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Low socioeconomic status increases short-term mortality of acute myocardial infarction despite universal health coverage

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ABSTRACT

Background: This nationwide population-based study investigated the relationship between individual and neighborhood socioeconomic status (SES) and mortality rates for acute myocardial infarction (AMI) in Taiwan.
Methods: A population-based follow-up study included 23,568 patients diagnosed with AMI from 2004 to 2008. Each patient was monitored for 2 years, or until their death, whichever came first. The individual income-related insurance payment amount was used as a proxy measure of patient's individual SES. Neighborhood SES was defined by household income, and neighborhoods were grouped as advantaged or disadvantaged. The Cox proportional hazards model was used to compare the mortality rates between the different SES groups after adjusting for possible confounding risk factors.
Results: After adjusting for potential confounding factors, AMI patients with low individual SES had an increased risk of death than those with high individual SES who resided in advantaged neighborhoods. In contrast, the cumulative readmission rate from major adverse cardiovascular events did not differ significantly between the different individual and neighborhood SES groups. AMI patients with low individual SES had a lower rate of diagnostic angiography and subsequent percutaneous coronary intervention ($P < 0.001$). The presence of congestive heart failure, chronic kidney disease, chronic obstructive pulmonary disease, pneumonia, septicemia, and shock revealed an incremental increase with worse SES ($P < 0.001$).
Conclusions: The findings indicate that AMI patients with low individual SES have the greatest risk of short-term mortality despite being under a universal health-care system. Public health strategies and welfare policies must continue to focus on this vulnerable group.

1. Introduction

Numerous studies have linked socioeconomic status (SES) to health outcomes [1–7]. Cardiovascular disease (CVD), and acute myocardial infarction (AMI), is an important cause of death worldwide. Both individual SES and neighborhood SES are independently and significantly associated with the incidence of CVD and AMI [8–19]. The effect of neighborhood SES on AMI is well documented—those living in deprived areas experience the largest burden of the disease with higher incidence [8–18] and mortality rates [13,19]. Furthermore, patients with low individual SES have been shown to have a decreased treatment utilization rate and a higher mortality risk [20–24]. However, different types of medical coverage may impact treatment and outcomes for patients with AMI [25–27].

Universal health-care systems have been implemented in many industrialized countries, including Taiwan, and these systems have resulted in improved access to medical care and reduced mortality; however, disparities between different SES groups in medical care remain. Interestingly, the association between AMI and SES has been demonstrated most from Western society. The objective of this study was to examine the association between the cross-level effect of individual

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and neighborhood SESs on the mortality rates of patients with AMI in the National Health Insurance Research Database (NHIRD) in Taiwan.

2. Methods and materials

In 1995 Taiwan implemented a National Health Insurance (NHI) program that requires mandatory enrollment in the government-run, universal, single-payer insurance system and provides comprehensive benefits coverage. Currently, up to 99% of the 23 million residents of Taiwan receive medical care through the NHI program. Over 97% of the hospitals and clinics in Taiwan are contracted to provide health care services [28], which are reimbursed by the Bureau of NHI, and all data related to these services are collected and input into the National Health Research Institute Database (NHIRD) by the National Health Research Institutes to provide a comprehensive record of medical care. The data consisted of ambulatory care records, inpatient care records, and the registration files of the insured. The data set included all claims data from Taiwan's NHI program, which was implemented as a means of financing health care for all Taiwanese citizens.

This observational study was conducted in a retrospective cohort of the Chinese population from the 2004–2008 NHIRD in Taiwan. The National Health Insurance Bureau of Taiwan randomly reviews the charts of 1 out of every 100 ambulatory cases and one out of every 20 inpatient cases, as well as performing patient interviews to verify the accuracy of the diagnosis [29,30]. The in-hospital health care database makes an epidemiological study of AMI possible because nearly all patients with AMI are hospitalized in order to receive optimal medical care. Inpatients ≥18 years of age diagnosed with AMI between 2004 and 2008 and with a discharge diagnosis that met the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) code of 410.X were recruited for the study. From 2004 to 2008, 80,726 patients with a new diagnosis of AMI were identified. Because there was a significant difference in proportion of gender and mean age between the 3 individual SES groups. The selection criteria were further refined by randomly selecting 23,568 age (with a caliber of 5) and gender-matched patients. The key dependent variable of interest was 6-month, 1-year and 2-year in-hospital mortality rate. A more comprehensive outcome included cumulative re-hospitalization rate due to AMI, stroke and congestive heart failure. The key independent variables were the contextual effects of individual SES and neighborhood SES. Patients were then linked to the mortality data covering the years from 2004 to 2008 to calculate mortality rate. Each patient was tracked for 2 years from the time of their first curative treatment using administrative data to identify all patients who died during the study period. Patient characteristics included age, gender, geographic location, treatment modality, co-morbidities, and monthly income.

Risk factors were included in the analyses if they had previously been shown to be associated with CVD or AMI or if they were candidates on theoretical grounds [31,32]. Co-morbid conditions and therapeutic procedures were identified according to the ICD-9-CM system and were further grouped into the following broad categories to construct a logistic regression model: hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, congestive heart failure, chronic kidney disease, pneumonia, chronic obstructive pulmonary disease, septicemia, and shock.

