Do Contributing Factors for Health Inequality Really Indicate Worse Conditions Among Upper Non-manual Workers Than Among Lower Non-manual and Manual Workers in Korea?: A Cross-sectional Study Using a Nationally Representative Survey Data of Korea

Eunjeong Noh
Seoul National University

Young-Ho Khang (yhkhang@snu.ac.kr)
Institute of Health Policy and Management, Seoul National University Medical Research Center, Seoul, Korea; https://orcid.org/0000-0002-9585-8266

Research

Keywords: Health Inequalities, Mortality, Occupations, Psychology, Republic of Korea, Risk Factors, Socioeconomic Factors

Posted Date: November 19th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-110426/v1

Abstract

Background: Despite the consensus that higher occupational classes tend to have better health and lower mortality rates, a previous study reported reversed occupational gradients in mortality rates among Korean men after the economic crisis in the late 2000s. This study investigated occupational gradients in socioeconomic position and multiple pathway indicators known to affect mortality.

Methods: We used data from 4,176 men aged 35–64 in Korea, derived from the 2007-2009 and 2013-2015 Korean National Health and Nutrition Examination Surveys, to compare the age-standardized prevalence and age-adjusted mean value of each contributing factor to health inequality among occupational groups, which were divided into upper non-manual workers, lower non-manual workers, manual workers, and others. Contributing factors included childhood and adulthood socioeconomic position indicators, biological risk factors, health behaviors, psychosocial factors, and work environment.

Results: Upper non-manual workers had prominently higher levels of education, income, parental education, and economic activity than lower non-manual and manual workers. The rates of smoking and high-risk alcohol consumption were lower in the non-manual classes, and the rate of weight control activities was higher. Depression and suicidal ideation levels were lower and perceptions of the work environment were better among non-manual workers than among their manual counterparts.

Conclusions: This study confirmed occupational inequality in a wide range of socioeconomic positions and pathway indicators in Korea, with consistently favorable patterns for upper non-manual workers. These occupational gradients do not support the previously reported reversed pattern of higher mortality in non-manual groups than in the manual job class in Korea.

Background

International studies have investigated health gradients according to occupational status, with generally concordant findings of better health and lower mortality among people with a higher occupational status. In other words, people with non-manual jobs (e.g., professional and office jobs) have lower mortality and morbidity, as well as better health behaviors, than those who work in jobs with high levels of manual labor(1–7). Nonetheless, Tanaka and colleagues examined health inequalities across occupational groups in European and Asian countries(8), and argued that occupational gradient patterns in mortality tended to be different in Korea relative to European countries after a certain time. They claimed that since the economic crisis of the 2000s in Korea, the all-cause mortality rate for people with upper non-manual jobs increased dramatically, exceeding that of people with lower non-manual and manual jobs. It was proposed that the economic crisis might have affected the rising prevalence of cancer cases and suicide among non-manual workers, thereby contributing to the reversed patterns of health inequalities(8–10). Based on the findings of the study, Mackenbach stated in his recent book(10) that “the main exception is Japan and South Korea where occupational class inequalities in mortality do not follow the usual pattern” (p. 47). It was suggested that the deterioration of factors contributing to health in response to the economic crisis might explain the anomalous occupational gradients in Korea. However, Khang (2019)(11) pointed out that these purportedly reversed patterns are likely to be biased due to the use of unlinked data with population denominators from census data and mortality numerators from death certificates. Prior Korean studies have also shown that using unlinked data may result in increased mortality estimates among non-manual workers and reduced mortality estimates among manual workers(12). Moreover, the category of an

“inactive or class unknown” group, which accounted for 44–51% of total deaths in the most recent decade in Korea, may be related to the reversed pattern that Tanaka (2019)(8, 9) reported.

Although the finding of reversed health inequality patterns in Korea poses an important challenge to the universality of health inequality by occupational class, little research has clearly identified unusual patterns of occupational inequality in mortality in Korea(10). To shed further light on this controversy, our study aimed to investigate occupational inequality in the socioeconomic environment and various pathway factors known to affect mortality, with the goal of determining whether, as Tanaka and colleagues (2019)(8) suggested, Korea exhibits this unique phenomenon due to changes in factors negatively influenced by the economic crisis in the late 2000s.

