Community level socioeconomic inequality in ischemic heart disease incidence: A nationwide, Cohort Study

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Research article

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Abstract

Background

The purpose of this study is to confirm that the inequalities of community level social economic status (SES) actually affect ischemic heart disease (IHD) incidence, using the analysis of the Korean population-based cohort study of the National Health Insurance Service–National Sample Cohort (NHIS-NSC) database.

Methods

This study used the National Health Insurance Service–National Sample Cohort database, a population-based cohort database established by the NHIS in South Korea. The regional income level was classified in three categories, i.e. low, moderate, and high, according to the rank. The outcome measure of interest was IHD which was defined as according to the International Classification of Disease, 10th Revision (ICD-10) codes.

Results

In the low community level SES group, the incidence of IHD was 3.56 per 1,000 person years (cumulative incidence rate, 1.78%). In the high community level SES group, the incidence of IHD was 3.13 per 1,000 person years (cumulative incidence rate, 1.57%). the cumulative incidence of IHD according to the community level SES cohort during the follow-up period using the Kaplan-Meier. The log-rank test showed that the cumulative incidence of IHD was higher in the low community level SES group compared with the high community level SES group (adjusted hazard ratio, 1.16; 95% CI, 1.01-1.32)

Conclusion

Differences in SES levels at the local level may also differ in the incidence of IHD, as well as individual SES differences. Therefore, intervention in active, health-related behaviors at the local level will be required in order to reduce the IHD incidence.

Background

There is already much research that reports the association of ischemic heart disease (IHD) with individual level, social economic status (SES). These studies have shown that the lower the individual SES, the higher the incidence of IHD [1–6]. The previous study suggested that the causes of these findings are unaware of the risk factor for IHD and the negative health-related behaviors for IHD [7]. The unawareness and these negative, health-related behaviors are influenced by people living in community [8–14]. However, to my knowledge there has not yet been a published study regarding whether the difference in community level SES affects the incidence of IHD. Therefore, the purpose of this study is to confirm that the inequalities of community level SES actually affect IHD incidence, using the analysis of

the Korean population-based cohort study of the National Health Insurance Service–National Sample Cohort (NHIS-NSC) database.

Methods

Study population

This study used the NHIS– NSC database (NHIS–2018–2–290), a population-based cohort database established by the NHIS in South Korea [15]. This is the national representative cohort database for health service use, and in which approximately 1,025,340 patients (2.2% of 46,605,433 Korean residents in 2002) were followed until 2013 by annually updating samples of newborn infants. From this database, all of the patients aged ≥ 20 years in 2009 were identified. Patients without health check-up data or with a history of ischemic heart disease before their enrollment were excluded (Figure 1).

Exposure measures

The gross domestic product of the region in 2009 was used as a measure of regional income (http://kostat.go.kr/portal/korea/index.action). The regional income level was classified in three categories, i.e. low, moderate, and high, according to the rank.

Outcome measures

The outcome measure of interest was ischemic heart disease (IHD) which was defined as according to the International Classification of Disease, 10th Revision (ICD–10) codes I20, I21, I22, I23, I24, and I25. Follow-up of all patients began on 1 January 2009 and ended when any of the following occurred, i.e. onset of ischemic heart disease, death from any cause, moving to a different region at baseline, and the end of the study period (31 December 2013).

Confounder variables

Evaluation of confounders included patient age, gender, personal income level, smoking, body mass index (BMI), diabetes mellitus, hypertension, dyslipidemia, peripheral arterial disease, and stroke at baseline. Personal income is defined as the average premium for the insurance premiums per category. Premiums are based on taxes paid to the government for real estate and personal property owned by individuals. The history of disease was defined as follows: diabetes mellitus (DM) (ICD–10 E11, E12, E13, E14); hypertension (HTN) (I10, I11, I12, I13, I15); dyslipidemia (ICD–10 E78); peripheral arterial disease (PAD) (ICD–10 I70.0, I70.2, I73.9, I70.8, I70.9, I74.2, I74.3, I74.4, I74.5); and stroke (ICD–10 I60, I61, I63).

