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Long-run measurement of income-related inequalities in health care under universal coverage: evidence from longitudinal analysis in Korea

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Abstract

Background Many countries have sought to promote well-being for their entire populations through the implementation of universal health coverage (UHC). To identify the extent to which UHC has been attained, it is necessary to evaluate equity of access to use of needed care and the cost burden of health services for the country's entire population. This study considers income-related inequalities in health care utilization and spending in a long-term perspective for the case of the Republic of Korea.

Methods Exploiting longitudinal data from a nationally representative health survey from 2008 to 2018, this study investigates how income-related inequalities in health care in Korea have varied over time and examines the extent to which need and non-need factors contribute those inequalities, using an in-depth decomposition analysis, allowing for heterogeneous responses across income groups.

Results The empirical results show that overall health care utilization is disproportionately concentrated among the poor over both the short and long run. Income-group differences and non-need determinants, such as marital status and private health insurance, make larger pro-poor contributions to inequality in inpatient care use, while chronic disease prevalence greatly pushes outpatient care utilization in a pro-poor direction. The results regarding inpatient care expenses indicate a similar pattern of pro-poor bias. Long-run inequality favors the better-off in terms of outpatient care expenses, where the contribution of income-group differences has the largest impact.

Conclusion My findings suggest that it is important for health care policy in Korea to focus on improvements in the health status and well-being of low-income groups, as poor people are likely to be in poorer health. Non-need contributors could worsen pro-poor inequalities if the economic disparity across households were to increase due to the demographic transition. Higher spending on inpatient care may be a heavier financial burden for low-income people. Additional supportive measures should be provided to prevent them from suffering economic hardship. By contrast, people in high-income groups may spend most on costly services in outpatient care, including uninsured services, with the help of private health insurance. Nevertheless, the expansion of income disparity should be alleviated even from a health care policy perspective.

Keywords Income-related inequality, Health care, Concentration index, Factor decomposition, Korea

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Introduction

Many countries seek to promote well-being for their entire populations by achieving universal health coverage (UHC), which is one of the health-related targets proposed among the Sustainable Development Goals. According to the World Health Organization (WHO), UHC has the goal of ensuring that every individual, regardless of their circumstances, including standard of living, should be able to receive safe, effective, and high-quality essential health care services as needed at an affordable cost without the need for financial hardship [31]. Strengthening the health care systems plays an important role in making progress toward UHC: health financing that influences the level of people's direct payments for the use of health services may be a key policy instrument for providing a population with equal access to needed services, along with other components of health systems, such as the health care workforce and organizations, service delivery, and health information [30].[1] To measure the extent to which UHC is attained, it is necessary to evaluate equity of access to use of needed care and the cost burden of health services for a country's entire population, including the most vulnerable and disadvantaged in that society [31].

The Republic of Korea (Korea) first introduced mandatory health insurance based on a social insurance system in 1977, and this has been a major financing scheme for health care nationwide since then. Gradually expanding health insurance coverage,[2] Korea ultimately achieved UHC in 1989, with more than 90% of the population covered by national health insurance and the remaining falling under the tax-financed Medical Aid Program. However, the achievement of UHC does not immediately ensure that all the people have an equal access to essential health services for free of charge or at little out-of-pocket expenses so as not to cause financial hardship [31]. Specifically, there have remained some limitations in the Korean healthcare system such as insufficient benefits coverage and higher rate of catastrophic health expenditures among low-income households due to high out-of-pocket payments and uninsured services [16]. These problems emphasize the necessity of quantifying the degree of income-related inequalities in health care utilization and spending under the universal coverage in Korea.

Within the bounds of this universal health insurance scheme in Korea, managed by a single insurer (National Health Insurance Service), the government has taken a laissez-faire position in providing health services for citizens; health care delivery relies heavily on the private sector to directly respond to the increased demand for health care [13]. Health care providers are generally reimbursed on a fee-for-service basis, where the fee schedule set by the insurer is enforced only for insured services, with higher prices allowable for uninsured services at their discretion to increase their profit margins. In the absence of a gatekeeping system, patients have a high degree of freedom to choose health care providers at any facility level they wish so long as they can afford to pay for the services they need [13].

Despite the rapid accomplishment of universal health insurance coverage within a period of only 12 years, health financing in Korea has been characterized by the shrinking role of government and a limited range of covered services,[3] as well as a greater dependence on private spending,[4] which could result in weak financial protections from the benefits package. According to OECD health statistics for Korea, health care spending from public sources accounted for 57% of total health expenditures (OECD average of 71%), and the proportion of out-of-pocket payments and voluntary health insurance were 34% and 7%, respectively, of total spending (OECD averages of 21% and 4%) in 2017 [20]. The large share of out-of-pocket spending on health care is partly attributable to relatively high cost-sharing for insured services,[5] and it is also driven by additional payments for increased uninsured services, most of which involve the adoption of new technology and medicines with uncertain levels of

[1] Although health financing does not necessarily refer to financial mechanisms involving an insurance scheme more than through tax-based systems, the percentage of the population covered by health insurance can be a crucial determinant of progress on UHC in some countries [14].

[2] Korea's national health insurance was first implemented among formal sector employees of large corporations (with more than 500 workers), and was incrementally extended to civil servants and private school teachers/employees, workers in smaller-sized firms, and finally to the self-employed [2, 13].

[3] Nevertheless, the benefits package has been expanded gradually over the past 30 years. Benefits covered by national health insurance encompass curative health care services (e.g., diagnosis, treatment, traditional medical care, emergency care, dental care, etc.), prescription pharmaceuticals, disease prevention (e.g., health check-ups and cancer screening), health promotion and rehabilitation [2, 13]. The criteria for the inclusion of the benefits package are based on safety, clinical effectiveness, cost-effectiveness, financial burden on patients and fiscal impacts on national health insurance, which are examined and evaluated predominantly by the Health Insurance Review and Assessment Service [13, 18].

[4] In recent years, the largest share of health insurance revenues are covered by social insurance contributions. Health insurance premiums are levied on the basis of wage income for employees and are shared equally between the employee and employer where the uniform contribution rate is applied to them. Health insurance premiums for the self-employed are assessed on the basis of income and the value of household assets, such as houses and vehicles [2, 13].

[5] Patients' cost-sharing for inpatient care services is generally set at 20% of the total amount of medical treatment. On the other hand, the copayment rate for insured outpatient care varies from 30 to 60%, according to the level and location of healthcare facilities. A reduced rate of copayment is specially applied to vulnerable groups (e.g., the elderly, children under six, pregnant women at high risk, patients with chronic illnesses, etc.). Low-income people enrolled in the Medical Aid Program are also exempt from cost-sharing at the time of health care use [13].

cost effectiveness [13]. To cover copayments for insured services and full payments for services not included in the benefits package, many Koreans purchase complementary private health insurance in recent years [22].[6] The wide coverage provided by voluntary private health insurance, however, is likely to encourage beneficiaries to overuse health services. On the other hand, high out-of-pocket payments may lead to limited access to needed care for low-income groups due to the financial burden,[7] which has caused inequity in health care utilization by different income groups.

Across a long period of time, many studies have been conducted to examine socioeconomic inequalities in the use of health care services in European countries. However, there has been little empirical study of inequity in health care utilization in Asian regions including Korea.[8] Lu et al. [17], in a pioneering work on this issue in Asian economies, compared the equity performance of health systems with the egalitarian goals of Hong Kong, South Korea, and Taiwan around 2000. They showed that Korea appeared to feature almost equal distribution in outpatient visits overall but a strong pro-poor bias for outpatient care in health centers and inpatient admissions, accounted for by non-need factors, such as lower levels of education and unemployment, combined with significant pro-rich inequality in outpatient use of tertiary medical institutions. Kim et al. [8] demonstrated horizontal inequity favoring the better-off in both outpatient and inpatient care for the elderly in the late 1990s and early 2000s, and they also revealed that the prevalence of chronic disease, educational attainment and income level may have significantly contributed to that disproportionate distribution. Kim et al. [11] found that pro-poor patterns appeared in terms of the probability of using secondary care and inpatient care relative to a pro-rich tendency that emerged in the number of visits and inpatient stays in the late 2000s. They also showed a modest pro-rich inequity in the amount of medical expenditures due to the substantial contributions of income, education, and private insurance. Furthermore, Kim et al. [10] separately estimated two age groups, below and above 60 years old, in 2010 and 2011, finding that health care utilization was concentrated on the worse-off in general and equally distributed, especially in emergency care and inpatient care, for the non-elderly.[9] On the other hand, larger amounts of medical expenses were seen for outpatient and inpatient care services among high-income groups, and pro-rich inequalities appeared to be greater among the elderly, who showed a higher need of health care utilization. Major limitations of these prior studies lie in the fact that they focused on the short-term socioeconomic inequity for several survey years based on the standard method of factor decomposition, while they have shown the mixed results for inequalities in health care depending on a period of time and age group.

Exploiting longitudinal data from a nationally representative health survey from 2008 to 2018, this study investigates how income-related inequalities in health care utilization and spending in Korea have varied over time and examines the extent to which different factors have contributed to them by using an in-depth decomposition analysis, allowing for heterogeneity. This clearly differs from the previous studies mentioned above that capture a sequence of independent snapshots of inequalities for each year in several ways: I use short-run and long-run concentration indices as measures of the degree of inequality and employ an extended decomposition method that allows for variation in individual responses to need and non-need determinants across income groups. In short, this study adds to the literature by expanding the standard methods of the concentration index and decomposition analysis with the use of the Korean panel data to take into account medium- to long-term inequalities and heterogeneous responses to factor contributions. Longitudinal analysis also enables me to derive policy implications for the long-run mechanism behind the equity performance of the Korean health care system under the universal coverage, which would otherwise be missing from a series of short-term cross-sectional analysis.