Methods

Data Sources and Population

This study used the Korea National Health and Nutrition Examination Survey (KNHANES) , which is a nationally representative cross-sectional survey conducted by the Korea Centers for Disease Control and Prevention (KCDC). The survey includes information on socioeconomic status, health-related behaviors, quality of life, healthcare utilization, anthropometric measures, and biochemical and clinical profiles collected through three component surveys: a health interview, a health examination, and a nutrition survey(13, 14). In particular, the 2007–2009 KNHANES contains information on participants’ work environment. Therefore, these data constitute an appropriate source for investigating occupational gradients in various pathway variables known to influence health status and to contribute to mortality in Korea. We also employed the more recent 2013–2015 KNHANES data, which lacked work environment variables, for an additional analysis of occupational inequalities in mortality in Korea. These nationwide surveys were approved by the Institutional Review Board (IRB) of the KCDC and this study was exempted from IRB approval by the Seoul National University Hospital IRB (IRB number: E-2005-091-1123).

The KNHANES was conducted among noninstitutionalized Korean citizens residing in Korea from 2007 to 2009. Of the 31,705 targeted individuals, 24,871 participated in the survey (participation rate = 78.4%). Because Tanaka’s (2019) study(8) considered the association of occupational class and mortality among men aged 35–64, our study also focused on the same population—men aged 35 to 64 years in Korea—to make equivalent comparisons. Ultimately, 4,176 men were included in the analyses. We extracted demographic information (age) and variables of interest (e.g., occupational class, socioeconomic position, and other pathway variables) from the dataset (see Appendix Table 1).

Table 1
Age-standardized percentages of childhood and adulthood socioeconomic position (SEP) indicators and pathway variables by occupational class for men aged 35–64: the 2007–2009 Korea National Health and Nutrition Survey (n = 4,176)

		Upper Non-manual		Lower Non-manual		Manual		Others	
		%	95% CI	%	95% CI	%	95% CI	%	95% CI
Childhood SEP	**Parents' education level**								
	Father's education (elementary school or less)	43.2	38.8–47.7	52.2	48.6–55.7	59.1	56.3–62.0	56.2	51.9–60.5
	Mother's education (elementary school or less)	62.5	58.6–66.3	68.0	64.6–71.4	72.6	69.9–75.3	70.8	66.5–75.0
	Parents' economic activity								
	Absence of parents	10.3	7.5–13.0	11.6	9.2–14.1	13.9	11.9–15.9	13.3	10.5–16.1
Adulthood SEP	**Education level**								
	Elementary school or less	2.8	1.4–4.3	4.3	2.9–5.8	18.5	16.2–20.7	27.3	24.0–30.6
	Middle school	1.4	0.4–2.3	8.8	6.8–10.7	21.0	18.5–23.5	22.4	19.3–25.5
	High school	23.8	20.0–27.6	38.3	34.8–41.8	48.4	45.3–51.5	33.3	29.6–37.1
	College or above	72.0	68.0–76.0	48.6	44.9–52.4	12.2	10.3–14.0	17.0	13.6–20.3
Biological health risk factors	Body mass index (BMI) (≥ 30 kg/m^2)	4.1	2.7–5.5	2.9	1.8–4.1	2.7	1.7–3.7	4.2	2.0–6.5
	BMI (≤ 18 kg/m^2)	2.1	1.1–3.2	2.3	1.3–3.2	3.4	2.3–4.4	5.8	3.7–7.9
	Blood pressure (≥ 140 mmHg)	5.0	3.2–6.8	7.1	5.0–9.1	10.3	8.5–12.1	11.9	8.9–15.0
	Serum total cholesterol (≥ 240 mg/dL)	7.6	5.6–9.7	6.9	5.3–8.5	8.7	6.9–10.6	8.0	5.8–10.3
	Serum glucose level (≥ 126 mg/dL)	8.0	5.8–10.2	8.1	5.9–10.3	9.1	7.3–10.8	8.7	6.2–11.1

a. The rate of drinking more than 7 drinks a day on average and almost every day in the past year.

b. The proportion of those who responded "agree" or higher for each question about the working environment (strongly disagree, 1; disagree, 2; agree, 3; strongly agree, 4).

