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Commentary: Using geographical data to monitor socioeconomic inequalities in mortality: experiences from Japanese studies

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Policies to reduce socioeconomic inequalities in health need detailed and accurate descriptions of health inequalities in order to define priority areas for intervention.[1] Essential for the monitoring of health inequalities is the use of national data on cause-specific mortality according to socioeconomic indicators such as education and income level. Longitudinal mortality data covering large national samples are available for only a dozen countries in Europe and elsewhere in the world.[2] When such data are not available, alternative data sources have to be considered, such as 'unlinked' cross-sectional studies, longitudinal studies among small national samples or local populations, or geographical studies comparing neighbourhoods, municipalities, or regions.

Japan is a country of special interest. The record life expectancy of Japanese women did not only set a benchmark for public health in Western countries,[3] but it also raised the question whether Japan had made similar achievements with respect to socioeconomic inequalities in mortality. Health inequalities in Japan may show different patterns, and may perhaps be substantially smaller than elsewhere. In the past century, Japan's social and economic policies had a distinct outcome-oriented egalitarian ethos.[4] In addition, Japan has a large middle class that is highly homogeneous in attitudes and life styles, even though its social stratification system may not be fundamentally different from Western capitalist countries.[5]

Most Japanese studies on socioeconomic inequalities in mortality relied on geographical analysis. For example, a recent comparison of Japan's 47 regions (prefectures) showed a strong association between women's mortality and the average educational level of regions, while men's mortality was strongly associated with measures of average income and income inequalities.[4] Despite the ecological fallacy problem, results from such geographical analyses may be interpreted more broadly to suggest that also in Japanese society socioeconomic disadvantage was associated with higher mortality.

Fukuda and colleagues recently made important contributions to the monitoring of socioeconomic inequalities in mortality in Japan.[6–8] They acquired data on the level of mortality for the ~3300 Japanese municipalities, distinguished causes of death, and studied trends between 1973–77 and 1993–98. Their results have been presented in a series of papers, of which the paper in the current issue of IJE is the most recent one.[6] An important finding is that, at the municipal level, there were large socioeconomic inequalities in mortality from suicides and other injuries. This finding corresponds to recent European evidence of large socioeconomic differences in mortality from traffic injuries and suicides,[2] and it points to injury prevention as an important area for tackling inequalities in health.

A salient finding from their study is that between the 1970s and 1990s mortality differences between poor and rich municipalities narrowed among men and even reverted among women.[6] An inverse association between socioeconomic level and women's mortality existed in 1993–98 because mortality from most cancers and coronary heart disease (CHD) was highest in rich municipalities. These trends and patterns strongly contrast to those observed for Western industrialized countries, in geographical and other studies. For example, between the 1980s and 1990s, socioeconomic inequalities in mortality in Europe were widening, at least in relative terms. CHD was a main contributor to the widening of relative inequalities in mortality among middle-aged men.[9]

Could these findings be seen as an indication that socioeconomic inequalities in mortality within Japanese society were small or perhaps even absent? The fragmentary evidence from individual-level studies does not give a clear answer. A national study using 'unlinked' cross-sectional data observed inequalities in mortality according to occupational class around 1990.[4] For men and women 20–59 years, mortality was highest among those working in manual and agricultural classes. However, no consistent mortality differences were observed between middle classes (e.g. clerical workers) and higher classes. Similarly, the results of a few longitudinal studies among small and selective population samples do not yield a consistent picture. For example, a longitudinal study among elderly Japanese observed elevated mortality among low educated men and women 60–69 years, but a disappearance or even reversal of this mortality gradient at higher ages.[10]

The positive association between socioeconomic levels and mortality from cancer and CHD might perhaps indicate that 'modern' risk factors were more prevalent in upper socioeconomic groups. If so, this would have diminished inequalities in mortality in Japan, similar to the situation in northern Europe in the 1950s and in southern Europe more recently.[11] However, in Japan, recent inequalities in smoking had a similar pattern and magnitude as in northern European countries. In addition, lower socioeconomic groups consumed