The remainder of the paper is structured as follows: Section "Methodology" presents the empirical methods I use to quantify the degree of income-related inequalities and factor decomposition. Secton "Data" describes the data used in this study and presents the summary statistics. Section "Results" outlines the results for the concentration indices and reports the results of estimation in

[6] Private health insurance in Korea either pays a lump-sum disbursement upon diagnosis of critical illness, or provides compensation for itemized medical expenses upon service use [22].

[7] To alleviate the financial burden on households against catastrophic health spending and to prevent them from falling into bankruptcy, the government sets the cumulative cost-sharing ceiling (out-of-pocket maximum) at the thresholds of 2 to 4 million Korean won per person depending on income level within a period of six consecutive months, beyond which the patients are exempt from further copayments. However, it is applicable only to out-of-pocket payments for insured care services without the stop-loss mechanism in practice [2, 13, 18].

[8] There has also been a few empirical studies on socioeconomic inequalities in health care access in Japan, which has a the similar healthcare system to Korea: universal health insurance coverage, price regulation by the government, fee-for-service reimbursement in general, high dependence on the private sector in health care delivery, and free access by the patient to healthcare facilities. Major relevant works include those of Ohkusa and Honda [21], Toyokawa et al. [23], and Watanabe and Hashimoto [28].

[9] Kim et al. [9] showed the similar empirical results for pro-rich inequity in outpatient care payments by pooling the entire population over the age of 20 during the same study period.

the regression and decomposition analysis. Section "Discussion" discusses the implications and limitations of this study.

Methodology

Concentration indices in the short and long run

The concentration index method developed by Wagstaff et al. [26] and Kakwani et al. [7] is a standard tool used in health economics to quantify the extent of socioeconomic inequalities in a health-related variable. The concentration index (CI) can be simply calculated as follows:

$$CI = \frac{2}{\bar{y}} cov(y_i, r_i) \tag{1}$$

where y_i is the health-related measure for individual i ($i = 1, \ldots, N$),[10] $\bar{y}$ is the mean of y_i for all individuals ($= \sum_i y_i / N$), and r_i is the individual's fractional rank in the distribution of their socioeconomic status, that is, household income per equivalent household member[11]; this value ranges from -1 to 1 and becomes zero when the health outcome is equally distributed among individuals irrespective of their standard of living (the values of -1 and 1 represent perfect inequality). When the concentration index takes a negative value ($CI < 0$), the outcome measure (e.g., the use of health services) is concentrated on the poor, while a positive value ($CI > 0$) indicates that it is biased toward the rich.

Because the concentration index above depicts the degree of inequality at a point in time, it corresponds to the short-run concentration index (CI^t) as presented in Jones and López Nicolás [5] and Allanson et al. [1]. Alternatively, following those works, Eq. (1) can be rewritten as

$$CI^t = \frac{2}{\bar{y}^t} cov(y_{it}, r_i^t) = \frac{2}{N\bar{y}^t} \sum_i (y_{it} - \bar{y}^t)\left(r_i^t - \frac{1}{2}\right) \tag{2}$$

where y_{it}, $\bar{y}^t$, and r_i^t are defined in the same way as above for time period t ($t = 1, \ldots, T$). Similarly, they proposed that when longitudinal data are available, the long-run concentration index (CI^T) over T periods can be derived as

$$CI^T = \frac{2}{\bar{\bar{y}}^T} cov\left(y_i^T, r_i^T\right) = \frac{2}{N\bar{\bar{y}}^T} \sum_i \left(y_i^T - \bar{\bar{y}}^T\right)\left(r_i^T - \frac{1}{2}\right) \tag{3}$$

where y_i^T is the average health measure of individual i after T periods ($= \sum_t y_{it}/T$), $\bar{\bar{y}}^T$ is the mean of y_i^T for all individuals in T periods ($= \sum_t \bar{y}^t / T$), and r_i^T is the individual's fractional rank in the distribution of their average equivalized incomes over all T periods. Note that both concentration indices over the short and long run have the same properties as the standard concentration index, in terms of an interpretation of the inequity.

This study utilizes both the short and long run concentration indices because the longitudinal data across 11 survey years are available, allowing for a deeper investigation into medium- to long-term income-related inequalities in health care use and spending in Korea.[12]

Decomposition method with heterogeneity

Inequalities in health-related variables across the income distribution can be decomposed into the contributions of their potential determinants [27]. First, the individual's health measure y_i is assumed to be explained by a linear combination of J need variables x_{ji} that are likely to directly influence the health outcome (e.g., age, sex, health status, physical condition, etc.) and K non-need variables z_{ki}, which are generally defined as socioeconomic characteristics, including income level, such that

$$y_i = \alpha + \sum_{j=1}^{J} \beta_j x_{ji} + \sum_{k=1}^{K} \gamma_k z_{ki} + \varepsilon_i \tag{4}$$

where β_j and γ_k are their corresponding coefficients, α is the intercept, and ε_i is the error term. Wagstaff et al. [27] demonstrated that, based on the linear regression model in Eq. (4), the concentration index (CI) can be rewritten as follows:

$$CI = \sum_j \left(\beta_j \frac{\bar{x}_j}{\bar{y}}\right) CI_{x_j} + \sum_k \left(\gamma_k \frac{\bar{z}_k}{\bar{y}}\right) CI_{z_k} + \frac{2}{\bar{y}} cov(\varepsilon_i, r_i) \tag{5}$$

where $\bar{x}_j$ and $\bar{z}_k$ are the means of the covariates x_{ji} and z_{ki}, CI_{x_j} and CI_{z_k} are their concentration indices with respect

[10] Health-related outcomes are assumed to be unbounded variables for the concentration index, which measures relative inequality. For bounded outcomes (e.g., binary variables that represent the mirror condition), however, it is more appropriate to use the Erreygers index [3, 4], the Wagstaff index [25], or the generalized concentration index as an absolute inequality measure.

[11] Kakwani et al. [7] suggested that the concentration index can also be computed from a simple linear regression model, such that $2\sigma_r^2\left(\frac{y_i}{\bar{y}}\right) = \alpha + \beta r_i + \varepsilon_i$, where σ_r^2 is the variance of the fractional rank r_i. The OLS estimator of β is equivalent to the concentration index obtained from Eq. (1).

[12] To measure how much the long-run concentration index differs from the concentration index over the short run, Jones and López Nicolás [5] defined an index of health-related income mobility (M^T), such that $M^T = \frac{\sum_t w_t CI^t - CI^T}{\sum_t w_t CI^t} = 1 - \frac{CI^T}{\sum_t w_t CI^t}$, where weights are calculated as $w_t = \bar{y}^t / T\bar{\bar{y}}^T$. This index captures the difference between the concentration index for longitudinal averages and the weighted average of the cross-sectional concentration index. Watanabe [29] discusses its application to the concentration indices for health care outcomes, using the same panel data from a Korean health survey.

to the fractional rank in the income distribution,[13] and the final term is the generalized concentration index for the error term reflecting income-related inequality in health that is not explained by any systematic variation in the regressors. In other words, the concentration index in the decomposition method can be defined as the weighted sum of the concentration indices of the explanatory variables x_j and z_k, where the weights provide the elasticity of the health measure with respect to each factor, evaluated at the sample mean (i.e., $\beta_j\bar{x}_j/\bar{y}$ and $\gamma_k\bar{z}_k/\bar{y}$), plus the residual component [19]. Therefore, each term in Eq. (5) comprises factor contributions to the overall concentration index.

However, the standard decomposition method often involves the drawback that it only captures homogeneous responses to need and non-need determinants over the entire sample, due to the fixed parameters that are on average adjusted by the sample means. In addition, the contribution of the residuals is likely to be sufficiently large unless the regression model is well specified. Following Jones and López Nicolás [6] and Van de Poel et al. [24], I thus employ an extended decomposition method that allows for heterogeneity across certain socioeconomic groups. I hypothesize a heterogeneous responsiveness of health care to need and non-need factors according to individual income levels. Suppose that each individual belongs to one of G groups differentiated by the level of equivalized income. Then, Eq. (4) can be transformed into the similar linear function of a set of the same need and non-need variables, excluding the indicators of the income group g ($g = 1, \ldots, G$), such that

$$y_i = \alpha_g + \sum_{j=1}^{J} \beta_{jg} x_{ji} + \sum_{k=1}^{K} \gamma_{kg} z_{ki} + u_i, \forall i \in g \qquad (6)$$

where β_{jg} and γ_{kg} are the differential parameters by income groups, α_g is the group-specific intercepts, and u_i is the error term. Based on the estimation of separate regressions for each group in Eq. (6), the concentration index in Eq. (5) can also be further decomposed into detailed factor contributions as follows:

$$\begin{aligned} CI = &\sum_j \left(\beta_j \frac{\bar{x}_j}{\bar{y}}\right) CI_{x_j} + \frac{2}{\bar{y}N} \sum_j \sum_i x_{ji}\left(\beta_{jg} - \beta_j\right)\left(r_i - \tfrac{1}{2}\right) \\ &+ \sum_k \left(\gamma_k \frac{\bar{z}_k}{\bar{y}}\right) CI_{z_k} + \frac{2}{\bar{y}N} \sum_k \sum_i z_{ki}\left(\gamma_{kg} - \gamma_k\right)\left(r_i - \tfrac{1}{2}\right) \\ &+ \tfrac{2}{\bar{y}} cov\left(\alpha_g, r_i\right) + \tfrac{2}{\bar{y}} cov(u_i, r_i). \end{aligned} \qquad (7)$$

The first and third terms in Eq. (7) are the same as the first two terms in Eq. (5), obtained from the pooled regression, which indicates the homogeneous contributions of need and non-need factors, respectively, as their effects are constant over the entire sample. The second and fourth terms represent the heterogeneous contributions of the need and non-need determinants, respectively, defined as covariance between the differential parameters across income groups and fractional rank in income distribution, weighted by the values of the corresponding covariates. The fifth term refers to the direct contribution of income-group differences to income-related inequalities in the health outcome. We understand that it is transformed from the contribution of income level in the second term of Eq. (5), which is no longer captured in Eq. (7). The sixth term is the unexplained residual component of the concentration index, which is expected to be smaller than the last term in Eq. (5) due to the better specification, allowing for heterogeneity [24].