Statistical analyses

Data are presented as means (standard deviation, SD) for continuous variables or as numbers (n) and percentages (%) for categorical variables. Demographic and clinical characteristics among the regional income group were compared using the chi-square test or ANOVA, as appropriate. The incidence rate per 1000 person-years and the cumulative incidence for IHD were calculated in each group. To evaluate the association between the risk of IHD and the regional income level, Cox regression models with mixed effect ("Frailty model") were used. This model incorporates region-specific random effects to account for within-region homogeneity in outcomes [16]. Hazard ratios and 95% confidence intervals were presented and the high income group was considered the reference group. The adjusted hazard ratios were obtained from the model including regions as random effect and age, gender, smoking, BMI, personal income level, history of diabetes mellitus, hypertension, dyslipidemia, PAD, and stroke as covariates. All statistical analyses were performed using SAS version 9.4 software (SAS Institute Inc., Cary, NC, USA), and a two-sided P-value<0.05 was considered statistically significant.

Results

Baseline and clinical characteristics of the study population

From January 2002 to December 2009, we identified a total 356,126 patients, except those who had previously been diagnosed with IHD and those who were diagnosed according to a disorder code. The characteristics of the study population are shown in Table 1. Among the risk factors of IHD, the smoking ratio and BMI were found to be higher prevalence rates as the community level SES was lower (p = 0.006, p = 0.001). DM, HTN, and dyslipidemia showed lower prevalence rates with lower community level SES (p = 0.006, p<0.001, p<0.001). PAD had a higher prevalence rate with lower community level SES (p = 0.044) and stroke was not associated with lower community level SES (p = 0.745).

Incidence of IHD according to the community level SES

In the low community level SES group, the incidence of IHD was 3.56 per 1,000 person years (cumulative incidence rate, 1.78%). In the high community level SES group, the incidence of IHD was 3.13 per 1,000 person years (cumulative incidence rate, 1.57%). Multivariate analysis showed that the incidence of IHD was higher when the community level SES group was lower (p = 0.029) in Table 2. Figure 2 shows the cumulative incidence of IHD according to the community level SES cohort during the follow-up period using the Kaplan-Meier. The log-rank test showed that the cumulative incidence of IHD was higher in the low community level SES group compared with the high community level SES group (adjusted hazard

ratio, 1.16; 95% CI, 1.01–1.32). Figure 3 shows the risk of IHD associated with low community level SES among the various subgroups according to the demographic data and comorbidities. The significance of modification effects by each covariate regarding the risk of IHD associated with low community level SES was also tested and the results are shown as P for interactions. The patient age significantly modified the influence of low community level SES on IHD risk.

Discussion

Community level SES and IHD

The results of this study confirmed that even though the individual level of SES was adjusted, the incidence of IHD differed according to the SES difference at the community level. Therefore, community level SES also influences the occurrence of IHD. Negative health-related behaviors, such as smoking, low exercise, high fat diet, and psychological stress, serve as risk factors for IHD and directly affect the occurrence of IHD. These negative health-related behaviors are related to the community level SES position. Mayen et al. reported that healthier diet people are also relatively less frequently in the low SES community [17]. And community-level people with high SES share more information regarding health-related behaviors among neighbors or make more efforts to reduce IHD risk factors [18, 19]. Based on the results of this study, it is expected that the incidence of IHD will be lowered through community level intervention such as promoting educational materials on IHD or expanding smoking cessation areas. In fact, there are studies which propose that risk factors for non-communicable diseases, such as IHD, are more likely to be identified at lower SES levels and should therefore be controlled at the local level in order to reduce the risk factor for IHD [20, 21].

Advantages of this study

Previous SES-related studies have used income as a reference for SES [1, 3, 5]. However, as income does not reflect the level of property of real estate, it is difficult to say that it is an index that accurately reflects personal assets. In this study, the government's medical insurance premium, which is proportional to tax, is used as an indicator of SES. Tax reflects assets more objectively than income because it also includes the value of owning real estate or an automobile. And as this study is a nationwide, register-based cohort study, the number of patients is higher than in other studies and the quality is good because it is sample cohort data that governs the entire nation. Previous studies are mostly conducted in developed countries with well-being [3, 6]. The people used in these studies will have relatively less SES impact on the medical outcome than most people around the world. For example, in some European countries where healthcare is provided free of charge, the difference in income will have less impact on the accessibility of health care services. In this respect, this study has better data on the effect of SES inequality on the medical outcome than that seen in other studies. This is because the welfare benefits are relatively less developed and data from developing countries where SES is unfairly developed due to rapid urbanization [22].