		Upper Non-manual		Lower Non-manual		Manual		Others	
Health behaviors	Current smoking	41.3	37.2–45.4	40.8	37.4–44.2	51.0	48.2–53.8	49.3	44.9–53.8
	High-risk alcohol consumption [a]	9.1	6.8–11.4	11.4	9.0–13.8	14.3	12.2–16.3	12.9	10.2–15.5
	Moderate level of physical activity	9.3	7.0–11.6	11.4	9.1–13.7	17.4	15.3–19.6	13.3	10.4–16.2
	Exercise for weight control	52.2	48.3–56.2	45.8	42.2–49.3	34.5	31.6–37.3	35.9	31.5–40.4
Psychosocial factors	Feelings of depression (more than 2 weeks)	9.3	7.1–11.6	9.5	7.4–11.7	9.8	8.2–11.3	16.2	12.8–19.6
	Stress awareness	31.8	28.2–35.4	30.6	27.5–33.6	23.3	20.8–25.9	23.4	19.4–27.5
	Marital status (yes)	97.6	96.7–98.6	97.7	96.8–98.6	94.9	93.6–96.2	81.8	77.9–85.6
	Suicidal ideation	7.3	5.4–9.3	10.1	7.6–12.5	10.8	9.0–12.5	18.7	15.0–22.4
Work environment [b]	Cleanliness and comfort	88.4	85.6–91.2	85.8	83.2–88.4	54.9	52.1–57.7	34.6	30.2–38.9
	Dangerous	18.5	15.3–21.8	18.3	15.6–21.1	62.7	59.7–65.7	23.4	19.6–27.3
	Time pressure	36.9	33.2–40.5	35.9	32.6–39.2	36.5	33.8–39.1	25.1	21.0–29.1
	Authority	95.2	93.5–96.9	89.1	86.7–91.5	68.4	65.6–71.1	46.8	41.3–52.2
	Respected and trusted	92.4	90.1–94.7	91.8	89.8–93.8	85.7	83.7–87.7	47.1	41.7–52.6
	Long hours in an uncomfortable position	9.4	7.4–11.5	16.4	13.7–19.1	36.7	33.9–39.5	22.7	18.2–27.2
	Carrying heavy objects	7.8	5.6–10.0	22.7	19.5–25.8	39.7	36.5–42.8	25.5	21.5–29.5
	Hiding emotions	34.2	30.4–38.0	35.8	32.4–39.2	37.9	35.1–40.8	16.7	13.2–20.2

a. The rate of drinking more than 7 drinks a day on average and almost every day in the past year.

b. The proportion of those who responded “agree” or higher for each question about the working environment (strongly disagree, 1; disagree, 2; agree, 3; strongly agree, 4).

Occupational Class and Contributing Factors to Health Inequality

The data on occupational class and contributing variables to health were collected from the 2007–2009 KNHANES. Occupational class was categorized into four groups using the same definition as in Tanaka's (2019) study(8): upper non-manual workers, lower non-manual workers, manual workers, and others (e.g., agricultural, forestry and fishery workers and unemployed people). We also classified socioeconomic and pathway variables into six categories—childhood socioeconomic position (SEP), adulthood SEP, biological health risk factors, health behaviors, psychosocial factors, and work environment—to explore the determinants affected by specific events (e.g., the economic crisis of the late 1990s and the late 2000s) and their influence on health status and mortality. For childhood SEP, we employed parents' education level, the absence of parents, and adult height, all of which have been confirmed as valid indicators for early life exposure measures by numerous studies(10, 15–21). We used monthly household income and education level for adulthood SEP, and body mass index (BMI), systolic blood pressure, total cholesterol, and glucose levels for the main biological risk factors. To investigate health behaviors, we considered four measures: smoking, alcohol consumption, physical activity, and exercise for weight management. Psychosocial factors included feelings of depression for more than two weeks, stress awareness, marital status, and suicidal ideation. Finally, we analyzed responses to eight survey items asking about respondents' work environment.

Statistical Analysis

The KNHANES data were collected through a complex, multi-stage probability sample design(14). Thus, we analyzed the data using complex sample analysis methods considering sample weights. We compared the prevalence (for categorical variables) and mean value (for continuous variables) of each contributing variable among occupational groups to investigate occupational gradients. Because age is an important confounder in the association between SEP and health indicators, the resulting statistics are presented as age-standardized rates calculated with the direct standardized method using data from the 2010 population census as the reference population. Least squared means were also provided by using the *proc surveyreg* procedure in SAS to determine the age-adjusted means of variables. The 95% confidence intervals of adjusted prevalence and mean values by occupational class were estimated. Data processing and statistical analysis were conducted using SAS v.9.4 (SAS Institute, Cary, NC, USA).