Data

Korea health panel survey

This study uses individual-level longitudinal data from the Korea Health Panel Survey (KHPS) for 2008 to 2018 (Version 1.7.2).[14] The KHPS is a nationwide comprehensive survey carried out by the Korea Institute for Health and Social Affairs and the National Health Insurance Service on a household or individual basis, using a dually stratified cluster sampling frame of the National Population and Housing Census. It provides a variety of information on individuals' health status and behaviors, health care utilization, and expenditure by type of care service (e.g., emergency care, inpatient and outpatient care, childbirth, long-term care, and medication utilization), covering the demographic and socioeconomic characteristics of individuals as well. The survey data also include sampling weights to enable adjustment for unequal selection probabilities and non-responses based on the distribution of population totals, which enable nationally representative estimates to be obtained.

Participants in the KHPS are required to collect receipts for each instance of health care expenses to alleviate the problems of recall bias and increase the credibility of the survey data. The complete dataset contains a full sample of 195,032 person-years in 68,347 household-years across the entire survey that are all available in this study as a 11-year unbalanced panel

[13] CI_{x_j} and CI_{z_k} are defined analogously to the Eq. (1) by replacing y with x_j and z_k respectively, namely $CI_{x_j} = 2cov\left(x_{ji}, r_i\right)/\bar{x}_j$ and $CI_{z_k} = 2cov(z_{ki}, r_i)/\bar{z}_k$.

[14] As of 2024, the KHPS data are also available from 2019 to 2021 (Version 2.2) in the second survey period, which are constructed as a new panel independently from the dataset in the first survey period (2008–2018). The sample in the second survey period cannot be linked using the same unique individual or household identifier to the one in the first survey period. For this reason, this study uses the longitudinal data for 2008 to 2018 only available during the first survey period.

data set.[15] New samples were selected and added to the panel in 2012 to ensure the reliability of the survey in response to the decreasing number of households and household members originally included in the sample who persisted in supplying data. These new participants' data became available from the 2014 survey data as an aggregated panel with the original sample.

Outcome variables and need/non-need determinants

The health-related outcome measures of primary interest in this paper are health care utilization and spending in a year. I use six types of outcome variable: (1) length of hospital stay, (2) number of outpatient visits, (3) number of instances of emergency care use for health care utilization, (4) amount of inpatient care expenses, (5) amount of outpatient care expenses, and (6) total amount of medical expenses for health care spending. All of these outcomes are assumed to be continuous non-negative variables starting from 0.[16]

The need determinants of health care utilization and spending are proxied by individual's age, sex,[17] number of chronic diseases, and whether he/she is physically handicapped. The needs for health care services could also include variables such as self-reported health status, mental health problems, or various risk factors (e.g., smoking, drinking, eating habits, exercise, etc.), which are partly available in the KHPS. However, it would be better not to use these variables to prevent selection bias due to attrition. On the other hand, following previous studies on socioeconomic inequalities in health care, non-need determinants are defined as follows: individual's income level,[18] educational attainment,[19] labor force participation,[20] marital status,[21] number of household members, residential area,[22] whether he/she receives public assistance, whether he/she has a private health insurance policy, and total amount of monthly premium for private health insurance. A binary variable of private health insurance represents the fact that individuals cannot be reimbursed for an identical health care use from multiple private health insurance schemes in Korea. To reflect the growing popularity of the purchase of voluntary private health insurance, even under the UHC, I also use the variable that captures variation in capacity to pay for insurance.

In addition to need and non-need determinants, survey year fixed-effects are also taken into account in the regression and decomposition analysis. Note that monetary variables, expressed in ten thousand Korean won (i.e., equivalized income, medical expenses, and monthly premium for private health insurance) are transformed into real values adjusted by the consumer price index for each year to compare them across survey years.

Descriptive statistics

Table 1 reports the descriptive statistics, including concentration indices for outcomes and need/non-need variables across the entire sample. The concentration indices for health care utilization show negative values, indicating that it is disproportionately concentrated on poorer people as a whole. Nevertheless, the utilization for inpatient care (about 2 days on average per year) is more biased toward the poor than outpatient and emergency care use (on average, 15.4 and merely 0.1 times per year, respectively). However, the concentration indices for health care spending demonstrate a different tendency: inpatient care expenses show a pro-poor concentration, while the inequality favors the better-off in outpatient care spending, which is higher than the former on average. Total medical expenses are almost equally distributed among all of the samples available, even if the concentration index has a small positive value with no statistical significance. The concentration indices for outcome variables in descriptive statistics are slightly different from but nearly equal to those calculated in the regression and decomposition analysis, where some of the observations are dropped due to missing values of other covariates than equivalized income.

A graphical representation of the concentration indices for outcome variables is shown in the form of the concentration curves in Appendices A and B. The concentration curve plots the cumulative percentage of a health-related variable against that of the population according to socioeconomic status, from poorest to

[15] Some individual observations are dropped from the following analysis due to missing values.

[16] Length of hospital stay is in practical terms assumed to range from 0 to 366 days in a leap year. However, because it is calculated as a summation of days of stay in each episode of inpatient care utilization within a survey year, some samples exceed the supposed upper bound. I use the outcome variable as it is given in the analysis without manipulating the original data.

[17] Individual's sex is defined as a binary variable, taking a value of 1 if the sex is female, and a value of 0 if it is male.

[18] When I calculate the concentration indices, individual's income levels (i.e., household income divided by the square root of household size) is used as a continuous variable to rank the samples. On the other hand, these are categorized as quintiles of equivalized income for each survey year in the regression analysis, and then these income groups are transformed into dummy variables. The reference group is determined as the poorest quintile.

[19] Educational attainment is represented by three categories by highest level of educational achievement: junior high school graduate or lower education, high school graduate, and university graduate or higher education. Dummies for the first and third categories are used in the analysis, and the second category is set as a benchmark.

[20] Labor force participation refers to whether the respondent worked in a survey year. Note that those under the age of 15 are systematically identified as not working.

[21] Marital status is defined as a binary variable taking the value of 1 if the respondent is married and 0 otherwise.

[22] Residential area refers to whether he/she lives in the capital regions (i.e., Seoul, Incheon, and Gyeonggi Province). Residential information on whether urban or rural areas is not available in the KHPS.

Table 1 Summary statistics for outcomes and need/non-need variables

	N	Mean	SD	Min	Max	CI	N for CI
Outcomes							
Length of stay (inpatient)	195,032	1.96	15.20	0	2,920	-0.254	194,607
Num. of visits (outpatient)	195,032	15.40	22.93	0	455	-0.129	194,607
Num. of emergency	195,032	0.11	0.49	0	60	-0.072	194,607
Exp. for inpatient care	194,513	15.21	93.35	0	16,264	-0.091	194,088
Exp. for outpatient care	194,689	38.21	76.63	0	4,048	0.036	194,268
Total medical exp	194,936	53.99	131.20	0	16,264	0.003	194,513
Eq. income (10K KRW)	194,607	2,509	1,904	0	149,921	N/A	N/A
1st quintile	39,088	823	279	0	1,470	N/A	N/A
2nd quintile	38,825	1,565	244	1,046	2,221	N/A	N/A
3rd quintile	38,911	2,204	295	1,606	3,004	N/A	N/A
4th quintile	38,963	2,971	389	2,184	4,050	N/A	N/A
5th quintile	38,820	4,992	2,753	3,024	149,921	N/A	N/A
Need							
Age	195,031	41.92	22.59	0	105	-0.053	194,606
Female	195,032	0.52	0.50	0	1	-0.026	194,607
Chronic diseases	195,032	1.41	2.03	0	18	-0.181	194,607
Disabled	195,032	0.06	0.23	0	1	-0.388	194,607
Non-need							
Education							
Jr. high sch. grad. or lower	195,032	0.46	0.50	0	1	-0.194	194,607
High sch. graduate	195,032	0.31	0.46	0	1	0.008	194,607
Univ. grad. or higher	195,032	0.23	0.42	0	1	0.251	194,607
Labor participation	195,023	0.46	0.50	0	1	0.092	194,598
Married	194,993	0.53	0.50	0	1	0.019	194,569
Num. of family members	195,032	3.48	1.29	1	11	0.036	194,607
Capital area	195,032	0.41	0.49	0	1	0.080	194,607
Public assistance	195,032	0.04	0.20	0	1	-0.762	194,607
Private health insurance	195,032	0.72	0.45	0	1	0.095	194,607
Monthly premium	194,630	8.20	11.50	0	765	0.198	194,213

Underscored variables are used as reference categories in the regression analysis

richest. The concentration index is equal to twice the area between the concentration curve and the 45-degree line of perfect equality [7]. If the health variable is concentrated among the poor (rich), the concentration curve lies above (below) the line of equality [19]. The concentration curves for health care utilization and inpatient care spending are plotted above the 45-degree line, due to the negative values of the concentration indices, while the opposite is true for the case of outpatient care spending. However, it is worth noting that the concentration curve for the total amount of medical spending apparently crosses the line of equality.