Another advantage of this study is that there are no medical differences between races as this is a study conducted in a single nation-state, unlike other nationwide cohort studies.

Limitations of this study

First, one of the indicators that reflects SES is education level, but there is no information regarding education level in this study. However, it was thought that it was not meaningful in this data to distinguish the patients' SES according to their educational background because more than 98% of the patients included in this study had high school or higher education and more than 60% received a college education [23]. Second, the diagnosis of the disease may not be accurate. The data used in this study were based on the physician's input of the disease name which was classified by ICD–10. Therefore, there is a lack of objective data as to why the physicians in charge diagnosed the disease.

Conclusions

Differences in SES levels at the local level may also differ in the incidence of IHD, as well as individual SES differences. Therefore, intervention in active, health-related behaviors at the local level will be required in order to reduce the IHD incidence.

List Of Abbreviations

IHD: Ischemic heart disease; SES: Socioeconomic status; NHIS-NSC: National Health Insurance Service–National Sample Cohort; ICD–10: International Classification of Disease, 10th Revision; DM: diabetes mellitus; HTN: hypertension; PAD: peripheral arterial disease

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Korea university hospital (IRB number: 2018AN0217).

Consent for Publication

Not Applicable.

Availability of data and material

This data is available from the National Health Insurance Service–National Sample Cohort (NHIS-NSC) in Korea. However, NHIS (https://nhiss.nhis.or.kr) approval is required to use this data.

Competing interests

The authors declare that they have no competing interests.

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No funding was obtained for this study.Authors' contributions

YJH conceived of the study design. JGG wrote the manuscript. JC analyzed the data.

JGG and JC contributed equally to this work.

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Tables

Table 1. Baseline characteristics of the study populations

Variables	Total (N=356,126)	Community level SES			*p* value	*p* for trend
		Low (N=109,632)	Medium (N=117,936)	High (N=128,558)		
Age group, n (%)					<.001	0.758
20~29	42,875 (12.0)	12,801 (11.7)	14,058 (11.9)	16,016 (12.5)		
30~39	77,245 (21.7)	22,052 (20.1)	27,256 (23.1)	27,937 (21.7)		
40~49	98,444 (27.6)	31,356 (28.6)	34,306 (29.1)	32,782 (25.5)		
50~59	73,530 (20.7)	23,945 (21.8)	22,359 (19.0)	27,226 (21.2)		
60~69	40,605 (11.4)	12,541 (11.4)	12,473 (10.6)	15,591 (12.1)		
70~79	19,061 (5.4)	5,635 (5.1)	6,190 (5.3)	7,236 (5.6)		
80~	4,366 (1.2)	1,302 (1.2)	1,294 (1.1)	1,770 (1.4)		
Gender, n (%)					<.001	0.135
Male	180,598 (50.7)	54,738 (49.9)	61,160 (51.9)	64,700 (50.3)		
Female	175,528 (49.3)	54,894 (50.1)	56,776 (48.1)	63,858 (49.7)		
Smoking Ever, n (%)	120,972 (34.0)	36,648 (33.4)	41,879 (35.5)	42,445 (33.0)	<.001	0.006
BMI (kg/m^2), mean (SD)	23.4 (3.2)	23.4 (3.2)	23.4 (3.3)	23.3 (3.2)	<.001	0.001
Co-morbidities						
Diabetes mellitus, n (%)	28,745 (8.1)	8,764 (8.0)	9,321 (7.9)	10,660 (8.3)	0.001	0.006
Hypertension, n (%)	61,831	18,737	20,092	23,002	<.001	<.001

	(17.4)	(17.1)	(17.0)	(17.9)		
Dyslipidemia, n (%)	25,689 (7.2)	7,745 (7.1)	8,161 (6.9)	9,783 (7.6)	<.001	<.001
PAD, n (%)	5,560 (1.6)	1,829 (1.7)	1,728 (1.5)	2,003 (1.6)	0.001	0.044
Stroke, n (%)	6,728 (1.9)	2,098 (1.9)	2,196 (1.9)	2,434 (1.9)	0.658	0.745
Individual economic status (Medical premium: won), mean (SD)	77,526.1 (56,833.9)	72,459.8 (54,259.6)	78,492.6 (56,319.4)	80,960.0 (59,100.8)	<.001	<.001

* p-value by the chi-square test or ANOVA

Table 2. Incidence rates of ischemic heart disease according to the community level SES status.

