

BMJ Open Neighborhood-level and individual-level socioeconomic status and self-reported management of ischaemic heart disease: cross-sectional results from the Korea Health Examinees Study

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ABSTRACT

Objective Several studies identified neighbourhood context as a predictor of prognosis in ischaemic heart disease (IHD). The present study investigates the relationships of neighborhood-level and individual-level socioeconomic status with the odds of ongoing management of IHD, using baseline survey data from the Korea Health Examinees-Gem study.

Design In this cross-sectional study, we estimated the association of the odds of self-reported ongoing management with the neighborhood-level income status and percentage of college graduates after controlling for individual-level covariates using two-level multilevel logistic regression models based on the Markov Chain Monte Carlo function.

Setting A survey conducted at 17 large general hospitals in major Korean cities and metropolitan areas during 2005–2013.

Participants 2932 adult men and women.

Outcome measure The self-reported status of management after incident angina or myocardial infarction.

Results At the neighbourhood level, residence in a higher-income neighbourhood was associated with the self-reported ongoing management of IHD, after controlling for individual-level covariates [OR: 1.22, 95% credible interval (CI): 1.01 to 1.61]. At the individual level, higher education was associated with the ongoing IHD management (high school graduation, OR: 1.33, 95% CI: 1.08 to 1.65); college or higher, OR: 1.63, 95% CI: 1.22 to 2.12; reference, middle school graduation or below).

Conclusions Our study suggests that policies or interventions aimed at improving the quality and availability of medical resources in low-income areas may associate with ongoing IHD management. Moreover, patient-centred education is essential for ongoing IHD management, especially when targeted to patients with IHD with a low education level.

INTRODUCTION

Ischaemic heart disease (IHD), the current leading cause of death in Western countries,

Strengths and limitations of this study

- This study is among the first to examine the association between neighborhood-level and individual-level socioeconomic status (SES) and ongoing management of ischaemic heart disease in Asian countries.
- Our study benefitted from the use of population-based samples, which enabled a multilevel analysis based on the neighborhood-level SES.
- However, our findings were limited by the cross-sectional study design, use of survey data and risk of selection bias.

is rapidly becoming the leading cause of death in developing countries.¹ To reduce the mortality associated with IHD, researchers and clinicians have stressed the importance of patient management. Based on evidence demonstrating that medication adherence and behavioural lifestyle changes improved prognosis and retarded disease progression, guidelines for secondary IHD prevention suggest that patient management should comprise pharmacological treatments (eg, antiplatelet therapy, beta-blocker therapy) or lifestyle modifications (eg, weight control, smoking cessation, blood pressure management).^{2,3}

Earlier research suggests that the management of post-IHD may differ by socioeconomic status (SES). Notably, the lower rates of mortality among patients with IHD with a high SES⁴ may be attributable to the availability of better care,⁵ better adherence to therapy, better self-monitoring⁶ and more rapid implementation of behavioural lifestyle changes,⁷ which are facilitated by economic, educational and social resources. Independent of the individual-level SES,

neighbourhood contexts also play critical roles in various health outcomes, including IHD-related outcomes.^{8,9} Several previous studies have shown that residence in a socioeconomically disadvantaged neighbourhoods was associated with a greater risk of IHD^{10,11} and shorter survival duration.^{12,13} However, few studies have examined the association between the neighbourhood SES and IHD management.

To our knowledge, no study has addressed this association in South Korea (hereafter Korea) or another Asian country. Although the IHD-related mortality rate in 2011 remained lower in Korea (42 per 100 000 individuals) than in Western countries, the incidence of IHD in Korea has increased by 60% during the past decade¹⁴ consequent to increases in body mass index values and an increasingly westernised diet among middle-aged adults.¹⁵ Secondary IHD mortality may be significantly reduced by ongoing IHD management involving both proper quality treatment and lifestyle modification, which may be shaped by neighbourhood contexts as well as individual characteristics. Therefore, this study aimed to evaluate the individual-level and neighborhood-level SES as the main determinants of ongoing IHD management in Korea, using baseline data from a large population-based cohort study with a multilevel framework.

