities (Imanaga et al. 2012). There may be regional difference in diagnosing senility death. Lower SMRs for senility death in metropolitan areas may be associated with greater access to health care in urban areas in which clinical testing in hospitals may increase the possibility of making a disease diagnosis. In addition, there might be regional differences in attitudes toward dying and terminal care of aged people; older people in areas outside major urban areas may be more likely to want to die naturally at home without life-sustaining medical practices.

Distributional Transitions and Socioeconomic Disparities

Based on the traditional map projection, the overall distributional patterns of senility SMRs have not changed significantly over the last 20 years. On the other hand, the cartogram-based maps revealed distinctive distributional changes in the SMRs of metropolitan areas over the last 20 years (Fig. 6.22). In the latter half of the 1990s, the senility mortality was quite low in a large part of the Tokyo metropolitan area. There was a clear regional difference in senility morality between metropolitan and non-metropolitan areas. However, senility mortality has progressively risen even in the Tokyo metropolitan area. There might have been a change in the attitudes of aged urban residents and local healthcare providers about senility mortality.

The ASMR of senility have been increasing since around 2005 (Fig. 6.23). Although the association of mortality with areal deprivation is not consistent, in recent years, the lowest mortality was observed in the most deprived area group (Q5) (Fig. 6.24), and the SII and RII time-series indicates that the inverse socioeconomic disparity has become more apparent in recent years (Fig. 6.25). This may reflect the higher burden of disease and other distinct causes of death in socioeconomically deprived areas. On the other hand, the most affluent/least deprived areas (Q1) are likely to be in metropolitan


a
Senility
men
SMR Colour Legend
> 255
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3D Prismic Cartogram
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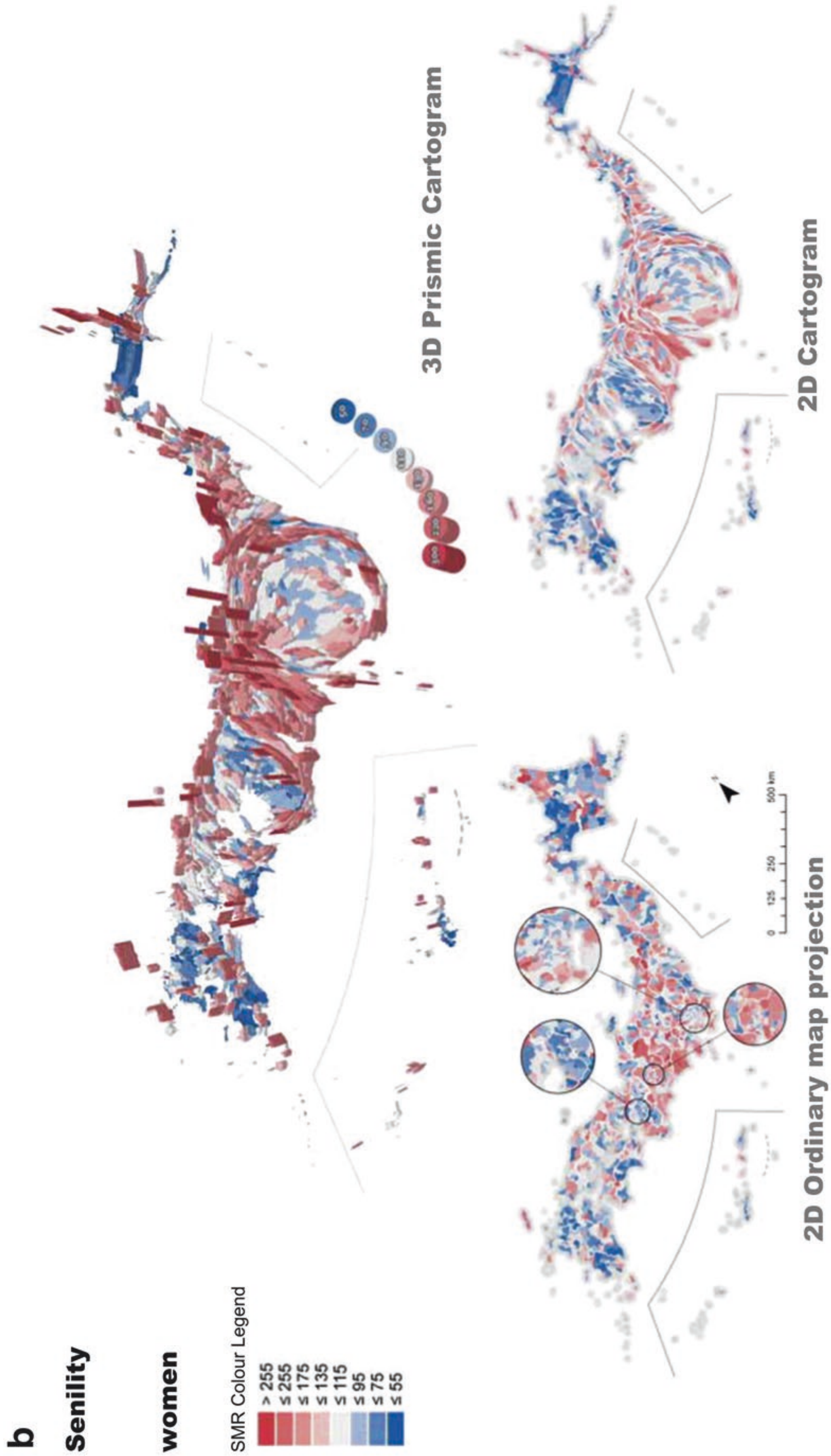
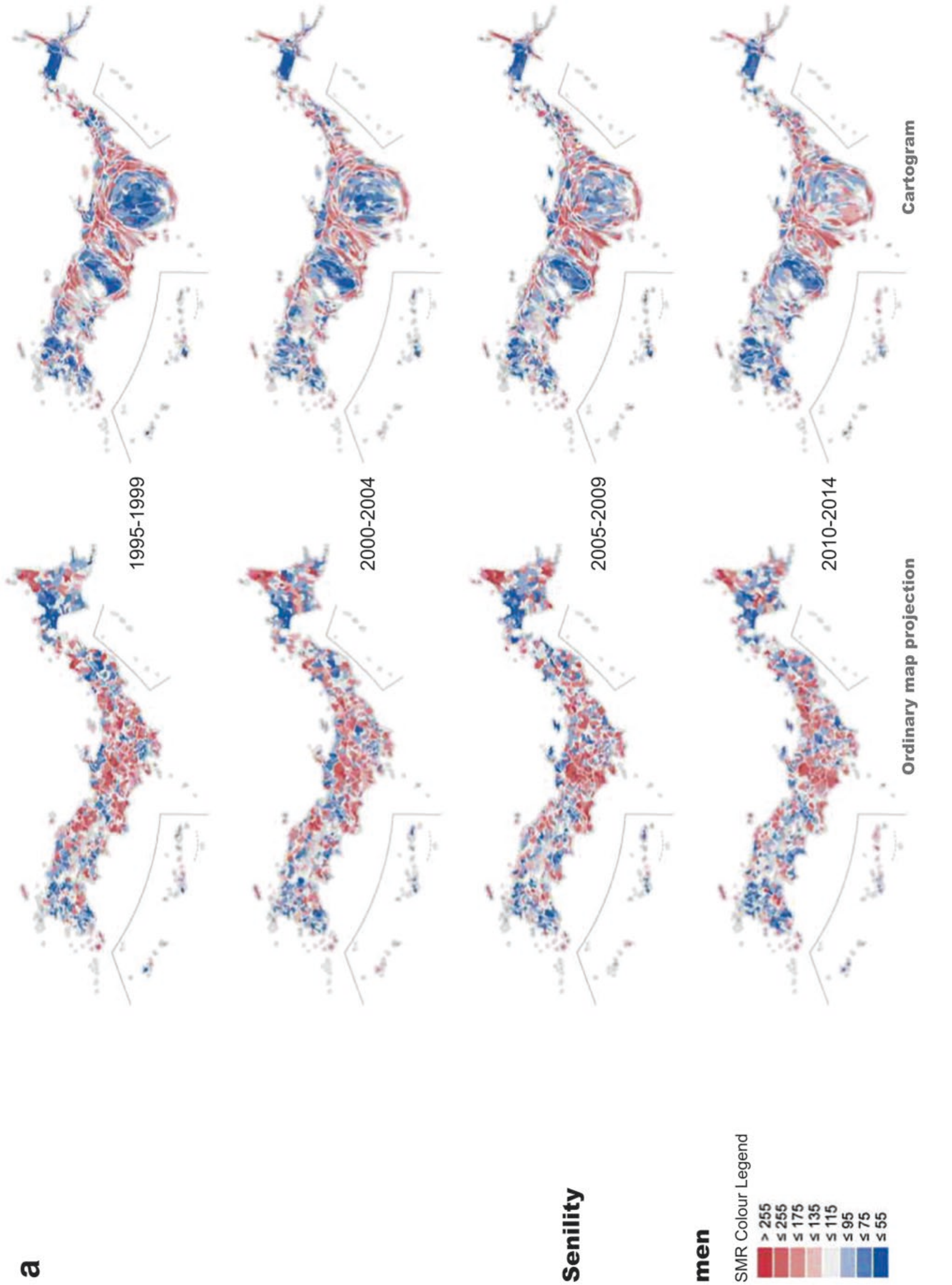


Fig. 6.21 SMR distribution of senility, 2010–2014. **(a)** Men. **(b)** Women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SMR Colour Legend
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1995-1999
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Ordinary map projection
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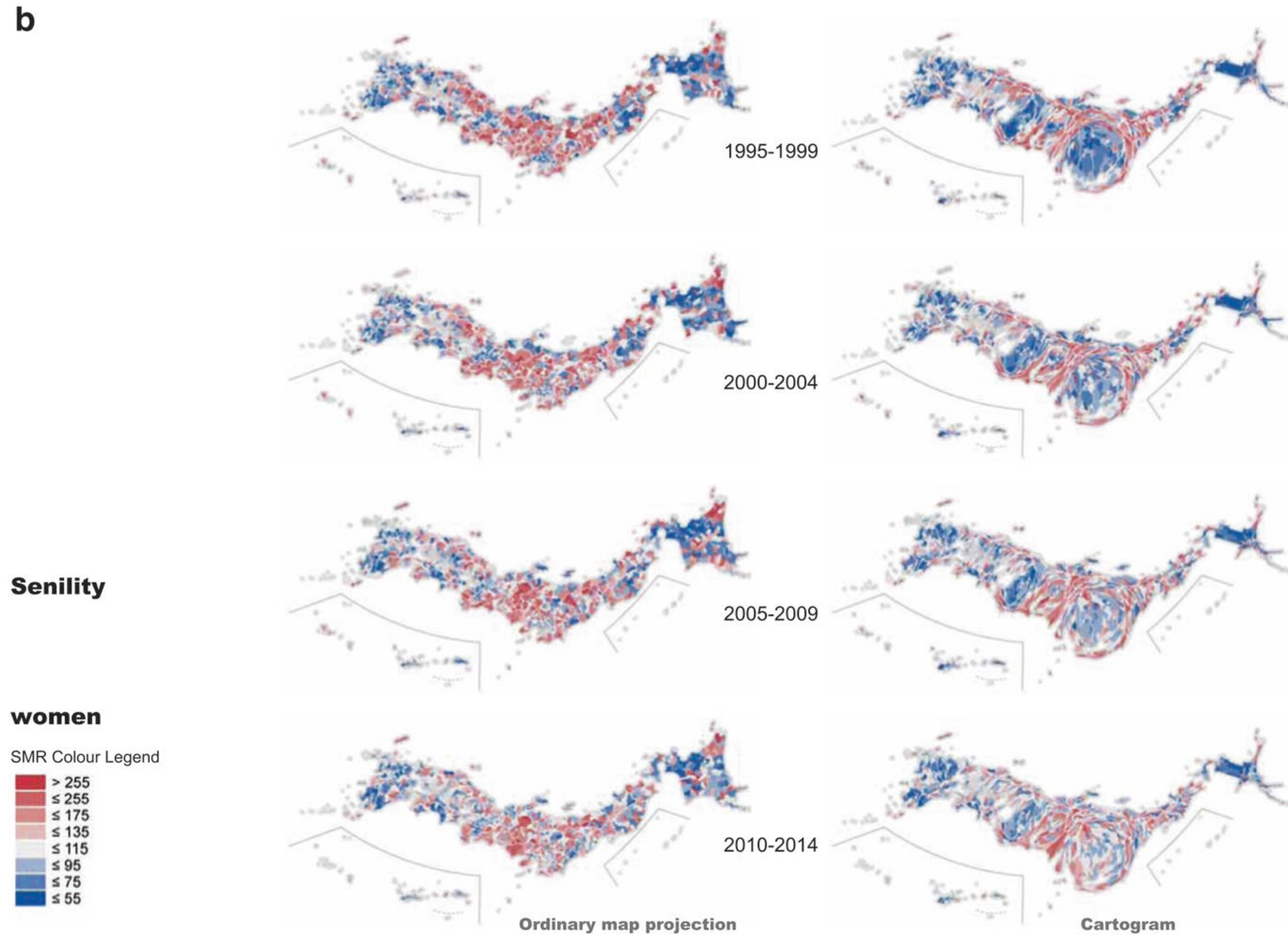
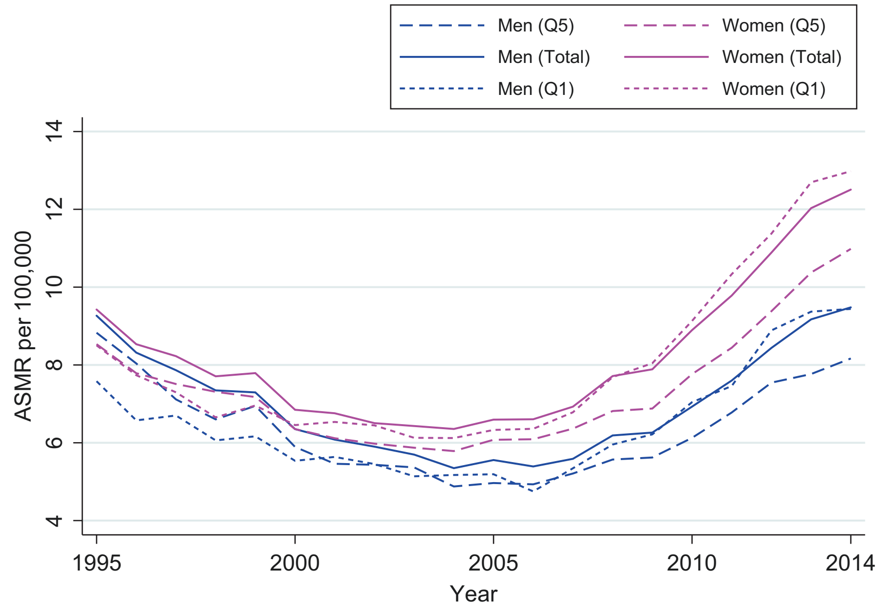


Fig. 6.22 Transition of SMR distribution of senility from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 6.23 Annual transition in the ASMR of senility from 1995 to 2014



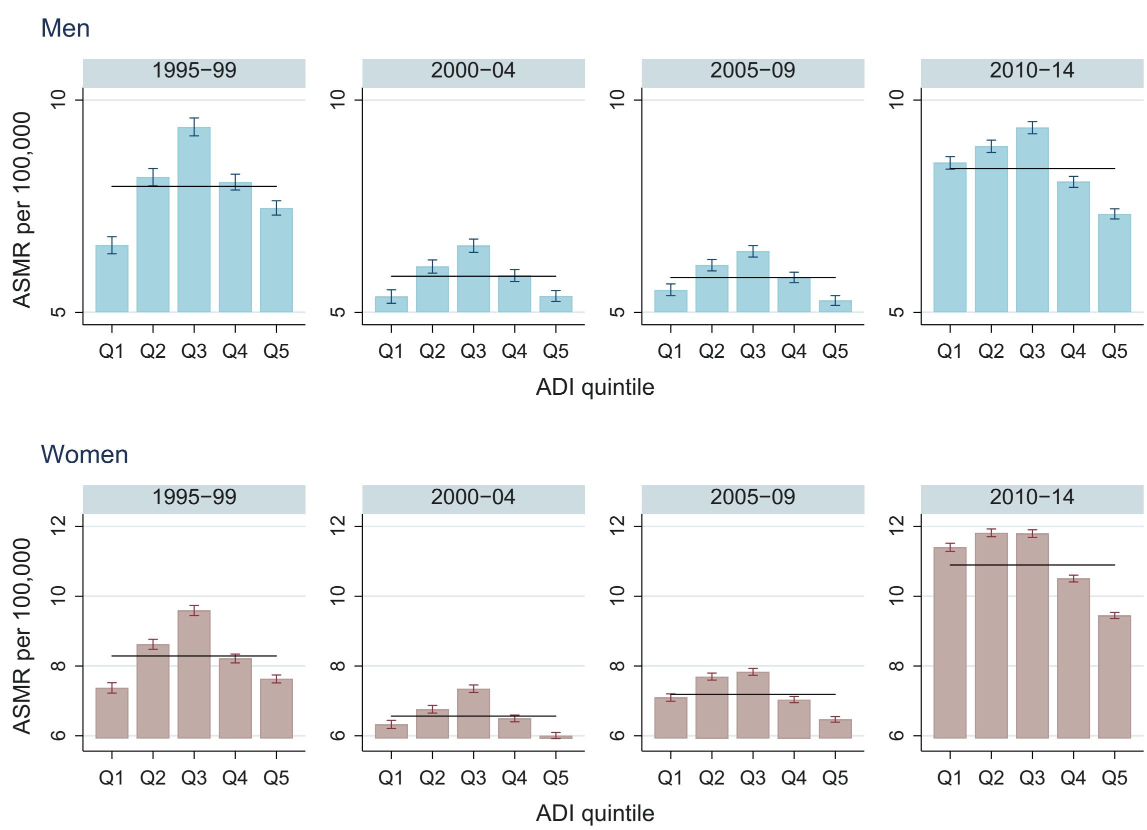


Fig. 6.24 The transition in the ASMR distribution of senility by ADI quintile. (Top: Men, Bottom: Women)

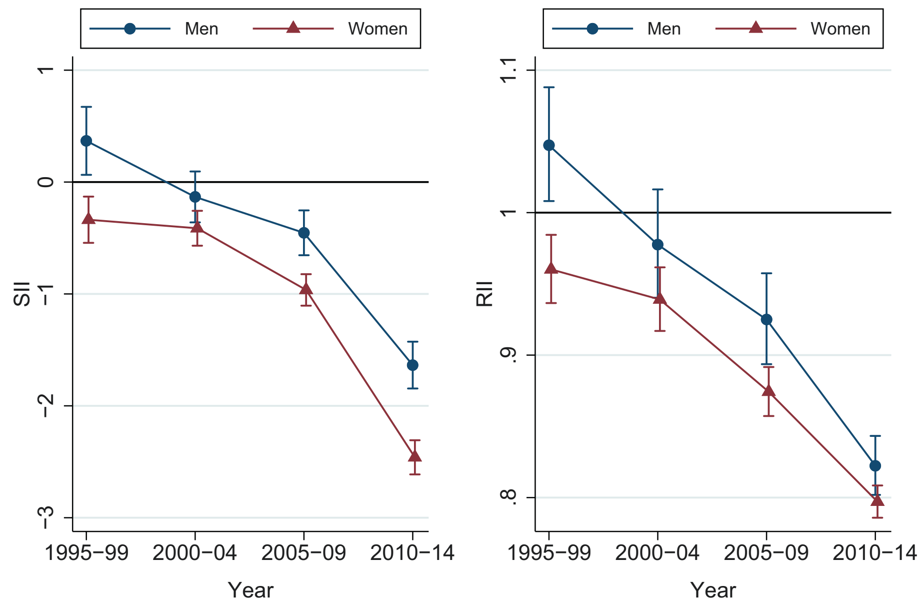


Fig. 6.25 Transition in SII and RII of senility from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

areas. These areas could be healthy areas, but diseases may be more likely to be diagnosed due to the better access to medical services compared to other areas. These factors may explain the inconsistent relationships between senility mortality and areal deprivation; senile mortality is largest in the intermediate group (Q3).

6.6 Accidents (ICD10: V01-X59): Highlighting Disaster Victims

Mayuko Yonejima

Overview

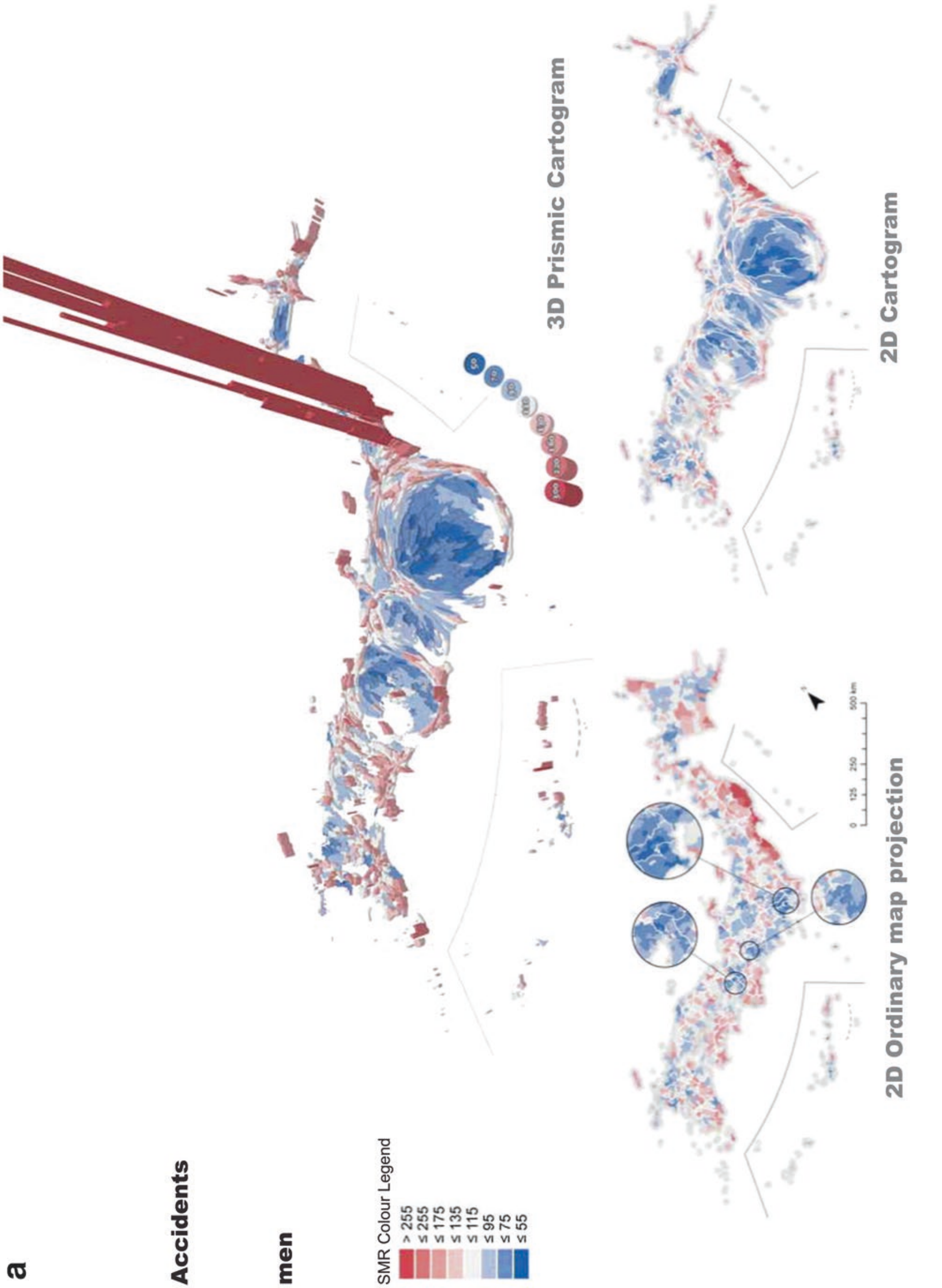
The accidents mentioned in this atlas were defined as traffic accidents, falls, accidental drowning, asphyxia, fire, poisoning, and so on. As shown by the prismic cartograms (Fig. 6.26), both males and females have remarkably high accidental SMR in the Tohoku region during the latest period from 2010 to 2014. Especially in the coastal areas of the Tohoku Pacific, the damage caused by the Great East Japan Earthquake which occurred off the coast of the Pacific Ocean in the Tohoku region on 11 March 2011 was enormous (see Chap. 2, Sect. 2.3).

Apart from these disaster-related deaths, SMRs for accidents tend to be low in metropolitan areas such as the Tokyo, Nagoya/Chukyo, and Osaka/Keihanshin metropolitan areas, while SMR for accidents is high in some peripheral regions such as Okinawa, Kagoshima, and Hokkaido Prefectures. Major types of the lethal accidents are for asphyxiation, falls, and drowning, and many of them are among the older adults (Ministry of Health, Labour and Welfare 2009).

Distributional Transitions and Socioeconomic Disparities

As mentioned in the above, the SMR maps of the latest period, 2010–2014, exhibit extremely high SMRs in the Tohoku coastal region. In addition, the cartograms in the first period, 1995–1999, show high SMR in Kobe city, Hyogo Prefecture (Fig. 6.27). The temporal trend of ASMR of accidents showed a small-sized peak in 1995 and a large-sized peak in 2011 (Fig. 6.28). These are attributed to the Great Hanshin-Awaji Earthquake which occurred in Kobe city in 1995 and the Great East Japan Earthquake in 2011.

There has been a clear socioeconomic disparity in the ASMR for accidents: the mortality is larger in more deprived areas (Fig. 6.29). Such disparity of deaths from accidents is particularly high in the latest period, 2010–2014. The ASMR of Q5 was much higher than those in the other deprivation groups. In the latest period, the SII and RII jumped up from those in the previous period (Fig. 6.30). This is because the 2011 disaster affected areas in the coastal districts in the Tohoku area categorized as Q5, indicating that the disaster substantially contributed to the increased socioeconomic inequality of health.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Accidents
men
SMR Colour Legend
> 255
≤ 255
≤ 175
≤ 135
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≤ 95
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≤ 55
3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
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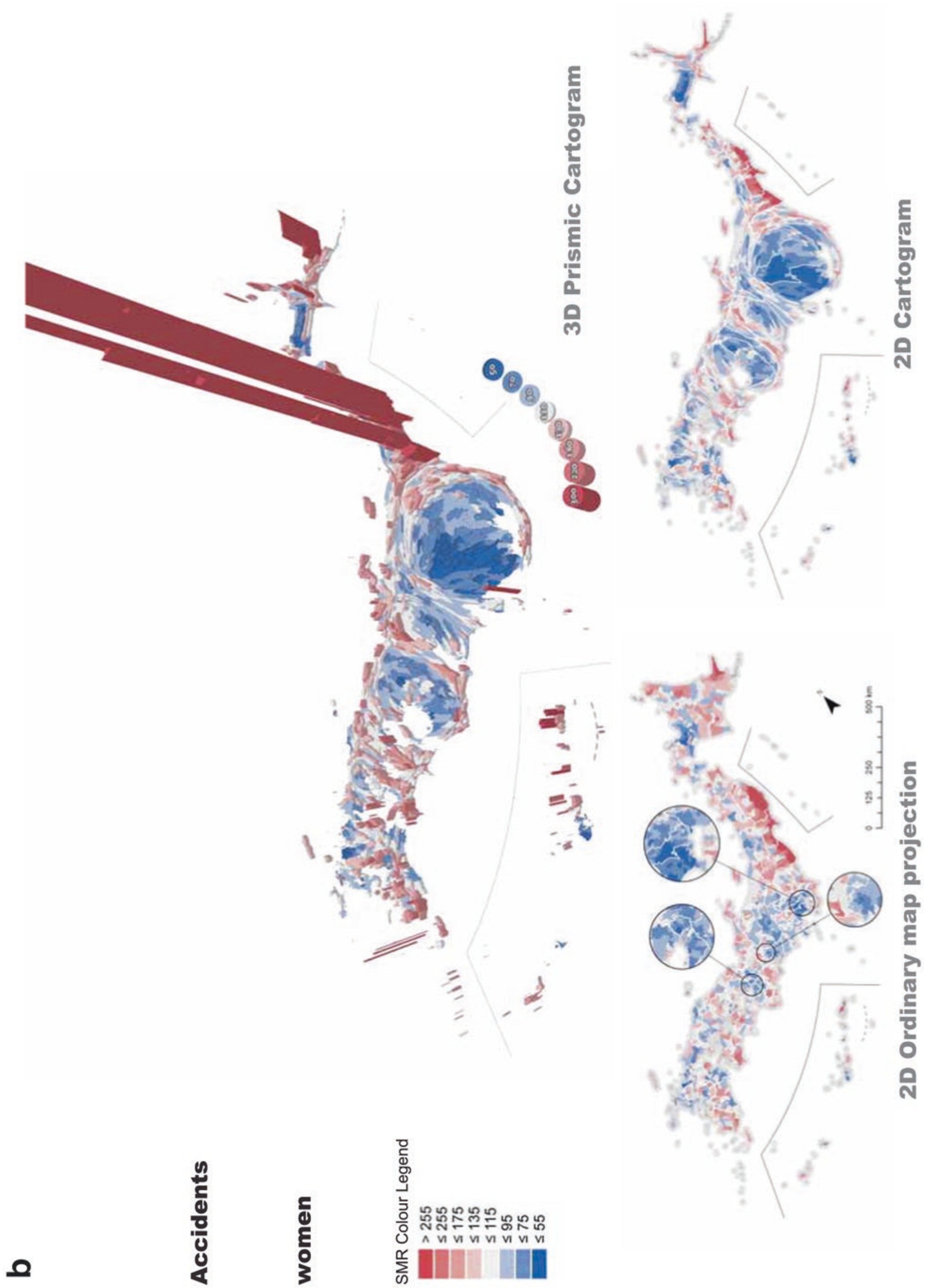
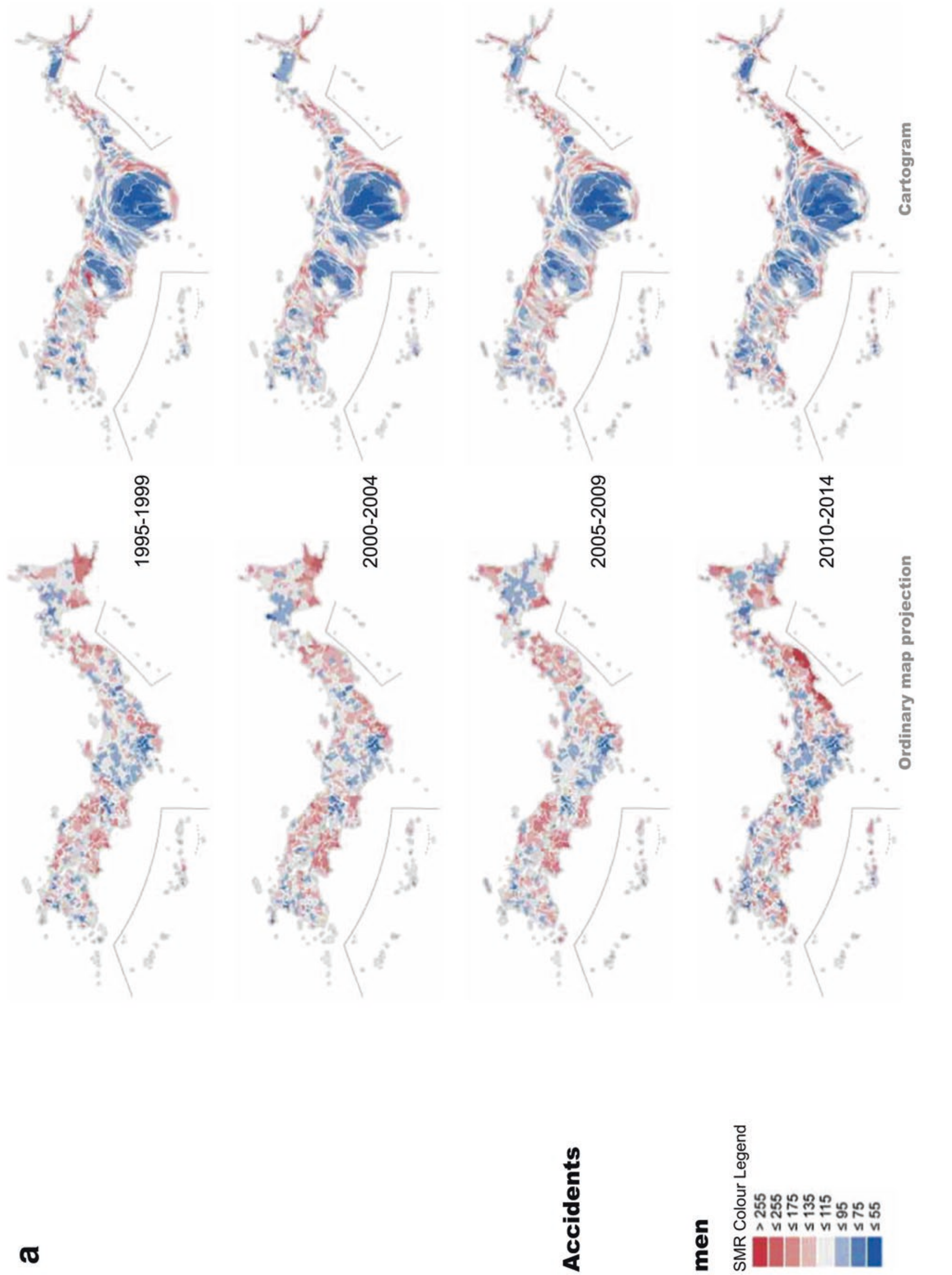