Table 1 also indicates that older people and females are more likely to belong to the poorer population, and having more chronic diseases and disabilities is more common among the poor. Individuals who have completed education beyond high school are concentrated in the richer groups, and those with lower education are biased toward the poorer groups. Approximately half of those sampled are married and have worked during the survey year, and these respondents are more prevalent among the wealthier people. Those who live in the capital regions were more than 40% of the samples and also showed a pro-rich prevalence, while public assistance recipients accounted for only 4% and were strongly concentrated in the poor group. Moreover, the richer population is likely to purchase private health insurance that has higher monthly premiums.

Results

Short-run/long-run concentration indices

Figure 1 shows changes in concentration indices for six outcome measures over the short and long run (Eqs. (2) and (3)), using a weighted average for the short-run

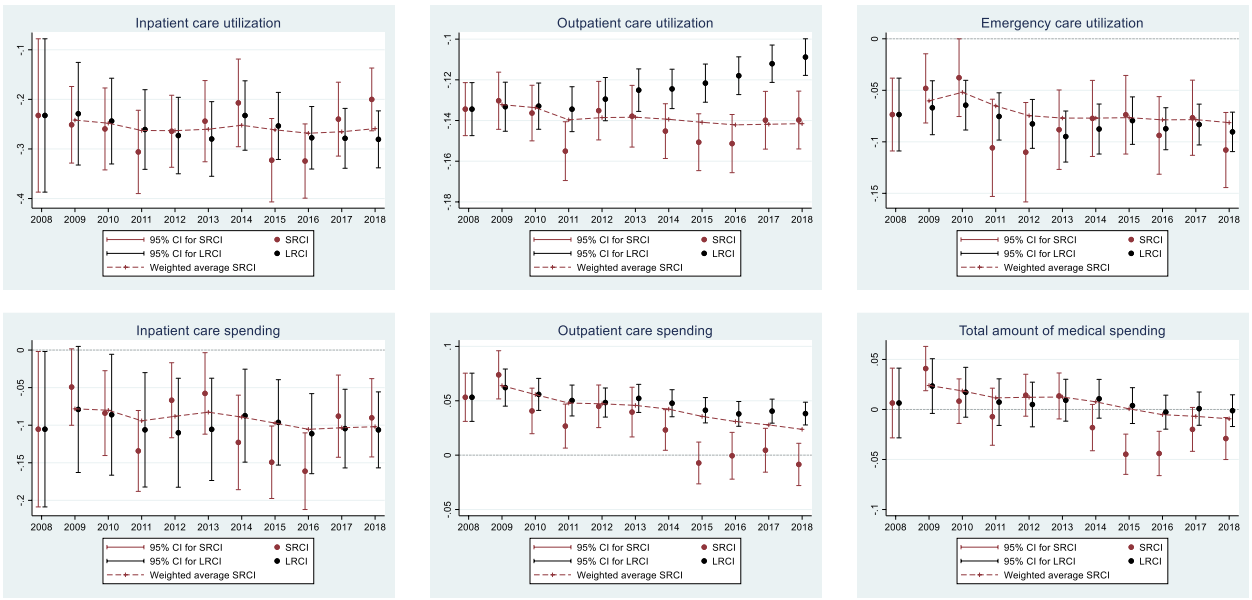

Fig. 1 Concentration indices for health care outcomes

Note: CI stands for a confidence interval. SRCI stands for the short-run concentration index. LRCI stands for the long-run concentration index

concentration indices. The confidence intervals for concentration indices are also obtained from the linear regression. As with the descriptive statistics across the entire sample, both the concentration indices of health care utilization (inpatient, outpatient, and emergency care) show negative values with sufficient statistical significance, implying a disproportionate concentration of overall health care utilization among the poor over the short and long run. The concentration indices for inpatient care spending also demonstrate a pro-poor concentration, while outpatient care spending is consistently biased toward the rich over the long run (although this relationship shows no statistical significance over the short run in some later years). The total amount of medical expenses, however, is more or less equally distributed across the population, as the concentration indices are not statistically different from zero in most survey years.

There exist some differences between the long-run concentration indices and the weighted average of the short-run concentration indices for every outcome measure, stemming from a systematic association between changes in individual income ranking and differences in measures of his/her health care outcomes over the given time period [1, 5]. Although digging into the mechanism behind these deviations is not the mainstream of this study, a series of the short-run inequalities over the longer period of time are likely to be underestimations or overestimations of the long-run inequality [29].

Regression analysis

The estimation results of the pooled regressions over the entire sample (Eq. (4)) and separate regressions across income groups (Eq. (6)) for six outcome measures are fully reported in Tables 2 and 3. They indicate a linear association between health care outcomes and need/non-need determinants while allowing for heterogeneous responses according to income group. Note that the fixed parameters over the entire sample in Eq. (5) and the differential parameters by income groups in Eq. (7) constitute a certain portion of the homogeneous and heterogeneous factor contributions, respectively. Thus, it is important to present the sign and magnitude of each coefficient with respect to need and non-need factors.

Among the need factors, age is positively associated with inpatient care utilization/spending and total medical expenses, but it is negatively correlated with outpatient and emergency care use ($p < 0.01$). Females are less likely to use inpatient and emergency care than males, and they tend to use outpatient care more and to spend more on it, with higher spending on total medical care ($p < 0.05$), and this effect tends to grow as income level grows. The number of chronic diseases shows a positive relationship with health care utilization and spending, as expected ($p < 0.01$), and their impacts become smaller for health care use but greater for expenditures as income level goes up. Being physically handicapped is also significantly associated with increasing frequency of overall

health care utilization and higher amount of medical spending ($p < 0.05$), with the exception of spending for outpatient care.

Among the non-need factors, lower educational attainment than graduation from high school is significantly correlated with greater use of health care as a whole and greater expenses for outpatient and total medical care ($p < 0.05$). On the other hand, those who have achieved higher education than high school graduates are less likely to utilize and spend on outpatient care (inpatient/emergency and total medical care only in the poorest group) ($p < 0.05$). The working population reveals a negative association with health care utilization and spending, as expected, likely due to the healthy worker effect ($p < 0.05$). People who are married tend to use more outpatient and emergency care and spend more on overall medical care ($p < 0.05$), but they also show shorter hospital stays for inpatient care ($p < 0.01$). The number of household members is negatively associated with health care utilization (except for inpatient care) and spending ($p < 0.05$). Living in the capital regions is significantly associated with higher spending on outpatient and total medical care ($p < 0.05$), although it is reverse-correlated with a decreasing frequency of overall health care use and lower expenses for inpatient care ($p < 0.05$). We also find a clear contrast such that public assistance recipients are likely to utilize more health care services but spend less on them, owing to the tax-funded Medical Aid Program ($p < 0.05$). Purchasing private health insurance raises the probability of spending more on outpatient and total medical care but leads to reduced utilization for inpatient and emergency care ($p < 0.05$). Those who pay higher monthly premiums tend to increase their overall health care use and expenses ($p < 0.05$). Nevertheless, positive gradients were not found across income levels in the effects of private health insurances on health care utilization and spending, as had been expected.

Decomposition analysis

The decomposition results of the concentration indices allowing for heterogeneity for six outcomes (Eq. (7)) are graphically displayed in Figs. 2, 3, 4, 5, 6 and 7. The corresponding results, expressed in numerical values and percentage shares, are also presented in Appendices C and D. It can be recalled that the homogeneous contributions of need and non-need determinants are evaluated as the product of the elasticity of health care measures with respect to each explanatory variable and the concentration index for each variable, whereas the heterogeneous contributions depend on the covariance of the differential parameters across income groups, with a fractional rank in the income distribution weighted by the values of the corresponding covariates. Note likewise that the direct contribution of income-group differences can be obtained from the covariance between the group-specific intercepts and the fractional income rank.

Within the result for inpatient care utilization, age makes the largest positive contribution in total to the income-related inequality (−0.254), where the positive heterogeneous contribution (i.e., the effect on length of hospital stay is stronger for high-income groups) overwhelms the negative homogeneous contribution, which is derived from its positive association with inpatient care use and pro-poor inequality in its distribution. In contrast, the number of chronic diseases forms a negative contribution to income-related inequality, mainly due to the negative heterogeneous contribution, in which the positive correlation is stronger for low-income groups. The total contribution of need factors takes a positive value (0.052) due to the greater positive effect of the heterogeneous contribution. Among the non-need determinants, marital status makes the largest negative (heterogeneous) contribution, where married people, who have their strong association with shorter days of hospital stay, belong to higher income groups. Another large negative (heterogeneous) contribution of private health insurance is shown in that the negative correlation with inpatient care use is stronger for high-income groups in the context of pro-rich inequality in its distribution. The total contribution of non-need factors (−0.113) accounts for 44% of the income-related inequality, and the largest contributor is the direct impact of income-group differences (−0.191), which accounts for 75%.

The result for inpatient care spending is similar to that for inpatient care use with respect to the direction of each need factor,[23] but the homogeneous and heterogeneous contributions of need determinants compensate for each other to some extent (−0.009). The number of household members produces the largest negative (heterogeneous) contributions among the non-need factors, suggesting that individuals living with more family members, who have their significant association with reduced inpatient care expenses, are likely to become high-income groups. Marital status and private health insurance are also larger for negative (heterogeneous) contributors. As a results, the total contribution of non-need determinants (−0.065) accounts for 72% of income-related inequality in inpatient care spending (−0.091). It is noteworthy that

[23] The largest positive contribution for gender is found in the positive heterogeneous effect such that females for whom the negative association with inpatient care expenses is greater tend to enjoy a lower than average income level.

