Sex and Age Differences in the Association Between Social Determinants of Health and Cardiovascular Health According to Household Income Among Mongolian Adults: Cross-Sectional Study

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Abstract

Background: Although social determinants of health (SDH) are an underlying cause of poor cardiovascular health (CVH), there is insufficient evidence for the association between SDH and CVH, which varies by sex and age among Mongolian adults.

Objective: We aimed to explore whether education, household income, and health insurance were associated with CVH according to sex and age among Mongolian adults.

Methods: The final sample included data on 5691 participants (male: n=2521. 44.3% and female: n=3170, 55.7%) aged 18-69 years from the 2019 World Health Organization STEPwise approach to noncommunicable disease risk-factor surveillance. CVH was measured using a modified version of Life’s Simple 7 with 4 health behaviors (cigarette smoking, BMI, physical activity, and a healthy diet) and 3 biological factors (blood pressure, fasting glucose, and total cholesterol blood levels) and classified into poor, intermediate, and ideal levels as recommended by the American Heart Association. Multinomial logistic regression analyses examined the associations between SDH and CVH by monthly equivalized household income after adjusting for age, sex, work status, area, history of myocardial infarction or stroke, use of aspirin, and use of statin. Subgroup analyses were conducted to examine the associations between SDH and CVH based on sex and age, considering monthly equivalized household income as a key variable.

Results: Using the ideal level of CVH as a reference, among those with the lowest household income, having less than 12 years of education, and not having health insurance were associated with poor CVH (education level: odds ratio [OR] 2.42, 95% CI 1.30-4.51; P=.006; health insurance: OR 2.17, 95% CI 1.13-4.18; P=.02). These associations were more profound among female individuals (education level: OR 2.99, 95% CI 1.35-6.63; P=.007; health insurance: OR 2.54, 95% CI 1.09-5.90; P=.03) and those aged 18-44 years (education level: OR 3.22, 95% CI 1.54-6.72; P=.002; health insurance: OR 2.03, 95% CI 0.98-4.18; P=.06).

Conclusions: Participants in the lowest household income group with lower educational levels and without health insurance were more likely to have poor CVH, and these results were more pronounced in female individuals and young adults. These findings suggest the need to develop strategies for CVH equity in Mongolian female individuals and young adults that consider income levels, education levels, and health insurance.

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KEYWORDS
social determinants of health; cardiovascular health; education; household income; health insurance; association; risk factors; cardiovascular; cardiovascular disease; cross-sectional study

Introduction
The trend toward universal health coverage in Mongolia seems to have stagnated. Service coverage related to cardiovascular health (CVH) risk factors such as hypertension, diabetes, and smoking is also below the global average; there was no improvement between 2000 and 2019 [1]. Of the 4 noncommunicable diseases (NCDs) most common among Mongolian adults aged 30-70 years, cardiovascular disease (CVD) accounted for the largest proportion (17.3%) of deaths [2]. In a cross-sectional study that examined a nationally representative sample of 70,380 people aged 35-75 years in Inner Mongolia, 25% of the study participants were at high-risk for CVD, with more than 10% at risk of developing CVD after 10 years [3]. However, Mongolian adults’ low rates of hypertension control treatment, along with high rates of smoking, sodium intake, and obesity, indicate that CVH is not adequately managed in Mongolian adults [4-7].

There is substantial evidence for the effectiveness of individual lifestyle changes to reduce CVH risk [8-10]; nevertheless, it is necessary to examine situations such as the structural social determinants of health (SDH) in Mongolia, where essential service coverage is not guaranteed. SDH, such as education and health insurance coverage, can be more important than lifestyle choices in influencing population health and health equity because of their connection to CVD pathogenesis. Chronic psychosocial stress can be induced among individuals who are susceptible to SDH, and this stress can lead to chronic inflammation by activating the sympathetic nervous system linked to altered stress hormone. For example, glucocorticoid receptor resistance due to chronic activation of the sympathetic nervous system blunts the anti-inflammatory response; it could contribute to enabling CVD development and progression. [11]. Further, the Denmark study showed that a low education level was independently associated with a higher risk of CVD among 1.6 million Danish employees [12]. In Colombia, people with lower education levels have a higher risk of dying prematurely from CVD, and these education inequalities affect female individuals more than male individuals [13]. A prospective cohort study that examined 390,881 Chinese adults aged 18-64 years with a mean follow-up of 10.4 years revealed that having private health insurance coverage was associated with a 21% lower risk of CVD mortality compared to being uninsured [14].