Fig. 6.26 SMR distribution of accidents, 2010–2014. **(a)** Men. **(b)** Women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Accidents
men
SMR Colour Legend
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1995-1999
2000-2004
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2010-2014
Ordinary map projection
Cartogram

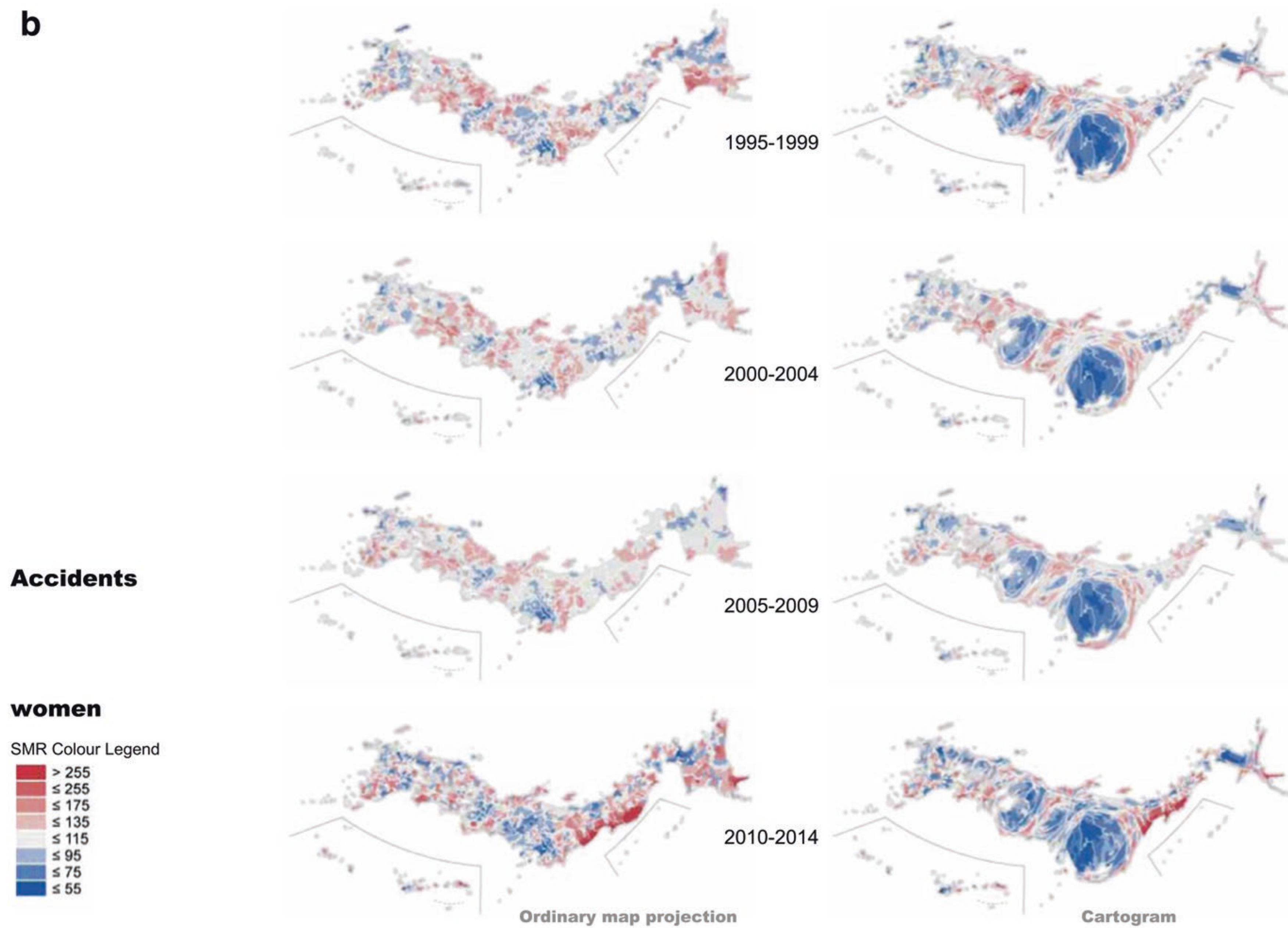


Fig. 6.27 Transition of SMR distribution of accidents from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

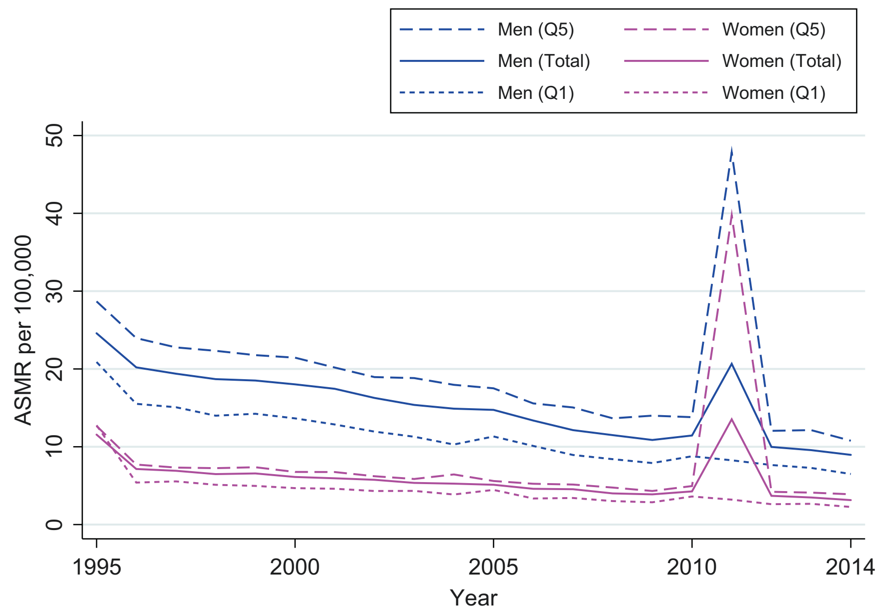


Fig. 6.28 Annual transition in the ASMR of accidents from 1995 to 2014

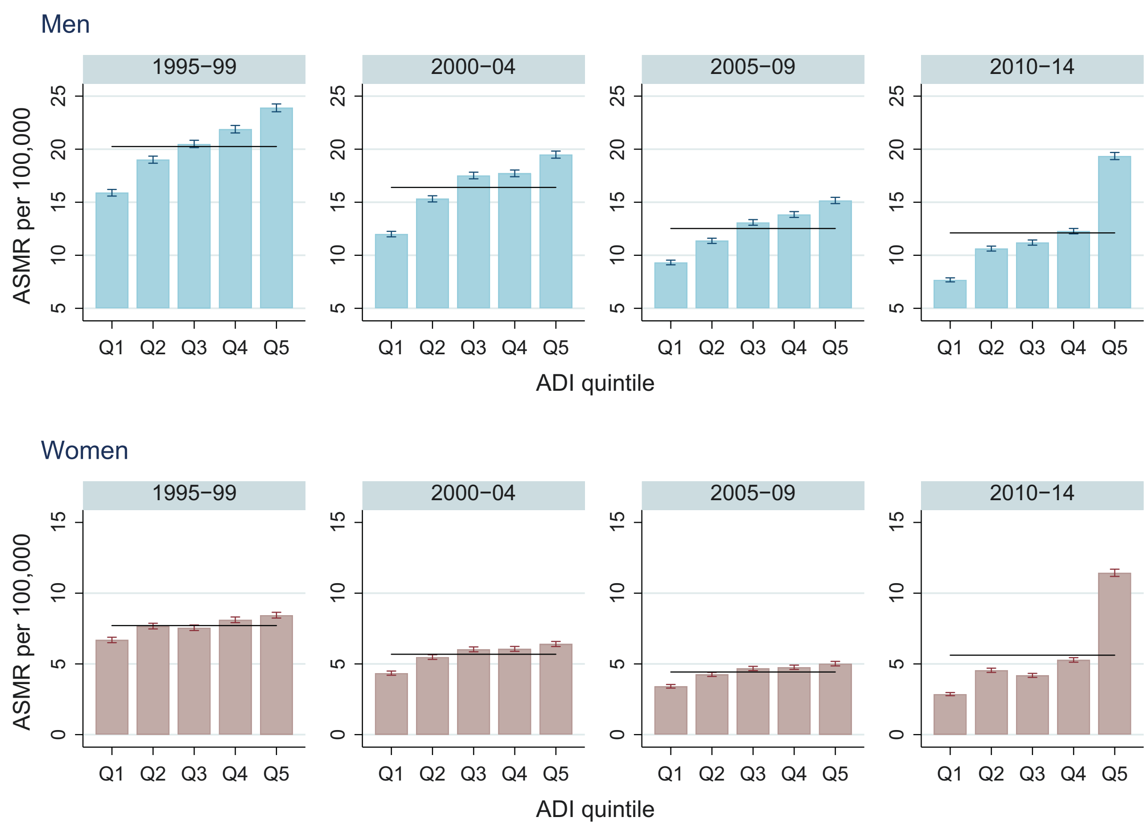


Fig. 6.29 The transition in the ASMR distribution of accidents by ADI quintile. (Top: Men, Bottom: Women)

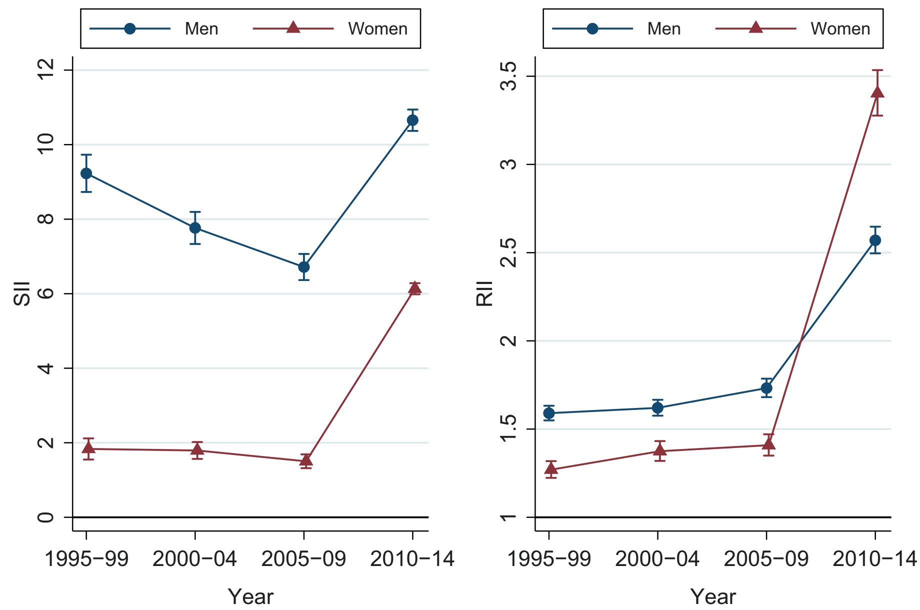


Fig. 6.30 Transition in SII and RII of accidents from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

6.7 Transport Accidents (ICD10: V01-V99): Where Do Cars Kill People?

Mayuko Yonejima

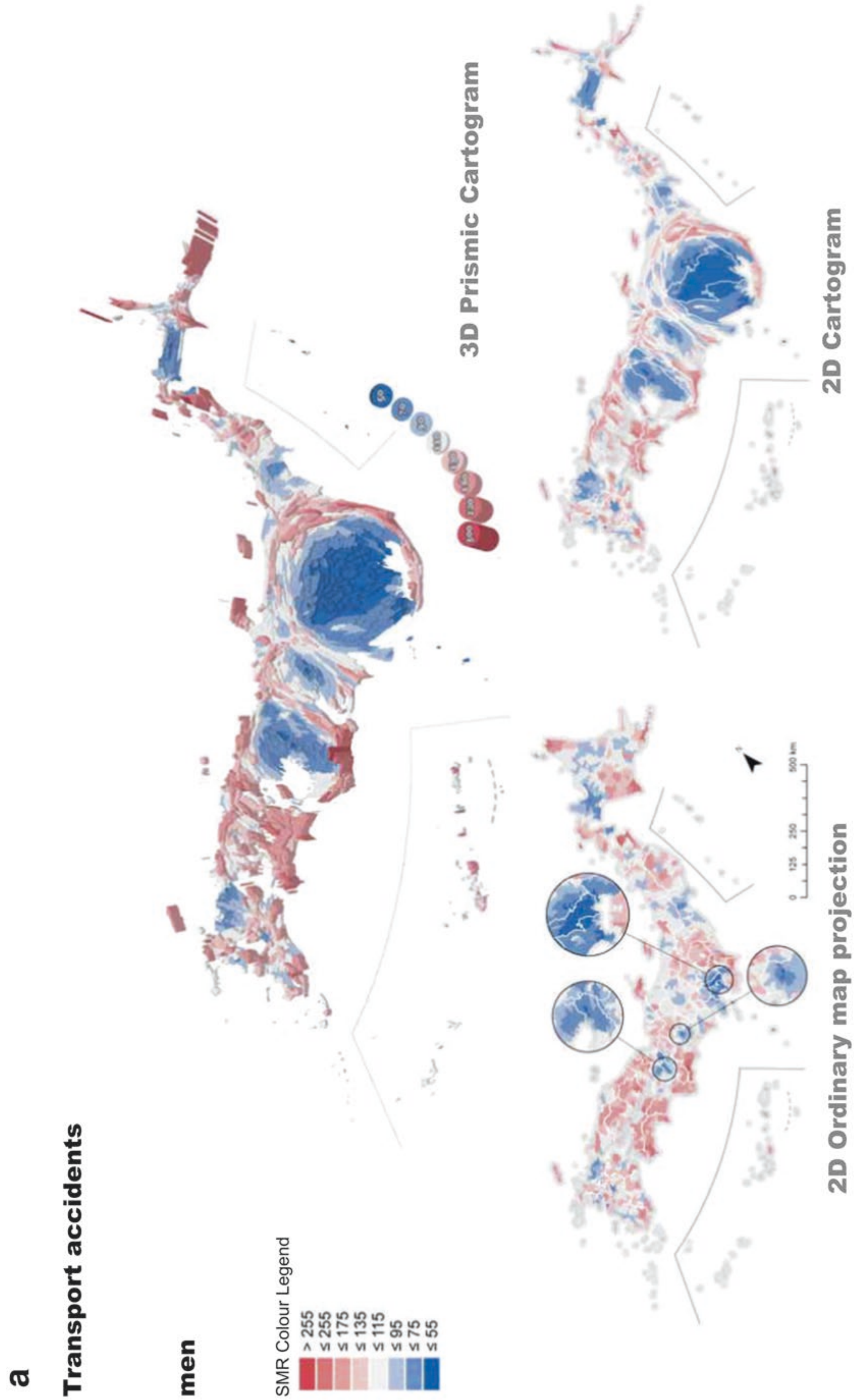
Overview

This is the subcategory of the previous cause of death, accidents. Most traffic accident fatalities are caused by cars which hit pedestrians or bicyclists. The prismic cartograms of the SMRs for transport accidents show a remarkably low tendency in urban areas such as Tokyo, Osaka, Nagoya, Sendai, Sapporo, and Fukuoka (Fig. 6.31). In such large cities, due to the availability of public transportation, people are more likely to refrain from driving cars, and congested traffic conditions force the driving speed of cars to decrease so that the mortality rate associated with the severe collision of cars seems to be decreasing (Wakita 1970). On the other hand, the SMR of traffic accidents is high in rural areas where many people drive more often due to the limited service of public transportation and because less congested traffic conditions allow for higher driving speeds on roads, causing greater risk of car accidents compared to urbanized areas (Tanaka 2009).

Distributional Transitions and Socioeconomic Disparities

The number of traffic accident fatalities exceeded 10,000 in the 1960s and 1980s, which were called the Traffic Wars (National Police Agency Traffic Bureau 2018). However, the number has been reduced due to environmental improvement of roads and the placement of traffic guards. In particular, the further decrease in the number of traffic accident fatalities since 2000 was achieved due to improved vehicle safety performance and improved driving manners, possibly encouraged by the new seat belt law (back-seat passengers as well as those in the front seats must wear seat belts).

Although there has been no significant change in the distribution of SMR over the 20 years from 1995 to 2014 (Fig. 6.32) and the ASMRs for both men and women decreased (Fig. 6.33), there remain clear socioeconomic inequalities in the mortality (Fig. 6.34). The ASMR and its socioeconomic inequality from traffic accidents were higher in men than women. The least deprived area group (Q1) consistently had the lowest ASMR among the five quintile groups of ADI. While the absolute inequality measured by SII decreased, the relative inequality measured by RII increased over the 20 years from 1995 to 2014 (Fig. 6.35).


a
Transport accidents
men
SMR Colour Legend
> 255
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3D Prismic Cartogram
2D Cartogram
2D Ordinary map projection
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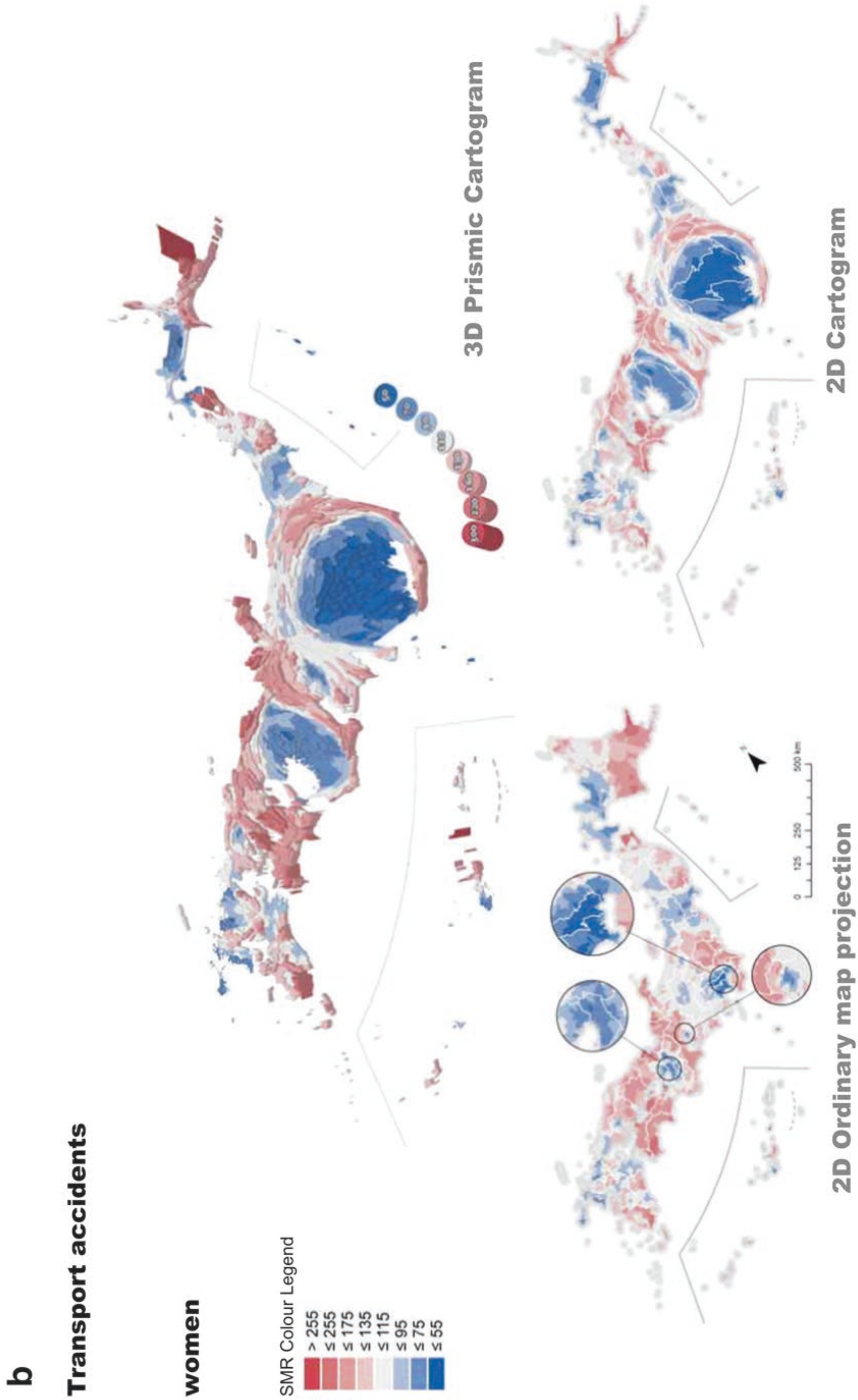
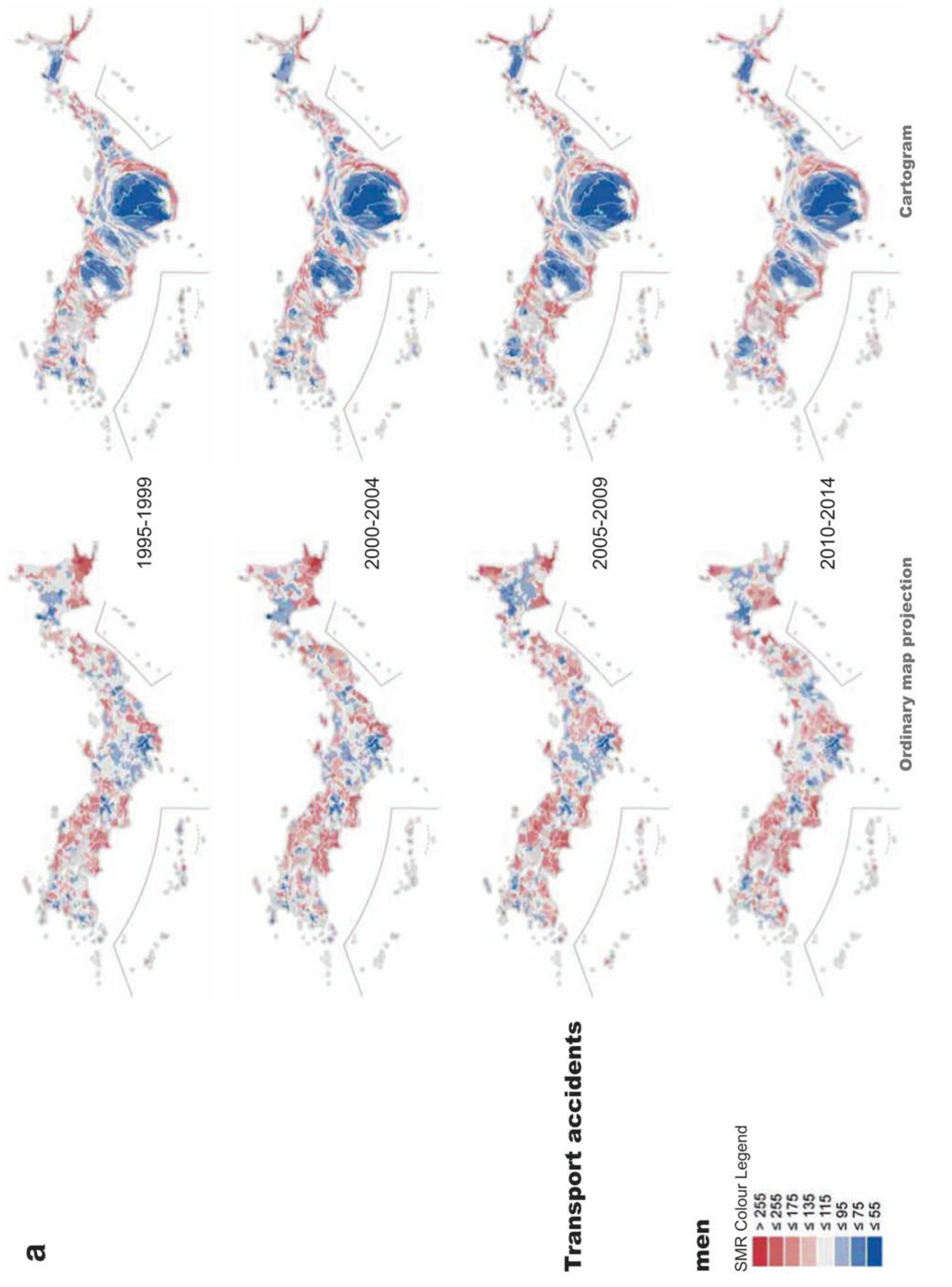


Fig. 6.31 SMR distribution of transport accidents, 2010–2014. (**a**) Men. (**b**) Women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Transport accidents
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1995-1999
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2010-2014
Ordinary map projection
Cartogram

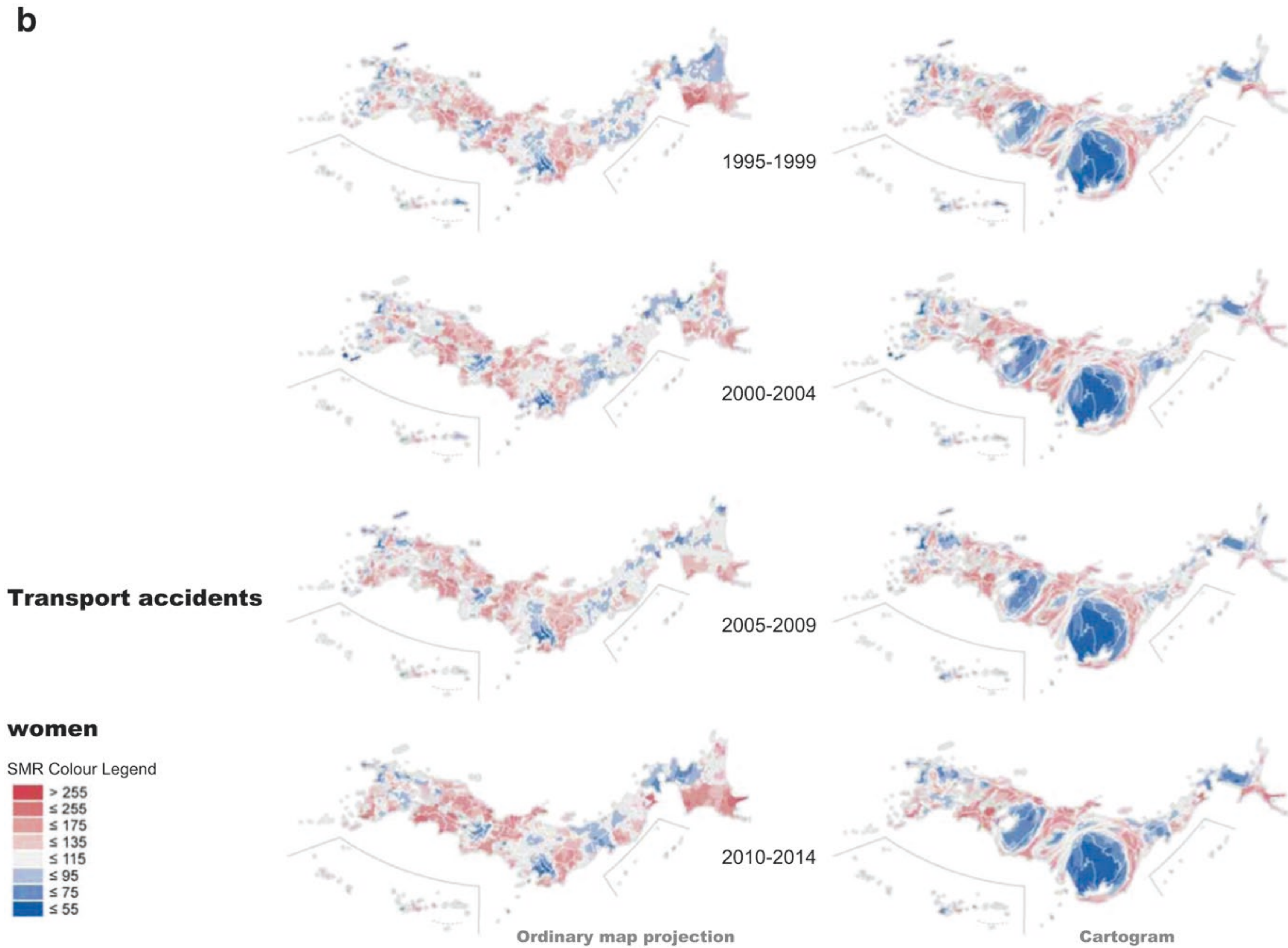
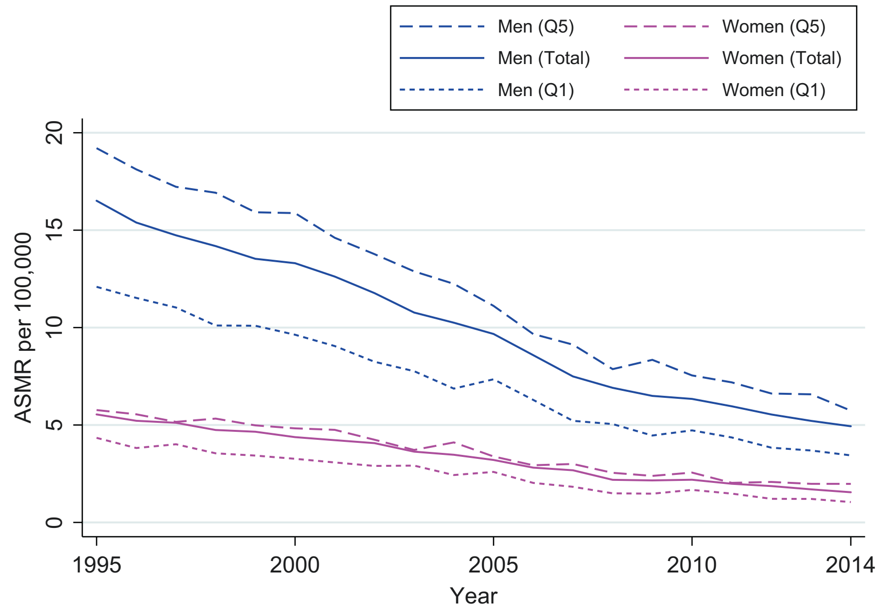


Fig. 6.32 Transition of SMR distribution of transport accidents from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

Fig. 6.33 Annual transition in the ASMR of transport accidents from 1995 to 2014



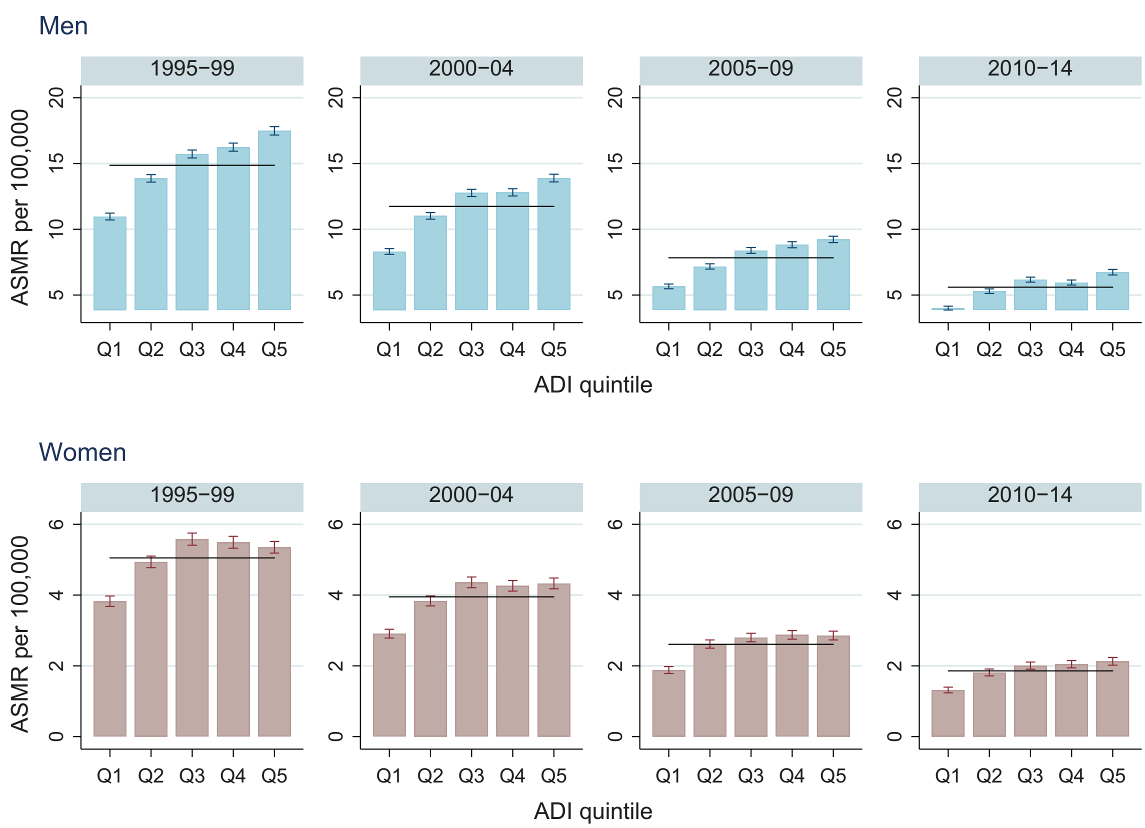
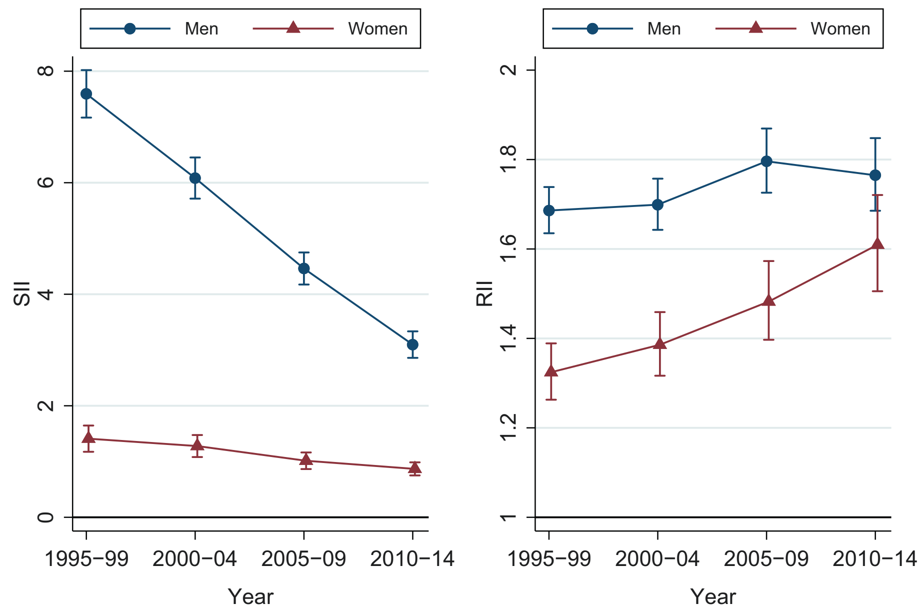


Fig. 6.34 The transition in the ASMR distribution of transport accidents by ADI quintile. (Top: Men, Bottom: Women)

Fig. 6.35 Transition in SII and RII of transport accidents from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)



6.8 Suicide (X60-X84): Distinctive Geographical and Socioeconomic Disparities in Men

Tomoya Hanibuchi

Overview

Japan has a high suicide rate relative to global standards. In the latter half of the 1990s, the number of suicides triggered by economic and lifestyle problems increased rapidly with rising unemployment rates and other social factors (Motohashi 2012). Although the number of suicides has been decreasing recently, it continued to exceed 30,000 per year throughout the 2000s. Suicide rates are higher in males than females, and suicide is the leading cause of death for people in their late teens to their 30s.