Table 2 Estimation results for health care utilization

	Inpatient care						Outpatient care						Emergency care					
	Pooled	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Pooled**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Pooled**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Age	**0.048** (0.004)	**0.026** (0.008)	**0.052** (0.008)	**0.067** (0.010)	**0.036** (0.008)	**0.081** (0.015)	**-0.045** (0.004)	0.013 (0.010)	**-0.063** (0.010)	**-0.074** (0.010)	**-0.056** (0.009)	**-0.050** (0.009)	**-0.002** (0.0001)	**-0.0008** (0.0003)	**-0.001** (0.0002)	**-0.002** (0.0002)	**-0.002** (0.0002)	**-0.001** (0.0003)
Female	**-0.401** (0.063)	**-1.881** (0.275)	**-0.484** (0.127)	-0.085 (0.097)	-0.197 (0.106)	**0.306** (0.100)	**2.047** (0.081)	**1.338** (0.275)	**1.790** (0.184)	**1.794** (0.166)	**2.044** (0.149)	**2.692** (0.154)	**-0.018** (0.002)	**-0.050** (0.007)	**-0.026** (0.005)	**-0.017** (0.005)	-0.006 (0.004)	-0.0007 (0.004)
Chronic diseases	**0.505** (0.035)	**0.762** (0.083)	**0.600** (0.065)	**0.370** (0.057)	**0.349** (0.059)	**0.285** (0.098)	**5.200** (0.046)	**5.897** (0.096)	**5.285** (0.103)	**4.939** (0.101)	**4.556** (0.105)	**4.493** (0.104)	**0.026** (0.001)	**0.031** (0.002)	**0.027** (0.002)	**0.026** (0.002)	**0.020** (0.002)	**0.021** (0.002)
Disabled	**3.815** (0.468)	**4.279** (0.892)	**3.506** (0.647)	**2.331** (0.636)	**3.880** (1.112)	**3.449** (1.755)	**3.077** (0.335)	**2.411** (0.583)	**4.001** (0.685)	1.404 (0.734)	**4.499** (0.837)	**3.645** (0.961)	**0.044** (0.007)	0.024 (0.013)	**0.052** (0.015)	**0.086** (0.018)	**0.043** (0.016)	0.019 (0.017)
Lower education	**0.417** (0.097)	0.170 (0.354)	0.297 (0.169)	**0.731** (0.143)	**0.430** (0.147)	**0.851** (0.259)	**6.149** (0.105)	**5.282** (0.288)	**6.270** (0.215)	**6.528** (0.213)	**5.789** (0.213)	**5.375** (0.251)	**0.041** (0.003)	**0.027** (0.007)	**0.034** (0.006)	**0.042** (0.006)	**0.053** (0.006)	**0.054** (0.006)
Higher education	0.106 (0.059)	**-0.677** (0.290)	0.098 (0.129)	**0.241** (0.104)	0.063 (0.117)	0.159 (0.121)	**-0.441** (0.085)	**-0.670** (0.327)	-0.356 (0.194)	**-0.394** (0.168)	**-0.451** (0.154)	**-1.229** (0.179)	-0.003 (0.002)	**-0.019** (0.008)	-0.0009 (0.007)	-0.002 (0.005)	-0.009 (0.005)	-0.0003 (0.005)
Labor participation	**-1.147** (0.077)	**-1.743** (0.238)	**-1.419** (0.166)	**-0.962** (0.145)	**-0.861** (0.177)	**-0.875** (0.160)	**-1.616** (0.100)	**-0.604** (0.278)	**-1.749** (0.219)	**-1.930** (0.202)	**-1.881** (0.196)	**-1.508** (0.220)	**-0.017** (0.003)	**-0.032** (0.007)	**-0.018** (0.006)	**-0.018** (0.005)	-0.009 (0.005)	-0.007 (0.005)
Married	**-0.550** (0.131)	0.511 (0.344)	**-0.884** (0.236)	**-1.161** (0.270)	-0.296 (0.224)	**-1.386** (0.372)	**3.011** (0.122)	**2.379** (0.350)	**2.437** (0.277)	**3.296** (0.262)	**3.759** (0.236)	**4.323** (0.234)	**0.027** (0.003)	**0.032** (0.008)	0.001 (0.008)	**0.042** (0.006)	**0.027** (0.007)	**0.023** (0.007)
Family members	0.019 (0.037)	-0.026 (0.122)	0.043 (0.063)	0.024 (0.058)	-0.046 (0.058)	-0.011 (0.077)	**-0.947** (0.039)	**-0.615** (0.117)	**-1.060** (0.089)	**-1.013** (0.079)	**-0.727** (0.078)	**-0.755** (0.080)	**-0.008** (0.001)	0.003 (0.003)	**-0.009** (0.002)	**-0.012** (0.002)	**-0.009** (0.002)	**-0.010** (0.002)
Capital area	**-0.411** (0.060)	**-0.807** (0.260)	**-0.561** (0.120)	**-0.313** (0.098)	**-0.267** (0.092)	**-0.236** (0.106)	**-0.519** (0.078)	**-2.347** (0.274)	**-0.545** (0.178)	**-0.343** (0.159)	0.014 (0.142)	0.205 (0.149)	**-0.012** (0.002)	**-0.024** (0.006)	**-0.010** (0.005)	**-0.016** (0.005)	-0.003 (0.004)	**-0.014** (0.004)
Public assistance	**2.413** (0.401)	**2.139** (0.461)	**2.064** (0.910)	1.553 (1.186)	0.211 (1.984)	**24.64** (11.74)	**3.116** (0.376)	**3.575** (0.456)	**3.126** (0.844)	**3.408** (1.663)	**-4.653** (1.752)	-1.990 (3.209)	**0.068** (0.011)	**0.082** (0.013)	0.017 (0.020)	0.035 (0.048)	-0.002 (0.041)	0.200 (0.235)
Priv. health ins	**-0.269** (0.088)	0.155 (0.324)	**-0.330** (0.145)	-0.287 (0.153)	**-0.391** (0.144)	**-0.697** (0.212)	0.099 (0.112)	**1.359** (0.322)	0.033 (0.235)	-0.051 (0.226)	**-0.475** (0.239)	-0.141 (0.241)	**-0.006** (0.003)	-0.012 (0.007)	0.003 (0.006)	-0.004 (0.006)	-0.007 (0.006)	-0.014 (0.007)
Monthly premium	**0.014** (0.002)	0.029 (0.018)	**0.032** (0.008)	**0.020** (0.005)	**0.019** (0.004)	**0.010** (0.003)	**0.011** (0.004)	-0.034 (0.020)	**0.023** (0.011)	**0.019** (0.009)	0.009 (0.007)	**0.012** (0.005)	**0.0005** (0.0001)	**0.001** (0.0005)	**0.0008** (0.0003)	**0.0006** (0.0003)	**0.0008** (0.0002)	**0.0003** (0.0001)
Years	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income quintiles	Yes	No	No	No	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No
Constant	0.083 (0.355)	2.068 (1.112)	0.139 (0.449)	-0.594 (0.406)	0.287 (0.362)	-0.266 (0.514)	**7.167** (0.280)	**3.534** (0.727)	**7.899** (0.578)	**8.289** (0.526)	**6.730** (0.518)	**6.268** (0.523)	**0.141** (0.008)	**0.102** (0.021)	**0.150** (0.017)	**0.170** (0.015)	**0.139** (0.014)	**0.138** (0.016)
Observations	194,172	39,007	38,720	38,830	38,888	38,727	194,172	39,007	38,720	38,830	38,888	38,727	194,172	39,007	38,720	38,830	38,888	38,727
R-squared	0.024	0.019	0.034	0.027	0.020	0.027	0.310	0.310	0.303	0.272	0.272	0.248	0.016	0.021	0.016	0.017	0.014	0.012

Coefficients in boldface represent the 5% level of statistical significance ($p < 0.05$). Robust standard errors adjusted by sampling weights are reported in parentheses