However, there are insufficient studies showing the influence of SDH on CVH among Mongolian adults. Thus, the identification of SDH should be the foundation for developing strategies that promote CVH and reduce long-term health inequality [15]. Research on this topic can provide critical information that can be used for evidence-based planning and decision-making based on priorities regarding CVH equity. As prevalence of CVD risk differed according to sex and age among Mongolian adults [3,4], the population group characteristics should be considered when confirming the influence of SDH on CVH. Thus, this study aimed to explore the sex and age differences in the independent associations between SDH (educational level and health insurance) and CVH among Mongolian adults.

Methods
Data and Study Participants
Data were obtained from the 2019 Mongolia STEPwise approach to noncommunicable disease risk-factor surveillance (STEPS). The World Health Organization (WHO) initiated STEPS in various countries, recognizing a need for standardized worldwide risk-factor data on NCD risk factors for surveillance systems [16,17]. STEPS was conducted in Mongolia to assess the impact and effect of the integrated national program on “NCD Prevention and Control” [5]. STEPS is a repeated household survey that is population based and cross-sectional. It uses multistage cluster sampling to extract and investigate a nationally representative sample [18]. The fourth Mongolia STEPS survey was carried out using 377 sampling clusters selected from 21 provinces and 9 districts of Ulaanbaatar in 2019 [5]. Of the 6654 people who participated in the 2019 Mongolia STEPS, participants aged younger than 18 years (n=173, 2.6%) and those who had missing data on key variables (n=790, 11.9%) were excluded and 5691 (85.5%) participants were finally included in this secondary data analysis.

Ethical Considerations
All participants provided written informed consent prior to participating in the 2019 Mongolia STEPS. This study was granted an exemption by the institutional review board (4-2021-1341) of Severance Hospital at Yonsei University College of Medicine, Republic of Korea, which allows secondary analyses without additional consent.

SDH Factor
Information about education level, possessing health insurance, and average household earnings in the past year were assessed through face-to-face interviews [16]. Educational attainment was categorized into 2 groups: <12 years of education and ≥12 years of education (reference group). Current health insurance was assessed using the question “Do you currently have any kind of health insurance or health care coverage?” [16]. The average monthly household income was calculated by dividing the average household income in the previous year by 12. Equivalized household income was defined as the average monthly household income divided by the square root of the number of household members [19]. The study participants were divided into 4 groups according to the quartiles of equivalized household income.

CVH Factor
We used the modified Life’s Simple 7 by the American Heart Association to measure CVH. It addresses 4 health behaviors, including BMI, smoking, physical activity, and diet, and 3 health risk factors, including blood pressure, fasting glucose levels,
and total cholesterol [20]. A cutoff of 23 kg/m² for BMI, which has been validated for the Asian population, was used in this study [21]. Smoking, physical activity, and diet were assessed through face-to-face interviews using standardized questionnaires [16]. Salt consumption for diet was used instead of the American Heart Association’s guidelines [22]. Blood pressure was measured 3 times for 3-minute intervals. Each measurement was taken on the left arm, with the participants in a seated posture [18]. The mean of the last 2 measurements was used in the analysis [18]. Overnight fasting blood samples were collected at a local clinic or health center [18]. CVH metrics were scored as poor (0 points), intermediate (1 point), and ideal (2 points). The total CVH scores were calculated as the sum of the scores for each component for a possible range of 0-14 (Table S1 in Multimedia Appendix 1). Scores of 0-7 were considered as poor, 8-11 as intermediate, and 12-14 as ideal for CVH [23].

**Covariates**

We adjusted for sex, age (18-39, 40-59, and ≥60 years), work status (employee, self-employed, or others), area (rural or urban), history of myocardial infarction or stroke (yes or no), use of aspirin (yes or no), and use of statin (yes or no). The history of myocardial infarction or stroke was investigated using the question “Have you ever had a heart attack or chest pain from heart disease (angina) or a stroke (cerebrovascular accident or incident)?” The use of aspirin or statin was assessed using the questions “Are you currently taking aspirin regularly to prevent or treat heart disease?” and “Are you currently taking statins (Lovastatin/Simvastatin/Atorvastatin or any other statin) regularly to prevent or treat heart disease?” respectively. The covariate data were collected by self-reporting.