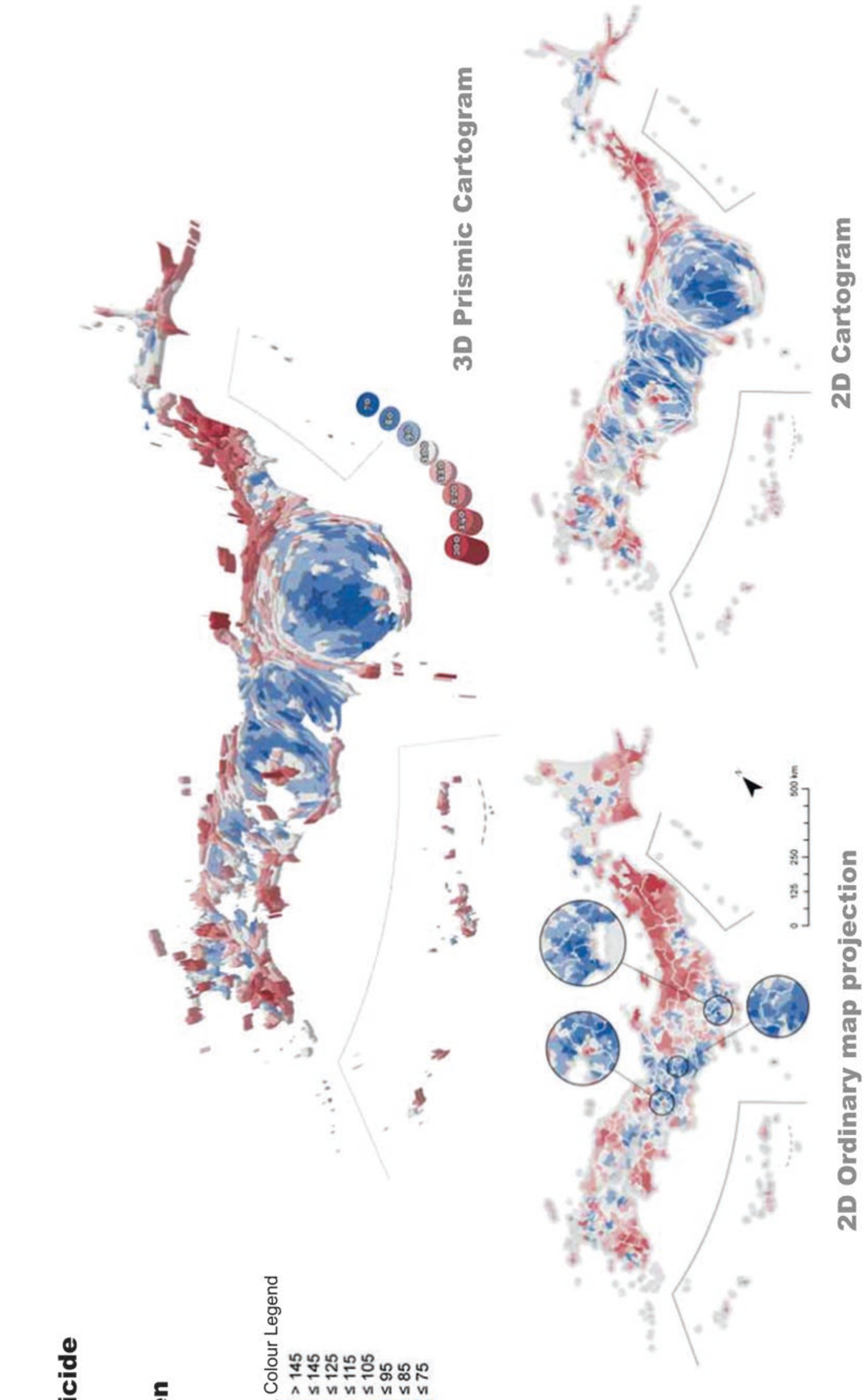
Suicide SMR tends to be high for both sexes in the Tohoku region (Fig. 6.36). For men, SMR is markedly lower in metropolitan areas (especially in Tokyo and Nagoya) and higher in peripheral regions of the country. This roughly corresponds to the geographical distribution of areal deprivation/affluence. In the case of women, on the other hand, the gap between urban and rural areas is unclear, and areas with high suicide rates are scattered within large metropolitan areas.

Transitions and Socioeconomic Disparities

The overall distributional trends of the SMRs (Fig. 6.37) have not changed significantly over the last 20 years from 1995 to 2014, but geographical variations in the SMRs became large in the 2000s—when suicide rates were particularly high (Fig. 6.38)—and they have become less noticeable in the latest period from 2010 to 2014. Looking at the series of cartogram-based SMR maps, it is evident that the suicide rate for women has gradually increased in metropolitan areas, while the low SMR in metropolitan areas is conspicuous in men.

Suicide rates are associated with local socioeconomic environments (Congdon 1996). The trend toward higher mortality rates in areas with higher deprivation levels was particularly pronounced among men in the 2000s (Fig. 6.39). There is a similar trend among women, but the association is by no means strong.

According to both SII and RII trends (Fig. 6.40), although the SII and RII became smaller after the 2000s, significant geographical and socioeconomical inequalities in suicide mortality rates have persisted among men. These disparities have disappeared among women in recent years. The increased mortality rate of women in socioeconomically affluent large cities suggests that urban environmental factors may have different effects on men and women.


a
Suicide
men
SMR Colour Legend
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3D Prismic Cartogram
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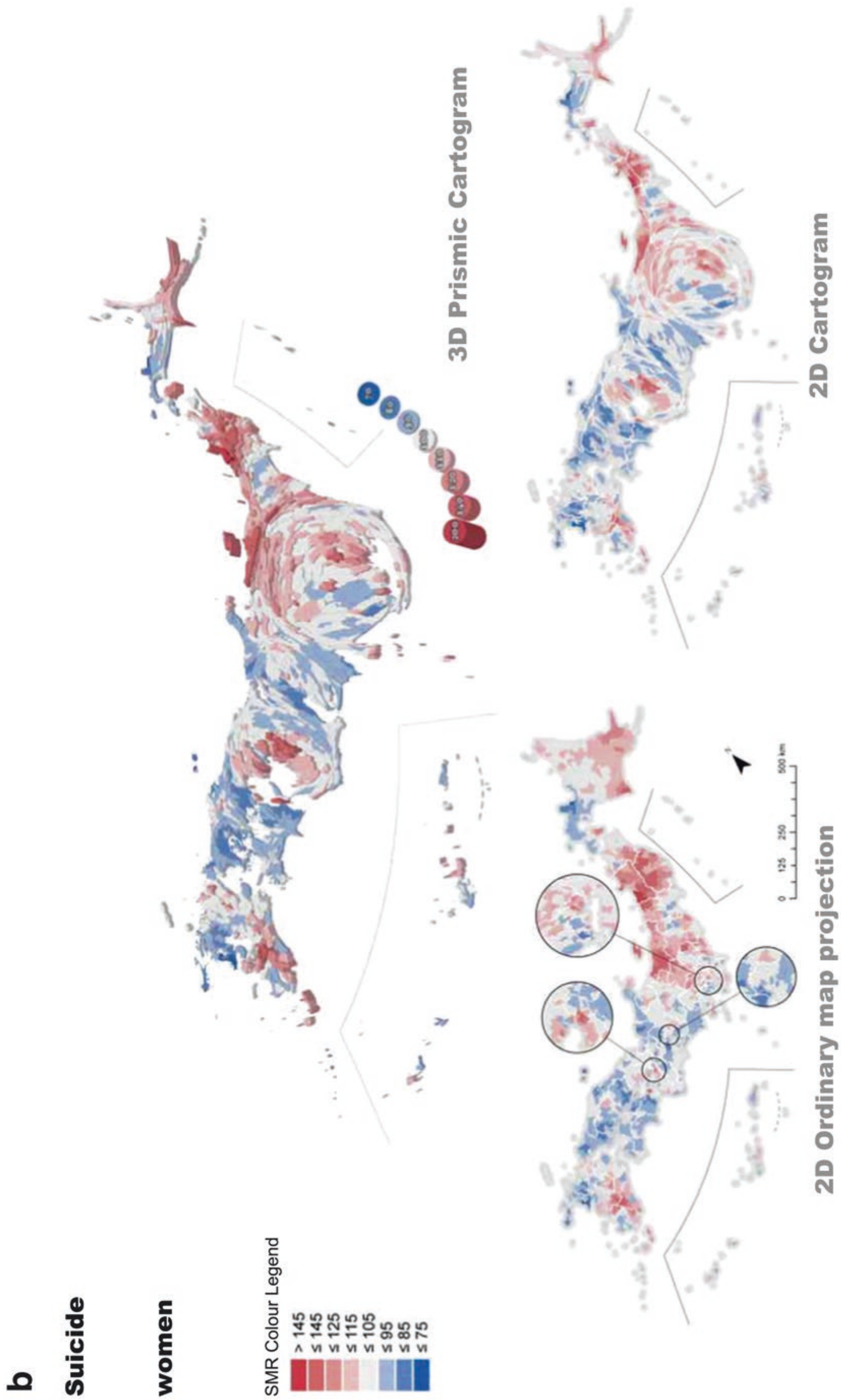
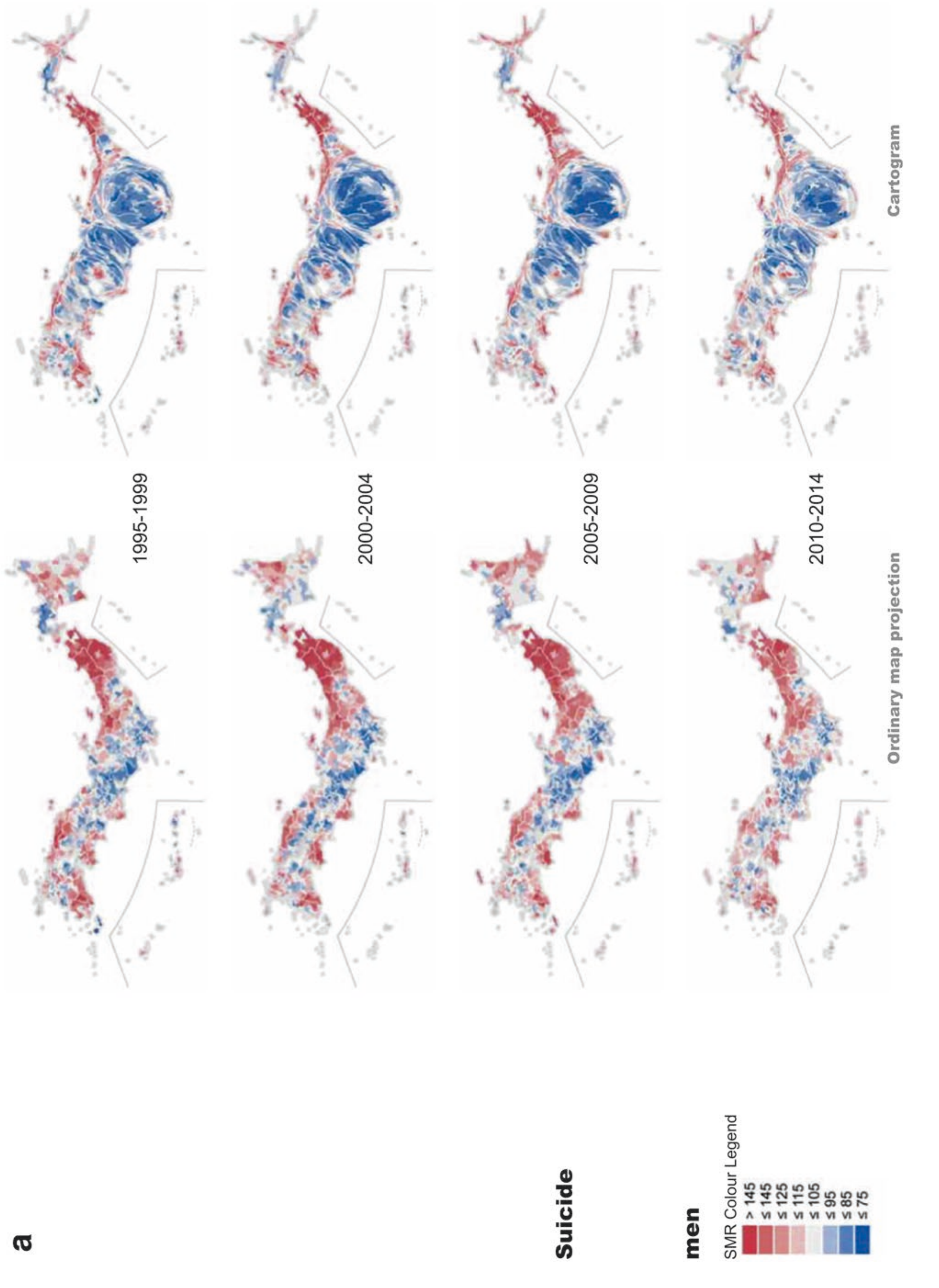


Fig. 6.36 SMR distribution of suicide, 2010–2014. (**a**) Men. (**b**) Women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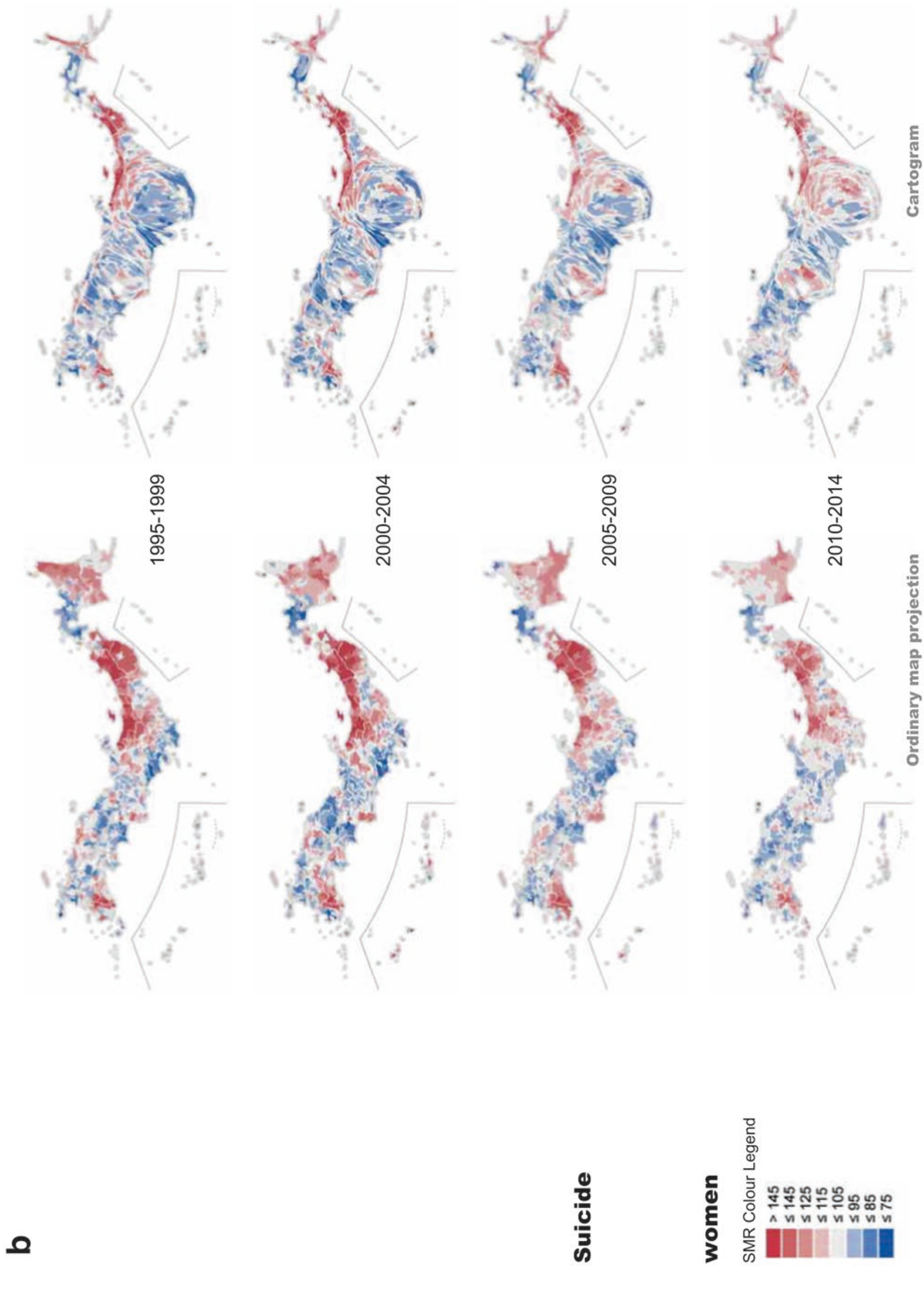

Fig. 6.37 Transition of SMR distribution of suicide from 1995 to 2014 by 5-year period. (**a**) Men. (**b**) Women

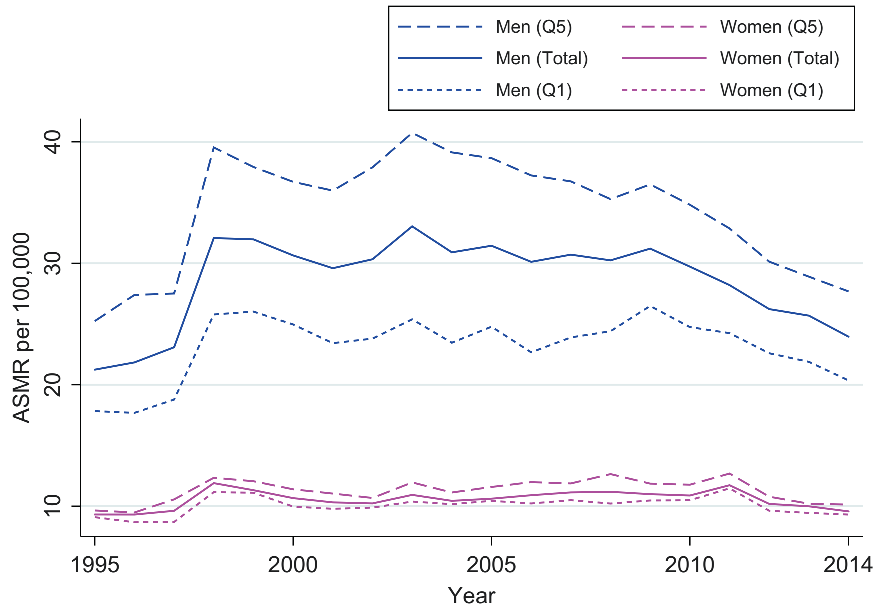

Fig. 6.38 Annual transition in the ASMR of suicide from 1995 to 2014

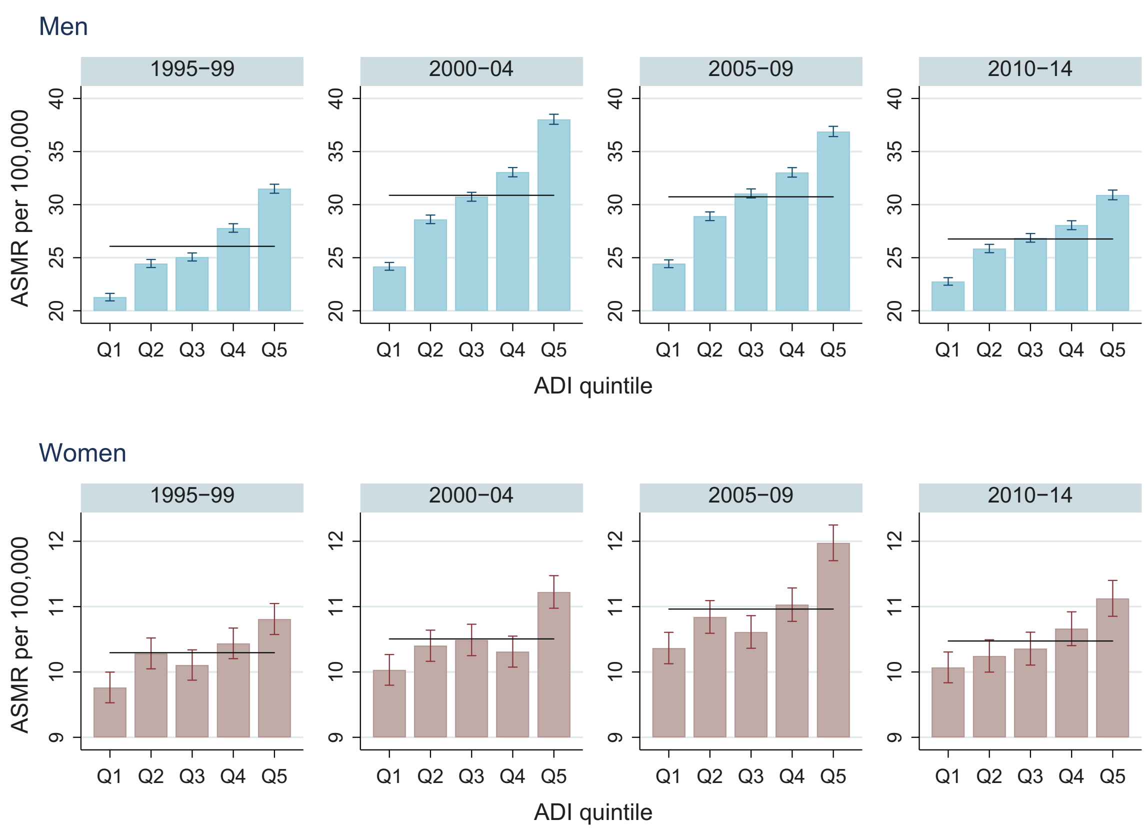

Fig. 6.39 The transition in the ASMR distribution of suicide by ADI quintile. (Top: Men, Bottom: Women)

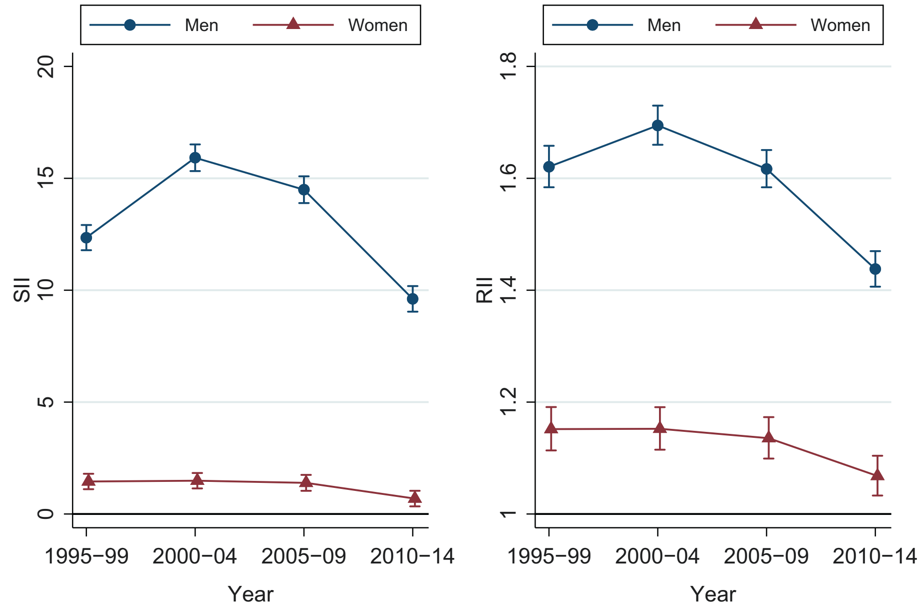

Fig. 6.40 Transition in SII and RII of suicide from 1995 to 2014 by 5-year period. (Left: SII, Right: RII)

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7 Synthesis

Tomoki Nakaya and Yuri Ito

This last chapter provides a summary of the health atlas project. The series of cartographic representations and inequality indices contained in the atlas clarified that area-based socioeconomic inequalities in mortality were widespread in Japanese society for various age groups and causes of death in the period from 1995 to 2014. It clearly shows that the relative socioeconomic inequalities in health based on the municipality-based deprivation index which are measured by the relative index of inequality (RII) widened for both men and women throughout the two decades of economic stagnation. Although a reduction in absolute social inequalities can be seen among men, this may reflect a decline in health levels in high socioeconomic status (SES) populations, such as the suicide epidemic among managers and professionals, that occurred in Japan during that period. On the other hand, the main causes of death, cancer, cerebrovascular disease among women, heart disease, pneumonia and accidents for both men and women, show tendencies of widening absolute inequalities, except for suicide and cerebrovascular disease among men. The absolute and relative inequalities among children and the older adults have widened in both sexes. The implications of these results and challenges for future works are discussed.

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7.1 What We Intended to Achieve with the Atlas Project

Socioeconomic inequalities in health have been universally observed in different societies even in developed 'welfare states' (Mackenbach 2012), and their reduction is a major public health goal. Since the World War II, while socioeconomic disparities in health have widened in many Western societies, Japanese society has not only achieved longer life expectancy in a short period of time, but also less pronounced disparities in health (Ikeda et al. 2011; Marmot and Smith 1989). However, as pointed out in Chap. 1, during the long period of economic stagnation period which began in the 1990s, the lost decades, there was concern that the growth of income and other social inequalities would lead to widening inequalities in health in Japan.

Individual-level studies to measure socioeconomic inequalities in self-rated health based on individual SES, such as occupation, education or income, indicated that health inequalities had been stagnating or narrowing rather than widening since the beginning of the lost decades (Hiyoshi et al. 2013; Kachi et al. 2013; Kondo et al. 2008). This narrowing inequality trend, which was not generally observed in Western societies, was caused by the deterioration of health level among middle- and high-SES populations. Exceptionally, Hanibuchi et al. (2016) reported a pronounced widening trend of the smoking rate among women during the 2000s but they also confirmed that there were no widening trends in self-rated health and physical activity. It should be noted that trends in health inequality may vary depending on the analytical setting, particularly, the type of socioeconomic position (SEP) and health outcome. Wada et al. (2012) and Tanaka et al. (2017) analysed recent health inequality trends using mortality data as the objective health outcome by occupation group. These studies commonly reported that inequalities among occupation groups had narrowed or reversed—meaning that higher occupation groups show higher mortality—, at least in terms

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https://doi.org/10.1007/978-3-030-22707-4_7

Table 7.1 Summary table of indices of mortality inequalities by age group

		ASMR per 100,000		Slope index of inequalities			Relative index of inequalities		
		1st Quintile	5th Quintile	Estimate	95% CI (LL & UL)		Estimate	95% CI (LL & UL)	
Men									
All ages	1995–1999	625.6	728.7	**125.3**	122.4	128.2	**1.20**	1.20	1.21
	2010–2014	472.3	587.1	**117.3**	115.3	119.3	**1.25**	1.25	1.26
0–14	1995–1999	46.3	52.3	**7.2**	6.3	8.2	**1.16**	1.14	1.18
	2010–2014	25.3	33.2	**7.8**	7.0	8.6	**1.32**	1.28	1.35
15–39	1995–1999	65.1	93.2	**33.3**	32.6	34.1	**1.54**	1.53	1.56
	2010–2014	52.9	77.1	**25.7**	24.9	26.4	**1.50**	1.49	1.52
40–64	1995–1999	450.2	608.3	**193.1**	191.1	195.1	**1.46**	1.45	1.46
	2010–2014	336.8	488.0	**175.9**	174.3	177.6	**1.56**	1.55	1.57
65–74	1995–1999	2244.9	2595.2	**434.3**	425.2	443.5	**1.20**	1.19	1.20
	2010–2014	1542.3	1942.0	**485.2**	478.9	491.5	**1.33**	1.32	1.33
75+	1995–1999	7821.3	8302.2	**572.6**	549.7	595.4	**1.07**	1.07	1.08
	2010–2014	6208.8	6990.9	**889.1**	875.0	903.3	**1.14**	1.14	1.15
Women									
All ages	1995–1999	346.1	368.1	**23.6**	21.9	25.3	**1.07**	1.06	1.07
	2010–2014	254.1	294.3	**30.0**	28.9	31.1	**1.12**	1.11	1.12
0–14	1995–1999	39.0	42.2	**4.2**	3.3	5.1	**1.11**	1.09	1.14
	2010–2014	22.2	29.4	**7.1**	6.3	7.8	**1.34**	1.30	1.38
15–39	1995–1999	34.3	42.7	**10.6**	10.0	11.2	**1.32**	1.30	1.34
	2010–2014	29.1	40.9	**11.9**	11.4	12.5	**1.43**	1.41	1.46
40–64	1995–1999	227.5	263.4	**46.4**	45.1	47.8	**1.21**	1.20	1.22
	2010–2014	174.3	225.1	**58.5**	57.3	59.6	**1.35**	1.35	1.36
65–74	1995–1999	1039.2	1101.6	**91.2**	85.7	96.8	**1.09**	1.08	1.10
	2010–2014	667.6	800.1	**158.8**	154.9	162.7	**1.24**	1.24	1.25
75+	1995–1999	4796.5	4870.9	**123.3**	110.9	135.7	**1.03**	1.02	1.03
	2010–2014	3624.4	3871.1	**246.9**	239.5	254.4	**1.07**	1.07	1.07

Notes: 95% CI: 95% confidence interval; LL: Lower Limit; UL: Upper Limit.

of absolute inequality of mortality, and suicide played an important role in mortality inequality among men.