METHODS

Data source

We used baseline survey data from the Health Examinees-Gem (HEXA_G) study, which was constructed by dropping inconsistent data collected during pilot HEXA survey periods. The original HEXA, which is part of the Korean Genome Epidemiology Study (KoGES),¹⁶ was a large-scale genomic cohort study of 1 69 722 adults aged 40–69 years living in major Korean cities and metropolitan areas. Samples were recruited from 38 health examination centres and training hospitals (mainly general hospitals) during 2004–2013.¹⁷ Eligible participants who visited the participating sites for biannual health check-ups, which were covered in full by the National Health Insurance Program were asked to respond voluntarily to an interview-based survey conducted by well-trained interviewers using a structured questionnaire. The survey collected information about sociodemographic characteristics, medical history, medication usage, family history and health/lifestyle behaviours. More detailed information about the HEXA cohort study can be found elsewhere.^{16,17} The HEXA-G dataset comprised 139 345 participants [men: 46 977 (33.7%); women: 92 368 (66.3%)]. Participants were excluded because of inconsistencies in data quality control, biospecimen collection, a short duration of study participation at 21 centres that participated in a pilot study, or the withdrawal of provision of personal information for studies. The original HEXA and HEXA-G were deidentified for research.

Patient and public involvement

Patients and public were not involved in the design and conduct of this study. The results will not be disseminated to study participants.

Study outcome

The outcome of the study was the self-reported current management status after incident angina or myocardial infarction. To identify participants with a history of IHD, the survey included the yes/no question of ‘Have you ever been diagnosed with angina or myocardial infarction by a medical doctor in a medical facility?’ The sub-population that responded ‘yes’ then answered a subquestion regarding the current status of disease management for which the following options were available: (a) ‘condition has been good or improved due to management’; (b) ‘currently managed and treated’; (c) ‘was previously managed but is now neglected’ and (d) ‘neither managed nor treated.’ We dichotomised these responses as ‘ongoing management’ by combining (a) with (b) versus ‘failure of ongoing management’ (reference) by combining (c) with (d), respectively.

Neighborhood-level SES variables

The main neighborhood-level SES variables were (1) the regional median income status and (2) the regional mean percentage of college graduates. Seventeen neighbourhoods were defined as 17 major cities and metropolitan areas (mean population: 201 210, range: 115 000–574 000) associated with 17 large general hospitals (figure 1). The total catchment area of these hospitals covered 6.6% of the total Korean population. We obtained neighborhood-level SES data from a nationally and regionally representative dataset, Korea Community Health Survey (<https://chs.cdc.go.kr/chs/index.do>), which has been

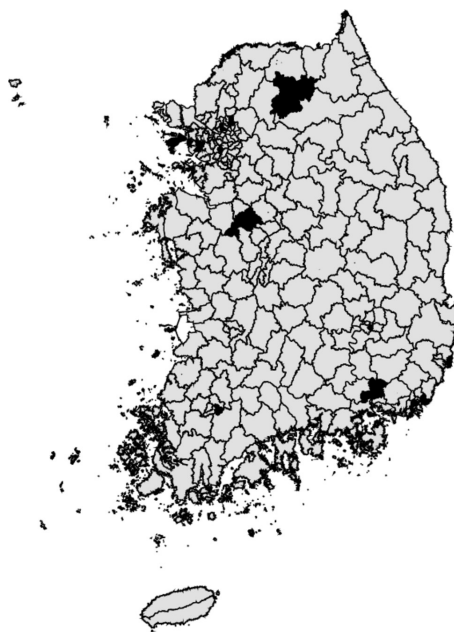


Figure 1 Study areas of 17 major cities and counties in the Korea HEXA-Gem dataset, 2005–2013.

conducted in 253 communities annually since 2008. This survey aims to estimate regional patterns of disease prevalence and morbidity, as well as to understand the personal lifestyle and health behaviour.¹⁸ An average of 800–900 adults (age: ≥ 19 years) who resided in each neighbourhood were selected using the probability proportional to sampling and systematic sampling methods. The sampling strategies are described in more detail elsewhere.¹⁸ We calculated exogenous neighborhood-level SES measures using regional mean centering of the percentage of college graduates and median centering of the income status of the survey years. We then linked the regional SES indicators to our main dataset using the neighbourhood identifier and the year variable. A comparison of sociodemographic characteristics between neighbourhoods included and not included in the study revealed that the former was comprised of younger (age: 49.2 vs 52.9 years), more highly educated (college graduates: 43.9% vs 33.0%) and wealthier (the top 25% of household incomes: 30.9% vs 27.8%) population.

Individual-level SES variables

Educational level was categorised into middle school or lower, high school graduation or college graduation or higher. Income was measured by collapsing the data into four categories: <1 , 1–2, 2–4 and ≥ 4 million Korean won (M KRW).