**Statistical Analysis**

Descriptive values were calculated for the total participant group as well as the male and female groups, represented as a weighted mean (95% CI) and number (weighted proportion). The differences in variables according to CVH categories in male and female participants were calculated using ANOVA for continuous variables and the chi-square test for categorical variables. Independent associations between SDH (education level and health insurance) and CVH were assessed through multinomial logistic regression analyses between the sexes after adjusting for covariates. Subgroup analyses regarding associations between SDH and CVH according to monthly equivalized household income were conducted among the total participants. This subgroup analysis according to monthly equivalized household income was also performed by sex and age to identify different sex and age associations between SDH and CVH by household income. The period of public education in Mongolia gradually changed from 10 years in 2004 to 12 years in 2013; students who graduated in 2013 were the first to have received 12 years of public education. Therefore, sensitivity analyses were conducted by defining low education level as less than 11 years of education and examining the association between education level and CVH according to monthly equivalized household income. Adjusted odds ratios (ORs) and 95% CIs were calculated using the PROC SURVEYLOGISTIC procedures to apply population weights, and all statistical tests were performed using SAS (version 9.4; SAS Institute Inc).

**Results**

The general characteristics of study participants by sex according to CVH are described in Multimedia Appendix 2. Of the total 5691 participants, 29.6% (n=1685), 56.4% (n=3208), and 14% (n=798) showed poor, intermediate, and ideal CVH, respectively. The mean CVH score of study participants was 8.80 (SD 2.46). The weighted mean age of study participants was 37.5 (SE 0.26) years, and more than two-thirds (2888/5691, 69.3%) were aged 18-44 years. Approximately half (n=3075, 49.6%) of the participants had less than 12 years of education, and one-fifth (n=888, 19.5%) had no health insurance. In male participants, 41.1% (n=1036), 50.2% (n=1265), and 8.7% (n=220) showed poor, intermediate, and ideal CVH, respectively. The mean age, the proportion of employees, self-employment, and use of aspirin were likely to be higher in participants with poor CVH (all P<.001). In female participants, 20.5% (n=649), 61.3% (n=1943), and 18.2% (n=578) showed poor, intermediate, and ideal CVH, respectively. The mean age and the proportion of aspirin and of statin use were likely to be higher in those with poor CVH (all P<.001). Those with less than 12 years of education were more likely to have poorer CVH (P=.001).

Table 1 shows the results of multinomial logistic regression regarding the association between education, health insurance, and CVH categories. Of the total participants, using ideal CVH as a reference, those with less than 12 years of education were not associated with intermediate and poor CVH after adjusting for potential covariates (intermediate CVH: OR 1.12, 95% CI 0.91-1.40; poor CVH: OR 1.00, 95% CI 0.78-1.29). Similarly, of the total participants, those without health insurance were not associated with intermediate and poor CVH, respectively (intermediate CVH: OR 0.97, 95% CI 0.73-1.28; poor CVH: OR 1.19, 95% CI 0.85-1.67). For both male and female participants, low education level and absence of health insurance were not associated with intermediate and poor CVH.

However, as a result of stratification according to quartiles of monthly household income, participants with less than 12 years of education in the Q1 (lowest household income) and Q2 groups were associated with a 2.42 (95% CI 1.30-4.51) and 1.90 (95% CI 1.08-3.33) times higher likelihood of poor CVH, respectively (Figure 1 and Table S2 in Multimedia Appendix 1). These associations were consistently found when defining low education level as less than 11 years (data not shown). Participants without health insurance in the Q1 group were also associated with a 2.17 (95% CI 1.13-4.18) times higher likelihood of poor CVH.
Table 1. Results of multinomial logistic regression of the association between education, health insurance, and CVH\(^a\) by modified Life’s Simple 7\(^b,c\).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Intermediate CVH</th>
<th>Poor CVH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>OR(^d) (95% CI)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All participants (N=5691)</td>
<td>1458 (55.7)</td>
<td>1.00 (N/A(^e))</td>
</tr>
<tr>
<td>≥12 years</td>
<td>1750 (56.9)</td>
<td>1.12 (0.91-1.40)</td>
</tr>
<tr>
<td>&lt;12 years</td>
<td>964 (31.4)</td>
<td>1.12 (0.91-1.40)</td>
</tr>
<tr>
<td>Male participants (N=2521)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥12 years</td>
<td>497 (50.0)</td>
<td>1.00 (N/A)</td>
</tr>
<tr>
<td>&lt;12 years</td>
<td>768 (50.3)</td>
<td>0.98 (0.6-1.40)</td>
</tr>
<tr>
<td>Female participants (N=3170)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥12 years</td>
<td>961 (59.3)</td>
<td>1.00 (N/A)</td>
</tr>
<tr>
<td>&lt;12 years</td>
<td>982 (63.4)</td>
<td>1.24 (0.94-1.64)</td>
</tr>
<tr>
<td>Health insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All participants (N=5691)</td>
<td>2718 (56.6)</td>
<td>1.00 (N/A)</td>
</tr>
<tr>
<td>Yes</td>
<td>490 (55.2)</td>
<td>0.97 (0.73-1.28)</td>
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<td>No</td>
<td>1014 (50.1)</td>
<td>1.00 (N/A)</td>
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<td>Yes</td>
<td>251 (50.7)</td>
<td>0.86 (0.56-1.33)</td>
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<tr>
<td>No</td>
<td>1704 (61.4)</td>
<td>1.00 (N/A)</td>
</tr>
<tr>
<td>Female participants (N=3170)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>239 (60.8)</td>
<td>1.05 (0.75-1.49)</td>
</tr>
<tr>
<td>No</td>
<td></td>
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</tbody>
</table>