Studies have also measured social inequalities in health using geographic indices and have reported a widening trend of geographic inequalities since around the latter half of the 1990s (Fukuda et al. 2007; Nomura et al. 2017). It is easier to cover all age groups by using such regional statistics of mortality or life expectancy. However, these studies used prefecture as the research unit which masked place-based socioeconomic inequalities and these can be large within a prefecture.

Our intention was to produce a clearer picture of the current state of health inequalities using a finer geographic unit. In contrast to these previous studies, the health atlas used mortality, which is an objective indicator of health, as the health outcome and displayed the geographic inequalities in health by municipality as the spatial unit. The cartogram used detailed geographic units which enabled us to visually display the health inequalities, reflecting detailed socioeconomic/deprivation differences between residential areas inside the metropolitan areas as well as overall regional differences in area deprivation across the whole of Japan. The regional SEP based on the census-based areal deprivation index was employed here to trace trends in socioeconomic inequalities in health in the past two decades from 1995 to 2014. Tables 7.1 and 7.2 summarise the socioeconomic inequality indices of mortality used here by age group and major cause of death. The proportion contribution of each main cause of death to the absolute inequalities of all-cause mortality (prop. cont. all-cause SII(%)) is shown in Table 7.2, which was calculated as the proportion of SII of each main cause of death to the SII of all cause of death, following the methods from a previous study (Teng et al. 2017). Summary tables of SII and RII for all other causes of death in this atlas are shown in the appendix (Tables A.2 and A.3).

7.2 What We Gained from the Atlas Project

Widespread Existence of Socioeconomic Health Disparities

In this atlas, we have confirmed that area-based socioeconomic inequalities in mortality are widespread among Japanese societies for various age groups and causes of death, although they may still be less pronounced in Japan than in Western societies such as the UK (Nakaya and Dorling 2005) and the USA (Ikeda et al. 2011). The geographic aspect of socioeconomic disparities in Japan is dually structured as metropolitan vs. non-metropolitan areas

Table 7.2 Summary table of indices of mortality inequalities by major cause of death

		ASMR per 100,000		Slope index of inequalities			Prop. cont. all-cause SII (%)	Relative index of inequalities		
		1st Quintile	5th Quintile	Estimate	95% CI (LL & UL)			Estimate	95% CI (LL & UL)	
Men										
All causes	1995–1999	625.6	728.7	**125.3**	122.4	128.2	100	**1.20**	1.20	1.21
	2010–2014	472.3	587.1	**117.3**	115.3	119.3	100	**1.25**	1.25	1.26
Cancer	1995–1999	211.6	234.5	**27.0**	25.3	28.6	22	**1.13**	1.12	1.14
	2010–2014	163.5	190.6	**31.6**	30.4	32.7	27	**1.20**	1.19	1.20
Heart disease	1995–1999	90.5	99.0	**12.0**	10.9	13.1	10	**1.14**	1.12	1.15
	2010–2014	66.8	79.9	**13.0**	12.3	13.8	11	**1.20**	1.19	1.21
Cerebrovascular disease	1995–1999	79.5	89.8	**12.0**	11.0	13.0	10	**1.15**	1.13	1.16
	2010–2014	38.3	48.3	**10.0**	9.4	10.5	9	**1.25**	1.24	1.27
Pneumonia	1995–1999	54.3	60.2	**8.9**	8.0	9.7	7	**1.17**	1.15	1.19
	2010–2014	39.5	49.1	**9.9**	9.4	10.5	8	**1.26**	1.24	1.27
Accidents	1995–1999	15.9	23.9	**9.2**	8.7	9.7	7	**1.59**	1.55	1.63
	2010–2014	7.7	19.4	**10.7**	10.4	10.9	9	**2.57**	2.50	2.65
Suicide	1995–1999	21.3	31.5	**12.4**	11.8	12.9	10	**1.62**	1.58	1.66
	2010–2014	22.8	30.9	**9.6**	9.0	10.2	8	**1.44**	1.41	1.47
Women										
All causes	1995–1999	346.1	368.1	**23.6**	21.9	25.3	100	**1.07**	1.06	1.07
	2010–2014	254.1	294.3	**30.0**	28.9	31.1	100	**1.12**	1.11	1.12
Cancer	1995–1999	107.2	109.1	**2.8**	1.9	3.8	12	**1.03**	1.02	1.04
	2010–2014	87.6	95.5	**8.0**	7.3	8.7	27	**1.09**	1.08	1.10
Heart disease	1995–1999	54.0	57.0	**3.1**	2.5	3.7	13	**1.06**	1.05	1.07
	2010–2014	36.4	41.5	**4.4**	4.0	4.7	15	**1.12**	1.11	1.13
Cerebrovascular disease	1995–1999	52.8	55.4	**0.9**	0.3	1.6	4	**1.02**	1.01	1.03
	2010–2014	22.1	25.4	**2.0**	1.7	2.3	7	**1.09**	1.07	1.10
Pneumonia	1995–1999	26.0	26.7	**2.0**	1.6	2.4	8	**1.08**	1.07	1.10
	2010–2014	16.6	19.9	**3.5**	3.2	3.7	12	**1.21**	1.20	1.23
Accidents	1995–1999	6.7	8.4	**1.8**	1.6	2.1	8	**1.27**	1.22	1.32
	2010–2014	2.9	11.4	**6.1**	6.0	6.3	20	**3.40**	3.28	3.53
Suicide	1995–1999	9.8	10.8	**1.5**	1.1	1.8	6	**1.15**	1.11	1.19
	2010–2014	10.1	11.1	**0.7**	0.3	1.0	2	**1.07**	1.03	1.10

Notes: 95% CI: 95% confidence interval; LL: Lower Limit; UL: Upper Limit.

and wealthy suburbs vs. deprived inner city areas within metropolitan areas. We were able to identify both through the mortality maps which display regional differences in mortality rates by age group and cause of death, through the effective use of cartograms reflecting regional differences in population size (Nakaya 2010).

Changes in Geographic Health Disparities

The atlas clearly shows that the relative socioeconomic inequalities in health based on the municipality-based deprivation index, which are measured by the relative index of inequality (RII), have been widening for both men and women of various ages and with different causes of death during the two decades of economic stagnation, 1995–2014 (Figs. 7.1 and 7.2). Regarding trends for the major causes of death, cancer, heart disease and cerebrovascular disease showed decreasing trends in the ASMRs and widening RII, while pneumonia and accidents showed stable ASMR and widening RII. Suicide showed stable trends in ASMR and shrinking RII. Regarding trends of all-cause deaths for different age groups, most of them showed decreased trends in the ASMRs and widening RII except the AYA (15–39 years old) of men showing decreasing RII trend.

It is often argued that relative inequalities are likely to increase with decreasing mortality, and ideally, both absolute and relative inequalities in health should be reduced at the same time (Mackenbach 2012). In terms of absolute inequalities measured by the slope index of inequality (SII), there was a trend toward shrinkage for men but widening for women. The decrease in absolute inequalities among men is partly explained by the recent decrease in absolute inequalities in suicide mortality (Fig. 7.3). A past study using municipality data, as in the case of this atlas, pointed out that the decline in the death rate due to cerebrovascular disease contributed to the reduction in socioeconomic inequalities in mortality from the 1970s to the 1990s, and that suicide and accident/injury became more influential components of total socioeconomic inequalities of health (Fukuda et al. 2005). In the 2010s, the absolute inequality of suicide mortality began to shrink, but the ASMR of suicide is still at a higher level

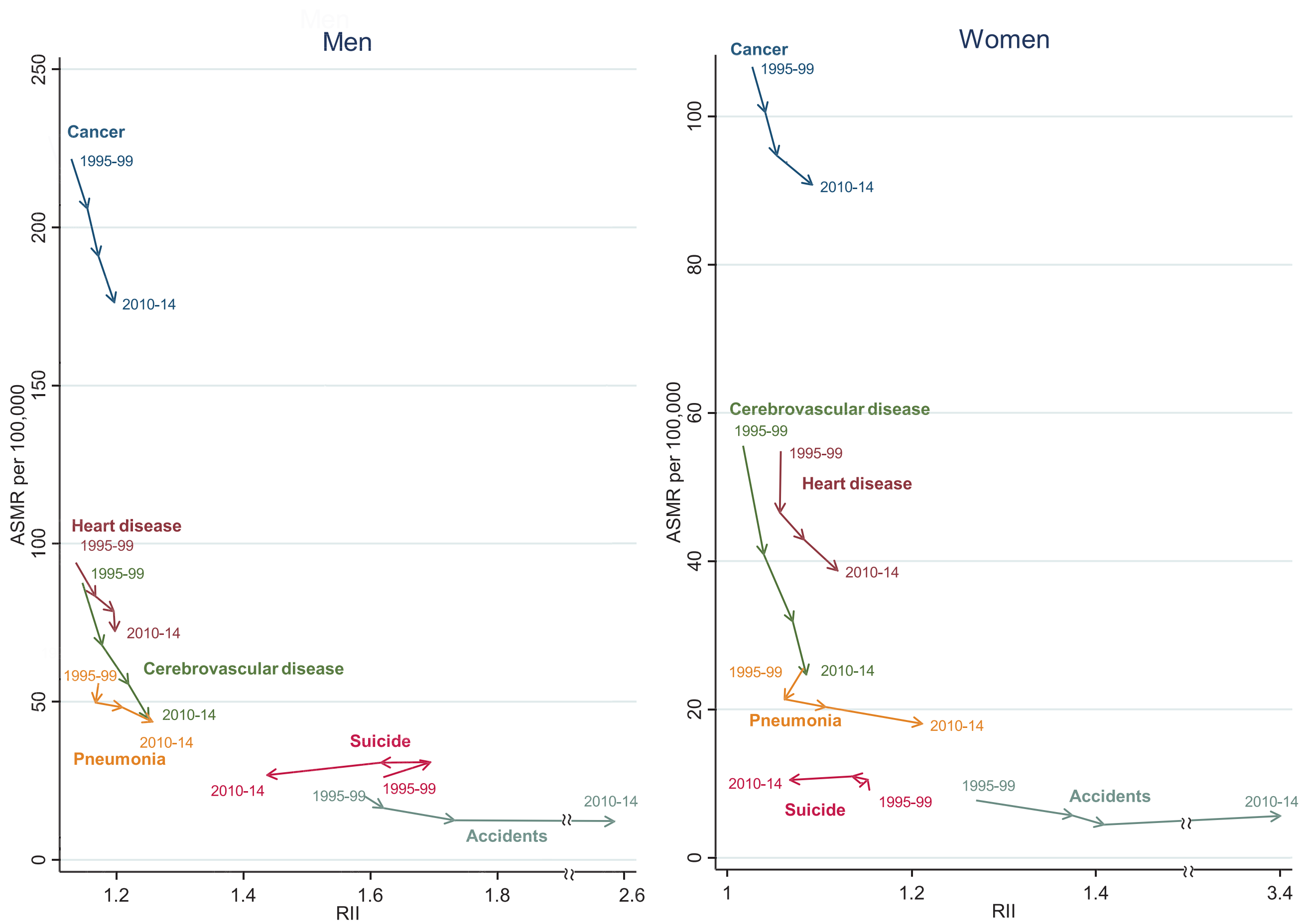

Fig. 7.1 Transitions in ASMR and RII for main causes of death

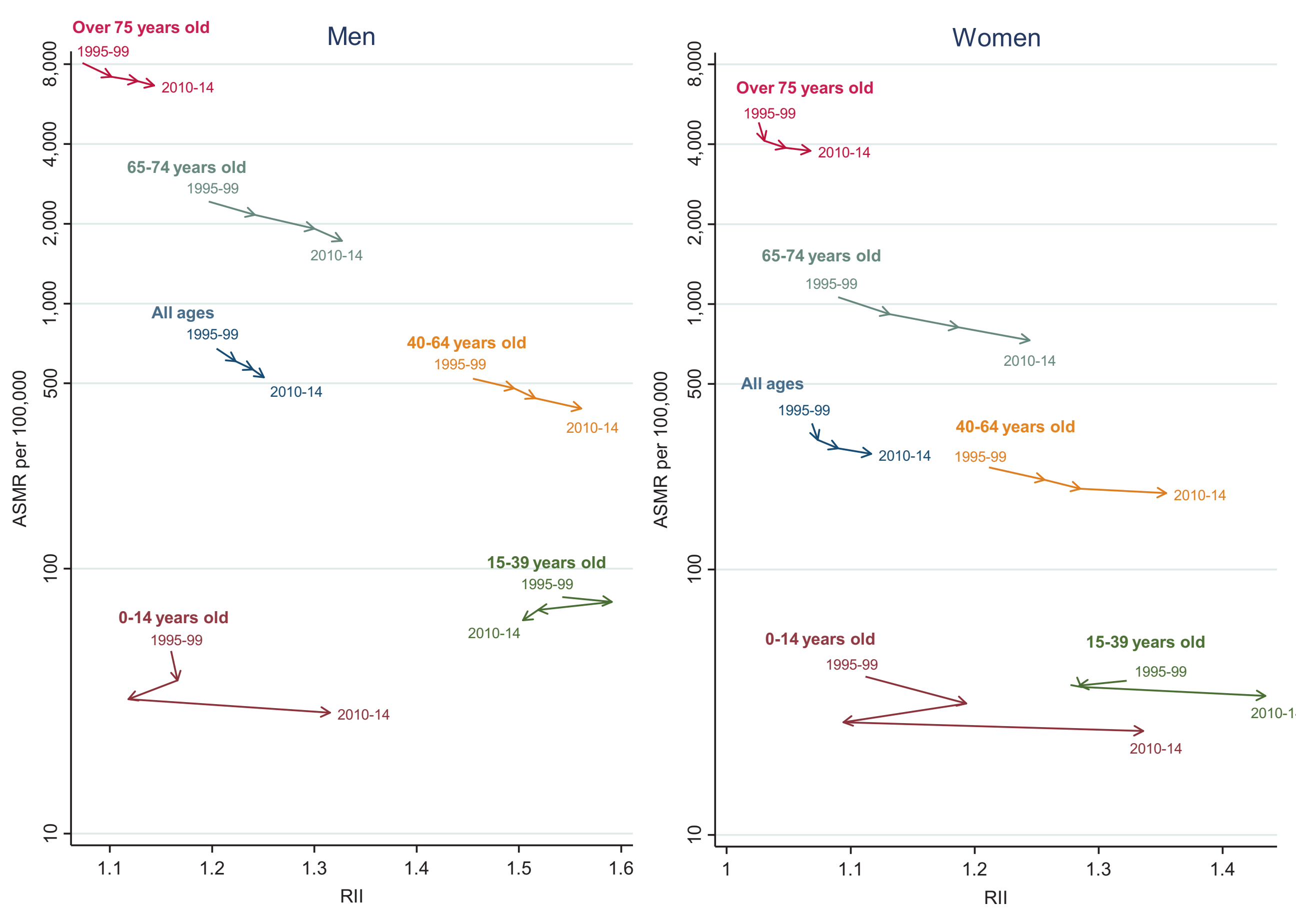

Fig. 7.2 Transitions in ASMR and RII for age groups of all-cause death

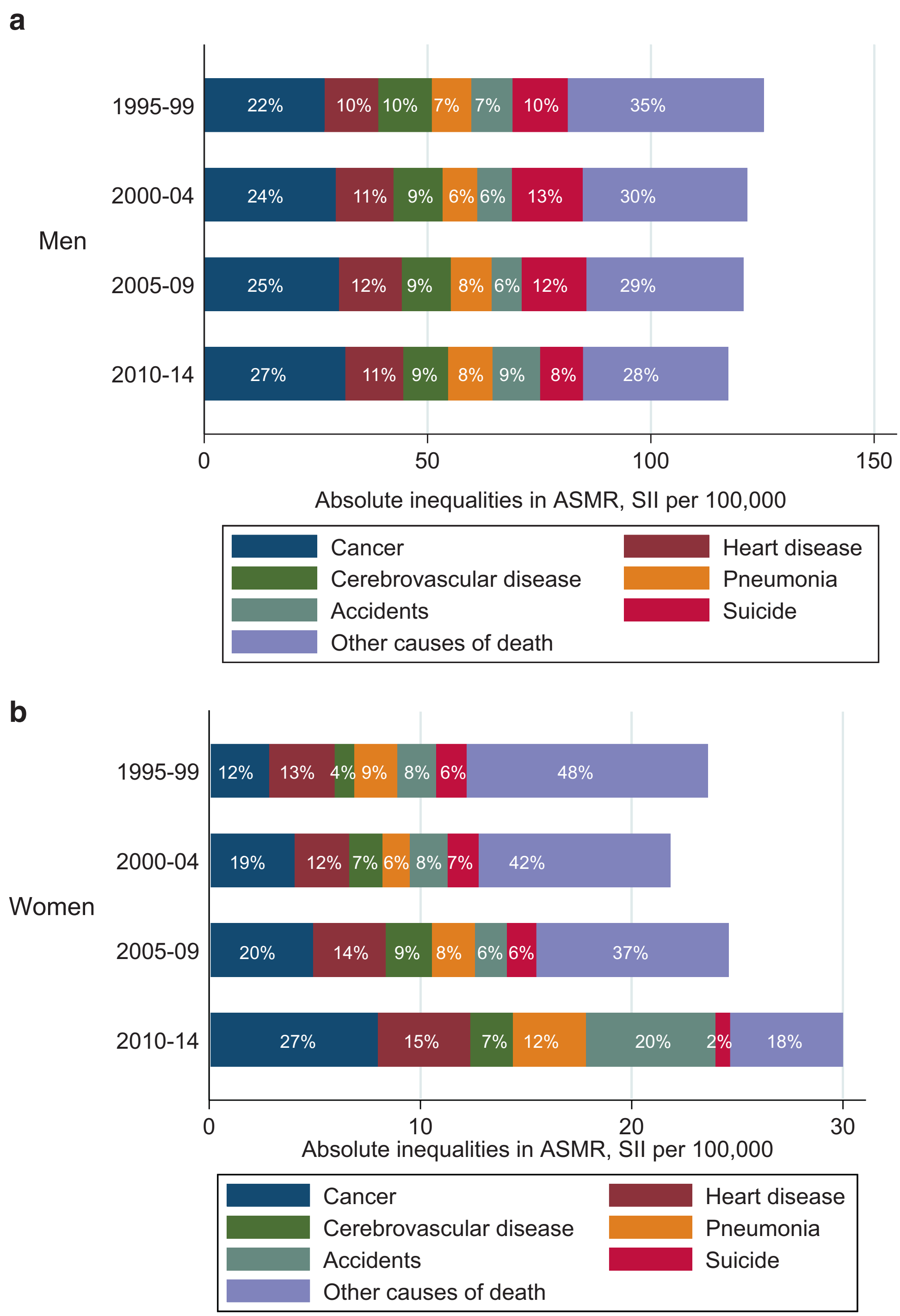

Fig. 7.3 SII by main causes of death (per 100,000) and the contribution of each cause of death to SII of all causes of death (%). (**a**) Men. (**b**) Women. Note: The total length of the bar is the SII for all-cause mortality per 100,000 person-years and the length of each bar is the SII for the corresponding causes of mortality. SII for other causes of death is the difference between SII for all-cause mortality and sum of SIIs for six main causes of death. % in the bar indicate the contribution of each SII for main causes of death to SII for all-cause mortality

than in Western societies, and thus further suicide prevention measures are required.

On the other hand, many of the main causes of death, cancer, cerebrovascular disease, heart disease, pneumonia and accidents for both men and women, have tendencies of widening absolute inequalities; however, this is not the case for suicide in both sexes and cerebrovascular disease in men (Fig. 7.3). In particular, the contribution of cancer death to the SII of all-cause deaths was greatest for men in both 1995–1999 and 2010–2014 and tended to increase (from 22 to 27%). In the period from 1995 to 1999, the contribution of cancer (12%) was nearly equivalent to that of heart disease (13%), whereas in 2010–2014, that of cancer was the largest at 27%. This result illustrates the importance of cancer control efforts to eliminate these geographically based socioeconomic disparities in mortality.

We summarise the changes in SII and RII in Fig. 7.4. In this figure, while the vertical axis represents the difference of RII from 1995–1999 to 2010–2014, the horizontal axis does the rate of change in SII from 1995–1999 to 2010–

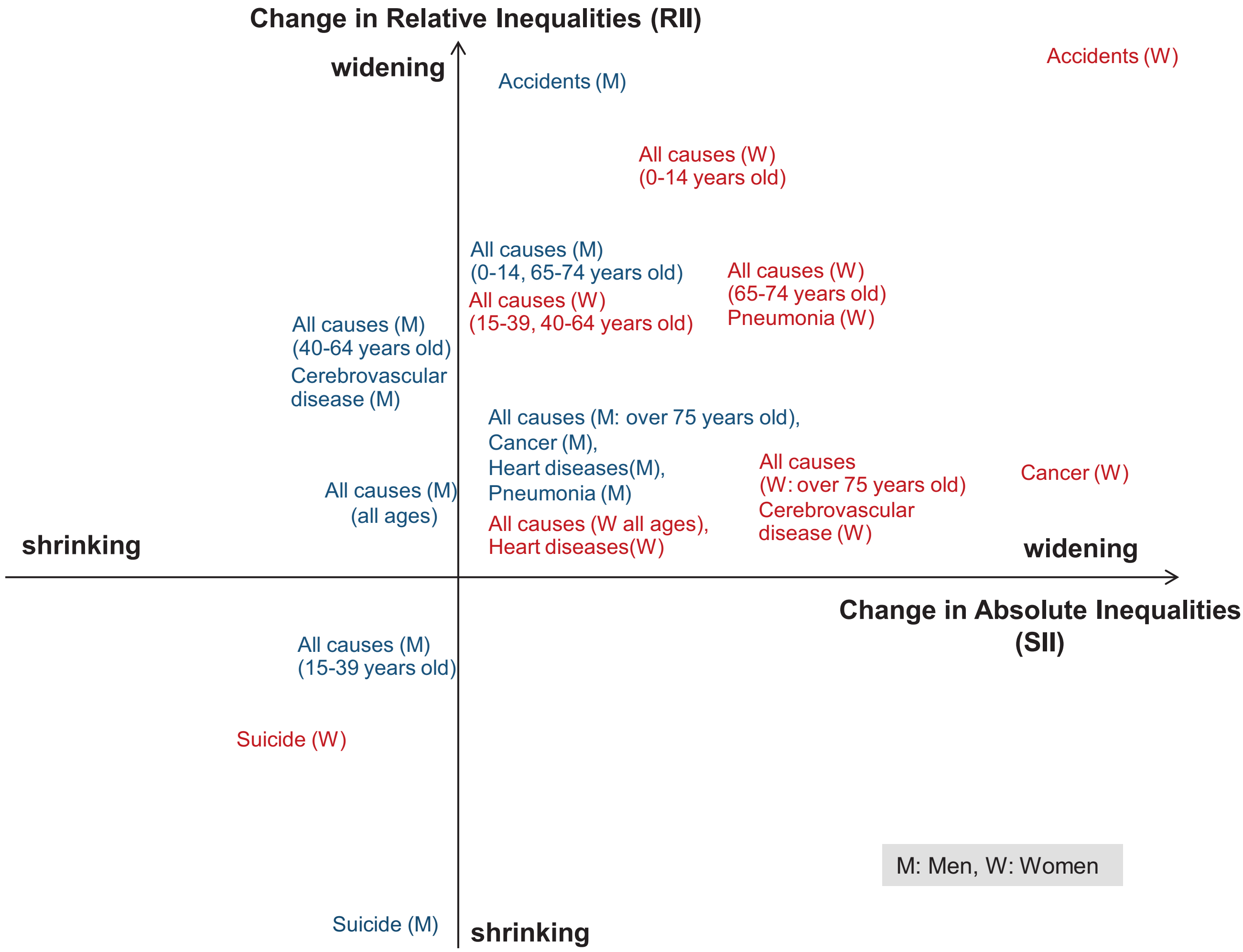

Fig. 7.4 Summary of changes in SII and RII of main causes of death and age groups of all-cause death between 1995–1999 and 2010–2014

2014—the difference of SII from 1995–1999 to 2010–2014 divided by the SII in 1995–1999—for each cause of death and age group of all-cause death. Since the values for accidents were extremely large because of the earthquake disaster, the accident was placed at the peripheral position in the figure indicating the large changes in the inequality indices. The upper right quadrant meaning that both SII and RII became larger between the two periods contains many major causes of death and age groups. It should be noted that while the absolute inequalities in the working age of men became smaller, the absolute and relative inequalities among children and the older adults, often referred to as vulnerable demographic groups with respect to their health, have widened in both sexes.

Vulnerable People and Geographic Health Disparities

As introduced in Chap. 2, Sect. 2.2, several vulnerable populations have been identified within the globalisation and social changes that took place in the lost decades: high-SES workers, children (or child-rearing families) and the older adults. The observed reduction in absolute social inequalities among men in the atlas project might be led by successful suicide prevention activities in deprived regions. The reduction might also be caused by the decline in health levels among high-SES populations, such as managers and professionals in metropolitan regions, as argued by Wada et al. (2012) and Hiyoshi et al. (2013). The reduction in absolute disparity without equivalent deterioration of any specific group should be pursued. One paradoxical issue is that while Wada et al. (2012) observed greater mortality in the higher-level occupation groups, than other occupation groups (including blue collar workers), residential areas with high SES consistently showed lower SMRs in the metropolitan areas. This might indicate that such vulnerable high-SES populations were geographically contextualised and lived in different zones compared to the general high-SES populations.

In general, socioeconomic inequalities in mortality are larger among men than women, but the widening of inequalities observed in this project is more pronounced among women. The relative inequalities of mortality for children became larger with the absolute inequalities largely unchanged.

We also observed that the socioeconomic inequalities in mortality were greater among children and working age groups than the older adults. However, social inequalities in mortality among the older adults have been widening both absolutely and relatively. These trends might be associated with the problems of poverty among women such as single mother related to child poverty and the high rate of relative poverty among the older adults. Health disparity monitoring and public health policies should take account of populations with still small but widening socioeconomic disparities of health as well as the currently large ones.

7.3 Challenges

The atlas demonstrates that the cartographic and geographic approach is useful for monitoring socioeconomic inequalities in health in the context of Japanese society. Socioeconomic inequalities in health should be examined from a variety of perspectives including geography. There are various challenges to developing this approach further.

First, we need to improve the statistical data on mortality in order to understand the transition of the health disparity over the longer term. Although mortality is a vital objective indicator of health, the reliability of the detailed cause of death classification remains to be considered. As mentioned in Chap. 1, there was a change in the criteria for cause of death classification in 1995, which resulted in unusual changes in the components of the cause of death. Further, Japanese autopsy rates are low (Maeda et al. 2013) meaning that there may be regional biases in diagnoses, particularly diagnoses of heart disease and senility. It is also important to establish a system that facilitates the reclassification of mortality data resulting from changes in administrative units, such as municipalities.

Second, the mortality maps within this health atlas were constructed mainly to understand the overall geographic patterns of health inequalities in Japan. For use in planning and evaluating health policies at regional levels (e.g. what approaches are needed in deprived areas), it is vital to link the mortality maps to other types of epidemiological information with geographic references. ‘Why health is impaired in deprived areas’ can be better understood through linkages with different regional indicators such as health behaviours, clinical treatment and environmental measures including walkability (Inoue et al. 2011; Hanibuchi et al. 2015) and food environment (Ishikawa et al. 2016). Not only primary prevention but secondary prevention (screening, early detection) and treatment after diagnosis of disease would also influence inequalities in mortality. In order to reduce health inequalities effectively, we need to explore the mechanisms of socioeconomic inequality in mortality, which is the final stage outcome. Complex causal relationships between geographically based deprivation and health outcome can be investigated based on multi-dimensional data.

Third, there is the possibility of investigating more detailed health disparities using finer geographic units through geocoding the online-based information of death register which became operative recently. Figure 7.5 is an analysis of all-cause death SMRs (all-age SMRs) in Osaka Prefecture at the *chocho-aza* level, as of 2014. It illustrates

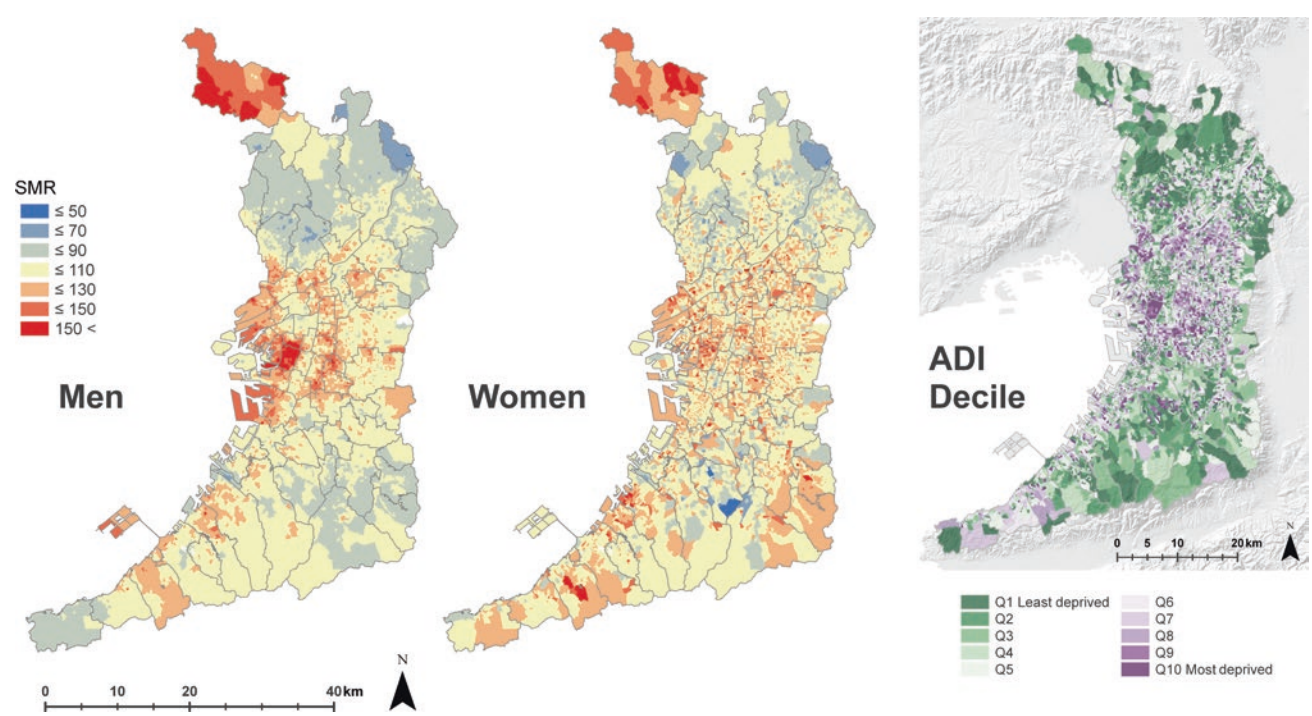

Fig. 7.5 Neighbourhood (*chocho-aza*) level map of all-cause SMR in Osaka Prefecture, 2014. SMRs were spatially smoothed by BYM model. Counts of deaths obtained from the Vital Statistics of Japan. Population data to compute SMRs is based on the 2015 population census of Japan

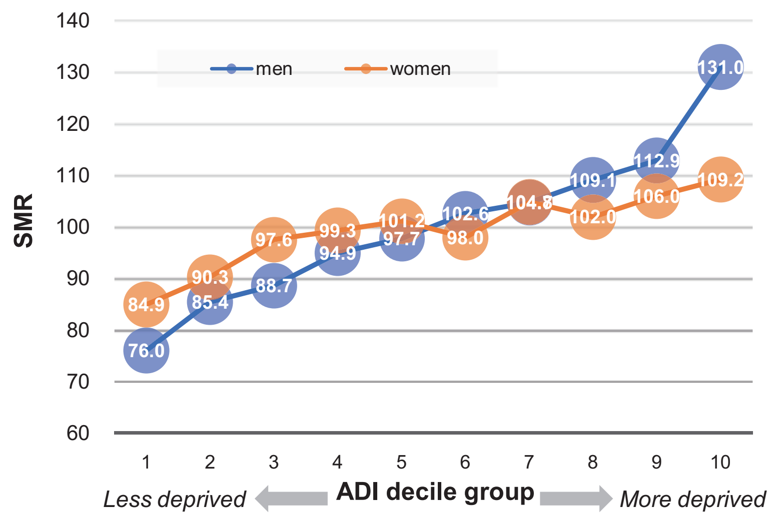

Fig. 7.6 Neighbourhood level all-cause SMR by decile groups of areal deprivation index. The areal deprivation index is calculated based on the 2015 population census of Japan

that socioeconomic inequalities in mortality (SMR) can be larger at the neighbourhood scale than at the municipality level (Fig. 7.6). Such detailed geographic information should be handled carefully because of concerns that it may create negative impressions of individuals and local communities. However, since the socioeconomic residential mix within a municipality is large in Japanese cities (Fielding 2004), it is expected that the finer geographic information may guide effective, regionally tuned measures to reduce health inequality at the neighbourhood level (Dwyer-Lindgren et al. 2017).