Results

We examined whether gaps in SEP and pathway variables existed depending on occupational status (Table 1 and Table 2). In terms of childhood SEP, 43.2% of upper non-manual workers' fathers had a primary education or below, compared to 52.2% of lower non-manual workers and 59.1% of manual workers. In total, 62.5% of upper non-manual workers' mothers had a primary education or below, compared to 68% for lower non-manual workers and 72.6% for manual workers. The rate of parents' absence in childhood was highest in manual workers (10.3% for upper non-manual, 11.6% for lower non-manual, and 13.9% for manual workers). Average adult height was 169.8 cm in upper non-manual, 169.7 cm in lower non-manual, and 168.1 cm in manual workers (Table 2).

Table 2

Age-adjusted means[a] of childhood and adulthood socioeconomic position (SEP) indicators and pathway variables by occupational class for men aged 35–64: the 2007–2009 Korea National Health and Nutrition Survey (n = 4,176)

		Upper Non-manual		Lower Non-manual		Manual		Others	
		Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Childhood SEP	Height (cm)	169.8	169.4–170.3	169.7	169.4–170.1	168.1	167.7–168.4	168.4	167.9–168.9
Adulthood SEP	Monthly household income (10,000 won) [b]	424.9	404.1–445.8	354.1	338.0–370.2	272.8	261.3–284.2	210.6	194.5–226.7
Biological health risk factors	Body mass index (kg/m^2)	24.7	24.5–24.9	24.5	24.3–24.8	24.1	23.9–24.3	24.0	23.8–24.2
	Blood pressure (mmHg)	117.5	116.1–119.0	118.9	117.8–120.0	120.6	119.5–121.7	120.6	119.2–121.9
	Serum total cholesterol (mg/dL)	192.1	189.5–194.7	189.9	190.0–1.3	191.8	189.5–194.1	191.0	188.2–193.8
	Serum glucose level (mg/dL)	102.4	100.6–104.2	102.5	100.9–104.0	102.7	101-104.38	102.2	100.1–104.3
Health behaviors	Smoking quantity per day (cigarettes)	17.8	16.6–19.1	18.5	17.4–19.5	19.4	18.7–20.2	18.6	17.5–19.6
Work environment [c]	Cleanliness and comfort	3.1	3.1–3.2	3.0	3.0–3.1	2.5	2.5–2.6	2.6	2.6–2.7
	Dangerous	1.7	1.7–1.8	1.8	1.8–1.9	2.6	2.6–2.7	2.3	2.2–2.4
	Time pressure	2.3	2.3–2.4	2.3	2.2–2.3	2.3	2.2–2.3	2.4	2.4–2.5
	Authority	3.2	3.2–3.3	3.0	3.0–3.1	2.7	2.7–2.8	3.0	3.0–3.1
	Respected and trusted	3.1	3.0–3.1	3.0	3.0–3.1	2.9	2.9–3.0	3.0	2.9–3.0

a. Age-adjusted (at 50 years old) least squared means.

b. Bottom-coding for less than 170,000 won per month and top-coding for more than 9 million won per month were applied.

c. Mean score of responses for each question about the working environment (strongly disagree, 1; disagree, 2; agree, 3; strongly agree, 4).

		Upper Non-manual		Lower Non-manual		Manual		Others	
	Long hours in an uncomfortable position	1.8	1.8–1.9	1.9	1.9–2.0	2.3	2.3–2.4	2.4	2.3–2.5
	Carrying heavy objects	1.6	1.5–1.6	1.9	1.8–2.0	2.3	2.3–2.4	2.5	2.4–2.5
	Hiding emotions	2.2	2.2–2.3	2.3	2.2–2.3	2.3	2.3–2.3	2.1	2.1–2.2

a. Age-adjusted (at 50 years old) least squared means.

b. Bottom-coding for less than 170,000 won per month and top-coding for more than 9 million won per month were applied.

c. Mean score of responses for each question about the working environment (strongly disagree, 1; disagree, 2; agree, 3; strongly agree, 4).