Community level SES	Event	Total person years	Incidence rate per 1,000 person years	Cumulative Incidence* (%)	Crude HR (95% CI)	*p*	Adjusted HR† (95% CI)	*p*
Low	1,776	499,273.5	3.56	1.78	1.10 (0.91-1.33)	0.339	1.16 (1.01-1.32)	0.030
Medium	1,513	531,663.9	2.84	1.43	0.97 (0.76-1.23)	0.768	1.03 (0.88-1.22)	0.697
High	1,797	574,652.6	3.13	1.57	1.00		1.00	
p for trend					0.311		0.029	

*By Kaplan-Meier’s estimates

†Adjusting by age, gender, smoking, BMI, individual economic status, history of DM, hypertension, dyslipidemia, PAD and stroke

Figures

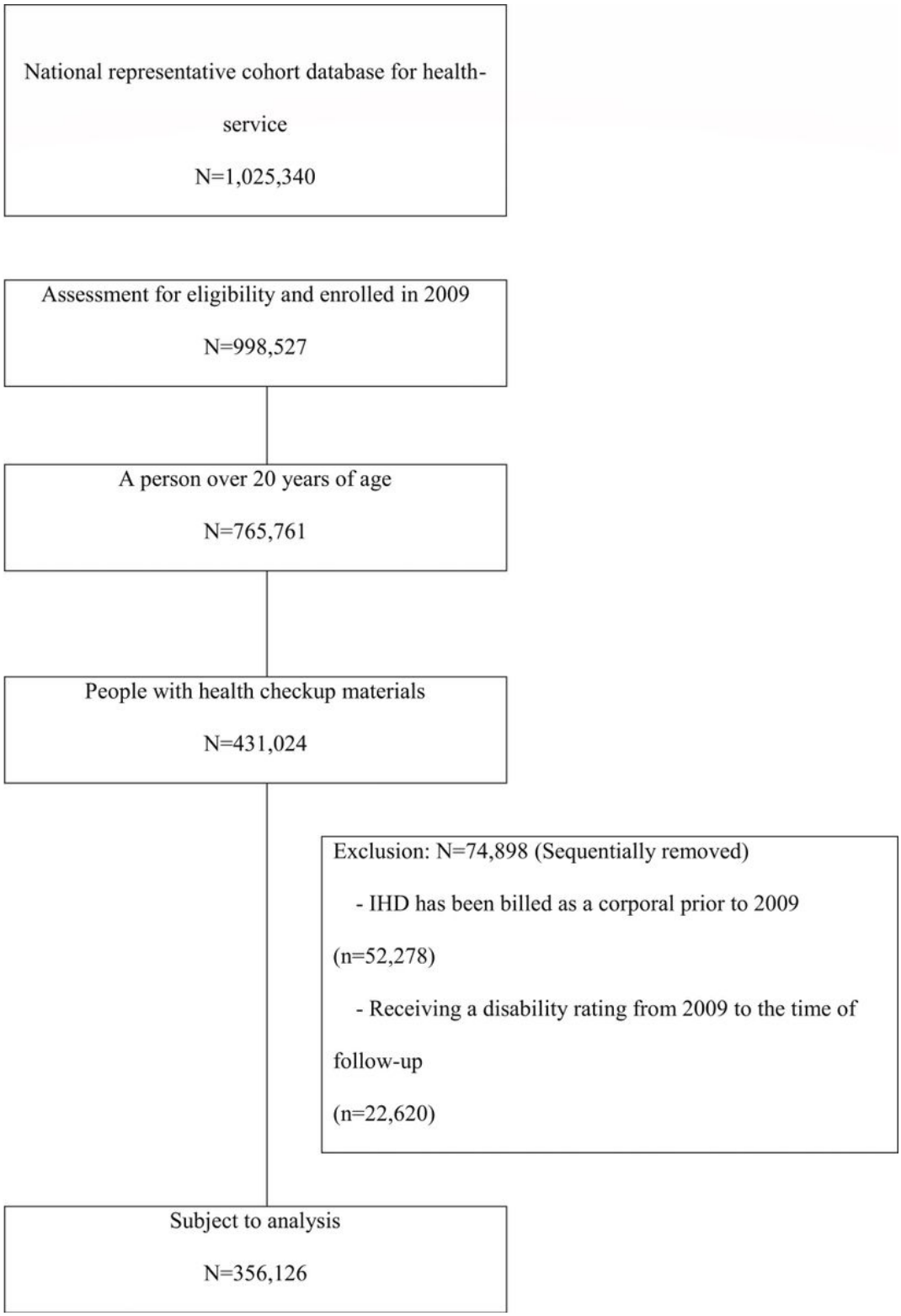
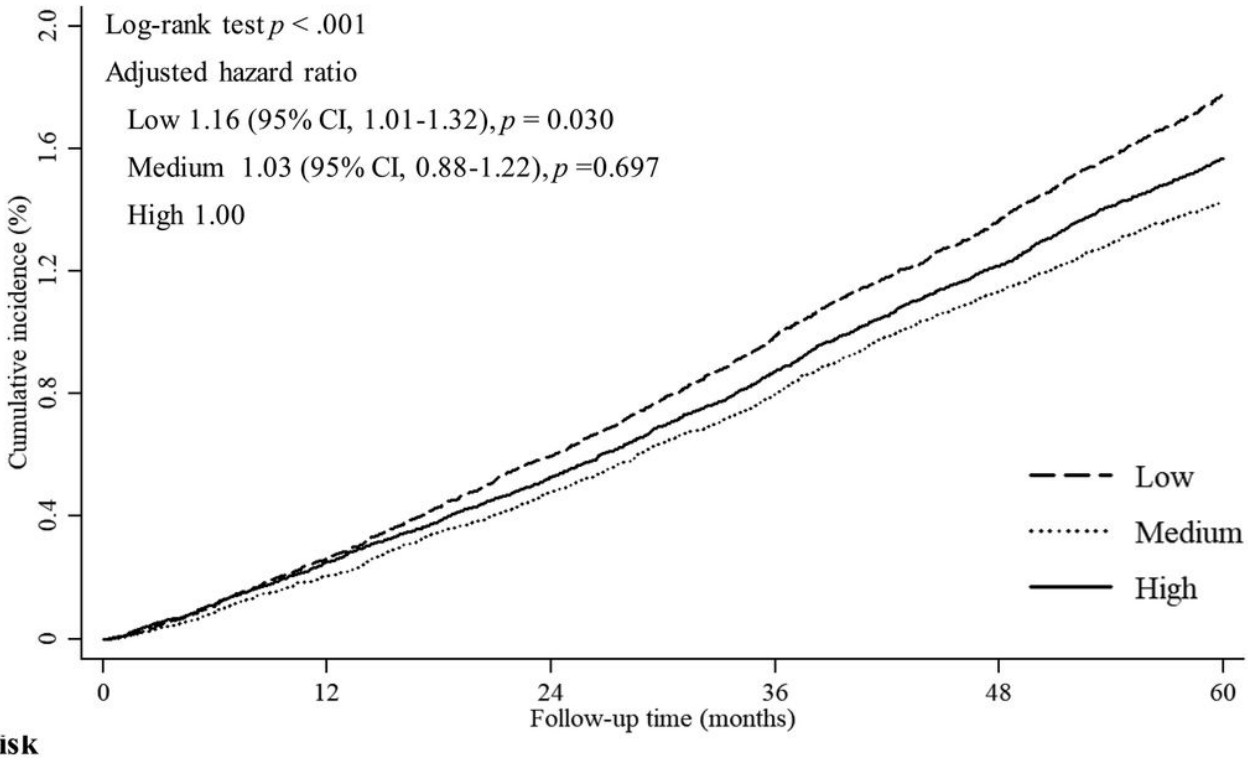


Figure 1

Flowchart of the study



Number ar risk

Low	109,632	109,344	105,764	97,525	94,317	91,418
Medium	117,936	117,694	113,866	103,224	99,599	96,527
High	128,558	128,234	124,150	111,753	107,067	102,548