Table 3 Estimation results for health care spending

	Inpatient care						Outpatient care						Total medical care					
	Pooled	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Pooled**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Pooled**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Age	**0.184** (0.022)	**0.118** (0.033)	**0.251** (0.063)	**0.186** (0.037)	**0.206** (0.060)	**0.230** (0.067)	0.016 (0.015)	-0.040 (0.024)	0.052 (0.030)	0.017 (0.032)	**0.127** (0.038)	0.006 (0.044)	**0.190** (0.027)	0.073 (0.043)	**0.294** (0.071)	**0.193** (0.052)	**0.316** (0.072)	**0.233** (0.083)
Female	-0.449 (0.400)	**-2.949** (1.024)	**-2.745** (1.084)	-0.482 (0.720)	0.660 (0.871)	**2.558** (0.803)	**6.861** (0.377)	**2.135** (0.766)	**5.709** (0.741)	**7.040** (0.734)	**6.590** (0.848)	**11.36** (0.979)	**6.422** (0.585)	-0.987 (1.359)	**2.935** (1.365)	**6.490** (1.093)	**7.199** (1.276)	**14.14** (1.370)
Chronic diseases	**4.706** (0.231)	**4.396** (0.320)	**4.888** (0.447)	**4.697** (0.472)	**4.898** (0.746)	**5.163** (0.792)	**11.96** (0.169)	**9.164** (0.218)	**12.24** (0.361)	**13.19** (0.398)	**13.21** (0.452)	**15.49** (0.586)	**16.77** (0.306)	**13.73** (0.414)	**17.26** (0.603)	**18.04** (0.651)	**18.25** (0.929)	**20.51** (1.059)
Disabled	**11.97** (2.196)	**4.418** (1.880)	**17.64** (7.781)	**11.00** (3.245)	**22.47** (5.771)	**18.69** (7.311)	-0.473 (0.899)	-2.093 (1.125)	3.626 (2.181)	-2.099 (2.345)	2.644 (2.976)	-1.796 (3.141)	**11.41** (2.410)	2.309 (2.304)	**21.14** (8.077)	**9.135** (4.226)	**25.53** (6.715)	15.50 (7.932)
Lower education	0.448 (0.536)	-0.518 (1.220)	1.864 (1.122)	1.898 (0.970)	-0.847 (1.323)	0.632 (1.562)	**2.087** (0.477)	**3.695** (0.894)	**2.397** (1.015)	**2.892** (0.971)	**2.383** (1.206)	1.939 (1.347)	**2.492** (0.766)	3.163 (1.611)	**4.356** (1.581)	**4.789** (1.459)	1.712 (1.880)	2.066 (2.211)
Higher education	0.603 (0.634)	**-4.571** (1.415)	3.892 (2.573)	1.309 (1.016)	1.175 (1.140)	-0.536 (1.000)	**-1.964** (0.503)	-1.375 (1.454)	-1.446 (1.004)	-1.293 (0.956)	-1.937 (1.060)	-0.553 (1.186)	-1.520 (0.857)	**-6.207** (2.152)	2.499 (2.801)	-0.137 (1.489)	-0.674 (1.636)	-1.541 (1.715)
Labor participation	**-6.061** (0.594)	**-5.913** (1.106)	**-9.247** (1.784)	**-5.732** (1.057)	**-6.134** (1.454)	**-4.268** (1.206)	**-3.442** (0.481)	-0.232 (0.888)	**-3.277** (1.018)	**-3.814** (0.998)	**-3.640** (1.113)	**-6.605** (1.372)	**-9.737** (0.824)	**-6.310** (1.506)	**-12.37** (2.107)	**-9.632** (1.542)	**-9.865** (1.934)	**-11.79** (2.133)
Married	**1.573** (0.718)	**5.607** (1.235)	-0.303 (2.302)	1.435 (1.169)	-0.258 (1.626)	-0.647 (1.780)	**10.36** (0.527)	**10.75** (0.878)	**5.985** (1.145)	**8.773** (1.110)	**7.532** (1.368)	**12.51** (1.378)	**12.36** (0.941)	**16.67** (1.600)	**5.656** (2.616)	**10.44** (1.725)	**7.698** (2.180)	**12.95** (2.434)
Family members	**-0.759** (0.212)	-0.640 (0.458)	-0.593 (0.530)	**-1.198** (0.345)	**-1.064** (0.445)	**-1.246** (0.547)	**-2.941** (0.179)	**-2.744** (0.310)	**-3.566** (0.329)	**-3.535** (0.322)	**-3.302** (0.435)	**-3.473** (0.543)	**-3.837** (0.300)	**-3.375** (0.582)	**-4.205** (0.637)	**-4.771** (0.502)	**-4.491** (0.656)	**-5.170** (0.894)
Capital area	**-1.609** (0.399)	**-2.941** (0.995)	-1.623 (1.136)	-1.360 (0.721)	-0.178 (0.852)	**-2.267** (0.814)	**2.997** (0.359)	**2.339** (0.797)	1.374 (0.727)	**3.077** (0.709)	**2.904** (0.815)	**4.698** (0.901)	**1.371** (0.576)	-0.576 (1.348)	-0.042 (1.396)	1.837 (1.076)	**2.881** (1.242)	1.867 (1.387)
Public assistance	**-9.774** (1.038)	**-7.908** (1.086)	**-10.67** (2.538)	**-12.00** (3.411)	**-17.35** (4.726)	9.005 (23.41)	**-28.45** (0.884)	**-28.82** (1.026)	**-20.43** (2.294)	**-17.62** (6.535)	**-31.72** (6.094)	**-47.61** (5.968)	**-38.66** (1.431)	**-37.27** (1.570)	**-31.48** (3.654)	**-28.98** (7.777)	**-50.09** (8.584)	-38.99 (21.59)
Priv. health ins	-0.933 (0.539)	1.975 (1.260)	**-3.772** (1.323)	-1.340 (1.070)	0.633 (1.152)	**-3.066** (1.277)	**3.538** (0.465)	**4.438** (1.052)	**3.051** (1.004)	1.690 (1.051)	1.704 (1.192)	**4.271** (1.260)	**2.434** (0.779)	**6.638** (1.736)	-0.677 (1.728)	0.297 (1.577)	2.352 (1.744)	-0.096 (2.374)
Monthly premium	**0.120** (0.029)	0.094 (0.095)	**0.220** (0.094)	**0.168** (0.055)	**0.116** (0.052)	**0.111** (0.048)	**0.069** (0.020)	0.112 (0.104)	**0.133** (0.056)	**0.152** (0.056)	0.058 (0.044)	0.046 (0.028)	**0.188** (0.036)	0.196 (0.149)	**0.352** (0.111)	**0.322** (0.082)	**0.175** (0.072)	**0.155** (0.057)
Years	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income quintiles	Yes	No	No	No	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No
Constant	**4.932** (1.387)	**9.042** (2.797)	**8.721** (3.632)	**7.018** (2.232)	3.454 (2.856)	**9.750** (3.127)	**10.78** (1.203)	**19.51** (2.363)	**19.48** (2.236)	**19.35** (2.253)	**20.46** (2.824)	**23.83** (3.327)	**16.84** (1.965)	**29.00** (3.871)	**28.78** (4.380)	**26.91** (3.355)	**24.88** (4.200)	**37.36** (5.676)
Observations	193,654	38,876	38,624	38,735	38,790	38,629	193,833	38,954	38,664	38,711	38,867	38,637	194,083	38,975	38,703	38,824	38,869	38,712
R-squared	0.021	0.025	0.018	0.025	0.019	0.021	0.114	0.162	0.141	0.127	0.099	0.092	0.089	0.113	0.086	0.111	0.083	0.078

Coefficients in boldface represent the 5% level of statistical significance ($p < 0.05$). Robust standard errors adjusted by sampling weights are reported in parentheses

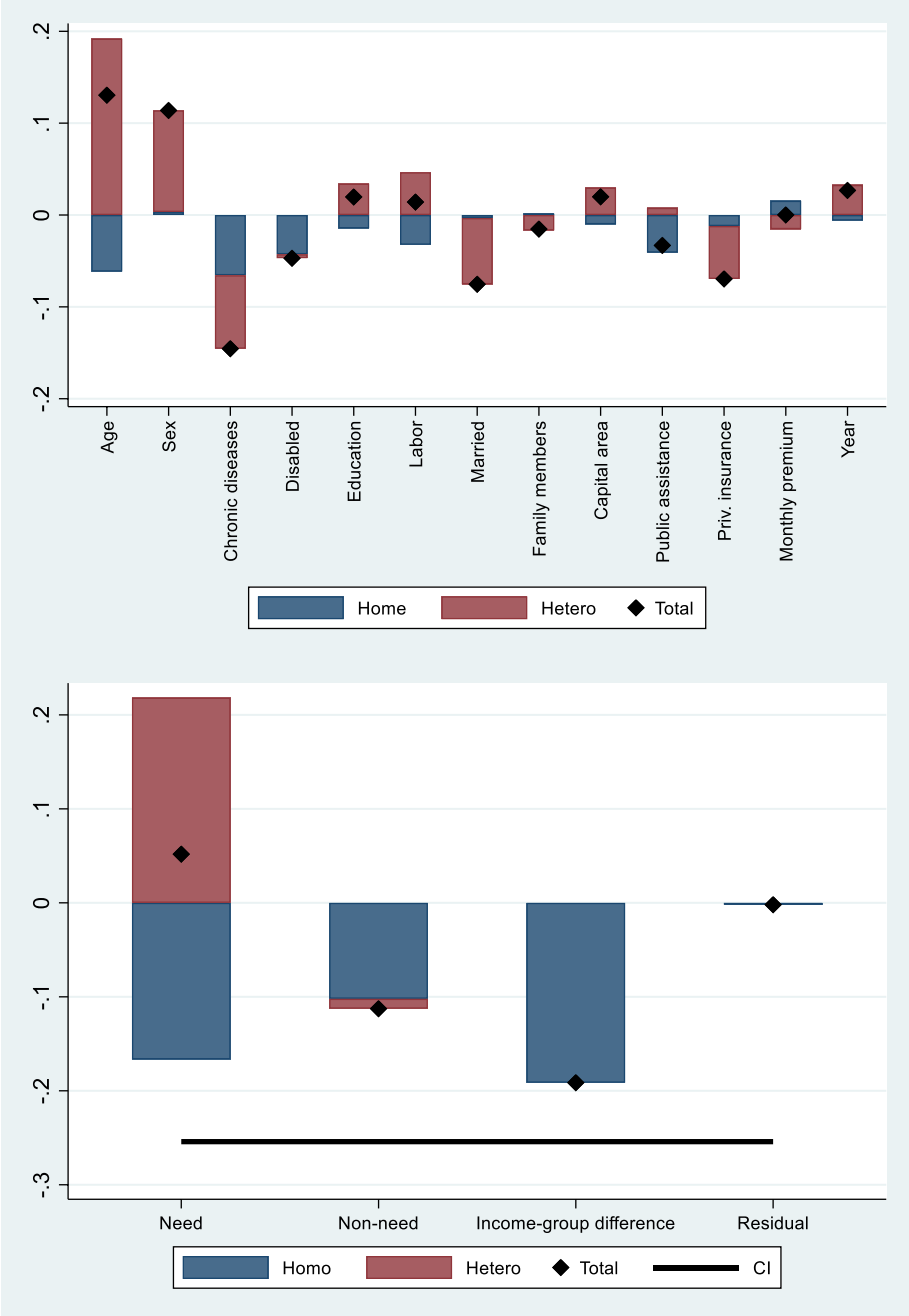

Fig. 2 Decomposition results for inpatient care utilization

the direct effect of income-group differences (−0.015), which accounts for 17% of inequality, is also the important contributor, implying that individuals who belong to lower income groups are likely to spend more on hospitalization, despite the greater financial burden on them.