2.1. Individual-level measures

The four-factor Hollingshead scale uses marital status, gender, education and occupation [33]. This study used the income-related insurance payment amount as a proxy measure of individual SES at the time of diagnosis, which is an important prognostic factor for AMI [4,27,34–42]. The AMI patients were classified into three groups: (1) low SES: lower than US $528 per month (New Taiwan Dollar (NT$) 15840); (2) moderate SES: between US $528–833 per month (NT$15841–25000); and (3) high SES: US $833 per month (NT$25001) or more [43]. We selected NT$15,840 as the low income level cutoff point because this was the government-stipulated minimum wage for full-time employees in Taiwan in 2006.

2.2. Neighborhood-level Socioeconomic Status

Winkleby et al. identified the following variables to characterize neighborhood SES: percentage high-school education, median annual family income, percentage blue collar workers, percentage unemployed, and median household income [44]. In this study, we adopted median household income as a proxy of neighborhood SES. For neighborhood SES, household income is a contextual characteristic representing averages and percentages measured at the enumeration level in the 2001 Taiwan Census. Neighborhood household income was measured using per capita personal income by township acquired from the 2001 income tax statistics released by Taiwan's Ministry of Finance (http://www.fdc.gov.tw/dp.asp?mp=5). Advantaged and disadvantaged neighborhoods were distinguished based on the median values of neighborhood household income (NT $540000 or US $17992 per year) for neighborhood characteristics, with advantaged neighborhoods having higher-than-median neighborhood household incomes, and disadvantaged neighborhoods having lower-than median household incomes.

2.3. Other variables

Patient residences were classified into 7 urbanization levels based on 5 indices in Taiwan: population density, percentage of residents with college level or higher education, percentage of residents >65 years of age, percentage of residents who were agriculture workers, and the number of physicians per 100,000 people [45]. The urbanization level of residences as urban (urbanization level 1), sub-urban (urbanization levels 2–3), or rural (urbanization levels 4–7) was also recorded. The hospitals were categorized by ownership (public, nonprofit, or for-profit), and hospital level (medical center, regional, or district hospital). The geographic regions where the AMI patients resided were recorded as Northern, Central, Southern, and Eastern Taiwan.

2.4. Statistical analysis

The SAS statistical package (version 9.2; SAS Institute, Inc., Cary, NC, USA), and SPSS (version 15, SPSS Inc., Chicago, IL, USA) were used for data analysis. Pearson's chi-square test was used for categorical variables such as gender, level of urbanization, geographic regions of residence, comorbidities, treatment modality, and hospital characteristics (teaching level, ownership, and caseload) in AMI patients. Continuous variables were analyzed using a one-way ANOVA test.

Mortality rate, stratified by individual SES and neighborhood SES, were measured from the time of diagnosis using overall mortality as the event variable. The cumulative 6-month mortality rates and the mortality curves were constructed and compared using the log-rank test. The Cox proportional hazards regression model adjusting for patients' characteristics (age, gender, co-morbidities, urbanization, and area of residence), treatment modality (percutaneous coronary intervention [PCI], coronary artery bypass graft or medical therapy [CABG]), and hospital characteristics (ownership, teaching level, and caseload) was used to compare outcomes between different SES categories. SES variables were introduced into the Cox model, with the high individual SES and advantaged neighborhood group as the reference group. A two-sided P-value ($P < 0.05$) was used to determine statistical significance.

3. Results

3.1. Demographic data and clinical characteristics

The study cohort consisted of 23,568 patients with a new diagnosis of AMI who were matched for age and gender. The distribution of demographic characteristics and selected comorbidities for the 3 groups is shown in Table 1. AMI patients with high individual SES were more likely to reside in urban areas, especially in northern Taiwan, and to undergo treatment in a medical center, compared with their moderate- and low-individual SES counterparts ($P < 0.001$). AMI patients with low individual SES also demonstrated a lower rate of diagnostic angiography and subsequent PCI ($P < 0.001$). Hypertension was the most common co-morbidity, followed by DM, and dyslipidemia across all SES groups. CHF, CKD, COPD, pneumonia, septicemia, and shock increased incrementally as SES decreased ($P < 0.001$).

3.2. Univariate analysis

Interaction effects between gender and several other variables were noted, and the patients were further stratified into two groups: male and female. The result of a Kaplan–Meier analysis showed that patients with low individual SES had poorer prognoses at 6 months after the AMI and was maintained thereafter in both male and female (Fig. 1a and b). The 6-month, 1-year and 2-year overall mortality rates stratified by gender are shown in Table 2. Although most deaths occurred within the first 6 months after the AMI, the effects of low individual SES on survival persisted at 2 years ($P < 0.001$). Analysis of the combined effect of individual SES and neighborhood SES revealed that mortality rates were highest among male and female AMI patients with low individual SES residing in either advantaged or disadvantaged neighborhoods. The 2-year cumulative mortality rates were highest among AMI patients who had low individual SES resided in advantaged neighborhood (14.8% of male and 16.2% of female, respectively).

3.3. Multivariate analysis

After adjustment for covariates, the combined effect of individual SES and neighborhood SES remained statistically significant in the Cox proportional hazards regression model (Table 3). Adjusted hazard ratios revealed that, female AMI patients with low individual SES in disadvantaged neighborhoods had the highest risk of mortality (HR = 2.37; 95% CI, 1.66 to 3.4, $P < 0.001$) compared with females with high individual SES residing in advantaged neighborhoods. Male AMI patients with