Figure 2

Kaplan-Meier estimates were plotted to show the ischemic heart disease incidence of the three groups divided by the community level SES

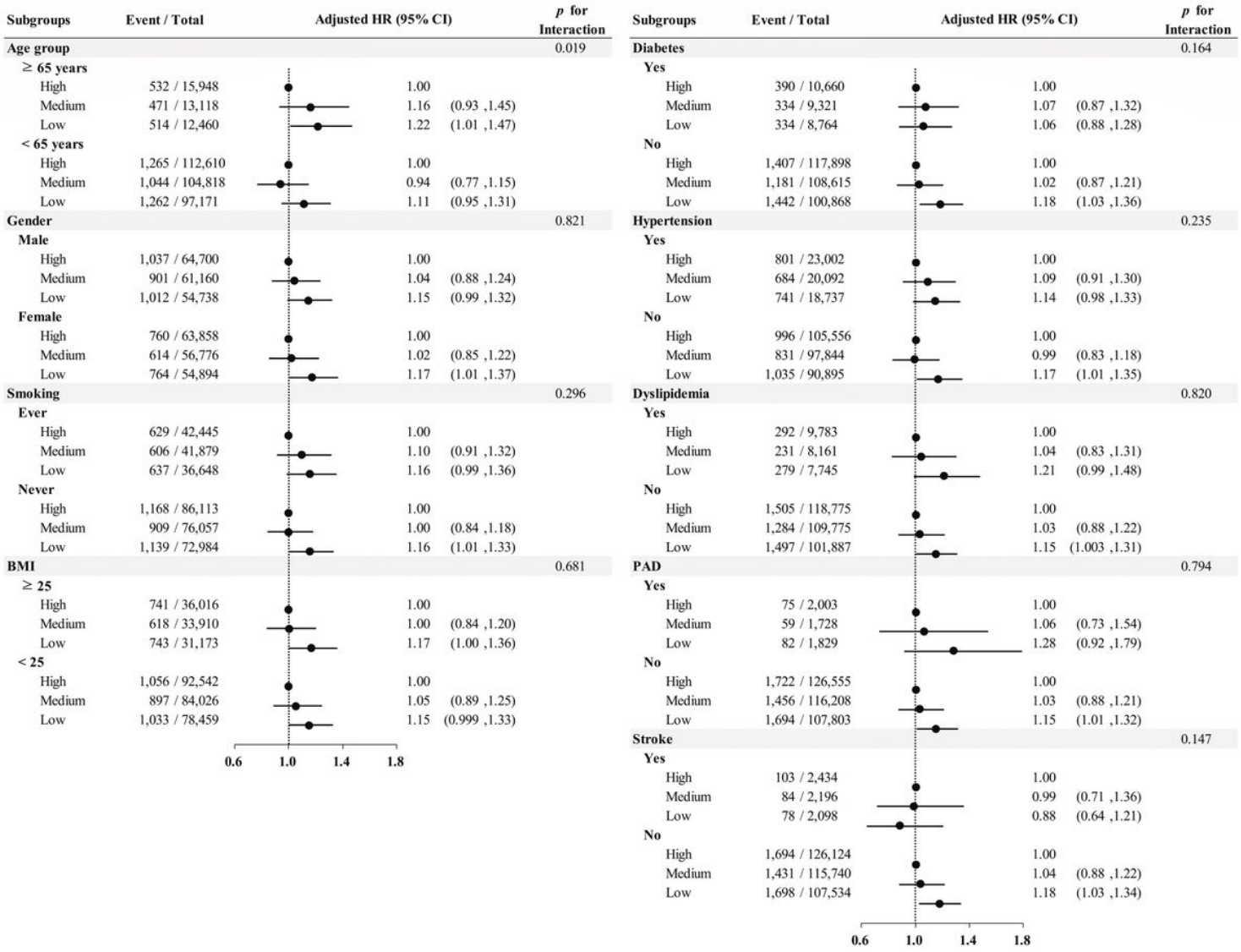


Figure 3

Risk of ischemic heart disease according to the community level SES status in the subgroups as stratified by other covariates.