7.4 Conclusion

In this atlas, the socioeconomic inequalities in mortality in Japanese society during the lost decades are cartographically drawn as thematic maps of mortality and geographically measured by inequality indices. Although narrowing inequality trends were observed for some groups, the maps confirm that socioeconomic disparity widened in many of the main causes of death, particularly cancer. These results can serve as basic information for considering measures against geographic health disparities in Japan. Internationally, the country still has excellent health standards, having less pronounced health inequalities and differences within the social strata and residential social area formation compared to Western societies. Understanding the trends in geographical health disparities during the economic stagnation period in this unique society may provide valuable insight into the general question of the relationship between social disparities and health.

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Supplementary Chapter: Technical Notes

Tomoki Nakaya, Keisuke Fukui, and Kazumasa Hanaoka

This supplementary provides the details of several advanced methods and analytical procedures used for the atlas project.

T1 Spatial Smoothing for Small-Area-Based Disease Mapping: BYM Model and Its Implementation

T. Nakaya

Disease mapping using small areas such as municipalities in this atlas often suffers from the problem of small numbers. In the case of mapping SMRs, small numbers of deaths in a spatial unit cause unstable SMRs and make it difficult to read meaningful geographic patterns over the map of SMRs. To overcome this problem, spatial smoothing using statistical modelling is a common practice in spatial epidemiology.

When we can consider the events of deaths to occur independently with a small probability, it is reasonable to assume the following Poisson process:

$$o_i \mid \theta_i \sim \text{Poisson}\left(e_i \theta_i\right)$$

where o_i and e_i are the observed and expected numbers of deaths in area i, and θ_i is the relative risk of death in area i. The standardized mortality ratio of area i is shown as $\text{smr}_i = o_i/e_i \times 100$. A crude estimate of the underlying risk, $\widehat{\theta}_i = o_i / e_i$, which is derived by the maximum likelihood principle, tends to be statistically unstable when e_i is small.

Bayesian hierarchical modelling with spatially structured random effects provides flexible inference frameworks to obtain statistically stable and spatially smoothed estimates of the area-specific relative risk. The most popular model is the BYM model after the three authors who originally proposed it, Besag, York, and Mollié (Besag et al. 1991). The model without covariates is shown as:

$$o_i \mid \theta_i \sim \text{Poisson}\left(e_i \theta_i\right)$$

$$\log\left(\theta_i\right) = \alpha + v_i + u_i$$

where α is a constant representing the overall risk, and v_i and u_i are unstructured and spatially structured random effects, respectively. The unstructured random effect is a simple white noise representing the geographically independent fluctuation of the relative risk:

$$v_i \sim N\left(0, \sigma_v^2\right).$$

The spatially structured random effect models the spatial correlation of the area-specific relative risks among neighbouring areas:

$$u_i \mid u_{j, i \neq j} \sim N\left(\frac{\sum_{j \neq i} w_{ij} u_j}{\sum_{j \neq i} w_{ij}}, \frac{1}{\sum_{j \neq i} w_{ij}} \sigma_u^2\right).$$

where w_{ij} is the spatial weight representing the spatial adjacency relationship between areas i and j. The weight is one when area i is adjacent to area j, or zero otherwise. The expectation of u_i is equal to the average of u_j in the areas adjacent to area i. This spatial dependency leads to a spatial smoothness of the relative risk posterior estimates. The two precision parameters, σ_v and σ_u, control the strength of the spatially independent and correlated effects in the variation of the area-specific relative risks.

A recently proposed modified BYM model introduces scaling and re-parametrization of the two random effect terms (Riebler et al. 2016):

$$\log\left(\theta_i\right) = \alpha + \sigma_r \left(\sqrt{1-\phi}\, v_i^* + \sqrt{\phi}\, u_i^*\right)$$

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where σ_r is the precision parameter of the entire random effect variation, v_i^* and u_i^* are again unstructured and spatially structured effects that are now standardized to have (generalized) variance equal to one such that the parameter, ϕ ($0 \leq \phi \leq 1$), represents the proportion of the total (marginal) relative risk variance explained by the spatially structured effect. The model can be implemented by the integrated nested Laplace approximations (INLA) R-package, which enables the efficient computation of the full Bayesian inference for disease mapping by avoiding Markov Chain Monte Carlo simulation runs (Lindgren and Rue 2015).

For our disease mapping, we computed the mean of the posterior distribution of the relative risk by using the modified BYM model and multiplied this by 100 to obtain the smoothed SMR of small areas. We implement the computation by using the BYM2 model specification function of the R-INLA package. Regarding the spatial weights, we follow the queen contiguity, meaning that sharing a border, even if it is only a point, is regarded as spatial contiguity. For remote islands, we added additional contiguity based on regular sea routes.

T2 Municipal Population Interpolation

K. Fukui

In Japan, age-sex-specific population data by municipality were monitored by the national census every 5 years: e.g. 1985, 1990, 1995, 2000, 2005, and 2010. In order to measure the longitudinal trend more continuously, the non-observed population data between two periods were calculated by linear interpolation. Let t_1, t_2 be the adjacent periods ($t_1 < t_2$) and y_1, y_2 be the corresponding age-sex-specific population at each municipality. Then, the age-sex-specific population y at any period t in the interval $[t_1, t_2]$ was obtained by following the general formula of linear interpolation,

$$y = y_1 + \frac{y_2 - y_1}{t_2 - t_1} \times \left(t - t_1\right).$$

However, Japan's national government plan for municipal mergers has been carried out at an accelerated pace in recent years. The number of municipalities that were over 3200 in 1985 decreased to approximately 1700 in 2010 through municipal mergers. This causes inconsistency in the analysis of municipal units between adjacent periods. To avoid this problem, we unified the municipal units into the new units for the analysis by the following rules:

1. If multiple municipalities simply merged, the municipality units before the merger were replaced with those in 2010 and the populations were summed.
2. If one municipality has been divided into several municipalities (e.g. Shizuoka-shi in the Shizuoka Prefecture, which became a 'designated city' on 1 April 2005 and was divided into three wards), the municipality units were replaced with those before the division and the populations were summed.
3. If no changes occurred during the period from 1985 to 2010, the original municipal units were used.

T3 Weights of the Areal Deprivation Index of Japan

T. Nakaya

The Gordon method (Gordon 1995) to derive the areal deprivation index consists of three steps. First, the condition of a 'poverty household' is defined by using the microdata of a social survey. Second, a logistic regression is applied to the dataset to predict poverty households with selected explanatory variables which are available both in the microdata and the census statistical tables of the census areas. The weights are obtained from the odds ratios of the coefficients of the fitted logistic regression model. Third, the areal deprivation index is computed by the weighted sum of the selected census variables at the areal level.

A 'poverty household' is defined here as a household of low socioeconomic position which meets both objective and subjective conditions simultaneously (Dorling et al. 2007). The two conditions for the Japanese index are that an equalized annual household income is below half of the national median and that a reference occupant of the household identified his/herself as being of low social class (i.e. selected one of the bottom two choices of a five-point 'top-bottom self-placement' question). It is noted that the income was adjusted by regional differences in housing cost and commodity prices with reference to the public assistance calculation system. The weights are then obtained from the estimated odds ratios in a logistic regression analysis predicting 'poverty households' in the individual samples of the Japanese General Social Survey (JGSS) cumulative data 2000–2003, nationally representative samples of adult Japanese. The index was proposed by Nakaya et al. (2014) for a prospective analysis to associate the survival rates of middle-aged residents with their residential neighbourhood deprivation (Nakaya et al. 2014). An earlier version of the index was used for an ecological study to measure socioeconomic inequalities in cancer deaths in Japan (Nakaya 2011).

The JGSS estimate of the national poverty rate (%household) in 2000–2003 is 8.63% based on the abovementioned definition. Gordon computes the constant, k, in the equation in Sect. 2.8 to match the national mean weighted by the number of households in census areas with the national poverty rate and proposes the deprivation index as a synthetic estimate of the percentage of poor households by census area. As mentioned in Sect. 2.8, the parameter can be any positive constant resulting in the same order of relative positions of census areas based on the proposed index.

T4 Computation of Relative Index of Inequality and Slope Index of Inequality

T. Nakaya and K. Fukui

As introduced in Chap. 2 (Sect. 2.9), the relative index of inequality (RII) and slope index of inequality (SII) are popular indices of social inequalities in health. These require a unidimensional socioeconomic position (SEP) variable, which is given by the municipal ADI in this atlas:

$$\text{sep}_i = \sum_j p_j I\left(\text{ADI}_j < \text{ADI}_i\right) + p_i / 2$$

where p_i is the population proportion of municipality i to the entire national population and $I()$ is an indicator function:

$$I\left(\text{ADI}_j < \text{ADI}_i\right) = \begin{cases} 1 & \text{if } \text{ADI}_j < \text{ADI}_i \\ 0 & \text{otherwise} \end{cases}$$

Now, the SEP variable is scaled to [0, 1].

Although there are several variations in the concepts and formulae of RIIs, we employ the definition given by Mackenbach and Kunst (1997). This RII can be understood as a hypothetical model-based estimate of ‘the rate ratio’ of relative risk in the most deprived area to that in the least deprived area. For example, when RII = 2, it means that the relative risk of death in the most deprived area is as twice that in the least deprived area.

The RII can be estimated by fitting a Poisson regression model which represents the relation between the number of deaths and the socioeconomic position. Let o_i and e_i be the observed and expected number of deaths in area i, respectively. Note that the $\text{smr}_i = o_i/e_i \times 100$ stands for the standardized mortality ratio of area i. Then, the observed number of deaths o_i is assumed as the following Poisson distribution:

$$o_i \mid \theta_i \sim \text{Poisson}\left(e_i \theta_i\right),$$

where θ_i is the relative risk of death in area i. In the estimation of the RII, the θ_i is regressed by the socioeconomic position sep_i as follows (Nakaya 2011):

$$\log \theta_i = \beta_0 + \beta_1 \cdot \text{sep}_i .$$

Recall that the definition of the RII is the relative risk ratio of death between the hypothetical best SEP ($\text{sep}_i = 1$) and the worst SEP ($\text{sep}_i = 0$). Then, by using this regression model, we can estimate the RII as

$$\text{RII} = \hat{\theta}\Big|_{\text{sep}_i = 1} \Big/ \hat{\theta}\Big|_{\text{sep}_i = 0} = \frac{\exp\left(\widehat{\beta_0} + \widehat{\beta_1}\right)}{\exp\left(\widehat{\beta_0}\right)} = \exp\left(\widehat{\beta_1}\right).$$

where $\widehat{\beta_0}, \widehat{\beta_1}$ are the estimators of β_0, β_1. The confidence interval of the RII is obtained by using the standard error of $\widehat{\beta_1}$.

The SII is defined here as an estimate of the absolute difference in the age-standardized mortality rate (ASMR) between the most and least deprived areas. We use the following formula to derive the SII in terms of the ASMR from the estimated RII (Mackenbach et al. 2008):

$$\text{SII} = 2\overline{\text{ASMR}} \times \left(\text{RII} - 1\right) / \left(\text{RII} + 1\right),$$

where $\overline{\text{ASMR}}$ is the ASMR of the entire national population.

T5 Synthetic Estimates of Health-Related Indices at the Neighbourhood Level: A Brief Introduction to the Spatial Microsimulation Approach

K. Hanaoka

It is often difficult to obtain large-scale microdata with health-related attributes, because (1) survey samples are unavailable for academic researchers as well as local government officers, (2) sampling surveys cannot have an adequate number of samples from all neighbourhoods, owing to budget constraints and the limitation of available human resources, and (3) the data contain various sampling biases (e.g. elderly people in rural areas are more likely to respond to questionnaires than young people in urban areas), which result in skewed output indices. Spatial microsimulation has been developed as a method to create geographically disaggregated microdata by synthesizing multiple data sources (Williamson 2012).

Figure T.1 presents the procedure to create a set of synthetic population microdata. The spatial microsimulation attempts to find the best combination of survey samples (seed) such that the aggregated tables agree with the benchmark small area census tables (benchmark). We used simulated annealing (SA), which is a combinatorial optimization algorithm, to repeatedly select samples from the seed survey samples until the aggregates of the synthetic population microdata agreed with the benchmark tables. (Hanaoka et al. 2014) This procedure is equivalent to updating weights of the survey samples, but it can adjust sampling biases multidimensionally by considering multiple benchmark tables.

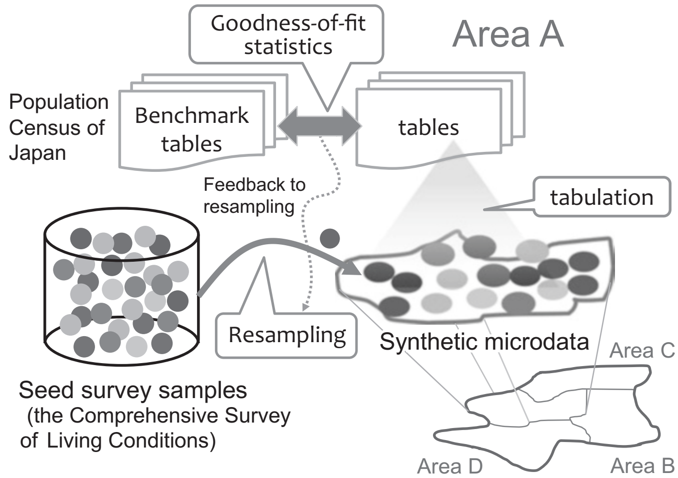

Fig. T.1 Illustrative explanation of synthetic microdata generation in spatial microsimulation

For the seed survey samples, approximately 270,000 household samples in the Comprehensive Survey of Living Conditions 2010 were included. As the benchmark tables, we selected five tabulations of persons and three tabulations of households from the 2010 Population Census of Japan. All the tabulations were compiled at 'Cho-cho-aza', which is a neighbourhood area of the Japanese census. The selected benchmark tables are: at person-level, tables of (1) sex by age, (2) sex by occupation, (3) sex by marital status, (4) sex by education, and (5) sex by employment, and at household-level, tables of (6) housing tenure, (7) dwelling type, and (8) family type.

The spatial microsimulation can combine information of the survey samples and population census to produce health-related synthetic population microdata for over 120 million Japanese people. The merits of the synthetic population microdata are that sampling biases are adjusted during the SA procedure and an analyst can tabulate them flexibly according to their analytical needs.

Although this atlas used the municipality aggregation for mapping the estimated smoking rates and the proportion of periodical medical examination, the spatial distributions of health habits and behaviour indices can be mapped, even at the neighbourhood level all over the country. This can be used to examine, for example, the gender differences in smoking habits between urban and rural neighbourhoods or those among urban neighbourhoods in a large city. Figure T.2 shows the smoking rates by gender at the neighbourhood level, indicating that women tend to have higher rates of smoking in the central parts of the Osaka metropolitan areas compared to those in the suburbs.

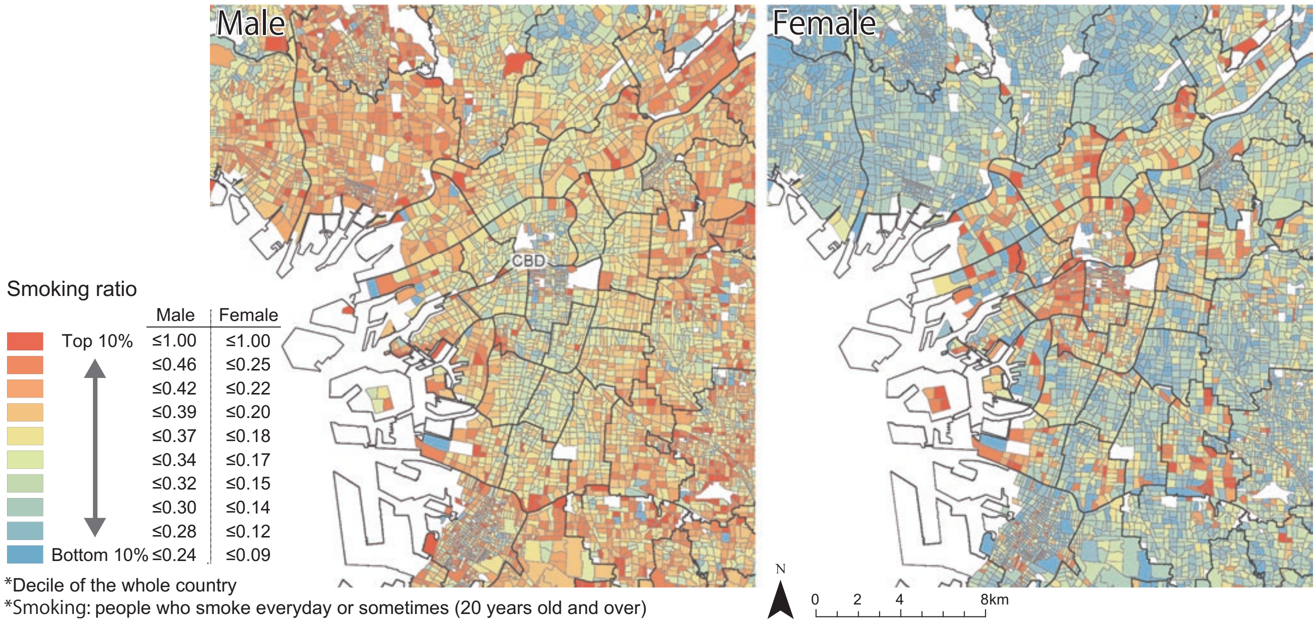

Fig. T.2 Mapping smoking rates at the neighbourhood level as of 2010 around Osaka City

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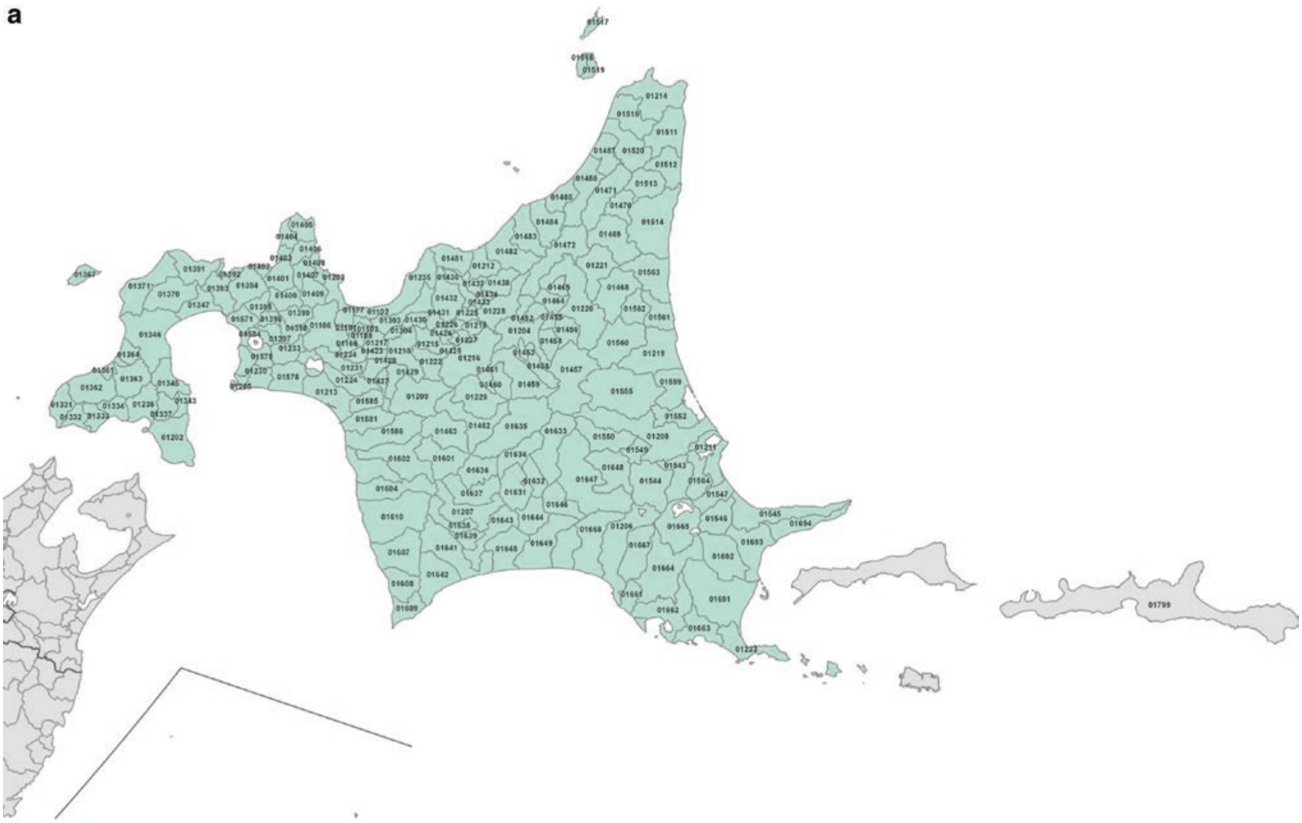
Appendix

Index Map of Municipality for the Atlas

T. Nakaya, Y. Ito (eds.), *The Atlas of Health Inequalities in Japan*, Global Perspectives on Health Geography,
https://doi.org/10.1007/978-3-030-22707-4

a



b

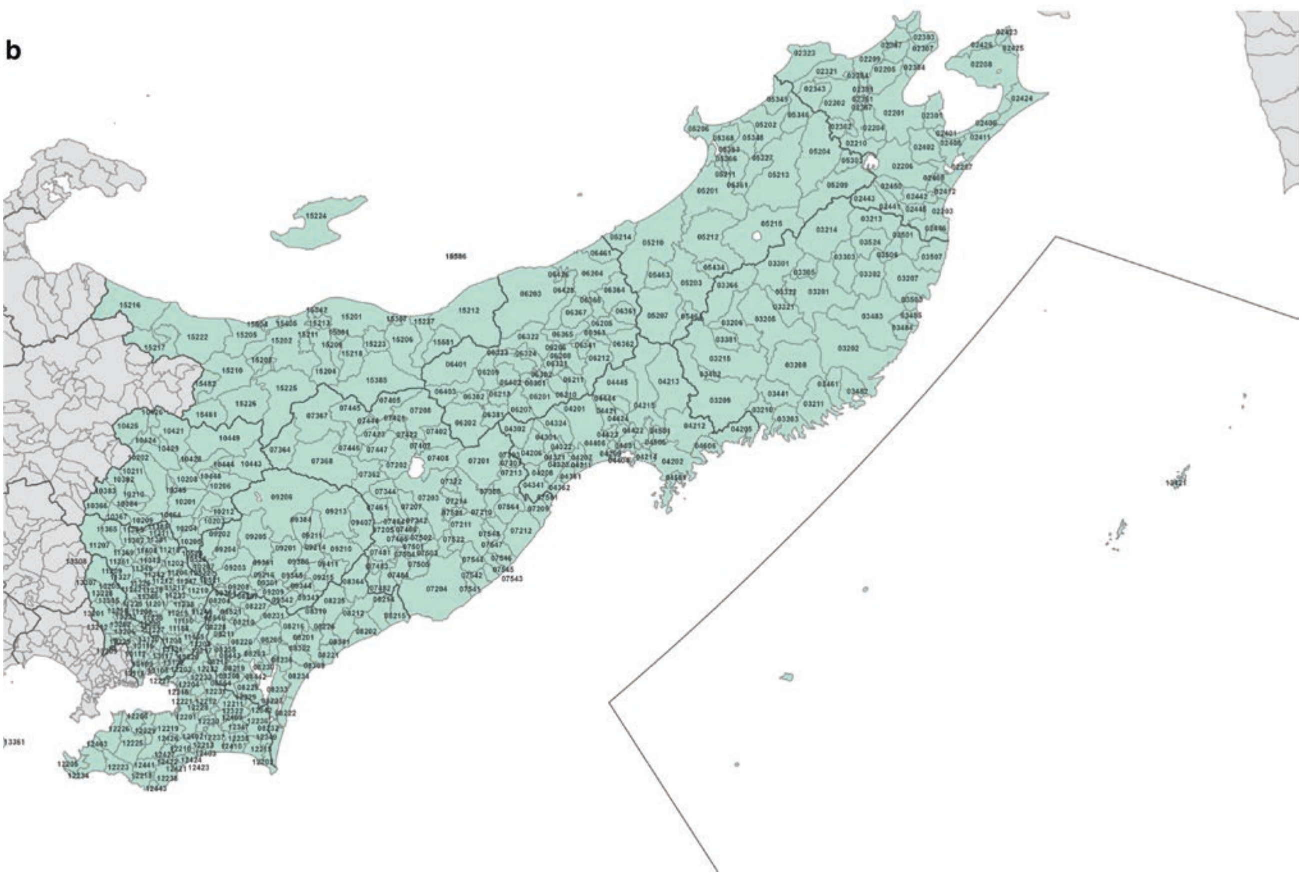


Fig. A.1 Index map of municipalities for the atlas (ordinary map projection), 1995–2014. (**a**) Hokkaido. (**b**) The Tohoku and eastern Kanto regions. (**c**) The Chubu, Kinki, and western Kanto regions. (**d**) The Chugoku, Shikoku, and Kyusyu regions. (**e**) Okinawa and Kagoshima Prefectures c

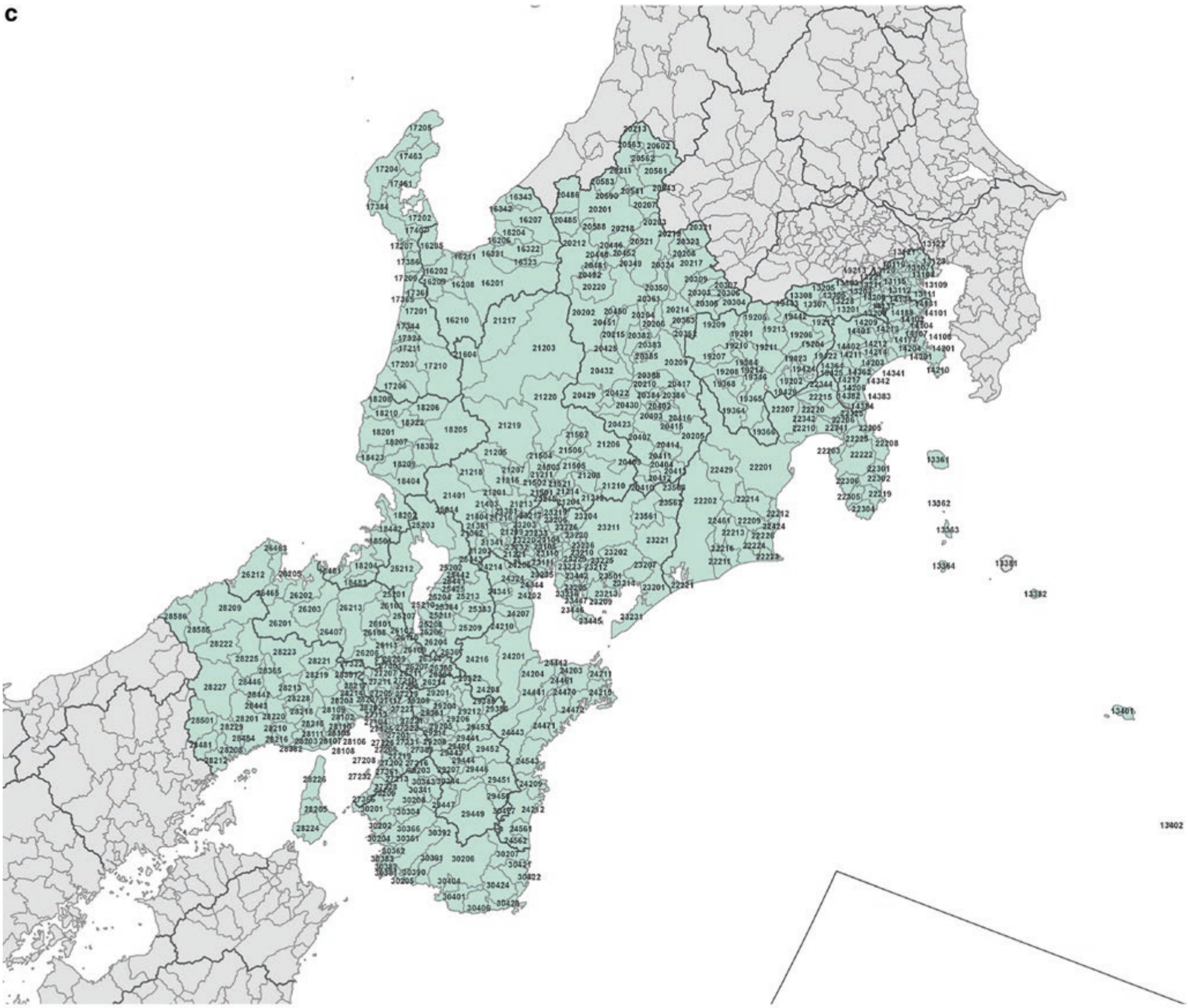


Fig. A.1 (continued)