Regarding adulthood SEP, 2.8% of upper non-manual respondents had an elementary school or lower education, compared to 4.3% of lower non-manual and 18.5% of manual workers. In contrast, 72% of upper non-manual respondents had a college degree or higher, considerably exceeding the proportions among lower non-manual and manual worker respondents (48.6% and 12.2%, respectively) (Table 1). The average monthly household income was 4.25 million won for upper non-manual workers, 3.54 million won for lower non-manual workers, and 2.73 million won for manual workers (Table 2).

The proportions of individuals with a BMI exceeding 30 kg/m² were 4.1%, 2.9%, and 2.7% among upper non-manual, lower non-manual, and manual workers, respectively. Meanwhile, those who had a BMI of less than 18 kg/m² accounted for 2.1%, 2.3%, and 3.4% of upper non-manual, lower non-manual, and manual workers, respectively. Blood pressure readings of 140 mmHg and over were found was 5%, 7.1%, and 10.3% of upper non-manual, lower non-manual, and manual workers, respectively. Cholesterol levels exceeding 240 mg/dL were found in 7.6% of upper non-manual workers, 6.9% of lower non-manual workers, and 8.7% of manual workers. High glucose levels (≥ 126 mg/dL) were found in 8% of upper non-manual workers, 8.1% of lower non-manual workers, and 9.1% of manual workers. Except for BMI, high-risk status for these indicators tended to be more common in manual than non-manual workers (Table 1).

The average smoking quantity per day (19.4 cigarettes) and smoking rate (51%) were higher in manual workers than in non-manual workers (Table 1 and Table 2). High-risk alcohol consumption was also more common in manual workers (14.3%) than in upper (9.1%) or lower (11.4%) non-manual workers. Manual workers also tended to report a higher percentage of physical activity (17.4%) than upper (9.3%) or lower (11.4%) non-manual workers. However, exercise for weight control was more common in non-manual workers (upper, 52.2%; lower, 45.8%) than in manual workers (34.5%) (Table 1).

The percentage of those who experienced sustained feelings of depression was only slightly higher among manual workers (9.8%) than among upper (9.3%) and lower (9.5%) non-manual workers. Stress awareness rates were higher in non-manual workers (upper, 31.8%; lower, 30.6%) than in manual workers (23.3%). The marriage rate was higher among non-manual workers. Furthermore, 97.6% of upper and 97.7% of lower non-manual

workers were likely to receive social support through marriage, compared to 94.9% of manual workers. Suicidal ideation was more common in lower non-manual (10.1%) and manual (10.8%) workers than in upper non-manual workers (7.3%) (Table 1).

In terms of the work environment, more non-manual workers agreed or strongly agreed that their workplaces were clean and comfortable (upper, 88.4%; lower, 85.8%) than manual workers (54.9%). Far more manual workers (62.7%) agreed or strongly agreed that they worked in a dangerous environment than non-manual workers. However, the proportion of respondents who agreed or strongly agreed about time pressure did not differ significantly among the occupational groups (upper non-manual, 36.9%; lower non-manual, 35.9%; manual, 36.5%). With regard to having authority at work, more non-manual workers agreed or strongly agreed (upper, 95.2%; lower, 89.1%) than manual workers (68.4%). Those who agreed or strongly agreed that they were respected and trusted were more likely to be non-manual workers (upper, 92.4%; lower, 91.8%) than manual workers (85.7%). More manual workers responded that they worked long hours in an uncomfortable position and carried heavy objects. Finally, more respondents who agreed or strongly agreed that they hid their emotions were manual workers (37.9%) than non-manual workers (upper, 34.2%; lower, 35.8%) (Table 1).

Similar results were found in an analysis of the 2013–2015 KNHANES data containing the same variables on childhood and adulthood SEP indicators and pathway variables, but lacking work environment variables (see Appendix Tables 2 and 3).

Discussion

A distinct occupational gap was found in childhood and adulthood SEP. Non-manual worker groups tended to have a better childhood and adulthood SEP than manual workers. This relationship between adulthood SEP and occupational status is not surprising. The results are in line with the existing studies that reported close correlations among high education levels, non-manual job choices, and higher income(6, 22, 23).

Moderate occupational gaps in biological health risk factors were also found, with the exception of BMI. The levels of systolic blood pressure, cholesterol, and glucose were higher in manual workers than in non-manual workers. These high levels of risk factors are presumed to indicate greater exposure for manual workers, although the occupational gaps in these risk factors were weaker than those for childhood and adulthood SEP.