The decomposition result for outpatient care utilization shows a different picture, although outpatient care is also disproportionately concentrated on the poor. Income-related inequality in outpatient care use (−0.129) is mostly attributable to the contribution of need factors (−0.125), which accounts for 98%, among which the prevalence of chronic disease makes the largest negative (homogeneous) contribution, due to its positive association with utilization for outpatient care and pro-poor inequality in its distribution. Among the non-need determinants, educational attainment is the largest negative

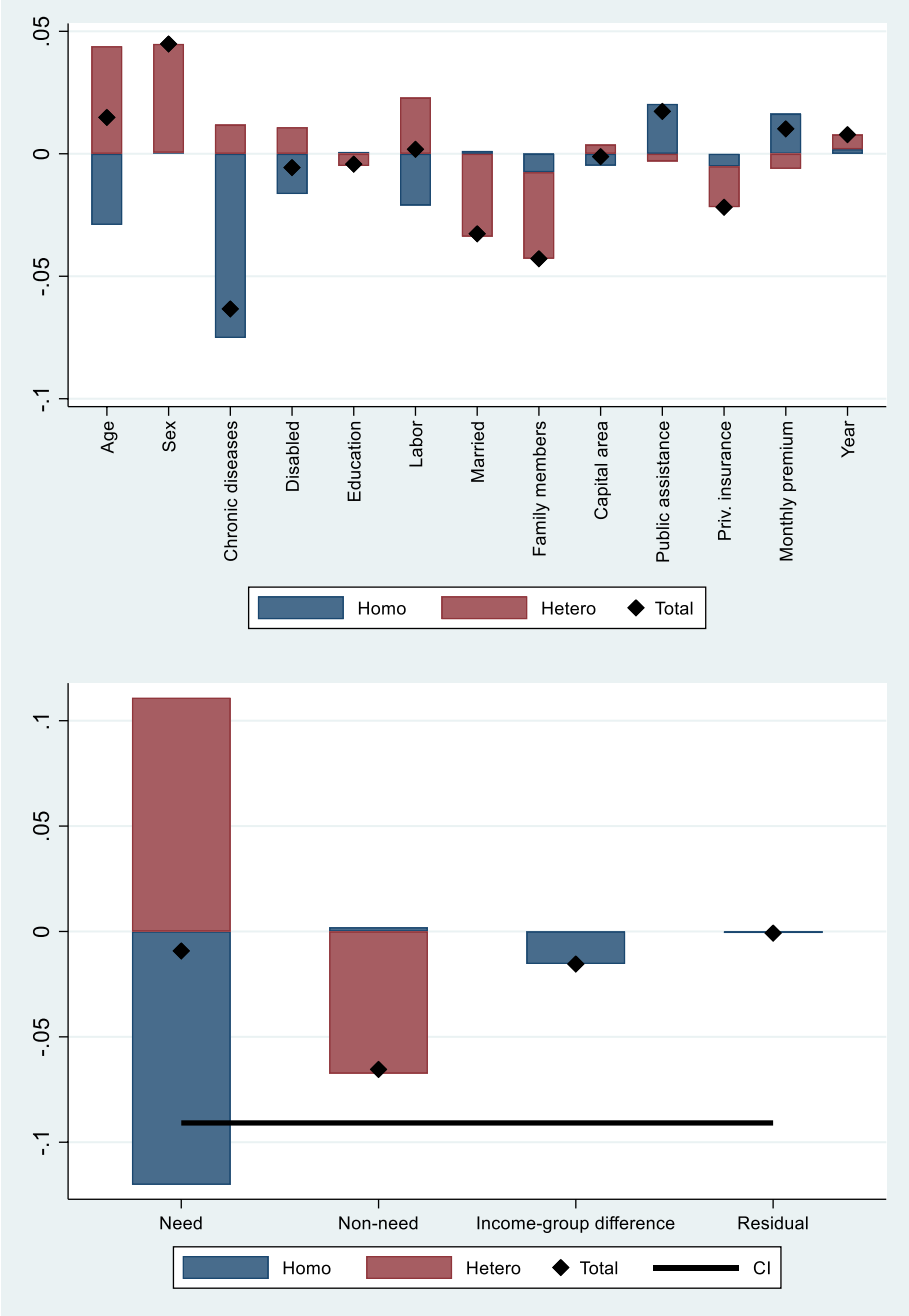

Fig. 3 Decomposition results for inpatient care spending

(homogeneous) contributor, in terms of the combination of the positive/negative effects and pro-poor/rich inequalities in the education dummies, whereas marital status,[24] residential area,[25] and the effects of survey years contribute positively (and heterogeneously) on a larger scale to income-related inequality. Thus, the total contribution of non-need factors (−0.02) results in a smaller share of 15%, and the direct impact of income-group differences also makes less of a contribution in the opposite direction (0.016).

The result for outpatient care spending reveals an insightful pattern of homogeneous and heterogeneous

[24] Married people, who have their stronger correlation with increased number of outpatient visits, belong to higher income groups.

[25] The negative effect of living in the capital regions on outpatient care utilization is stronger for low-income groups.

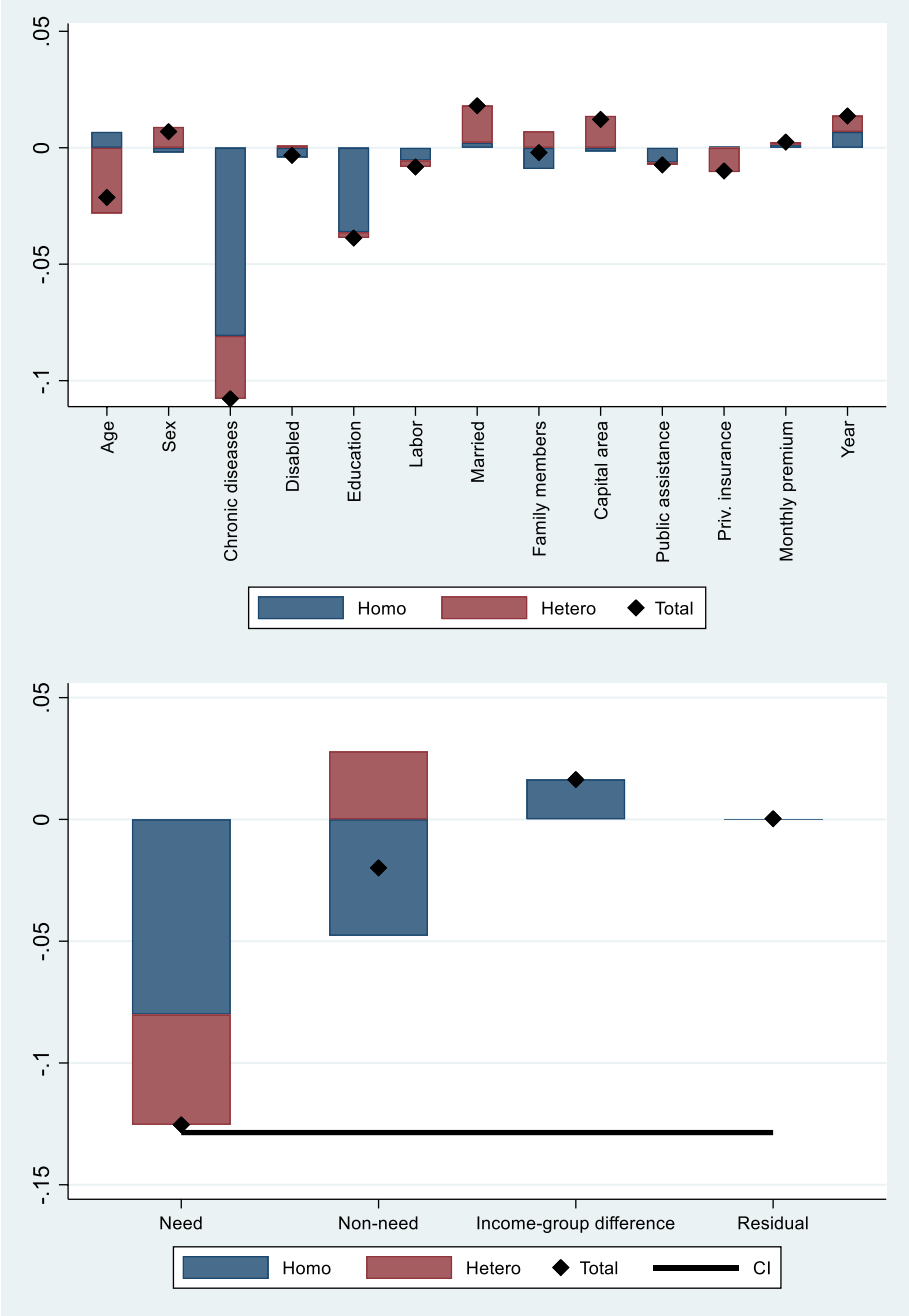

Fig. 4 Decomposition results for outpatient care utilization

contributions. We find that the status of public assistance is the greatest positive (homogeneous) contributor, deriving from its negative correlation to outpatient care expenses and strong pro-poor concentration, while number of family members and working status[26] make larger negative contributions among the non-need determinants. Consequently, the homogeneous and heterogeneous contributions of non-need and need factors turn out to nearly cancel out (0.007 and 0.001 in total, respectively). Therefore, a large share, 62%, of income-related inequality in outpatient care spending (0.036) can be accounted for by the direct contribution of income-group differences (0.023), suggesting that the better-off tend to have expenses from costlier outpatient care, probably including uninsured services.