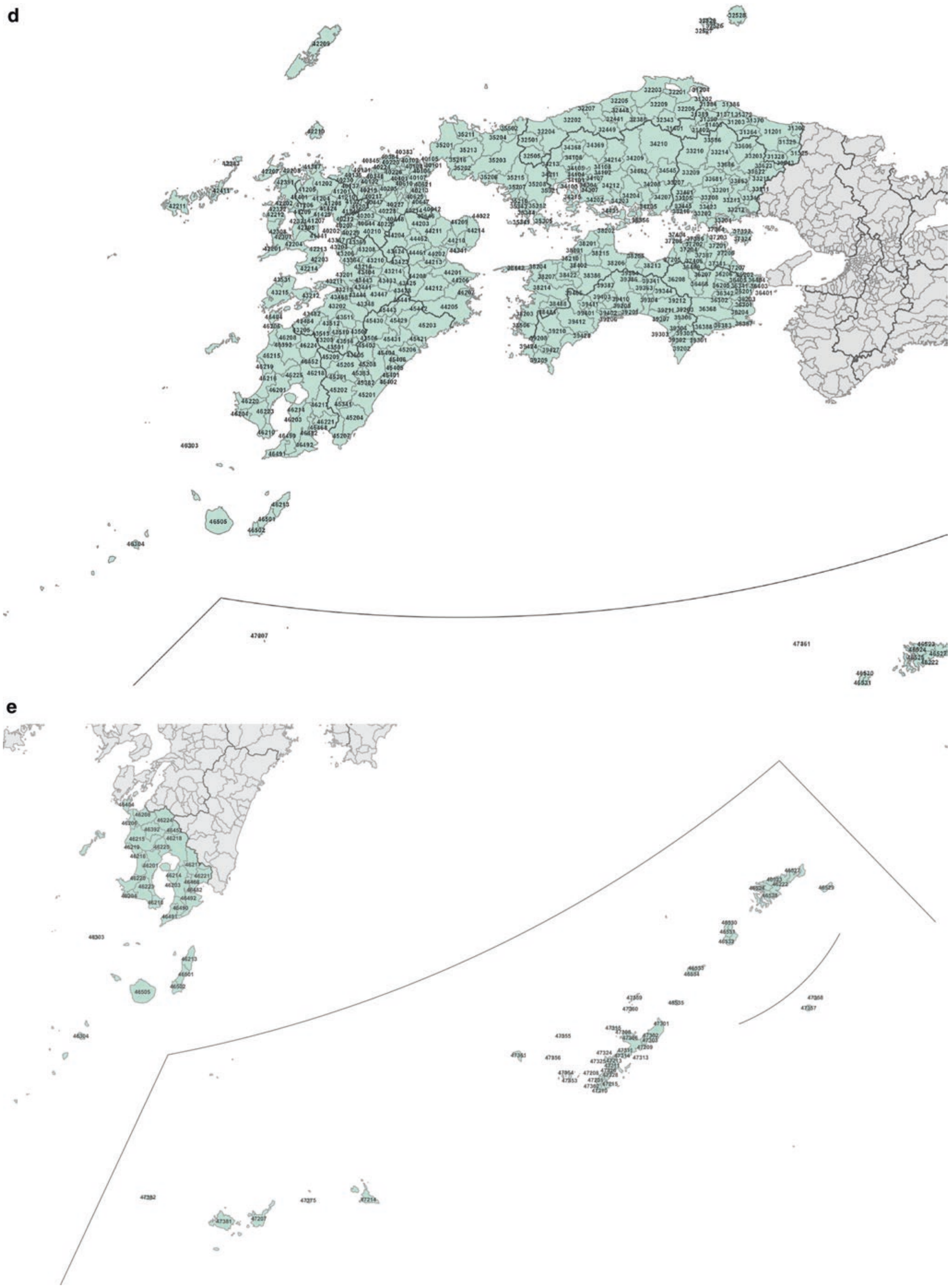


Fig. A.1 (continued)

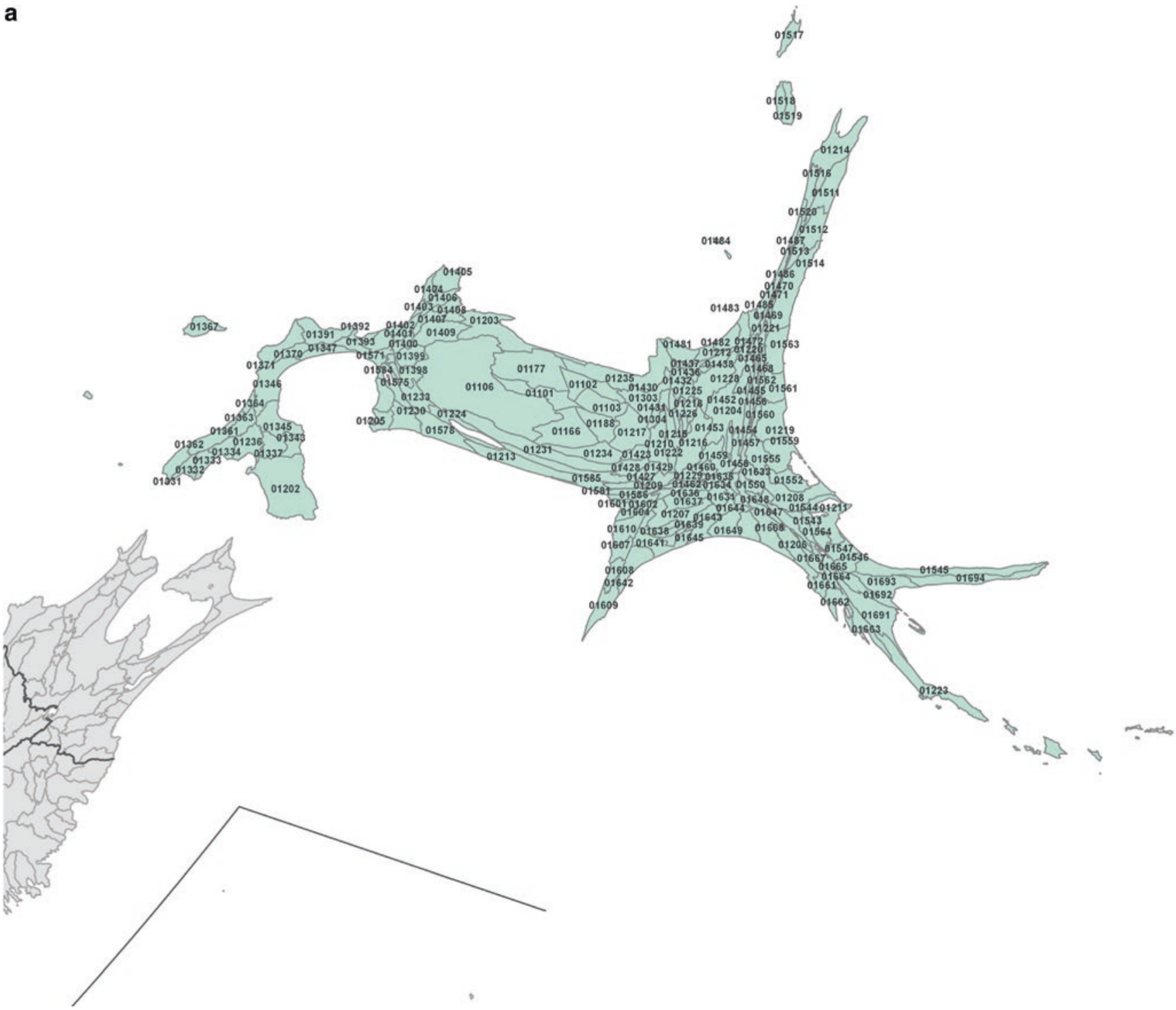


Fig. A.2 Index map of municipalities for the atlas (cartogram), 1995–2014. (**a**) Hokkaido. (**b**) The Tohoku and eastern Kanto regions. (**c**) The Chubu, Kinki, and western Kanto regions. (**d**) The Chugoku, Shikoku, and Kyusyu regions. (**e**) Okinawa and Kagoshima Prefectures b

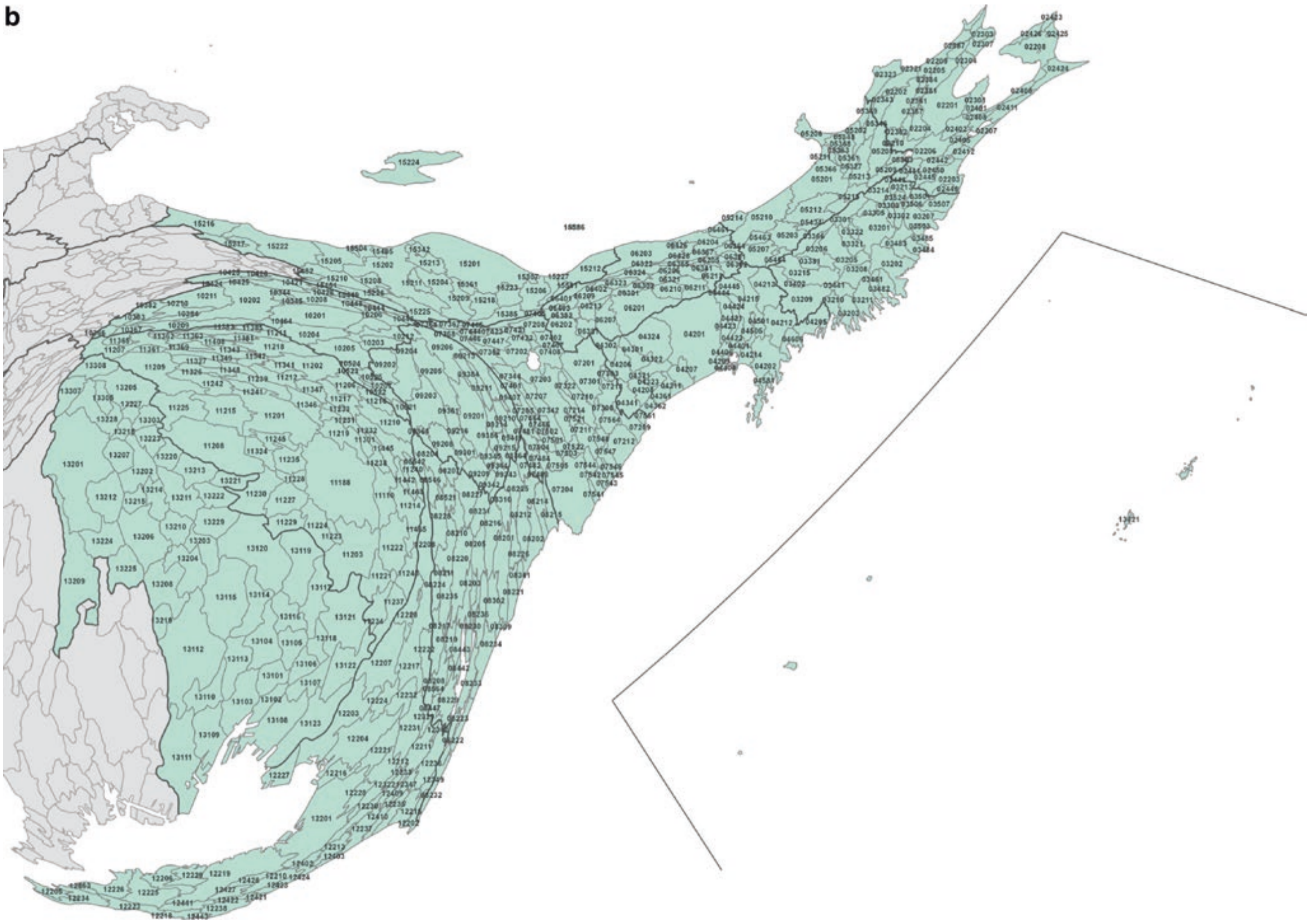


Fig. A.2 (continued)

c

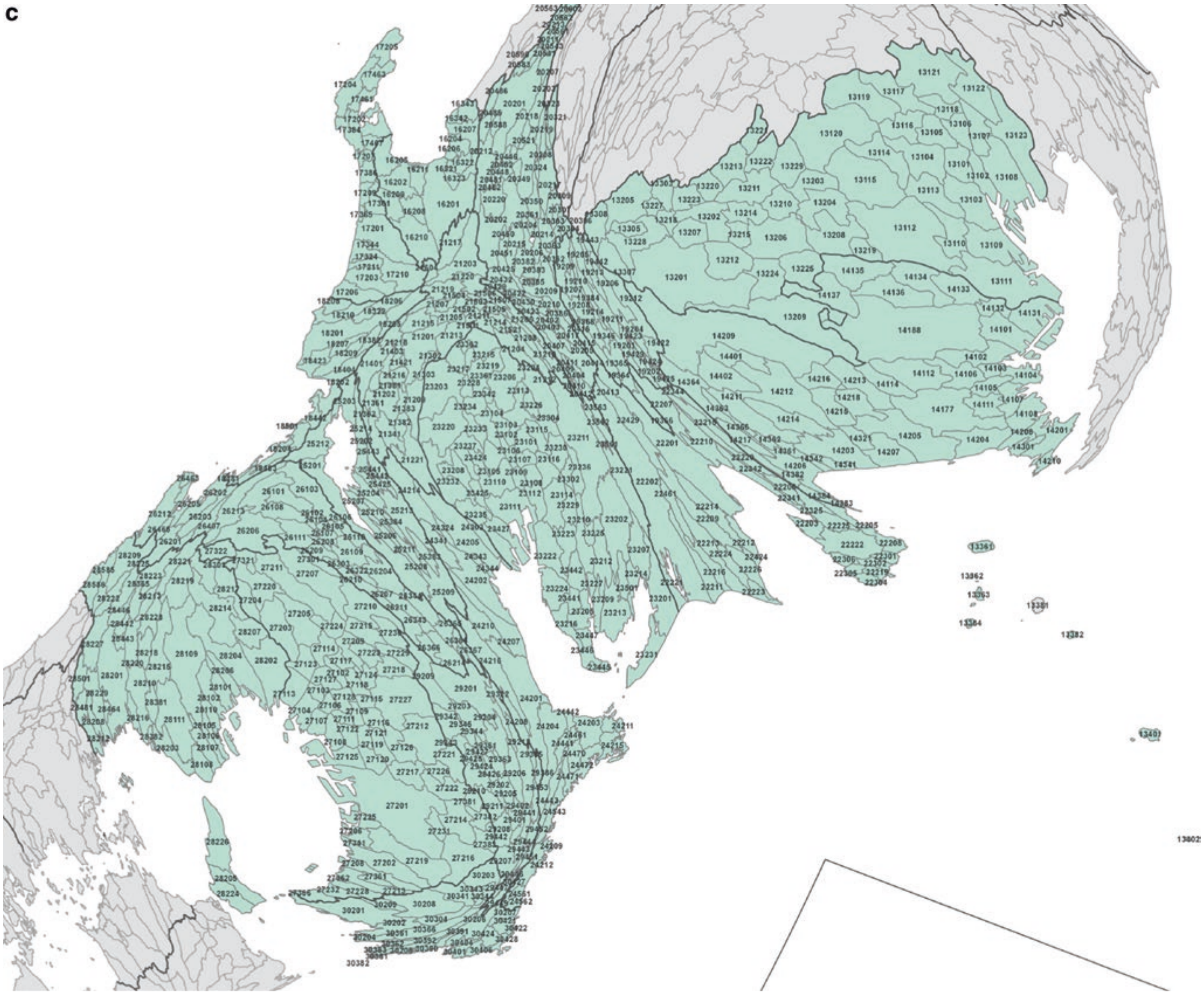


Fig. A.2 (continued)

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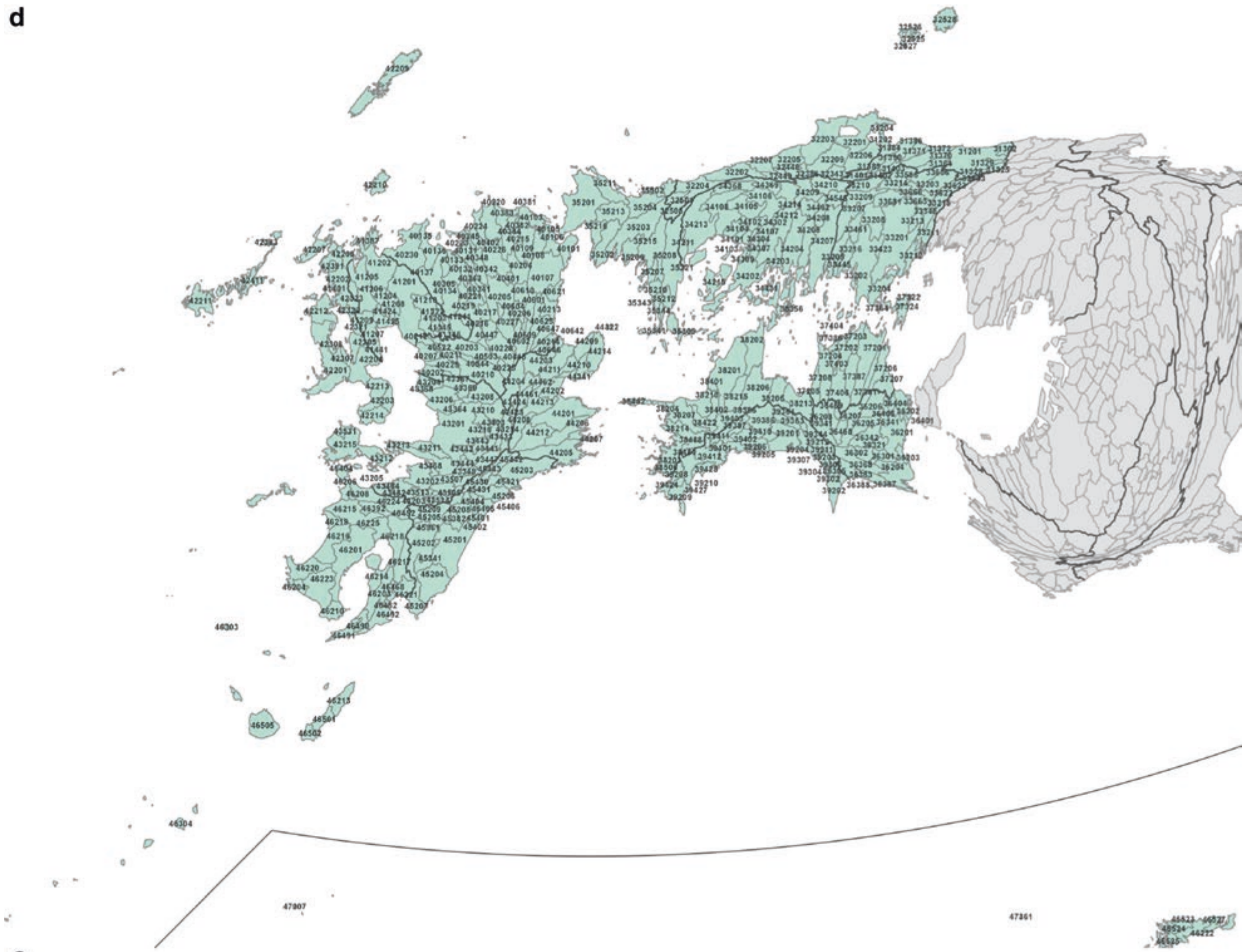

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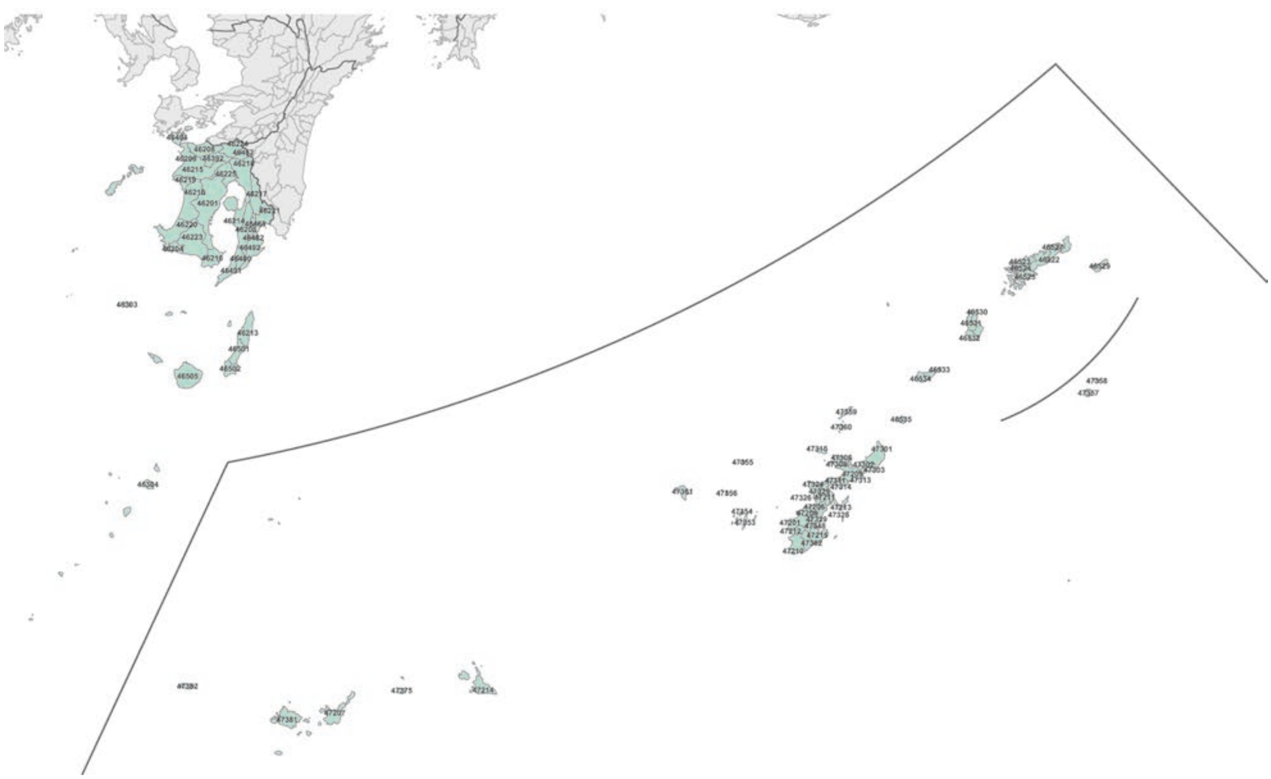

Fig. A.2 (continued)

The municipality-based units for the atlas are explained in Chap. 2, Sect. 2.5.

The original municipality names are listed in Table A.1 to avoid confusion in case several original municipalities have been merged into one unit.

Table A.1 Municipality codes and names

Code	Municipality name
Hokkaido	
01101	Sapporo-shi Chuo-ku
01102	Sapporo-shi Kita-ku
01103	Sapporo-shi Higashi-ku
01106	Sapporo-shi Minami-ku
01166	Sapporo-shi Toyohira-ku, Kiyota-ku
01177	Sapporo-shi Nishi-ku, Teine-ku
01188	Sapporo-shi Shiroishi-ku, Atsubetsu-ku
01202	Hakodate-shi
01203	Otaru-shi
01204	Asahikawa-shi
01205	Muroran-shi
01206	Kushiro-shi
01207	Obihiro-shi
01208	Kitami-shi
01209	Yubari-shi
01210	Iwamizawa-shi
01211	Abashiri-shi
01212	Rumoi-shi
01213	Tomakomai-shi
01214	Wakkanai-shi
01215	Bibai-shi
01216	Ashibetsu-shi
01217	Ebetsu-shi
01218	Akabira-shi
01219	Mombetsu-shi
01220	Shibetsu-shi
01221	Nayoro-shi
01222	Mikasa-shi
01223	Nemuro-shi
01224	Chitose-shi
01225	Takikawa-shi
01226	Sunagawa-shi
01227	Utashinai-shi
01228	Fukagawa-shi
01229	Furano-shi
01230	Noboribetsu-shi
01231	Eniwa-shi
01233	Date-shi
01234	Kitahiroshima-shi
01235	Ishikari-shi
01236	Hokuto-shi
01303	Tobetsu-cho
01304	Shinshinotsu-mura
01331	Matsumae-cho
01332	Fukushima-cho
01333	Shiriuchi-cho

(continued)

Code	Municipality name
01334	Kikonai-cho
01337	Nanae-cho
01343	Shikabe-cho
01345	Mori-machi
01346	Yakumo-cho
01347	Oshamambe-cho
01361	Esashi-cho
01362	Kaminokuni-cho
01363	Assabu-cho
01364	Otobe-cho
01367	Okushiri-cho
01370	Imakane-cho
01371	Setana-cho
01391	Shimamaki-mura
01392	Suttsu-cho
01393	Kuromatsunai-cho
01394	Rankoshi-cho
01395	Niseko-cho
01396	Makkari-mura
01397	Rusutsu-mura
01398	Kimobetsu-cho
01399	Kyogoku-cho
01400	Kutchan-cho
01401	Kyowa-cho
01402	Iwanai-cho
01403	Tomari-mura
01404	Kamoenai-mura
01405	Shakotan-cho
01406	Furubira-cho
01407	Niki-cho
01408	Yoichi-cho
01409	Akaigawa-mura
01423	Nanporo-cho
01424	Naie-cho
01425	Kamisunagawa-cho
01427	Yuni-cho
01428	Naganuma-cho
01429	Kuriyama-cho
01430	Tsukigata-cho
01431	Urausu-cho
01432	Shintotsukawa-cho
01433	Moseushi-cho
01434	Chippubetsu-cho
01436	Uryu-cho
01437	Hokuryu-cho
01438	Numata-cho
01452	Takasu-cho
01453	Higashikagura-cho
01454	Tohma-cho
01455	Pippu-cho
01456	Aibetsu-cho
01457	Kamikawa-cho
01458	Higashikawa-cho
01459	Biei-cho
01460	Kamifurano-cho
01461	Nakafurano-cho
01462	Minamifurano-cho

(continued)

Code	Municipality name
01463	Shimukappu-mura
01464	Wassamu-cho
01465	Kembuchi-cho
01468	Shimokawa-cho
01469	Bifuka-cho
01470	Otoineppu-mura
01471	Nakagawa-cho
01472	Horokanai-cho
01481	Mashike-cho
01482	Obira-cho
01483	Tomamae-cho
01484	Haboro-cho
01485	Shosambetsu-mura
01486	Embetsu-cho
01487	Teshio-cho
01511	Sarufutsu-mura
01512	Hamatombetsu-cho
01513	Nakatombetsu-cho
01514	Esashi-cho
01516	Toyotomi-cho
01517	Rebun-cho
01518	Rishiri-cho
01519	Rishirifuji-cho
01520	Horonobe-cho
01543	Bihoro-cho
01544	Tsubetsu-cho
01545	Shari-cho
01546	Kiyosato-cho
01547	Koshimizu-cho
01549	Kunneppu-cho
01550	Oketo-cho
01552	Saroma-cho
01555	Engaru-cho
01559	Yubetsu-cho
01560	Takinoue-cho
01561	Okoppe-cho
01562	Nishiokoppe-mura
01563	Omu-cho
01564	Ozora-cho
01571	Toyoura-cho
01575	Sobetsu-cho
01578	Shiraoi-cho
01581	Atsuma-cho
01584	Toyako-cho
01585	Abira-cho
01586	Mukawa-cho
01601	Hidaka-cho
01602	Biratori-cho
01604	Niikappu-cho
01607	Urakawa-cho
01608	Samani-cho
01609	Erimo-cho
01610	Shinhidaka-cho
01631	Otofuke-cho
01632	Shihoro-cho

(continued)

Code	Municipality name
01633	Kamishihoro-cho
01634	Shikaoi-cho
01635	Shintoku-cho
01636	Shimizu-cho
01637	Memuro-cho
01638	Nakasatsunai-mura
01639	Sarabetsu-mura
01641	Taiki-cho
01642	Hiroo-cho
01643	Makubetsu-cho
01644	Ikeda-cho
01645	Toyokoro-cho
01646	Hombetsu-cho
01647	Ashoro-cho
01648	Rikubetsu-cho
01649	Urahoro-cho
01661	Kushiro-cho
01662	Akkeshi-cho
01663	Hamanaka-cho
01664	Shibecha-cho
01665	Teshikaga-cho
01667	Tsurui-mura
01668	Shiranuka-cho
01691	Betsukai-cho
01692	Nakashibetsu-cho
01693	Shibetsu-cho
01694	Rausu-cho
01799	Shikotan-mura, Tomari-mura, Ruyobetsu-mura, Rubetsu-mura, Shana-mura, Shibetoro-mura
Aomori-ken	
02201	Aomori-shi
02202	Hirosaki-shi
02203	Hachinohe-shi
02204	Kuroishi-shi
02205	Goshogawara-shi
02206	Towada-shi
02207	Misawa-shi
02208	Mutsu-shi
02209	Tsugaru-shi
02210	Hirakawa-shi
02301	Hiranai-machi
02303	Imabetsu-machi
02304	Yomogita-mura
02307	Sotogahama-machi
02321	Ajigasawa-machi
02323	Fukaura-machi
02343	Nishimeya-mura
02361	Fujisaki-machi
02362	Owani-machi
02367	Inakadate-mura
02381	Itayanagi-machi
02384	Tsuruta-machi
02387	Nakadomari-machi
02401	Noheji-machi
02402	Shichinohe-machi

(continued)

Code	Municipality name
02405	Rokunohe-machi
02406	Yokohama-machi
02408	Tohoku-machi
02411	Rokkasho-mura
02412	Oirase-cho
02423	Oma-machi
02424	Higashidori-mura
02425	Kazamaura-mura
02426	Sai-mura
02441	Sannohe-machi
02442	Gonohe-machi
02443	Takko-machi
02445	Nambu-cho
02446	Hashikami-cho
02450	Shingo-mura
Iwate-ken	
03201	Morioka-shi
03202	Miyako-shi
03203	Ofunato-shi
03205	Hanamaki-shi
03206	Kitakami-shi
03207	Kuji-shi
03208	Tono-shi
03209	Ichinoseki-shi
03210	Rikuzentakata-shi
03211	Kamaishi-shi
03213	Ninohe-shi
03214	Hachimantai-shi
03215	Oshu-shi
03301	Shizukuishi-cho
03302	Kuzumaki-machi
03303	Iwate-machi
03305	Takizawa-shi
03321	Shiwa-cho
03322	Yahaba-cho
03366	Nishiwaga-machi
03381	Kanegasaki-cho
03402	Hiraizumi-cho
03441	Sumita-cho
03461	Otsuchi-cho
03482	Yamada-machi
03483	Iwaizumi-cho
03484	Tanohata-mura
03485	Fudai-mura
03501	Karumai-machi
03503	Noda-mura
03506	Kunohe-mura
03507	Hirono-cho
03524	Ichinohe-machi
Miyagi-ken	
04201	Sendai-shi Aoba-ku, Miyagino-ku, Wakabayashi-ku, Taihaku-ku, Izumi-ku
04202	Ishinomaki-shi
04203	Shiogama-shi
04205	Kesennuma-shi

(continued)

Code	Municipality name
04206	Shiroishi-shi
04207	Natori-shi
04208	Kakuda-shi
04209	Tagajo-shi
04211	Iwanuma-shi
04212	Tome-shi
04213	Kurihara-shi
04214	Higashimatsushima-shi
04215	Osaki-shi
04301	Zao-machi
04302	Shichikashuku-machi
04321	Ogawara-machi
04322	Murata-machi
04323	Shibata-machi
04324	Kawasaki-machi
04341	Marumori-machi
04361	Watari-cho
04362	Yamamoto-cho
04401	Matsushima-machi
04404	Shichigahama-machi
04406	Rifu-cho
04421	Taiwa-cho
04422	Osato-cho
04423	Tomiya-machi
04424	Ohira-mura
04444	Shikama-cho
04445	Kami-machi
04501	Wakuya-cho
04505	Misato-machi
04581	Onagawa-cho
04606	Minamisanriku-cho
Akita-ken	
05201	Akita-shi
05202	Noshiro-shi
05203	Yokote-shi
05204	Odate-shi
05206	Oga-shi
05207	Yuzawa-shi
05209	Kazuno-shi
05210	Yurihonjo-shi
05211	Katagami-shi
05212	Daisen-shi
05213	Kitaakita-shi
05214	Nikaho-shi
05215	Semboku-shi
05303	Kosaka-machi
05327	Kamikoani-mura
05346	Fujisato-machi
05348	Mitane-cho
05349	Happou-cho
05361	Gojome-machi
05363	Hachirogata-machi
05366	Ikawa-machi
05368	Ogata-mura
05434	Misato-cho
05463	Ugo-machi

(continued)

Code	Municipality name
05464	Higashinaruse-mura
Yamagata-ken	
06201	Yamagata-shi
06202	Yonezawa-shi
06203	Tsuruoka-shi
06204	Sakata-shi
06205	Shinjo-shi
06206	Sagae-shi
06207	Kaminoyama-shi
06208	Murayama-shi
06209	Nagai-shi
06210	Tendo-shi
06211	Higashine-shi
06212	Obanazawa-shi
06213	Nanyo-shi
06301	Yamanobe-machi
06302	Nakayama-machi
06321	Kahoku-cho
06322	Nishikawa-machi
06323	Asahi-machi
06324	Oe-machi
06341	Oishida-machi
06361	Kaneyama-machi
06362	Mogami-machi
06363	Funagata-machi
06364	Mamurogawa-machi
06365	Okura-mura
06366	Sakegawa-mura
06367	Tozawa-mura
06381	Takahata-machi
06382	Kawanishi-machi
06401	Oguni-machi
06402	Shirataka-machi
06403	Iide-machi
06426	Mikawa-machi
06428	Shonai-machi
06461	Yuza-machi
Fukushima-ken	
07201	Fukushima-shi
07202	Aizuwakamatsu-shi
07203	Koriyama-shi
07204	Iwaki-shi
07205	Shirakawa-shi
07207	Sukagawa-shi
07208	Kitakata-shi
07209	Soma-shi
07210	Nihonmatsu-shi
07211	Tamura-shi
07212	Minamisoma-shi
07213	Date-shi
07214	Motomiya-shi
07301	Kori-machi
07303	Kunimi-machi
07308	Kawamata-machi
07322	Otama-mura
07342	Kagamiishi-machi

(continued)