Covariates

The individual-level covariates included sex, age, marital status occupation and comorbidities. Age was categorised into 40–50, 51–60 or 61+ years. Marital status was dichotomised into living with a spouse or not. Occupation was categorised as white collar, blue collar, housewife or other. Comorbidities were defined as the presence of hypertension, diabetes or hyperlipidaemia at the time of the survey.

Statistical analysis

Two-level multilevel logistic regression models were fitted with individuals (level 1) nested within neighbourhoods (level 2) to estimate the contributions of the individual-level and neighborhood-level factors simultaneously. Random intercept models were fitted for the whole study samples to correct for cluster effects of the individual variables within the same neighbourhood according to the neighbourhood identifier in the model. We used the command *runmwin* to run *MLwiN* within Stata V.14).¹⁹ This command enables researchers to fit multilevel models more quickly with *MLwiN* by taking advantage of the multilevel dataset analysis features included in Stata.¹⁹ *MLwiN* was used to fit a binomial logit response model to an estimation using the iterative generalized least squares and second-order penalised quasi-likelihood (PQL2).

Estimates obtained using the above-described methods are known to exhibit a bias for discrete responses²⁰; therefore, we fitted our final model using the Markov chain Monte Carlo (MCMC) function. Additionally, we adopted

the Bayesian estimation function to ensure the accuracy of the estimates and their standard errors, as a small sample size at level 2 can lead to biased estimates.^{21 22} The MCMC was conducted to burn-in for 500 simulations, which yielded distribution starting values to discard, and subsequently to proceed for 5000 additional simulations to obtain a precise estimate and distribution of interest. Once the convergence diagnostics were confirmed, the ORs and 95% credible intervals (CIs) were presented in a Bayesian framework. We created separate missing dummy categories to retain the missing cases in income (n=295), occupation (n=265) and other covariate data (n=35) in the regression analysis. Due to of little interpretive value, the results for the category were not reported. We did not stratify the analyses by gender because a Chow test [47] failed to detect significant differences in the slopes and intercepts of the gender-stratified regressions [$F(1, 2,364)=0.95, p=0.3309$].

RESULTS

Table 1 presents the characteristics of participants with IHD from the HEXA-Gem dataset (n=2932), stratified by self-reported IHD management. Men had higher proportions of self-reported ongoing management than women (85.9% vs 75.5%). Participants of younger groups had higher proportions of failures of ongoing IHD management (40–49: 29.5% vs. 50–59: 21.3% vs. 60–69: 15.2%).

Table 2 presents the results of the two-level multilevel logistic regression models for ongoing IHD management. In model 1, the odds of ongoing management were higher for those with IHD who resided in higher-income neighbourhoods, with an OR of 1.39 (95% CI: 1.15 to 1.66). In model 2, a higher individual education level was associated with ongoing IHD management, with ORs of 1.35 (95% CI: 1.06 to 1.66) and 1.52 (95% CI: 1.14 to 2.02) for high school graduation and college graduation or higher, respectively, compared with those with a middle school or lower education. However, no significant associations were observed between an individual's income group and the likelihood of self-reported ongoing management. In model 3, the neighborhood-level income status remained significantly associated with self-reported ongoing management even after adjusting for individual-level factors (OR: 1.22, 95% CI 1.01 to 1.61). In this model, however, the association of residence in a neighbourhood with a high percentage of college graduates with self-reported ongoing IHD management was not statistically significant. Finally, all models exhibited significant between-neighbourhood variance.

DISCUSSION

According to our findings, residence in a neighbourhood with a one-unit higher income was associated with a 22% higher likelihood of self-reported ongoing IHD management, compared with residence in a neighbourhood with a lower income status. By contrast, at the individual level, a

Table 1 Characteristics of the study sample from the Korea HEXA-Gem dataset (n=2932), 2005–2013, stratified by self-reported ongoing management of post-ischæmic heart disease