\(^a\)CVH: cardiovascular health.

\(^b\)The estimates are in reference to the ideal CVH group.

\(^c\)Age, sex, work status, area, history of myocardial infarction or stroke, use of aspirin, and use of statin were adjusted.

\(^d\)OR: odds ratio.

\(^e\)N/A: not available.
Figure 1. Results of multinomial logistic regression of the association between social determinants of health and CVH according to household income. Age, sex, work status, area, history of myocardial infarction or stroke, use of aspirin, and use of statin were adjusted. CVH: cardiovascular health; OR: odds ratio; Ref: reference.

The associations between education level and CVH according to monthly household income quartile by sex and age are illustrated in Figure 2. Female participants in the Q1 (lowest household income) group with less than 12 years of education were associated with a 2.99 (95% CI 1.35-6.63) times higher likelihood of poor CVH compared to female participants with more than 12 years of education (Table S3 in Multimedia Appendix 1). However, male participants with less than 12 years of education were not associated with intermediate and poor CVH in the Q1 group (intermediate CVH, OR 0.78, 95% CI 0.31-1.96; poor CVH, OR 1.44, 95% CI 0.56-3.72). Participants in the Q1 group who were aged 18-44 years and had less than 12 years of education were also associated with a 3.22 (95% CI 1.54-6.72) times higher likelihood of poor CVH. Participants in the Q3 and Q4 groups, aged 45-69 years, with less than 12 years of education were associated with a lower likelihood of poor CVH (Q3, OR 0.25, 95% CI 0.10-0.60; Q4, OR 0.36, 95% CI 0.13-0.97).

Similarly, female participants in the Q1 (lowest household income) group without health insurance were associated with a 2.54 (95% CI 1.09-5.90) times higher likelihood of poor CVH compared to female participants with health insurance (Figure 3 and Table S4 in Multimedia Appendix 1). However, male participants in the Q1 group without health insurance were not associated with poor CVH (OR 2.02, 95% CI 0.73-5.57). Participants in the Q1 group, aged 18-44 years, without health insurance were marginally associated with a 2.03 (95% CI 0.98-4.18) times higher likelihood of poor CVH. Participants in the Q1 group, aged 45-69 years, without health insurance were not associated with poor CVH (OR 2.67, 95% CI 0.60-11.95). The OR for the Q3 group of participants aged 45-69 years was not accounted for as the model did not converge due to quasi-complete separation.
Discussion

Principal Findings

For all participants, having less education or no health insurance was not associated with CVH; however, stratified analyses by monthly household income quartiles showed that having less education or no health insurance was associated with poor CVH in the lowest household income groups. These CVH disparities were more pronounced among female individuals and young adults. This study contributes to establishing policies implementation that reduces the disparity of CVH, the most notable cause of disease burden, by presenting the basis for prioritizing a vulnerable population. For example, health service delivery guidelines should include consideration of the link between SDH and CVD, and training for health care providers should emphasize this. Low levels of education may be associated with low levels of health literacy for CVD prevention and management practices [24,25]. Therefore, health care
Our study revealed that low education level or lack of health disparities in cardiovascular risk factors and diseases (1.00 parity).