Code	Municipality name
07344	Tenei-mura
07362	Shimogo-machi
07364	Hinoemata-mura
07367	Tadami-machi
07368	Minamiaizu-machi
07402	Kitashiobara-mura
07405	Nishiaizu-machi
07407	Bandai-machi
07408	Inawashiro-machi
07421	Aizubange-machi
07422	Yugawa-mura
07423	Yanaizu-machi
07444	Mishima-machi
07445	Kaneyama-machi
07446	Showa-mura
07447	Aizumisato-machi
07461	Nishigo-mura
07464	Izumizaki-mura
07465	Nakajima-mura
07466	Yabuki-machi
07481	Tanagura-machi
07482	Yamatsuri-machi
07483	Hanawa-machi
07484	Samegawa-mura
07501	Ishikawa-machi
07502	Tamakawa-mura
07503	Hirata-mura
07504	Asakawa-machi
07505	Furudono-machi
07521	Miharu-machi
07522	Ono-machi
07541	Hirono-machi
07542	Naraha-machi
07543	Tomioka-machi
07544	Kawauchi-mura
07545	Okuma-machi
07546	Futaba-machi
07547	Namie-machi
07548	Katsurao-mura
07561	Shinchi-machi
07564	Iitate-mura
Ibaraki-ken	
08201	Mito-shi
08202	Hitachi-shi
08203	Tsuchiura-shi
08204	Koga-shi
08205	Ishioka-shi
08207	Yuki-shi
08208	Ryugasaki-shi
08210	Shimotsuma-shi
08211	Joso-shi
08212	Hitachiota-shi
08214	Takahagi-shi
08215	Kitaibaraki-shi
08216	Kasama-shi
08217	Toride-shi

(continued)

Code	Municipality name
08219	Ushiku-shi
08220	Tsukuba-shi
08221	Hitachinaka-shi
08222	Kashima-shi
08223	Itako-shi
08224	Moriya-shi
08225	Hitachiomiya-shi
08226	Naka-shi
08227	Chikusei-shi
08228	Bando-shi
08229	Inashiki-shi
08230	Kasumigaura-shi
08231	Sakuragawa-shi
08232	Kamisu-shi
08233	Namegata-shi
08234	Hokota-shi
08235	Tsukubamirai-shi
08236	Omitama-shi
08302	Ibaraki-machi
08309	Oarai-machi
08310	Shirosato-machi
08341	Tokai-mura
08364	Daigo-machi
08442	Miho-mura
08443	Ami-machi
08447	Kawachi-machi
08521	Yachiyo-machi
08542	Goka-machi
08546	Sakai-machi
08564	Tone-machi
Tochigi-ken	
09201	Utsunomiya-shi
09202	Ashikaga-shi
09203	Tochigi-shi
09204	Sano-shi
09205	Kanuma-shi
09206	Nikko-shi
09208	Oyama-shi
09209	Moka-shi
09210	Ohtawara-shi
09211	Yaita-shi
09213	Nasushiobara-shi
09214	Sakura-shi
09215	Nasukarasuyama-shi
09216	Shimotsuke-shi
09301	Kaminokawa-machi
09342	Mashiko-machi
09343	Motegi-machi
09344	Ichikai-machi
09345	Haga-machi
09361	Mibu-machi
09364	Nogi-machi
09384	Shioya-machi
09386	Takanezawa-machi
09407	Nasu-machi
09411	Nakagawa-machi

Code	Municipality name
Gumma-ken	
10201	Maebashi-shi
10202	Takasaki-shi
10203	Kiryu-shi
10204	Isesaki-shi
10205	Ota-shi
10206	Numata-shi
10207	Tatebayashi-shi
10208	Shibukawa-shi
10209	Fujioka-shi
10210	Tomioka-shi
10211	Annaka-shi
10212	Midori-shi
10344	Shinto-mura
10345	Yoshioka-machi
10366	Ueno-mura
10367	Kanna-machi
10382	Shimonita-machi
10383	Nammoku-mura
10384	Kanra-machi
10421	Nakanojo-machi
10424	Naganohara-machi
10425	Tsumagoi-mura
10426	Kusatsu-machi
10428	Takayama-mura
10429	Higashiagatsuma-machi
10443	Katashina-mura
10444	Kawaba-mura
10448	Showa-mura
10449	Minakami-machi
10464	Tamamura-machi
10521	Itakura-machi
10522	Meiwa-machi
10523	Chiyoda-machi
10524	Oizumi-machi
10525	Ora-machi
Saitama-ken	
11110	Saitama-shi Iwatsuki-ku
11188	Saitama-shi Nishi-ku, Kita-ku, Omiya-ku, Minuma-ku, Chuo-ku, Sakura-ku, Urawa-ku, Minami-ku, Midori-ku
11201	Kawagoe-shi
11202	Kumagaya-shi
11203	Kawaguchi-shi
11206	Gyoda-shi
11207	Chichibu-shi
11208	Tokorozawa-shi
11209	Hanno-shi
11210	Kazo-shi
11211	Honjo-shi
11212	Higashimatsuyama-shi
11214	Kasukabe-shi
11215	Sayama-shi
11216	Hanyu-shi
11217	Konosu-shi
11218	Fukaya-shi

Code	Municipality name
11219	Ageo-shi
11221	Soka-shi
11222	Koshigaya-shi
11223	Warabi-shi
11224	Toda-shi
11225	Iruma-shi
11227	Asaka-shi
11228	Shiki-shi
11229	Wako-shi
11230	Niiza-shi
11231	Okegawa-shi
11232	Kuki-shi
11233	Kitamoto-shi
11234	Yashio-shi
11235	Fujimi-shi
11237	Misato-shi
11238	Hasuda-shi
11239	Sakado-shi
11240	Satte-shi
11241	Tsurugashima-shi
11242	Hidaka-shi
11243	Yoshikawa-shi
11245	Fujimino-shi
11301	Ina-machi
11324	Miyoshi-machi
11326	Moroyama-machi
11327	Ogose-machi
11341	Namegawa-machi
11342	Ranzan-machi
11343	Ogawa-machi
11346	Kawajima-machi
11347	Yoshimi-machi
11348	Hatoyama-machi
11349	Tokigawa-machi
11361	Yokoze-machi
11362	Minano-machi
11363	Nagatoro-machi
11365	Ogano-machi
11369	Higashichichibu-mura
11381	Misato-machi
11383	Kamikawa-machi
11385	Kamisato-machi
11408	Yorii-machi
11442	Miyashiro-machi
11445	Shiraoka-shi
11464	Sugito-machi
11465	Matsubushi-machi
Chiba-ken	
12201	Chiba-shi Chuo-ku, Hanamigawa-ku, Inage-ku, Wakaba-ku, Midori-ku, Mihama-ku
12202	Choshi-shi
12203	Ichikawa-shi
12204	Funabashi-shi
12205	Tateyama-shi
12206	Kisarazu-shi
12207	Matsudo-shi
12208	Noda-shi

(continued)

Code	Municipality name
12210	Mobara-shi
12211	Narita-shi
12212	Sakura-shi
12213	Togane-shi
12215	Asahi-shi
12216	Narashino-shi
12217	Kashiwa-shi
12218	Katsuura-shi
12219	Ichihara-shi
12220	Nagareyama-shi
12221	Yachiyo-shi
12222	Abiko-shi
12223	Kamogawa-shi
12224	Kamagaya-shi
12225	Kimitsu-shi
12226	Futtsu-shi
12227	Urayasu-shi
12228	Yotsukaido-shi
12229	Sodegaura-shi
12230	Yachimata-shi
12231	Inzai-shi
12232	Shiroi-shi
12233	Tomisato-shi
12234	Minamiboso-shi
12235	Sosa-shi
12236	Katori-shi
12237	Sammu-shi
12238	Isumi-shi
12322	Shisui-machi
12329	Sakae-machi
12342	Kozaki-machi
12347	Tako-machi
12349	Tonosho-machi
12402	Oamishirasato-shi
12403	Kujukuri-machi
12409	Shibayama-machi
12410	Yokoshibahikari-machi
12421	Ichinomiya-machi
12422	Mutsuzawa-machi
12423	Chosei-mura
12424	Shirako-machi
12426	Nagara-machi
12427	Chonan-machi
12441	Otaki-machi
12443	Onjuku-machi
12463	Kyonan-machi
Tokyo-to	
13101	Chiyoda-ku
13102	Chuo-ku
13103	Minato-ku
13104	Shinjuku-ku
13105	Bunkyo-ku
13106	Taito-ku
13107	Sumida-ku
13108	Koto-ku
13109	Shinagawa-ku
13110	Meguro-ku

(continued)

Code	Municipality name
13111	Ota-ku
13112	Setagaya-ku
13113	Shibuya-ku
13114	Nakano-ku
13115	Suginami-ku
13116	Toshima-ku
13117	Kita-ku
13118	Arakawa-ku
13119	Itabashi-ku
13120	Nerima-ku
13121	Adachi-ku
13122	Katsushika-ku
13123	Edogawa-ku
13201	Hachioji-shi
13202	Tachikawa-shi
13203	Musashino-shi
13204	Mitaka-shi
13205	Ome-shi
13206	Fuchu-shi
13207	Akishima-shi
13208	Chofu-shi
13209	Machida-shi
13210	Koganei-shi
13211	Kodaira-shi
13212	Hino-shi
13213	Higashimurayama-shi
13214	Kokubunji-shi
13215	Kunitachi-shi
13218	Fussa-shi
13219	Komae-shi
13220	Higashiyamato-shi
13221	Kiyose-shi
13222	Higashikurume-shi
13223	Musashimurayama-shi
13224	Tama-shi
13225	Inagi-shi
13227	Hamura-shi
13228	Akiruno-shi
13229	Nishitokyo-shi
13303	Mizuho-machi
13305	Hinode-machi
13307	Hinohara-mura
13308	Okutama-machi
13361	Oshima-machi
13362	Toshima-mura
13363	Niijima-mura
13364	Kouzushima-mura
13381	Miyake-mura
13382	Mikurajima-mura
13401	Hachijo-machi
13402	Aogashima-mura
13421	Ogasawara-mura
Kanagawa-ken	
14101	Yokohama-shi Tsurumi-ku
14102	Yokohama-shi Kanagawa-ku
14103	Yokohama-shi Nishi-ku

(continued)

Code	Municipality name
14104	Yokohama-shi Naka-ku
14105	Yokohama-shi Minami-ku
14106	Yokohama-shi Hodogaya-ku
14107	Yokohama-shi Isogo-ku
14108	Yokohama-shi Kanazawa-ku
14111	Yokohama-shi Konan-ku
14112	Yokohama-shi Asahi-ku
14114	Yokohama-shi Seya-ku
14131	Kawasaki-shi Kawasaki-ku
14132	Kawasaki-shi Saiwai-ku
14133	Kawasaki-shi Nakahara-ku
14134	Kawasaki-shi Takatsu-ku
14135	Kawasaki-shi Tama-ku
14136	Kawasaki-shi Miyamae-ku
14137	Kawasaki-shi Asao-ku
14177	Yokohama-shi Totsuka-ku, Sakae-ku, Izumi-ku
14188	Yokohama-shi Kohoku-ku, Midori-ku, Aoba-ku, Tsuzuki-ku
14201	Yokosuka-shi
14203	Hiratsuka-shi
14204	Kamakura-shi
14205	Fujisawa-shi
14206	Odawara-shi
14207	Chigasaki-shi
14208	Zushi-shi
14209	Sagamihara-shi Midori-ku, Chuo-ku, Minami-ku
14210	Miura-shi
14211	Hadano-shi
14212	Atsugi-shi
14213	Yamato-shi
14214	Isehara-shi
14215	Ebina-shi
14216	Zama-shi
14217	Minamiashigara-shi
14218	Ayase-shi
14301	Hayama-machi
14321	Samukawa-machi
14341	Oiso-machi
14342	Ninomiya-machi
14361	Nakai-machi
14362	Oi-machi
14363	Matsuda-machi
14364	Yamakita-machi
14366	Kaisei-machi
14382	Hakone-machi
14383	Manazuru-machi
14384	Yugawara-machi
14401	Aikawa-machi
14402	Kiyokawa-mura
Niigata-ken	
15201	Niigata-shi Kita-ku, Higashi-ku, Chuo-ku, Konan-ku, Akiha-ku, Minami-ku, Nishi-ku, Nishikan-ku
15202	Nagaoka-shi
15204	Sanjo-shi

(continued)

Code	Municipality name
15205	Kashiwazaki-shi
15206	Shibata-shi
15208	Ojiya-shi
15209	Kamo-shi
15210	Tokamachi-shi
15211	Mitsuke-shi
15212	Murakami-shi
15213	Tsubame-shi
15216	Itoigawa-shi
15217	Myoko-shi
15218	Gosen-shi
15222	Joetsu-shi
15223	Agano-shi
15224	Sado-shi
15225	Uonuma-shi
15226	Minamiuonuma-shi
15227	Tainai-shi
15307	Seiro-machi
15342	Yahiko-mura
15361	Tagami-machi
15385	Aga-machi
15405	Izumozaki-machi
15461	Yuzawa-machi
15482	Tsunan-machi
15504	Kariwa-mura
15581	Sekikawa-mura
15586	Awashimaura-mura
Toyama-ken	
16201	Toyama-shi
16202	Takaoka-shi
16204	Uozu-shi
16205	Himi-shi
16206	Namerikawa-shi
16207	Kurobe-shi
16208	Tonami-shi
16209	Oyabe-shi
16210	Nanto-shi
16211	Imizu-shi
16321	Funahashi-mura
16322	Kamiichi-machi
16323	Tateyama-machi
16342	Nyuzen-machi
16343	Asahi-machi
Ishikawa-ken	
17201	Kanazawa-shi
17202	Nanao-shi
17203	Komatsu-shi
17204	Wajima-shi
17205	Suzu-shi
17206	Kaga-shi
17207	Hakui-shi
17209	Kahoku-shi
17210	Hakusan-shi
17211	Nomi-shi
17324	Kawakita-machi
17344	Nonoichi-shi
17361	Tsubata-machi

(continued)

Code	Municipality name
17365	Uchinada-machi
17384	Shika-machi
17386	Hodatsushimizu-cho
17407	Nakanoto-machi
17461	Anamizu-machi
17463	Noto-cho
Fukui-ken	
18201	Fukui-shi
18202	Tsuruga-shi
18204	Obama-shi
18205	Ono-shi
18206	Katsuyama-shi
18207	Sabae-shi
18208	Awara-shi
18209	Echizen-shi
18210	Sakai-shi
18322	Eiheiji-cho
18382	Ikeda-cho
18404	Minamiechizen-cho
18423	Echizen-cho
18442	Mihama-cho
18481	Takahama-cho
18483	Oi-cho
18501	Wakasa-cho
Yamanashi-ken	
19201	Kofu-shi, Fujikawaguchiko-machi
19202	Fujiyoshida-shi
19204	Tsuru-shi
19205	Yamanashi-shi
19206	Otsuki-shi
19207	Nirasaki-shi
19208	Minamiarupusu-shi
19209	Hokuto-shi
19210	Kai-shi
19211	Fuefuki-shi
19212	Uenohara-shi
19213	Koshu-shi
19214	Chuo-shi
19346	Ichikawamisato-cho
19364	Hayakawa-cho
19365	Minobu-cho
19366	Nanbu-cho
19368	Fujikawa-cho
19384	Showa-cho
19422	Doshi-mura
19423	Nishikatsura-cho
19424	Oshino-mura
19425	Yamanakako-mura
19429	Narusawa-mura
19442	Kosuge-mura
19443	Tabayama-mura
Nagano-ken	
20201	Nagano-shi
20202	Matsumoto-shi
20203	Ueda-shi
20204	Okaya-shi
20205	Iida-shi

(continued)

Code	Municipality name
20206	Suwa-shi
20207	Suzaka-shi
20208	Komoro-shi
20209	Ina-shi
20210	Komagane-shi
20211	Nakano-shi
20212	Omachi-shi
20213	Iiyama-shi
20214	Chino-shi
20215	Shiojiri-shi
20217	Saku-shi
20218	Chikuma-shi
20219	Tomi-shi
20220	Azumino-shi
20303	Koumi-machi
20304	Kawakami-mura
20305	Minamimaki-mura
20306	Minamiaiki-mura
20307	Kitaaiki-mura
20309	Sakuho-machi
20321	Karuizawa-machi
20323	Miyota-machi
20324	Tateshina-machi
20349	Aoki-mura
20350	Nagawa-machi
20361	Shimosuwa-machi
20362	Fujimi-machi
20363	Hara-mura
20382	Tatsuno-machi
20383	Minowa-machi
20384	Iijima-machi
20385	Minamiminowa-mura
20386	Nakagawa-mura
20388	Miyada-mura
20402	Matsukawa-machi
20403	Takamori-machi
20404	Anan-cho
20407	Achi-mura
20409	Hiraya-mura
20410	Neba-mura
20411	Shimojo-mura
20412	Urugi-mura
20413	Tenryu-mura
20414	Yasuoka-mura
20415	Takagi-mura
20416	Toyooka-mura
20417	Oshika-mura
20422	Agematsu-machi
20423	Nagiso-machi
20425	Kiso-mura
20429	Otaki-mura
20430	Okuwa-mura
20432	Kiso-machi
20446	Omi-mura
20448	Ikusaka-mura
20450	Yamagata-mura

(continued)

Code	Municipality name
20451	Asahi-mura
20452	Chikuhoku-mura
20481	Ikeda-machi
20482	Matsukawa-mura
20485	Hakuba-mura
20486	Otari-mura
20521	Sakaki-machi
20541	Obuse-machi
20543	Takayama-mura
20561	Yamanouchi-machi
20562	Kijimadaira-mura
20563	Nozawaonsen-mura
20583	Shinano-machi
20588	Ogawa-mura
20590	Iizuna-machi
20602	Sakae-mura
Gifu-ken	
21201	Gifu-shi
21202	Ogaki-shi
21203	Takayama-shi
21204	Tajimi-shi
21205	Seki-shi
21206	Nakatsugawa-shi
21207	Mino-shi
21208	Mizunami-shi
21209	Hashima-shi
21210	Ena-shi
21211	Minokamo-shi
21212	Toki-shi
21213	Kakamigahara-shi
21214	Kani-shi
21215	Yamagata-shi
21216	Mizuho-shi
21217	Hida-shi
21218	Motosu-shi
21219	Gujo-shi
21220	Gero-shi
21221	Kaizu-shi
21302	Ginan-cho
21303	Kasamatsu-cho
21341	Yoro-cho
21361	Tarui-cho
21362	Sekigahara-cho
21381	Godo-cho
21382	Wanouchi-cho
21383	Anpachi-cho
21401	Ibigawa-cho
21403	Ono-cho
21404	Ikeda-cho
21421	Kitagata-cho
21501	Sakahogi-cho
21502	Tomika-cho
21503	Kawabe-cho
21504	Hichiso-cho
21505	Yaotsu-cho
21506	Shirakawa-cho

(continued)

Code	Municipality name
21507	Higashishirakawa-mura
21521	Mitake-cho
21604	Shirakawa-mura
Shizuoka-ken	
22201	Shizuoka-shi Aoi-ku, Suruga-ku, Shimizu-ku
22202	Hamamatsu-shi Naka-ku, Higashi-ku, Nishi-ku, Minami-ku, Kita-ku, Hamakita-ku, Tenryu-ku
22203	Numazu-shi
22205	Atami-shi
22206	Mishima-shi
22207	Fujinomiya-shi
22208	Ito-shi
22209	Shimada-shi
22210	Fuji-shi
22211	Iwata-shi
22212	Yaizu-shi
22213	Kakegawa-shi
22214	Fujieda-shi
22215	Gotemba-shi
22216	Fukuroi-shi
22219	Shimoda-shi
22220	Susono-shi
22221	Kosai-shi
22222	Izu-shi
22223	Omaezaki-shi
22224	Kikugawa-shi
22225	Izunokuni-shi
22226	Makinohara-shi
22301	Higashiizu-cho
22302	Kawazu-cho
22304	Minamiizu-cho
22305	Matsuzaki-cho
22306	Nishiizu-cho
22325	Kannami-cho
22341	Shimizu-cho
22342	Nagaizumi-cho
22344	Oyama-cho
22424	Yoshida-cho
22429	Kawanehon-cho
22461	Mori-machi
Aichi-ken	
23101	Nagoya-shi Chikusa-ku
23102	Nagoya-shi Higashi-ku
23103	Nagoya-shi Kita-ku
23104	Nagoya-shi Nishi-ku
23105	Nagoya-shi Nakamura-ku
23106	Nagoya-shi Naka-ku
23107	Nagoya-shi Showa-ku
23108	Nagoya-shi Mizuho-ku
23109	Nagoya-shi Atsuta-ku
23110	Nagoya-shi Nakagawa-ku
23111	Nagoya-shi Minato-ku
23112	Nagoya-shi Minami-ku
23113	Nagoya-shi Moriyama-ku

(continued)

Code	Municipality name
23114	Nagoya-shi Midori-ku
23115	Nagoya-shi Meito-ku
23116	Nagoya-shi Tempaku-ku
23201	Toyohashi-shi
23202	Okazaki-shi
23203	Ichinomiya-shi
23204	Seto-shi
23205	Handa-shi
23206	Kasugai-shi
23207	Toyokawa-shi
23208	Tsushima-shi
23209	Hekinan-shi
23210	Kariya-shi
23211	Toyota-shi
23212	Anjo-shi
23213	Nishio-shi
23214	Gamagori-shi
23215	Inuyama-shi
23216	Tokoname-shi
23217	Konan-shi
23219	Komaki-shi
23220	Inazawa-shi
23221	Shinshiro-shi
23222	Tokai-shi
23223	Obu-shi
23224	Chita-shi
23225	Chiryu-shi
23226	Owariasahi-shi
23227	Takahama-shi
23228	Iwakura-shi
23229	Toyoake-shi
23230	Nisshin-shi
23231	Tahara-shi
23232	Aisai-shi
23233	Kiyosu-shi
23234	Kitanagoya-shi
23235	Yatomi-shi
23236	Miyoshi-shi
23237	Ama-shi
23302	Togo-cho
23304	Nagakute-shi
23342	Toyoyama-cho
23361	Oguchi-cho
23362	Fuso-cho
23424	Oharu-cho
23425	Kanie-cho
23427	Tobishima-mura
23441	Agui-cho
23442	Higashiura-cho
23445	Minamichita-cho
23446	Mihama-cho
23447	Taketoyo-cho
23501	Kota-cho
23561	Shitara-cho
23562	Toei-cho
23563	Toyone-mura

(continued)

Code	Municipality name
Mie-ken	
24201	Tsu-shi
24202	Yokkaichi-shi
24203	Ise-shi
24204	Matsusaka-shi
24205	Kuwana-shi
24207	Suzuka-shi
24208	Nabari-shi
24209	Owase-shi
24210	Kameyama-shi
24211	Toba-shi
24212	Kumano-shi
24214	Inabe-shi
24215	Shima-shi
24216	Iga-shi
24303	Kisosaki-cho
24324	Toin-cho
24341	Komono-cho
24343	Asahi-cho
24344	Kawagoe-cho
24441	Taki-cho
24442	Meiwa-cho
24443	Odai-cho
24461	Tamaki-cho
24470	Watarai-cho
24471	Taiki-cho
24472	Minamiise-cho
24543	Kihoku-cho
24561	Mihama-cho
24562	Kiho-cho
Shiga-ken	
25201	Otsu-shi
25202	Hikone-shi
25203	Nagahama-shi
25204	Omihachiman-shi
25206	Kusatsu-shi
25207	Moriyama-shi
25208	Ritto-shi
25209	Koka-shi
25210	Yasu-shi
25211	Konan-shi
25212	Takashima-shi
25213	Higashiomi-shi
25214	Maibara-shi
25383	Hino-cho
25384	Ryuo-cho
25425	Aisho-cho
25441	Toyosato-cho
25442	Kora-cho
25443	Taga-cho
Kyoto-fu	
26101	Kyoto-shi Kita-ku
26102	Kyoto-shi Kamigyo-ku
26103	Kyoto-shi Sakyo-ku
26104	Kyoto-shi Nakagyo-ku
26105	Kyoto-shi Higashiyama-ku

(continued)

Code	Municipality name
26106	Kyoto-shi Shimogyo-ku
26107	Kyoto-shi Minami-ku
26108	Kyoto-shi Ukyo-ku
26109	Kyoto-shi Fushimi-ku
26110	Kyoto-shi Yamashina-ku
26111	Kyoto-shi Nishikyo-ku
26201	Fukuchiyama-shi
26202	Maizuru-shi
26203	Ayabe-shi
26204	Uji-shi
26205	Miyazu-shi
26206	Kameoka-shi
26207	Joyo-shi
26208	Muko-shi
26209	Nagaokakyo-shi
26210	Yawata-shi
26211	Kyotanabe-shi
26212	Kyotango-shi
26213	Nantan-shi
26214	Kizugawa-shi
26303	Oyamazaki-cho
26322	Kumiyama-cho
26343	Ide-cho
26344	Ujitawara-cho
26364	Kasagi-cho
26365	Wazuka-cho
26366	Seika-cho
26367	Minamiyamashiro-mura
26407	Kyotamba-cho
26463	Ine-cho
26465	Yosano-cho
Osaka-fu	
27102	Osaka-shi Miyakojima-ku
27103	Osaka-shi Fukushima-ku
27104	Osaka-shi Konohana-ku
27106	Osaka-shi Nishi-ku
27107	Osaka-shi Minato-ku
27108	Osaka-shi Taisho-ku
27109	Osaka-shi Tennoji-ku
27111	Osaka-shi Naniwa-ku
27113	Osaka-shi Nishiyodogawa-ku
27114	Osaka-shi Higashiyodogawa-ku
27115	Osaka-shi Higashinari-ku
27116	Osaka-shi Ikuno-ku
27117	Osaka-shi Asahi-ku
27118	Osaka-shi Joto-ku
27119	Osaka-shi Abeno-ku
27120	Osaka-shi Sumiyoshi-ku
27121	Osaka-shi Higashisumiyoshi-ku
27122	Osaka-shi Nishinari-ku
27123	Osaka-shi Yodogawa-ku
27124	Osaka-shi Tsurumi-ku
27125	Osaka-shi Suminoe-ku
27126	Osaka-shi Hirano-ku
27127	Osaka-shi Kita-ku
27128	Osaka-shi Chuo-ku

(continued)

Code	Municipality name
27201	Sakai-shi Sakai-ku, Naka-ku, Higashi-ku, Nishi-ku, Minami-ku, Kita-ku, Mihara-ku
27202	Kishiwada-shi
27203	Toyonaka-shi
27204	Ikeda-shi
27205	Suita-shi
27206	Izumiotsu-shi
27207	Takatsuki-shi
27208	Kaizuka-shi
27209	Moriguchi-shi
27210	Hirakata-shi
27211	Ibaraki-shi
27212	Yao-shi
27213	Izumisano-shi
27214	Tondabayashi-shi
27215	Neyagawa-shi
27216	Kawachinagano-shi
27217	Matsubara-shi
27218	Daito-shi
27219	Izumi-shi
27220	Minoh-shi
27221	Kashiwara-shi
27222	Habikino-shi
27223	Kadoma-shi
27224	Settsu-shi
27225	Takaishi-shi
27226	Fujiidera-shi
27227	Higashiosaka-shi
27228	Sennan-shi
27229	Shijonawate-shi
27230	Katano-shi
27231	Osakasayama-shi
27232	Hannan-shi
27301	Shimamoto-cho
27321	Toyono-cho
27322	Nose-cho
27341	Tadaoka-cho
27361	Kumatori-cho
27362	Tajiri-cho
27366	Misaki-cho
27381	Taishi-cho
27382	Kanan-cho
27383	Chihayaakasaka-mura
Hyogo-ken	
28101	Kobe-shi Higashinada-ku
28102	Kobe-shi Nada-ku
28105	Kobe-shi Hyogo-ku
28106	Kobe-shi Nagata-ku
28107	Kobe-shi Suma-ku
28108	Kobe-shi Tarumi-ku
28109	Kobe-shi Kita-ku
28110	Kobe-shi Chuo-ku
28111	Kobe-shi Nishi-ku
28201	Himeji-shi
28202	Amagasaki-shi

(continued)

Code	Municipality name
28203	Akashi-shi
28204	Nishinomiya-shi
28205	Sumoto-shi
28206	Ashiya-shi
28207	Itami-shi
28208	Aioi-shi
28209	Toyooka-shi
28210	Kakogawa-shi
28212	Ako-shi
28213	Nishiwaki-shi
28214	Takarazuka-shi
28215	Miki-shi
28216	Takasago-shi
28217	Kawanishi-shi
28218	Ono-shi
28219	Sanda-shi
28220	Kasai-shi
28221	Sasayama-shi
28222	Yabu-shi
28223	Tamba-shi
28224	Minamiawaji-shi
28225	Asago-shi
28226	Awaji-shi
28227	Shiso-shi
28228	Kato-shi
28229	Tatsuno-shi
28301	Inagawa-cho
28365	Taka-cho
28381	Inami-cho
28382	Harima-cho
28442	Ichikawa-cho
28443	Fukusaki-cho
28446	Kamikawa-cho
28464	Taishi-cho
28481	Kamigori-cho
28501	Sayo-cho
28585	Kami-cho
28586	Shinonsen-cho
Nara-ken	
29201	Nara-shi
29202	Yamatotakada-shi
29203	Yamatokoriyama-shi
29204	Tenri-shi
29205	Kashihara-shi
29206	Sakurai-shi
29207	Gojo-shi
29208	Gose-shi
29209	Ikoma-shi
29210	Kashiba-shi
29211	Katsuragi-shi
29212	Uda-shi
29322	Yamazoe-mura
29342	Heguri-cho
29343	Sango-cho
29344	Ikaruga-cho
29345	Ando-cho

(continued)

Code	Municipality name
29361	Kawanishi-cho
29362	Miyake-cho
29363	Tawaramoto-cho
29385	Soni-mura
29386	Mitsue-mura
29401	Takatori-cho
29402	Asuka-mura
29424	Kammaki-cho
29425	Oji-cho
29426	Koryo-cho
29427	Kawai-cho
29441	Yoshino-cho
29442	Oyodo-cho
29443	Shimoichi-cho
29444	Kurotaki-mura
29446	Tenkawa-mura
29447	Nosegawa-mura
29449	Totsukawa-mura
29450	Shimokitayama-mura
29451	Kamikitayama-mura
29452	Kawakami-mura
29453	Higashiyoshino-mura
Wakayama-ken	
30201	Wakayama-shi
30202	Kainan-shi
30203	Hashimoto-shi
30204	Arida-shi
30205	Gobo-shi
30206	Tanabe-shi
30207	Shingu-shi
30208	Kinokawa-shi
30209	Iwade-shi
30304	Kimino-cho
30341	Katsuragi-cho
30343	Kudoyama-cho
30344	Koya-cho
30361	Yuasa-cho
30362	Hirogawa-cho
30366	Aridagawa-cho
30381	Mihama-cho
30382	Hidaka-cho
30383	Yura-cho
30390	Inami-cho
30391	Minabe-cho
30392	Hidakagawa-cho
30401	Shirahama-cho
30404	Kamitonda-cho
30406	Susami-cho
30421	Nachikatsuura-cho
30422	Taiji-cho
30424	Kozagawa-cho
30427	Kitayama-mura
30428	Kushimoto-cho
Tottori-ken	
31201	Tottori-shi
31202	Yonago-shi

(continued)

Code	Municipality name
31203	Kurayoshi-shi
31204	Sakaiminato-shi
31302	Iwami-cho
31325	Wakasa-cho
31328	Chizu-cho
31329	Yazu-cho
31364	Misasa-cho
31370	Yurihama-cho
31371	Kotoura-cho
31372	Hokuei-cho
31384	Hiezu-son
31386	Daisen-cho
31389	Nanbu-cho
31390	Hoki-cho
31401	Nichinan-cho
31402	Hino-cho
31403	Kofu-cho
Shimane-ken	
32201	Matsue-shi
32202	Hamada-shi
32203	Izumo-shi
32204	Masuda-shi
32205	Oda-shi
32206	Yasugi-shi
32207	Gotsu-shi
32209	Unnan-shi
32343	Okuizumo-cho
32386	Iinan-cho
32441	Kawamoto-machi
32448	Misato-cho
32449	Onan-cho
32501	Tsuwano-cho
32505	Yoshika-cho
32525	Ama-cho
32526	Nishinoshima-cho
32527	Chibu-mura
32528	Okinoshima-cho
Okayama-ken	
33201	Okayama-shi Kita-ku, Naka-ku, Higashi-ku, Minami-ku
33202	Kurashiki-shi
33203	Tsuyama-shi
33204	Tamano-shi
33205	Kasaoka-shi
33207	Ibara-shi
33208	Soja-shi
33209	Takahashi-shi
33210	Niimi-shi
33211	Bizen-shi
33212	Setouchi-shi
33213	Akaiwa-shi
33214	Maniwa-shi
33215	Mimasaka-shi
33216	Asakuchi-shi
33346	Wake-cho
33423	Hayashima-cho