Non-manual workers reported healthier behaviors—namely, lower rates of smoking and high-risk drinking—than manual workers. Previous studies also reported a lower age-standardized cancer mortality rate in upper non-manual workers (e.g., legislators, managers, and professionals) than manual workers, including elementary occupations(24). In particular, the incidence of and mortality from smoking- or alcohol-related cancers may be influenced by health behaviors linked with SEP(24). The results of our analysis provide no support for Tanaka's (2019)(8) argument that the rising mortality from cancer among upper non-manual workers may be affected by unhealthy lifestyle factors that contribute to higher all-cause mortality for them relative to lower occupational classes. However, in terms of other health behavior measures, the proportion of manual workers who engaged in physical activities was higher. The 2007–2009 KNHANES defined physical activity as moderate-intensity physical activities performed at least five days a week for 30 minutes or more per day. Manual workers' occupational physical activities may positively influence their health. Previous studies reported that non-sedentary physical activity may have a positive effect on workers' physical health(25) and that workers who engaged in physically demanding occupational physical activities had a lower prevalence of obesity than those who did not(26).

However, an additional analysis of the 2013–2015 KNHANES data showed that physical activity for leisure was more common in higher occupational classes (30.7% in upper non-manual, 30.0% in lower non-manual, and 16.2% in manual workers) (Appendix Tables 2 and 3). Physical activity for weight control was also more common in non-manual than manual workers.

Except for stress awareness, almost all psychosocial factors (i.e., a higher level of feelings of depression and suicidal ideation and a lower marriage rate) showed disadvantageous gaps for manual workers. Moreover, SEP-related factors such as lower education, income, and employment status are well-known risk factors for suicide(24, 27–29). We did not find distinct evidence of deterioration in SEP or psychosocial factors within the non-manual classes.

The proportion of workers who felt that their work environment was clean and pleasant, who had sufficient decision-making authority, and who felt respected and trusted was much higher in non-manual workers than among manual workers. In contrast, higher proportions of manual workers carried out dangerous work, worked long hours in an uncomfortable position, carried heavy items, and hid their emotions. Thus, non-manual workers had more favorable perceptions of their work environment than manual workers, even after the economic crisis in Korea, which is likely to work in favor of their health. Prior studies have reported that low job control, measured by self-reported items on decision authority and skill discretion, significantly contributed to the employment gradient in the frequency of coronary heart disease(30). Other research has shown that work stress, job strain, and effort-reward imbalance were related with the risk of cardiovascular death, with the association often confounded by SEP-related factors such as occupational class(6, 31, 32). Based on our analysis and previous studies, we cannot conclude that worse workplace conditions and increased psychosocial job stress caused by the economic crisis are linked to higher mortality among non-manual workers.

As this study used only three years of data from the 2007–2009 KNHANES, the results are limited in explaining the continuing effects of the economic crisis in Korea. However, our additional analyses of the 2013–2015 KNHANES, excluding aspects of the work environment that were not collected during those years, showed very similar outcomes as the 2007–2009 data (see Appendix Tables 2 and 3). These results provide further corroboration that the health status or mortality of non-manual workers may not have been more negatively affected by the economic crisis than that of manual workers in Korea. To further investigate this issue in Korea, a more direct explanation could be developed for mortality patterns by occupational class in Korea with use of mortality follow-up data, moving beyond an implicit interpretation based on risk factors for mortality.

Conclusion

Overall, almost all contributing factors showed better conditions in non-manual occupational classes than in the manual class. Smoking, alcohol consumption, and weight control activities tended to be worse, and the rates of depression and suicidal ideation were higher, among manual workers. The work environment was more likely to be supportive of physical and psychological health for non-manual workers than for manual workers. Childhood and adulthood SEP also showed more pronounced gaps by occupational class than other factors. Those with non-manual jobs had a better current socioeconomic status and generally had a better childhood socioeconomic environment than those with manual jobs. SEP is not likely to work in a way that exacerbates the health conditions and mortality of non-manual workers. In conclusion, there is little evidence that SEP and pathway factors that change in response to influential events such as the economic crisis were worse among upper non-

manual workers than among lower non-manual and manual workers. Instead, the numerator–denominator bias caused by using unlinked data is the most likely reason for the previously reported anomalous occupational gradients in mortality in Korea.