In this study, the CVH disparities according to SDH were ranked 69th out of 156 countries in the global gender gap. Furthermore, a recent cross-sectional study of 1634 Asian American adults aged ≥20 years in the United States revealed that low educational attainment was associated with a low likelihood of having ideal CVH compared to high educational attainment after adjusting for age and sex; however, this association became nonsignificant after additionally adjusting for income category and nativity status [26]. Further studies are needed to comprehensively understand the relationship between educational attainment and CVH in the contexts of including other SDH, such as income and race, for health equity in populations that are vulnerable to CVH problems.

The association between education level and CVH is inconsistent in previous studies. A cross-sectional study of 7771 nationally representative participants aged ≥25 years in the United States reported that participants with at least a college degree were 4.12 times more likely to have ideal CVH status than participants with less than a high school education [28]. However, a recent cross-sectional study of 1634 Asian American adults aged ≥20 years in the United States revealed that low educational attainment was associated with a low likelihood of having ideal CVH compared to high educational attainment after adjusting for age and sex; however, this association became nonsignificant after additionally adjusting for income category and nativity status [26]. Further studies are needed to comprehensively understand the relationship between educational attainment and CVH in the contexts of including other SDH, such as income and race, for health equity in populations that are vulnerable to CVH problems.

The WHO-initiated STEPS in 2002 is practical and helpful in monitoring the status of CVH and can identify the achievement rate for each cardiovascular risk factor, thereby aiding the formulation of effective health policies for managing risk factors at a country level [16]. Establishing a high-vulnerability priority population in population health is essential for ensuring universal health in which no one is excluded.

The WHO region or income level; Mongolia is a country with a high prevalence of CVD risk factors [26]. For example, nonelevated blood pressure, one of the tracer indicators for calculating the universal health coverage service coverage index, was 29, indicating the low coverage of blood pressure management in Mongolia [26]. Further, the linear trends in cardiovascular risk factors such as smoking, obesity, and elevated blood pressure among Mongolian adults are all projected to be significantly higher than the global target by 2025 [27]. Thus, there is a need for the adoption and dissemination of cardiovascular risk-factor management guidelines. The WHO-initiated STEPS in 2002 is practical and helpful in monitoring the status of CVH and can identify the achievement rate for each cardiovascular risk factor, thereby aiding the formulation of effective health policies for managing risk factors at a country level [16]. Establishing a high-vulnerability priority population in population health is essential for ensuring universal health in which no one is excluded.

In conclusion, we confirmed that in Mongolia, where universal health coverage is low, the population group that has low structural socioeconomic levels and health care coverage is more vulnerable to CVH problems. As in other low-income countries, female individuals are more vulnerable to CVH problems. As in other low-income countries, female individuals are more vulnerable to CVH problems. However, a recent cross-sectional study of 1634 Asian American adults aged ≥20 years in the United States revealed that low educational attainment was associated with a low likelihood of having ideal CVH compared to high educational attainment after adjusting for age and sex; however, this association became nonsignificant after additionally adjusting for income category and nativity status [26]. Further studies are needed to comprehensively understand the relationship between educational attainment and CVH in the contexts of including other SDH, such as income and race, for health equity in populations that are vulnerable to CVH problems.

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population should be prioritized for female individuals and young adults (aged 18-44 years) with low socioeconomic status and without health insurance.

Acknowledgments
This paper uses data from the Mongolia 2019 STEPwise approach to noncommunicable disease risk-factor surveillance survey, implemented by the Minister of Health, Mongolia, with the support of the World Health Organization. This research was supported by the Brain Korea 21 FOUR Project funded by National Research Foundation of Kora, Yonsei University College of Nursing.

Data Availability
The data sets generated or analyzed during this study are available in The World Health Organization noncommunicable disease microdata repository (World Health Organization, June 20, 2023, STEPwise approach to noncommunicable disease risk-factor surveillance 2019 Mongolia).

Conflicts of Interest
None declared.

Multimedia Appendix 1
Supplementary table 1-5. [DOCX File, 42 KB-Multimedia Appendix 1]

Multimedia Appendix 2
General characteristics of study participants according to cardiovascular health by the modified Life's Simple 7. [DOCX File, 23 KB-Multimedia Appendix 2]

References


Abbreviations

CVH: cardiovascular health
CVD: cardiovascular disease
NCD: noncommunicable disease
OR: odds ratio
SDH: social determinants of health
STEPS: STEPwise approach to noncommunicable disease risk-factor surveillance
WHO: World Health Organization