Individuals		Ongoing management				
		Yes (n=2366, 80.7%)		No (n=566, 19.3%)		
		N	%	N	%	
Sex	Men	1261	85.9	207	14.1	*
	Women	1105	75.5	359	24.5	
Age (years)	40–49	248	70.5	104	29.5	*
	50–59	904	78.7	245	21.3	
	60–69	1214	84.8	217	15.2	
Education	≤Middle school	987	77.8	281	22.2	*
	High school	868	82.0	191	18.0	
	≥College	487	84.3	91	15.7	
	Missing	24	85.7	3	11.1	
Income (million Korean won)	<1	779	83.1	159	16.9	*
	1–2	588	80.8	140	19.2	
	2–4	418	78.3	116	21.7	
	≥4	581	79.4	151	19.3	
	Missing	204	69.2	91	30.9	
Occupation	White collar	618	78.8	166	21.2	*
	Blue collar	359	81.8	80	18.2	
	Housewife	702	76.5	216	23.5	
	Other	466	88.6	60	11.4	
	Missing	221	83.4	44	16.6	
Marital status	Living with spouse	2073	80.9	488	19.1	
	Living without spouse	293	79	78	21.0	
Comorbidities	Hypertension	1104	84.5	202	15.5	*
	No hypertension	1262	77.6	364	22.4	
	Diabetes	465	85.3	80	14.6	*
	No diabetes	1901	79.6	486	20.4	
	Hyperlipidaemia	476	79.7	121	20.3	
No hyperlipidaemia	1890	80.9	445	19.1		
Neighbourhoods		Mean		SD		
Neighborhood-level income status		0.46		0.98		
Neighborhood-level % of college graduates or higher		0.10		0.07		

*Differences between two groups for the all variables were considered significant at a p value <0.05.

higher income was not significantly associated with self-reported ongoing IHD management. However, a higher individual education level was associated with a higher likelihood of self-reported ongoing IHD management.

Previous studies have found that a lower neighbourhood SES was associated with a higher risk of IHD^{10 11} and a shorter survival duration after incident IHD.^{12 13} Consistent with those reports, our study showed an association of the neighbourhood SES with ongoing IHD management that was independent of individual-level factors. We

attribute this association to several factors. First, residents of higher-income neighbourhoods may have greater access to higher quality medical resources, such as physicians or primary care clinics near their homes, regardless of individual income.²³ Second, residents in higher-income neighbourhoods may enjoy a more favourable social environment for IHD management, which might include an increased interest in health maintenance and a greater amount of social support from neighbours.²⁴ Third, residents of lower-income neighbourhoods might

Table 2 Estimations from the two-level multilevel logistic regression models of self-reported ongoing management among ischaemic heart disease survivors in the Korea HEXA-Gem dataset, 2005–2013

	Model 1	Model 2	Model 3
	OR (95% credible interval)	OR (95% credible interval)	OR (95% credible interval)
Fixed parameters			
Sex (ref. female)			
Male		1.83 (1.38 to 2.39)	1.81 (1.37 to 2.32)
Age (years; ref. 40–49)			
50–59		1.57 (1.16 to 2.07)	1.57 (1.14 to 2.07)
61–69		2.19 (1.60 to 2.94)	2.19 (1.56 to 2.93)
Education (ref. ≤middle school)			
High school		1.35 (1.06 to 1.66)	1.33 (1.08 to 1.65)
≥College		1.52 (1.14 to 2.02)	1.63 (1.22 to 2.12)
Income (ref. <1 million Korean won)			
1–2 million		0.89 (0.50 to 1.49)	0.88 (0.37 to 1.48)
2–4 million		1.09 (0.63 to 1.76)	1.14 (0.66 to 1.87)
≥4 million		1.26 (0.85 to 1.81)	1.07 (0.70 to 1.65)
Marital status (ref. living with spouse)			
Living without spouse		1.08 (0.82 to 1.42)	1.09 (0.80 to 1.44)
Occupation (ref. white collar)			
Blue collar		1.11 (0.79 to 1.53)	1.11 (0.81 to 1.50)
Housewife		1.13 (0.84 to 1.48)	1.12 (0.85 to 1.46)
Other		1.42 (1.00 to 1.97)	1.42 (0.99 to 1.97)
Hypertension (ref. no)			
Yes		1.49 (1.20 to 1.84)	1.49 (1.21 to 1.80)
Diabetes (ref. no)			
Yes		1.21 (0.91 to 1.58)	1.20 (0.91 to 1.57)
Hyperlipidaemia (ref. no)			
Yes		0.91 (0.67 to 1.23)	0.91 (0.68 to 1.19)
Neighborhood-level income status	1.39 (1.15 to 1.66)		1.22 (1.01 to 1.61)
Neighborhood-level % of college graduates or higher	1.06 (0.86 to 1.30)		1.12 (0.89 to 1.41)
Random parameters			
Between-neighborhood variance	0.11 (0.02 to 0.32)	0.14 (0.03 to 0.37)	0.16 (0.03 to 0.46)
Deivance Information Criterion (DIC)	2853.90	2756.97	2754.86

Model 1 included the neighborhood-level SES only; model 2 included individual-level factors only; model 3 included all individual. All models were controlled for year dummies.

have reduced access to health-oriented features such as recreation spaces and walkable environments²⁵ and stores that sell healthy foods,²⁶ concomitant with increased access to stores selling cigarettes and/or alcohol²⁷ and exposure to other environmental stressors. These factors may have important implications for self-care practices.