(continued)

Code	Municipality name
33445	Satosho-cho
33461	Yakage-cho
33586	Shinjo-son
33606	Kagamino-cho
33622	Shoo-cho
33623	Nagi-cho
33643	Nishiawakura-son
33663	Kumenan-cho
33666	Misaki-cho
33681	Kibichuo-cho
Hiroshima-ken	
34101	Hiroshima-shi Naka-ku
34102	Hiroshima-shi Higashi-ku
34103	Hiroshima-shi Minami-ku
34104	Hiroshima-shi Nishi-ku
34105	Hiroshima-shi Asaminami-ku
34106	Hiroshima-shi Asakita-ku
34107	Hiroshima-shi Aki-ku
34108	Hiroshima-shi Saeki-ku
34202	Kure-shi
34203	Takehara-shi
34204	Mihara-shi
34205	Onomichi-shi
34207	Fukuyama-shi
34208	Fuchu-shi
34209	Miyoshi-shi
34210	Shobara-shi
34211	Otake-shi
34212	Higashihiroshima-shi
34213	Hatsukaichi-shi
34214	Akitakata-shi
34215	Etajima-shi
34302	Fuchu-cho
34304	Kaita-cho
34307	Kumano-cho
34309	Saka-cho
34368	Akiota-cho
34369	Kitahiroshima-cho
34431	Osakikamijima-cho
34462	Sera-cho
34545	Jinsekikogen-cho
Yamaguchi-ken	
35201	Shimonoseki-shi
35202	Ube-shi
35203	Yamaguchi-shi
35204	Hagi-shi
35206	Hofu-shi
35207	Kudamatsu-shi
35208	Iwakuni-shi
35210	Hikari-shi
35211	Nagato-shi
35212	Yanai-shi
35213	Mine-shi
35215	Shunan-shi
35216	Sanyoonoda-shi
35305	Suooshima-cho

(continued)

Code	Municipality name
35321	Waki-cho
35341	Kaminoseki-cho
35343	Tabuse-cho
35344	Hirao-cho
35502	Abu-cho
Tokushima-ken	
36201	Tokushima-shi
36202	Naruto-shi
36203	Komatsushima-shi
36204	Anan-shi
36205	Yoshinogawa-shi
36206	Awa-shi
36207	Mima-shi
36208	Miyoshi-shi
36301	Katsuura-cho
36302	Kamikatsu-cho
36321	Sanagouchi-son
36341	Ishii-cho
36342	Kamiyama-cho
36368	Naka-cho
36383	Mugi-cho
36387	Minami-cho
36388	Kaiyo-cho
36401	Matsushige-cho
36402	Kitajima-cho
36403	Aizumi-cho
36404	Itano-cho
36405	Kamiita-cho
36468	Tsurugi-cho
36489	Higashimiyoshi-cho
Kagawa-ken	
37201	Takamatsu-shi
37202	Marugame-shi
37203	Sakaide-shi
37204	Zentsuji-shi
37205	Kanonji-shi
37206	Sanuki-shi
37207	Higashikagawa-shi
37208	Mitoyo-shi
37322	Tonosho-cho
37324	Shodoshima-cho
37341	Miki-cho
37364	Naoshima-cho
37386	Utazu-cho
37387	Ayagawa-cho
37403	Kotohira-cho
37404	Tadotsu-cho
37406	Manno-cho
Ehime-ken	
38201	Matsuyama-shi
38202	Imabari-shi
38203	Uwajima-shi
38204	Yawatahama-shi
38205	Niihama-shi
38206	Saijo-shi
38207	Ozu-shi

(continued)

Code	Municipality name
38210	Iyo-shi
38213	Shikokuchuo-shi
38214	Seiyo-shi
38215	Toon-shi
38356	Kamijima-cho
38386	Kumakogen-cho
38401	Masaki-cho
38402	Tobe-cho
38422	Uchiko-cho
38442	Ikata-cho
38484	Matsuno-cho
38488	Kihoku-cho
38506	Ainan-cho
Kochi-ken	
39201	Kochi-shi
39202	Muroto-shi
39203	Aki-shi
39204	Nankoku-shi
39205	Tosa-shi
39206	Susaki-shi
39208	Sukumo-shi
39209	Tosashimizu-shi
39210	Shimanto-shi
39211	Konan-shi
39212	Kami-shi
39301	Toyo-cho
39302	Nahari-cho
39303	Tano-cho
39304	Yasuda-cho
39305	Kitagawa-mura
39306	Umaji-mura
39307	Geisei-mura
39341	Motoyama-cho
39344	Otoyo-cho
39363	Tosa-cho
39364	Okawa-mura
39386	Ino-cho
39387	Niyodogawa-cho
39401	Nakatosa-cho
39402	Sakawa-cho
39403	Ochi-cho
39405	Yusuhara-cho
39410	Hidaka-mura
39411	Tsuno-cho
39412	Shimanto-cho
39424	Otsuki-cho
39427	Mihara-mura
39428	Kuroshio-cho
Fukuoka-ken	
40101	Kitakyushu-shi Moji-ku
40103	Kitakyushu-shi Wakamatsu-ku
40105	Kitakyushu-shi Tobata-ku
40106	Kitakyushu-shi Kokurakita-ku
40107	Kitakyushu-shi Kokuraminami-ku
40108	Kitakyushu-shi Yahatahigashi-ku
40109	Kitakyushu-shi Yahatanishi-ku
40131	Fukuoka-shi Higashi-ku
40132	Fukuoka-shi Hakata-ku

(continued)

Code	Municipality name
40133	Fukuoka-shi Chuo-ku
40134	Fukuoka-shi Minami-ku
40135	Fukuoka-shi Nishi-ku
40136	Fukuoka-shi Jonan-ku
40137	Fukuoka-shi Sawara-ku
40202	Omuta-shi
40203	Kurume-shi
40204	Nogata-shi
40205	Iizuka-shi
40206	Tagawa-shi
40207	Yanagawa-shi
40210	Yame-shi
40211	Chikugo-shi
40212	Okawa-shi
40213	Yukuhashi-shi
40214	Buzen-shi
40215	Nakama-shi
40216	Ogori-shi
40217	Chikushino-shi
40218	Kasuga-shi
40219	Onojo-shi
40220	Munakata-shi
40221	Dazaifu-shi
40223	Koga-shi
40224	Fukutsu-shi
40225	Ukiha-shi
40226	Miyawaka-shi
40227	Kama-shi
40228	Asakura-shi
40229	Miyama-shi
40230	Itoshima-shi
40305	Nakagawa-machi
40341	Umi-machi
40342	Sasaguri-machi
40343	Shime-machi
40344	Sue-machi
40345	Shingu-machi
40348	Hisayama-machi
40349	Kasuya-machi
40381	Ashiya-machi
40382	Mizumaki-machi
40383	Okagaki-machi
40384	Onga-cho
40401	Kotake-machi
40402	Kurate-machi
40421	Keisen-machi
40447	Chikuzen-machi
40448	Toho-mura
40503	Tachiarai-machi
40522	Oki-machi
40544	Hirokawa-machi
40601	Kawara-machi
40602	Soeda-machi
40604	Itoda-machi
40605	Kawasaki-machi
40608	Oto-machi
40609	Aka-mura
40610	Fukuchi-machi

(continued)

Code	Municipality name
40621	Kanda-machi
40625	Miyako-machi
40642	Yoshitomi-machi
40646	Koge-machi
40647	Chikujo-machi
Saga-ken	
41201	Saga-shi
41202	Karatsu-shi
41203	Tosu-shi
41204	Taku-shi
41205	Imari-shi
41206	Takeo-shi
41207	Kashima-shi
41208	Ogi-shi
41209	Ureshino-shi
41210	Kanzaki-shi
41327	Yoshinogari-cho
41341	Kiyama-cho
41345	Kamimine-cho
41346	Miyaki-cho
41387	Genkai-cho
41401	Arita-cho
41423	Omachi-cho
41424	Kohoku-machi
41425	Shiroishi-cho
41441	Tara-cho
Nagasaki-ken	
42201	Nagasaki-shi
42202	Sasebo-shi
42203	Shimabara-shi
42204	Isahaya-shi
42205	Omura-shi
42207	Hirado-shi
42208	Matsuura-shi
42209	Tsushima-shi
42210	Iki-shi
42211	Goto-shi
42212	Saikai-shi
42213	Unzen-shi
42214	Minamishimabara-shi
42307	Nagayo-cho
42308	Togitsu-cho
42321	Higashisonogi-cho
42322	Kawatana-cho
42323	Hasami-cho
42383	Ojika-cho
42391	Saza-cho
42411	Shinkamigoto-cho
Kumamoto-ken	
43201	Kumamoto-shi Chuo-ku, Higashi-ku, Nishi-ku, Minami-ku, Kita-ku
43202	Yatsushiro-shi
43203	Hitoyoshi-shi
43204	Arao-shi
43205	Minamata-shi
43206	Tamana-shi
43208	Yamaga-shi

(continued)

Code	Municipality name
43210	Kikuchi-shi
43211	Uto-shi
43212	Kamiamakusa-shi
43213	Uki-shi
43214	Aso-shi
43215	Amakusa-shi
43216	Koshi-shi
43348	Misato-machi
43364	Gyokuto-machi
43367	Nankan-machi
43368	Nagasu-machi
43369	Nagomi-machi
43403	Ozu-machi
43404	Kikuyo-machi
43423	Minamioguni-machi
43424	Oguni-machi
43425	Ubuyama-mura
43428	Takamori-machi
43432	Nishihara-mura
43433	Minamiaso-mura
43441	Mifune-machi
43442	Kashima-machi
43443	Mashiki-machi
43444	Kosa-machi
43447	Yamato-cho
43468	Hikawa-cho
43482	Ashikita-machi
43484	Tsunagi-machi
43501	Nishiki-machi
43505	Taragi-machi
43506	Yunomae-machi
43507	Mizukami-mura
43510	Sagara-mura
43511	Itsuki-mura
43512	Yamae-mura
43513	Kuma-mura
43514	Asagiri-cho
43531	Reihoku-machi
Oita-ken	
44201	Oita-shi
44202	Beppu-shi
44203	Nakatsu-shi
44204	Hita-shi
44205	Saiki-shi
44206	Usuki-shi
44207	Tsukumi-shi
44208	Taketa-shi
44209	Bungotakada-shi
44210	Kitsuki-shi
44211	Usa-shi
44212	Bungoono-shi
44213	Yufu-shi
44214	Kunisaki-shi
44322	Himeshima-mura
44341	Hiji-machi
44461	Kokonoe-machi
44462	Kusu-machi

(continued)

Code	Municipality name
Miyazaki-ken	
45201	Miyazaki-shi
45202	Miyakonojo-shi
45203	Nobeoka-shi
45204	Nichinan-shi
45205	Kobayashi-shi
45206	Hyuga-shi
45207	Kushima-shi
45208	Saito-shi
45209	Ebino-shi
45341	Mimata-cho
45361	Takaharu-cho
45382	Kunitomi-cho
45383	Aya-cho
45401	Takanabe-cho
45402	Shintomi-cho
45403	Nishimera-son
45404	Kijo-cho
45405	Kawaminami-cho
45406	Tsuno-cho
45421	Kadogawa-cho
45429	Morotsuka-son
45430	Shiiba-son
45431	Misato-cho
45441	Takachiho-cho
45442	Hinokage-cho
45443	Gokase-cho
Kagoshima-ken	
46201	Kagoshima-shi
46203	Kanoya-shi
46204	Makurazaki-shi
46206	Akune-shi
46208	Izumi-shi
46210	Ibusuki-shi
46213	Nishinoomote-shi
46214	Tarumizu-shi
46215	Satsumasendai-shi
46216	Hioki-shi
46217	So-shi
46218	Kirishima-shi
46219	Ichikikushikino-shi
46220	Minamisatsuma-shi
46221	Shibushi-shi
46222	Amami-shi
46223	Minamikyushu-shi
46224	Isa-shi
46225	Aira-shi
46303	Mishima-mura
46304	Toshima-mura
46392	Satsuma-cho
46404	Nagashima-cho
46452	Yusui-cho
46468	Osaki-cho
46482	Higashikushira-cho
46490	Kinko-cho
46491	Minamiosumi-cho
46492	Kimotsuki-cho

(continued)

Code	Municipality name
46501	Nakatane-cho
46502	Minamitane-cho
46505	Yakushima-cho
46523	Yamato-son
46524	Uken-son
46525	Setouchi-cho
46527	Tatsugo-cho
46529	Kikai-cho
46530	Tokunoshima-cho
46531	Amagi-cho
46532	Isen-cho
46533	Wadomari-cho
46534	China-cho
46535	Yoron-cho
Okinawa-ken	
47201	Naha-shi
47205	Ginowan-shi
47207	Ishigaki-shi
47208	Urasoe-shi
47209	Nago-shi
47210	Itoman-shi
47211	Okinawa-shi
47212	Tomigusuku-shi
47213	Uruma-shi
47214	Miyakojima-shi
47215	Nanjo-shi
47301	Kunigami-son
47302	Ogimi-son
47303	Higashi-son
47306	Nakijin-son
47308	Motobu-cho
47311	Onna-son
47313	Ginoza-son
47314	Kin-cho
47315	Ie-son
47324	Yomitan-son
47325	Kadena-cho
47326	Chatan-cho
47327	Kitanakagusuku-son
47328	Nakagusuku-son
47329	Nishihara-cho
47348	Yonabaru-cho
47350	Haebaru-cho
47353	Tokashiki-son
47354	Zamami-son
47355	Aguni-son
47356	Tonaki-son
47357	Minamidaito-son
47358	Kitadaito-son
47359	Iheya-son
47360	Izena-son
47361	Kumejima-cho
47362	Yaese-cho
47375	Tarama-son
47381	Taketomi-cho
47382	Yonaguni-cho

Summary of Mortality Inequalities by Cause of Death

Tables A.2 and A.3 are supplementary tables having the information for every cause of death used in the atlas to the content in Chap. 7 (Tables 7.1 and 7.2)

Table A.2 Summary table of indices of mortality inequalities by cause of death, men

		ASMR per 100,000		Slope index of inequalities			Relative index of inequalities		
		1st Quintile	5th Quintile	Estimate	95% CI (LL & UL)		Estimate	95% CI (LL & UL)	
All causes of death	1995–1999	625.6	728.7	**125.28**	122.40	128.15	**1.20**	1.20	1.21
	2010–2014	472.3	587.1	**117.30**	115.34	119.26	**1.25**	1.25	1.26
Cancer (all sites)	1995–1999	211.6	234.5	**26.95**	25.31	28.60	**1.13**	1.12	1.14
	2010–2014	163.5	190.6	**31.58**	30.44	32.72	**1.20**	1.19	1.20
Oesophageal cancer	1995–1999	10.7	10.8	**0.29**	−0.07	0.64	**1.03**	0.99	1.06
	2010–2014	8.4	9.0	**0.55**	0.29	0.81	**1.07**	1.03	1.10
Stomach cancer	1995–1999	41.6	41.4	**−1.27**	−2.00	−0.55	**0.97**	0.95	0.99
	2010–2014	24.8	27.1	**1.96**	1.52	2.40	**1.08**	1.06	1.10
Colorectal cancer	1995–1999	24.7	24.2	**−0.70**	−1.25	−0.16	**0.97**	0.95	0.99
	2010–2014	19.7	22.8	**3.34**	2.93	3.74	**1.17**	1.15	1.19
Liver and intrahepatic bile ducts cancer	1995–1999	26.5	36.0	**12.52**	11.93	13.10	**1.52**	1.49	1.55
	2010–2014	14.2	20.3	**7.92**	7.57	8.26	**1.60**	1.57	1.64
Gallbladder and other biliary tract cancer	1995–1999	7.6	9.3	**1.84**	1.52	2.16	**1.24**	1.20	1.29
	2010–2014	6.1	7.4	**1.46**	1.25	1.68	**1.24**	1.20	1.28
Pancreatic cancer	1995–1999	11.8	12.8	**0.84**	0.45	1.23	**1.07**	1.04	1.10
	2010–2014	12.7	13.5	**0.62**	0.30	0.94	**1.05**	1.02	1.07
Trachea, bronchus, and lung cancer	1995–1999	44.1	51.4	**8.84**	8.08	9.59	**1.21**	1.19	1.23
	2010–2014	37.3	45.4	**9.75**	9.21	10.30	**1.27**	1.25	1.29
Malignant mesothelioma	1995–1999	0.5	0.6	**0.16**	0.08	0.24	**1.32**	1.14	1.53
	2010–2014	0.9	1.1	**0.19**	0.10	0.27	**1.23**	1.12	1.34
Prostate cancer	1995–1999	8.4	8.2	**−0.18**	−0.50	0.13	**0.98**	0.94	1.02
	2010–2014	7.5	7.9	**0.57**	0.34	0.79	**1.08**	1.05	1.11
Malignant lymphoma	1995–1999	5.4	5.8	**0.37**	0.11	0.63	**1.07**	1.02	1.12
	2010–2014	4.8	5.2	**0.49**	0.29	0.68	**1.10**	1.06	1.15
Leukaemia	1995–1999	4.7	6.2	**1.77**	1.51	2.02	**1.41**	1.34	1.48
	2010–2014	4.0	5.3	**1.55**	1.36	1.74	**1.42**	1.36	1.49
Heart disease (excluding hypertensive heart diseases)	1995–1999	90.5	99.0	**12.02**	10.94	13.09	**1.14**	1.12	1.15
	2010–2014	66.8	79.9	**13.04**	12.32	13.75	**1.20**	1.19	1.21
Acute myocardial infarction	1995–1999	34.3	37.0	**4.69**	4.04	5.35	**1.14**	1.12	1.16
	2010–2014	17.7	20.8	**3.22**	2.84	3.59	**1.19**	1.16	1.21
Other ischaemic heart diseases	1995–1999	18.1	16.1	**−1.62**	−2.06	−1.18	**0.90**	0.88	0.93
	2010–2014	16.4	16.6	**−1.05**	−1.40	−0.70	**0.94**	0.92	0.96
Cardiac arrhythmias and conduction disorders	1995–1999	7.8	9.1	**2.13**	1.80	2.46	**1.27**	1.23	1.32
	2010–2014	8.9	13.0	**3.90**	3.62	4.17	**1.44**	1.40	1.48
Heart failure	1995–1999	22.3	26.6	**4.56**	4.02	5.11	**1.21**	1.18	1.23
	2010–2014	17.0	21.1	**4.44**	4.09	4.78	**1.27**	1.25	1.29
Cerebrovascular disease	1995–1999	79.5	89.8	**11.99**	10.95	13.02	**1.15**	1.13	1.16
	2010–2014	38.3	48.3	**9.98**	9.42	10.54	**1.25**	1.24	1.27
Subarachnoid haemorrhage	1995–1999	7.5	7.5	**0.00**	−0.31	0.31	**1.00**	0.96	1.04
	2010–2014	4.6	5.5	**0.94**	0.72	1.16	**1.20**	1.15	1.25
Intracerebral haemorrhage	1995–1999	20.8	24.8	**4.87**	4.34	5.39	**1.24**	1.21	1.27
	2010–2014	13.7	17.1	**3.35**	3.00	3.70	**1.24**	1.21	1.27
Cerebral infarction	1995–1999	48.5	53.6	**4.62**	3.81	5.42	**1.09**	1.07	1.11
	2010–2014	19.1	24.2	**5.29**	4.92	5.66	**1.26**	1.24	1.29
Hypertensive diseases	1995–1999	2.4	3.2	**1.00**	0.82	1.18	**1.45**	1.36	1.55
	2010–2014	1.1	2.1	**1.08**	0.99	1.16	**2.27**	2.12	2.44

(continued)

Table A.2 (continued)

		ASMR per 100,000		Slope index of inequalities			Relative index of inequalities		
		1st Quintile	5th Quintile	Estimate	95% CI (LL & UL)		Estimate	95% CI (LL & UL)	
Aortic aneurysm and dissection	1995–1999	5.7	5.6	**−0.21**	−0.47	0.05	**0.96**	0.92	1.01
	2010–2014	6.5	6.5	**−0.09**	−0.31	0.13	**0.99**	0.95	1.02
Diabetes mellitus	1995–1999	8.4	9.3	**1.29**	0.97	1.62	**1.16**	1.12	1.21
	2010–2014	5.2	7.1	**2.12**	1.91	2.34	**1.41**	1.36	1.46
Diseases of liver	1995–1999	13.3	18.6	**7.04**	6.62	7.45	**1.60**	1.55	1.64
	2010–2014	8.8	13.6	**5.25**	4.95	5.54	**1.65**	1.60	1.70
Renal failure	1995–1999	9.1	11.5	**3.08**	2.73	3.42	**1.36**	1.31	1.40
	2010–2014	6.7	9.6	**3.18**	2.96	3.40	**1.49**	1.44	1.53
Tuberculosis	1995–1999	2.7	3.1	**0.80**	0.62	0.98	**1.35**	1.26	1.45
	2010–2014	0.9	1.1	**0.23**	0.15	0.30	**1.29**	1.18	1.40
Pneumonia	1995–1999	54.3	60.2	**8.86**	8.04	9.68	**1.17**	1.15	1.19
	2010–2014	39.5	49.1	**9.95**	9.43	10.46	**1.26**	1.24	1.27
Chronic obstructive pulmonary disease	1995–1999	10.5	12.5	**2.09**	1.71	2.47	**1.19**	1.16	1.23
	2010–2014	7.3	9.6	**2.71**	2.48	2.93	**1.37**	1.34	1.41
Asthma	1995–1999	3.6	5.1	**2.09**	1.87	2.31	**1.64**	1.55	1.73
	2010–2014	0.4	0.8	**0.41**	0.35	0.47	**2.03**	1.81	2.27
Senility	1995–1999	6.6	7.5	**0.37**	0.06	0.67	**1.05**	1.01	1.09
	2010–2014	8.5	7.3	**−1.64**	−1.85	−1.43	**0.82**	0.80	0.84
Accidents	1995–1999	15.9	23.9	**9.23**	8.73	9.73	**1.59**	1.55	1.63
	2010–2014	7.7	19.4	**10.66**	10.37	10.94	**2.57**	2.50	2.65
Transport accidents	1995–1999	11.0	17.5	**7.59**	7.17	8.02	**1.69**	1.64	1.74
	2010–2014	4.0	6.7	**3.10**	2.86	3.33	**1.76**	1.69	1.85
Suicide	1995–1999	21.3	31.5	**12.35**	11.79	12.91	**1.62**	1.58	1.66
	2010–2014	22.8	30.9	**9.61**	9.04	10.18	**1.44**	1.41	1.47

Table A.3 Summary table of indices of mortality inequalities by cause of death, women

		ASMR per 100,000		Slope index of inequalities			Relative index of inequalities		
		1st Quintile	5th Quintile	Estimate	95% CI (LL & UL)		Estimate	95% CI (LL & UL)	
All causes of death	1995–1999	346.1	368.1	**23.60**	21.93	25.27	**1.07**	1.06	1.07
	2010–2014	254.1	294.3	**30.00**	28.93	31.07	**1.12**	1.11	1.12
Cancer (all sites)	1995–1999	107.2	109.1	**2.84**	1.86	3.83	**1.03**	1.02	1.04
	2010–2014	87.6	95.5	**7.99**	7.27	8.71	**1.09**	1.08	1.10
Oesophageal cancer	1995–1999	1.5	1.3	**−0.20**	−0.31	−0.09	**0.86**	0.80	0.93
	2010–2014	1.3	1.3	**−0.09**	−0.17	0.00	**0.93**	0.87	1.00
Stomach cancer	1995–1999	17.2	16.2	**−1.92**	−2.31	−1.53	**0.89**	0.87	0.91
	2010–2014	9.1	9.6	**−0.09**	−0.32	0.13	**0.99**	0.97	1.01
Colorectal cancer	1995–1999	14.3	14.0	**−0.80**	−1.15	−0.45	**0.94**	0.92	0.97
	2010–2014	11.7	12.7	**0.61**	0.35	0.86	**1.05**	1.03	1.07
Liver and intrahepatic bile ducts cancer	1995–1999	8.5	10.4	**2.67**	2.38	2.95	**1.34**	1.30	1.38
	2010–2014	4.9	6.5	**2.01**	1.84	2.17	**1.43**	1.39	1.47
Gallbladder and other biliary tract cancer	1995–1999	6.3	7.2	**0.90**	0.66	1.13	**1.14**	1.10	1.18
	2010–2014	3.9	4.7	**0.91**	0.77	1.05	**1.23**	1.19	1.27
Pancreatic cancer	1995–1999	7.1	7.2	**0.02**	−0.22	0.27	**1.00**	0.97	1.04
	2010–2014	8.1	8.6	**0.31**	0.10	0.53	**1.04**	1.01	1.06
Trachea, bronchus, and lung cancer	1995–1999	12.5	13.5	**1.67**	1.33	2.00	**1.14**	1.11	1.17
	2010–2014	11.0	12.7	**2.27**	2.03	2.52	**1.22**	1.19	1.25
Malignant mesothelioma	1995–1999	0.2	0.2	**0.03**	−0.01	0.06	**1.19**	0.92	1.52
	2010–2014	0.2	0.2	**0.01**	−0.02	0.04	**1.06**	0.88	1.29
Breast cancer	1995–1999	11.3	9.7	**−2.23**	−2.57	−1.90	**0.80**	0.78	0.83
	2010–2014	12.2	11.8	**−0.85**	−1.16	−0.53	**0.93**	0.91	0.96

(continued)

Table A.3 (continued)

		ASMR per 100,000		Slope index of inequalities			Relative index of inequalities		
		1st Quintile	5th Quintile	Estimate	95% CI (LL & UL)		Estimate	95% CI (LL & UL)	
Cervical cancer	1995–1999	2.5	2.8	**0.45**	0.29	0.62	**1.19**	1.12	1.27
	2010–2014	2.4	3.1	**0.58**	0.43	0.74	**1.24**	1.17	1.31
Uterine corpus cancer	1995–1999	1.2	1.1	**−0.04**	−0.15	0.06	**0.96**	0.87	1.06
	2010–2014	1.7	1.7	**0.01**	−0.10	0.13	**1.01**	0.94	1.08
Ovarian cancer	1995–1999	5.1	4.5	**−0.61**	−0.83	−0.39	**0.88**	0.84	0.92
	2010–2014	4.4	4.1	**−0.52**	−0.70	−0.33	**0.88**	0.85	0.92
Malignant lymphoma	1995–1999	2.9	3.0	**−0.01**	−0.17	0.15	**1.00**	0.94	1.06
	2010–2014	2.6	2.8	**0.19**	0.07	0.31	**1.07**	1.03	1.12
Leukaemia	1995–1999	2.8	3.8	**1.25**	1.07	1.42	**1.51**	1.42	1.60
	2010–2014	2.1	2.9	**1.04**	0.92	1.16	**1.56**	1.48	1.65
Heart disease (excluding hypertensive heart diseases)	1995–1999	54.0	57.0	**3.09**	2.47	3.72	**1.06**	1.05	1.07
	2010–2014	36.4	41.5	**4.37**	4.00	4.73	**1.12**	1.11	1.13
Acute myocardial infarction	1995–1999	17.3	18.3	**1.24**	0.88	1.60	**1.07**	1.05	1.10
	2010–2014	7.1	8.4	**1.33**	1.16	1.50	**1.19**	1.16	1.22
Other ischaemic heart diseases	1995–1999	9.5	8.5	**−0.86**	−1.10	−0.62	**0.90**	0.88	0.93
	2010–2014	6.8	6.2	**−1.41**	−1.57	−1.26	**0.80**	0.78	0.82
Cardiac arrhythmias and conduction disorders	1995–1999	4.6	5.3	**0.87**	0.68	1.06	**1.19**	1.15	1.24
	2010–2014	4.8	6.4	**1.35**	1.21	1.49	**1.28**	1.24	1.31
Heart failure	1995–1999	16.0	17.4	**1.27**	0.93	1.60	**1.08**	1.06	1.10
	2010–2014	12.9	14.8	**1.97**	1.77	2.17	**1.15**	1.14	1.17
Cerebrovascular disease	1995–1999	52.8	55.4	**0.94**	0.31	1.57	**1.02**	1.01	1.03
	2010–2014	22.1	25.4	**2.03**	1.73	2.33	**1.09**	1.07	1.10
Subarachnoid haemorrhage	1995–1999	8.9	9.2	**−0.16**	−0.45	0.13	**0.98**	0.95	1.01
	2010–2014	4.8	5.5	**0.47**	0.29	0.65	**1.09**	1.06	1.13
Intracerebral haemorrhage	1995–1999	12.2	13.2	**0.76**	0.44	1.07	**1.06**	1.04	1.09
	2010–2014	6.5	7.5	**0.45**	0.27	0.63	**1.06**	1.04	1.09
Cerebral infarction	1995–1999	29.5	30.3	**−0.53**	−0.98	−0.08	**0.98**	0.97	1.00
	2010–2014	10.2	11.6	**0.95**	0.77	1.14	**1.09**	1.07	1.10
Hypertensive diseases	1995–1999	2.2	2.7	**0.48**	0.36	0.60	**1.23**	1.16	1.29
	2010–2014	0.7	1.2	**0.45**	0.40	0.50	**1.63**	1.54	1.72
Aortic aneurysm and dissection	1995–1999	2.4	2.3	**−0.02**	−0.15	0.11	**0.99**	0.94	1.05
	2010–2014	3.1	3.4	**0.15**	0.03	0.26	**1.05**	1.01	1.08
Diabetes mellitus	1995–1999	5.2	5.8	**0.49**	0.28	0.70	**1.09**	1.05	1.14
	2010–2014	2.5	3.3	**0.74**	0.62	0.85	**1.28**	1.23	1.33
Diseases of liver	1995–1999	4.7	5.9	**1.48**	1.27	1.70	**1.34**	1.29	1.40
	2010–2014	3.2	4.3	**0.88**	0.74	1.03	**1.28**	1.23	1.33
Renal failure	1995–1999	5.8	7.4	**1.83**	1.62	2.04	**1.33**	1.29	1.37
	2010–2014	3.7	5.4	**1.79**	1.67	1.91	**1.49**	1.45	1.53
Tuberculosis	1995–1999	0.8	0.7	**−0.02**	−0.10	0.06	**0.97**	0.88	1.08
	2010–2014	0.3	0.4	**0.04**	0.01	0.07	**1.13**	1.02	1.26
Pneumonia	1995–1999	26.0	26.7	**2.03**	1.63	2.44	**1.08**	1.07	1.10
	2010–2014	16.6	19.9	**3.45**	3.22	3.68	**1.21**	1.20	1.23
Chronic obstructive pulmonary disease	1995–1999	2.3	2.9	**0.87**	0.74	1.00	**1.44**	1.36	1.51
	2010–2014	1.1	1.5	**0.47**	0.41	0.54	**1.47**	1.39	1.55
Asthma	1995–1999	2.0	2.7	**1.08**	0.95	1.22	**1.61**	1.51	1.71
	2010–2014	0.4	0.6	**0.27**	0.23	0.31	**1.79**	1.63	1.97
Senility	1995–1999	7.4	7.6	**−0.34**	−0.54	−0.13	**0.96**	0.94	0.98
	2010–2014	11.4	9.4	**−2.46**	−2.61	−2.31	**0.80**	0.79	0.81
Accidents	1995–1999	6.7	8.4	**1.83**	1.55	2.12	**1.27**	1.22	1.32
	2010–2014	2.9	11.4	**6.13**	5.98	6.28	**3.40**	3.28	3.53
Transport accidents	1995–1999	3.8	5.4	**1.41**	1.17	1.65	**1.32**	1.26	1.39
	2010–2014	1.3	2.1	**0.87**	0.75	0.99	**1.61**	1.51	1.72
Suicide	1995–1999	9.8	10.8	**1.45**	1.11	1.80	**1.15**	1.11	1.19
	2010–2014	10.1	11.1	**0.69**	0.34	1.04	**1.07**	1.03	1.10

Notes: 95% CI: 95% confidence interval, LL: Lower Limit; UL: Upper Limit.

Index

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