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fruit and vegetables less often, and were reported to have diabetes and hypertension more often. However, some studies, especially those carried out in peripheral areas, reported inconsistent or inverse social gradients with regard to physical inactivity, body mass index, and serum cholesterol.[12–14]

Thus, the weak associations between socioeconomic factors and mortality that Fukuda *et al*. observed at the municipal level agree with the inconsistent pictures arising from Japanese studies at the individual or household level. However, there are no indications for a higher mortality among women from higher socioeconomic groups. Why is this positive association nonetheless observed at the municipal level? The most likely answer is related to the strong correlation, at the municipal level, between socioeconomic factors and urbanization. In Japan, mortality levels were higher in urban areas and this mortality excess was increasing over time, especially among women.[7,8]

This confounding effect of urbanization could partly be removed in geographical analyses of mortality variations within urban areas. In one such analysis, Fukuda *et al*. found that women's mortality was lower (and not higher) in areas with high educational levels.[7] There is a parallel with regional mortality variations in western European countries in the 1980s, which were not clearly correlated to the socioeconomic level of regions. However, urbanization and industrialization were important correlates of regional mortality in Europe, and after control for these factors, a clear association between high regional mortality and low socioeconomic levels became evident for most of the main European countries.[15]

Thus, it is likely that the higher mortality of rich municipalities in Japan was not due to their higher average income level per se, but to their higher degree of urbanization. Fukuda *et al*. appear to be aware of this explanation, for example, when they conclude that the reverted mortality gradients for women were a problem of urban areas.[6] This conclusion underlines the need for in-depth studies that aim to identify the ways in which the high population density of the urban areas in Japan affects the health of their residents. For example, a longitudinal study in Tokyo demonstrated an increased mortality among residents who lacked access to 'walkable' public space.[16]

While this case illustrates the obvious point that area-level studies should be used to identify 'contextual' determinants of health, it leaves us with the question of what contribution area-level studies can make to the monitoring of socioeconomic inequalities in mortality, especially in countries where individual-level data are scarce and potentially biased. Two lessons can be drawn from the studies of Fukuda *et al*.

First, they illustrate the critical importance of the choice of the type and size of areas to be compared. While the association between women's mortality and socioeconomic factors was positive at the municipal level,[6] an inverse association was observed in another Japanese study at the level of the larger prefectures.[4] Inverse associations are also commonly observed in European and American studies at lower geographical levels, such as neighbourhoods and census tracts.[17] Most multi-level analyses showed that, at the level of these smaller and more homogeneous areas, the association between mortality and socioeconomic factors reflect to a large extent the association among individuals or households.[18]

Second, when regional or municipal data are used to determine associations between mortality and socioeconomic characteristics, it is essential to control for area characteristics that can be considered as confounders to these associations. Levels of urbanization and industrialization are potentially important confounders at the municipal or regional level, both in Japan and elsewhere.[8,15] In addition, studies may need to take into account unique characteristics of specific areas. This is exemplified by the southern island of Okinawa, which had the highest life expectancy even though its socioeconomic level ranked among the lowest in the Japanese regions.[19] Okinawa may owe its low mortality to factors such as dietary customs, warm climate, and cohesive local cultures.[19] Idiosyncratic factors like these may influence regional mortality variations in subtle but profound ways.

Geographical studies are increasingly used to identify environmental determinants of mortality and ill health.[18] This 'contextual' approach is at the forefront of epidemiological research and avoids the ecological fallacy problem. However, we should not ignore the complementary 'composition' approach but also use geographical data to study mortality in relation to socioeconomic characteristics of residents. The vast majority of the world population lives in countries where individual-level data on health inequalities are scarce, unreliable or even absent.[1] In these countries, geographical studies may yield the first evidence on the effect of socioeconomic disadvantage on mortality, and they may provide a broad descriptive overview of patterns of inequalities by age, sex, cause of death, and time period.[17,20] Wherever geographical data can make this important contribution to health inequalities monitoring, this opportunity should be seized.

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