Abbreviations

BMI
Body Mass Index
IRB
Institutional Review Board
KCDC
Korea Centers for Disease Control and Prevention
KHIDI
Korea Health Industry Development Institute
KNHANES
Korea National Health and Nutrition Examination Survey
SEP
Socioeconomic Position

Declarations

Ethics approval and consent to participate

Ethical approval for this study was received from the Seoul National University Hospital Institutional Review Board (IRB number: E-2005-091-1123).

Consent for publication

Not required.

Availability of data and materials

Data sharing statement: The data used are publicly available from the Korea Centers for Disease Control and Prevention.

Competing interests

None declared.

Funding

This research was supported by a grant of the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (grant number: HI18C0446).

Authors' contributions

Conception: YHK. Study design: YHK, EN. Data analysis: EN. Supervision: YHK. Data interpretation: EN, YHK. Drafting manuscript: EN. Revising manuscript content: YHK. Approval of the final version of the manuscript: All authors.

Acknowledgements

We thank the Korea Centers for Disease Control and Prevention for providing the data.

References

1. Macintyre S. The Black Report and beyond what are the issues? Soc Sci Med. 1997;44(6):723–45.
2. Marmot MG, McDowall ME. Mortality decline and widening social inequalities. Lancet. 1986;328(8501):274–6.
3. Son M, Armstrong B, Choi JM, Yoon TY. Relation of occupational class and education with mortality in Korea. J Epidemiol Community Heal. 2002;56(10):798–9.
4. Khang Y-H, Kim HR. Socioeconomic inequality in mortality using 12-year follow-up data from nationally representative surveys in South Korea. Int J Equity Health [Internet]. 2016;15(1):1–11. Available from: http://dx.doi.org/10.1186/s12939-016-0341-9
5. Stringhini S, Sabia S, Shipley M, Brunner E, Nabi H, Kivimaki M, et al. Association of socioeconomic position with health behaviors and mortality. J Am Med Assoc. 2010;303(12):1159–66.
6. Khang Y-H, Lynch JW, Yang S, Harper S, Yun SC, Jung-Choi K, et al. The contribution of material, psychosocial, and behavioral factors in explaining educational and occupational mortality inequalities in a nationally representative sample of South Koreans: Relative and absolute perspectives. Soc Sci Med [Internet]. 2009;68(5):858–66. Available from: http://dx.doi.org/10.1016/j.socscimed.2008.12.003
7. Khang YH, Kim HR. Relationship of education, occupation, and income with mortality in a representative longitudinal study of South Korea. Eur J Epidemiol. 2005;20(3):217–20.
8. Tanaka H, Nusselder WJ, Bopp M, Brønnum-Hansen H, Kalediene R, Lee JS, et al. Mortality inequalities by occupational class among men in Japan, South Korea and eight European countries: A national register-based study, 1990-2015. J Epidemiol Community Health. 2019;73(8):750–8.
9. Tanaka H. Re: Mortality inequalities by occupational class among men in Japan, South Korea and eight European countries: a national register-based study, 1990–2015 [Internet]. Journal of Epidemiology and Community Health. 2019. Available from: https://jech.bmj.com/content/early/2019/06/07/jech-2018-211715.responses?versioned=true#the-surprising-result-of-manual-workers-in-korea-enjoying-lower-mortality-than-non-manual-workers-is-likely-due-to-numerator-denominator-bias
10. Mackenbach JP. Health inequalities: Persistence and change in modern welfare states. Oxford University Press, USA; 2019.
11. Khang Y-H. The surprising result of manual workers in Korea enjoying lower mortality than non-manual workers is likely due to numerator-denominator bias [Internet]. Journal of Epidemiology and Community Health. 2019. Available from: https://jech.bmj.com/content/early/2019/06/07/jech-2018-211715.responses?versioned=true#the-surprising-result-of-manual-workers-in-korea-enjoying-lower-mortality-than-non-manual-workers-is-likely-due-to-numerator-denominator-bias