At the individual SES level, our study found that the education level was significantly associated with ongoing IHD management, whereas the income status was not. Similarly, previous studies also reported that IHD management may vary according to an individual's SES, and

suggested that the survivors with lower income and education levels might fail to manage themselves appropriately because of (a) a lack of knowledge related to prevention and healthy habits,²⁸ (b) limited access to care or drugs due to economic constraints²⁹ and (c) a lack of willingness or resources to change their lifestyles.⁷ Patient education has been identified as an important factor in terms of the understanding of a specific disease process, medication management and adherence and reported efficacies and side effects.³ Previous studies demonstrated improved adherence to suggested management among patients

with IHD with higher education levels,³⁰ whereas patients with lower education levels may not adhere to guidelines because of a lack of knowledge or understanding about their disease. Alternatively, our study findings may reflect suboptimal doctor–patient communication due to the exceptionally short consultation times with physicians in Korea, which are generally restricted to 2–3 min because of the lack of physicians and fee-for-service payment in the Korean healthcare system.³¹ This restriction may stunt ongoing IHD management, especially among patients with lower education levels. Accordingly, our findings suggest that individualised education could maximise IHD management outcomes.

Our finding that the individual-level income status and ongoing IHD management were not associated may imply that economic barriers to care or drugs do not determine the ongoing management of this condition. However, previous studies have shown that economically disadvantaged patients might be more likely to decline follow-up procedures or prescribed medications because economic constraint.^{5 29} Our favourable study finding of no significant income inequality might therefore be explained by the universal healthcare coverage benefits and medical subsidies provided to lower-income populations in Korea.³¹

Our study had several limitations of note. First, our cross-sectional study was unable to determine the causal relationship between our main exposures (eg, individual-level and neighborhood-level SES) and the self-reported management of IHD. Second, our study used self-reported survey data, which may have been biased by misclassification due to participants' misunderstanding or social desirability. Additionally, the participants' responses regarding ongoing IHD management may not have been confirmed by medical professionals whether the received treatment or participants' adherence to therapy was clinically appropriate. Third, we were not able to control for severity of IHD and time lapsed the acute event because of data limitations. Fourth, selection bias may have been introduced by non-random survey participation and attrition. Disadvantaged individuals were less likely to participate regular health examinations and were more likely to drop out in the survey, possibly due to a failure of ongoing management. This bias would have led to underestimating the likelihood of failure of ongoing management among disadvantaged individuals. Fifth, we assumed that most participants visited the general hospitals within the region they lived. This assumption is highly plausible, given the improved accessibility to the health examination service in Korea contexts, as the National Health Insurance Program provides free regular health examinations and medical facilities within and between regions exhibit minimal variations in examination quality.³² However, we could not completely exclude the possibility that participants may have visited general hospitals in other neighbourhoods to seek better-quality evaluations. Despite these limitations, however, one strength of our study was the use of population-based

samples, which enabled a multilevel analysis by linking neighborhood-level SES from the nationally and regionally representative dataset. By contrast, most previous studies used hospital data, which frequently lack information about the individual's SES and neighbourhood characteristics.³³ Moreover, to the best of our knowledge, this is among the first studies to examine the association between individual-level and neighborhood-level SES and IHD management in an Asian country.

In conclusion, our study findings provide an opportunity to improve ongoing IHD management by identifying the neighborhood-level and individual-level factors, which are associated with SES-related and geographical inequalities in IHD mortality. Our results suggest that policies or interventions intended to improve the quality and availability of medical resources in low-income areas might also effectively reduce inequalities in management and, ultimately, mortality. Moreover, our data suggest that patient-centred education is required to ensure ongoing IHD management and reduce related mortality, particularly among patients with a low education level.

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Contributors JH: analysed the data; drafted, reviewed and edited the manuscript and contributed to the discussion. JKL, DK: supervised the study. JO, HYL, JYC, SK, SVS: reviewed and edited the manuscript and contributed to the discussion.

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Competing interests None declared.

Patient consent for publication Obtained.

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Data sharing statement Data sharing of HEXA is available through the website of the Korea National Institute of Health (http://www.nih.go.kr/NIH/cms/content/eng/03/65203_view.html#menu4_1_2).

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