12. Kim H-R, Khang Y-H. Reliability of education and occupational class: A comparison of health survey and death certificate data. J Prev Med Public Heal. 2005;38(4):443–8.
13. Kweon S, Kim Y, Jang MJ, Kim Y, Kim K, Choi S, et al. Data resource profile: The korea national health and nutrition examination survey (KNHANES). Int J Epidemiol. 2014;43(1):69–77.
14. Korea Centers for Disease Control and Prevention. Guideline for using raw data for national health and nutrition surveys IV (2007-2009) [Internet]. Korea Centers for Disease Control and Prevention. 2008. Available from: https://knhanes.cdc.go.kr/knhanes/sub03/sub03_06_02.do
15. Shonkoff JP, Boyce WT, McEwen BS. Neuroscience, Molecular Biology, and the Childhood Roots of Health Disparities. Jama. 2009;301(21):2252.
16. Bahk J, Yun SC, Kim YM, Khang YH. Changes in the Relationship Between Socioeconomic Position and Maternal Depressive Symptoms: Results from the Panel Study on Korean Children (PSKC). Matern Child Health J. 2015;19(9):2057–65.
17. Oakley L, Maconochie N, Doyle P, Dattani N, Moser K. Multivariate analysis of infant death in England and Wales in 2005–06, with focus on socio-economic status and deprivation. Heal Stat Quarterly,. 2009;42(1):22–39.
18. Wickham S, Anwar E, Barr B, Law C, Taylor-Robinson D. Poverty and child health in the UK: Using evidence for action. Arch Dis Child. 2016;101(8):759–66.
19. Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: The development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. Soc Sci Med. 2008;66(6):1429–36.
20. Cavelaars AEJM, Kunst AE, Geurts JJM, Crialesi R, Grötvedt L, Helmert U, et al. Persistent variations in average height between countries and between socio-economic groups: An overview of 10 European countries. Ann Hum Biol. 2000;27(4):407–21.
21. Li L, Manor O, Power C. Are inequalities in height narrowing? Comparing effects of social class on height in two generations. Arch Dis Child. 2004;89(11):1018–23.
22. Fujishiro K, Xu J, Gong F. What does “occupation” represent as an indicator of socioeconomic status?: Exploring occupational prestige and health. Soc Sci Med. 2010;71(12):2100–7.
23. Ministry of Employment and Labor. Survey on labor conditions by employment type 2013 [Internet]. Ministry of Employment and Labor. 2015 [cited 2015 Feb 11]. Available from: http://kosis.kr/statisticsList/statisticsList_01List.jsp?vwcd=MT_%0AZTITLE&parentId=B#SubCont
24. Lee H-E, Kim H, Chung YK, Kang SK, Kim E-A. Mortality rates by occupation in Korea: A nationwide, 13-year follow-up study. Occup Environ Med. 2016;73:329–35.
25. Morassaei S, Smith PM. Examining the relationship between psychosocial working conditions, physical work demands, and leisure time physical activity in Canada. J Occup Environ Med. 2011;53(10):1099–105.
26. Bonauto DK, Lu D, Fan ZJ. Obesity prevalence by occupation in Washington State, behavioral risk factor surveillance system. Prev Chronic Dis. 2014;11.
27. Schneider B, Grebner K, Schnabel A, Hampel H, Georgi K, Seidler A. Impact of employment status and work-related factors on risk of completed suicide: A case–control psychological autopsy study. Psychiatry Res. 2011;190(2–3):265–70.

28. Kim MH, Jung-Choi K, Jun HJ, Kawachi I. Socioeconomic inequalities in suicidal ideation, parasuicides, and completed suicides in South Korea. Soc Sci Med. 2010;70(8):1254–61.
29. Bahk J, Lynch JW, Khang YH. Forty years of economic growth and plummeting mortality: The mortality experience of the poorly educated in South Korea. J Epidemiol Community Health. 2017;71(3):282–8.
30. Marmot MG, Bosma H, Hemingway H, Brunner E, Stansfeld S. Contribution of job control and other risk factors to social variations in coronary heart disease incidence. Lancet. 1997;350(9073):235–9.
31. Bruner EJ, Kivimäki M, Siegrist J, Theorell T, Luukkonen R, Riihimäki H, et al. Is the effect of work stress on cardiovascular mortality confounded by socioeconomic factors in the Valmet study? J Epidemiol Community Heal. 2004;58(12):1019–20.
32. Kivimäki M, Leino-Arjas P, Luukkonen R, Riihimäi H, Vahtera J, Kirjonen J. Work stress and risk of cardiovascular mortality: Prospective cohort study of industrial employees. BMJ. 2002;325(7369):857.