[26] The negative heterogeneous contribution of labor force participation is largely found because working individuals for whom its negative association with outpatient care spending is stronger are likely to have a higher than average level of income.

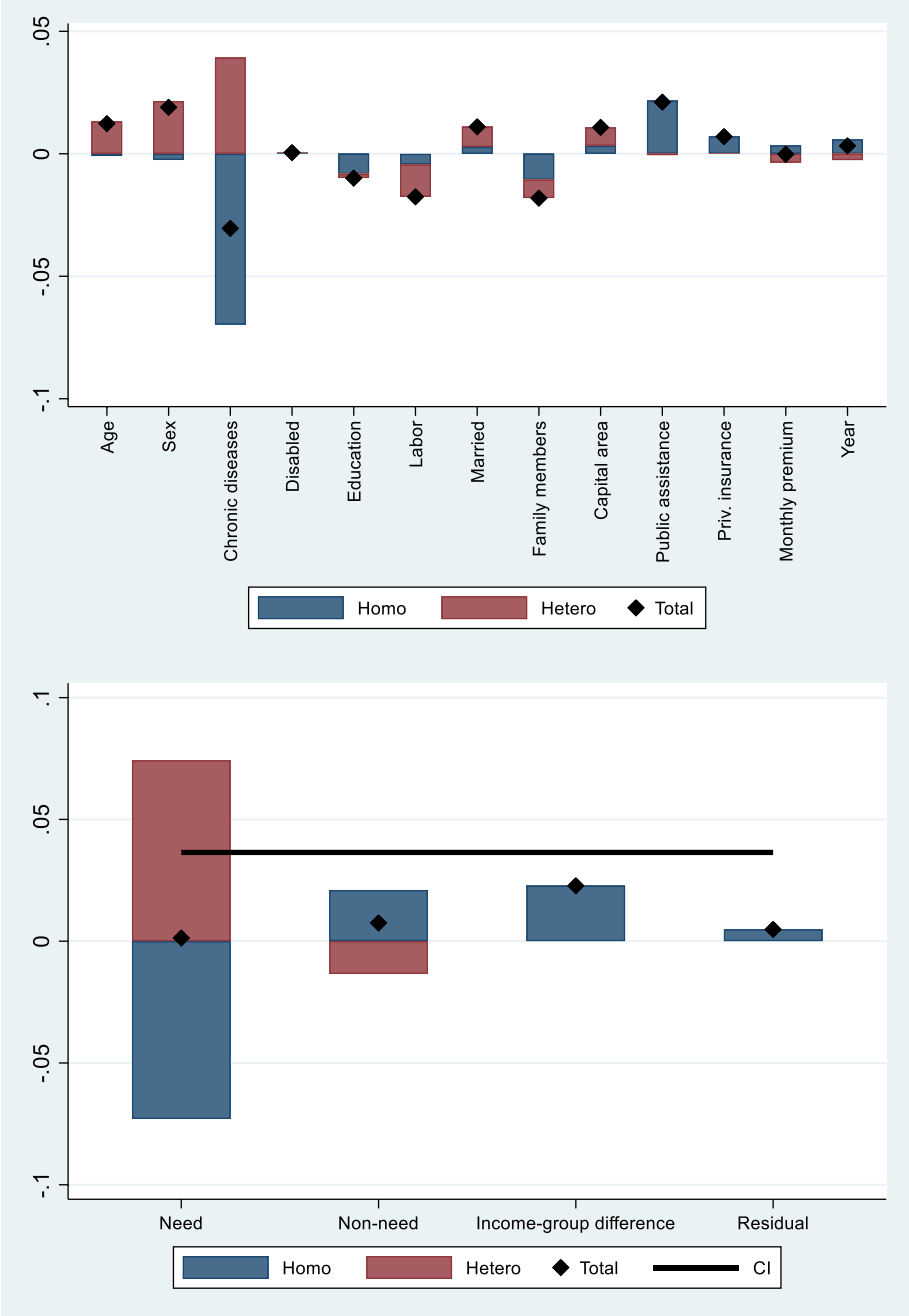

Fig. 5 Decomposition results for outpatient care spending

The decomposition result for emergency care utilization shows that income-related inequality (−0.072) is mostly explained by the contribution of non-need factors (−0.066), which accounts for 91%, among which the number of household members, public assistance status,[27] and private health insurance make relatively larger negative contributions. It also shows a negative contribution according to need determinants (−0.04), accounting for 55%, where the number of chronic diseases plays the most important role. However, the direct contribution of income-group differences involves a smaller share in the opposite direction (0.032). Finally, the result for overall medical care spending is found to be similar to that for outpatient care expenses, in terms of the contribution of each component. However, the offsetting effect of the contributions of need/non-need

[27] The positive correlation to emergency care use and strong pro-poor concentration produce a negative (homogeneous) contribution.

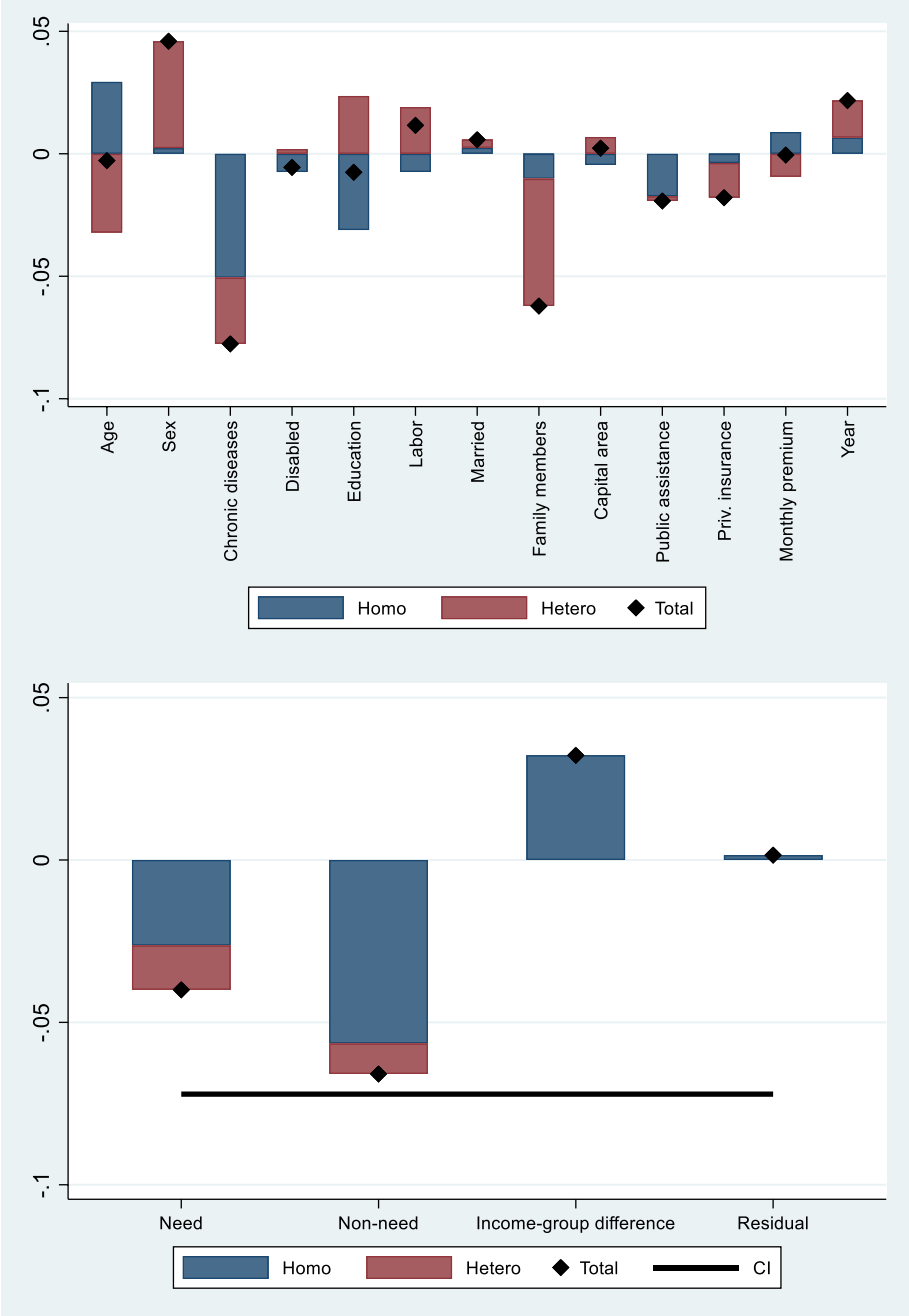

Fig. 6 Decomposition results for emergency care utilization

factors and income-group differences leads to small income-related inequality (0.003), which is close to perfect equality, indicating that total amount of medical expenses is almost uniformly spent across the population, irrespective of their income level.

These different patterns of the decomposition results reflect the demographic (age, sex, health status, and residential area) and socioeconomic (education, working status, household characteristics, private health insurance, and income-group disparity) differences in responses to health care outcomes. In addition, the differential effects of a welfare policy (public assistance to the poor) on health care utilization and spending could partly explain the different results for factor decomposition as an institutional background.

Discussion

This study investigates long-term, income-related inequalities in health care utilization and spending in Korea, and it examines the extent to which need and non-need

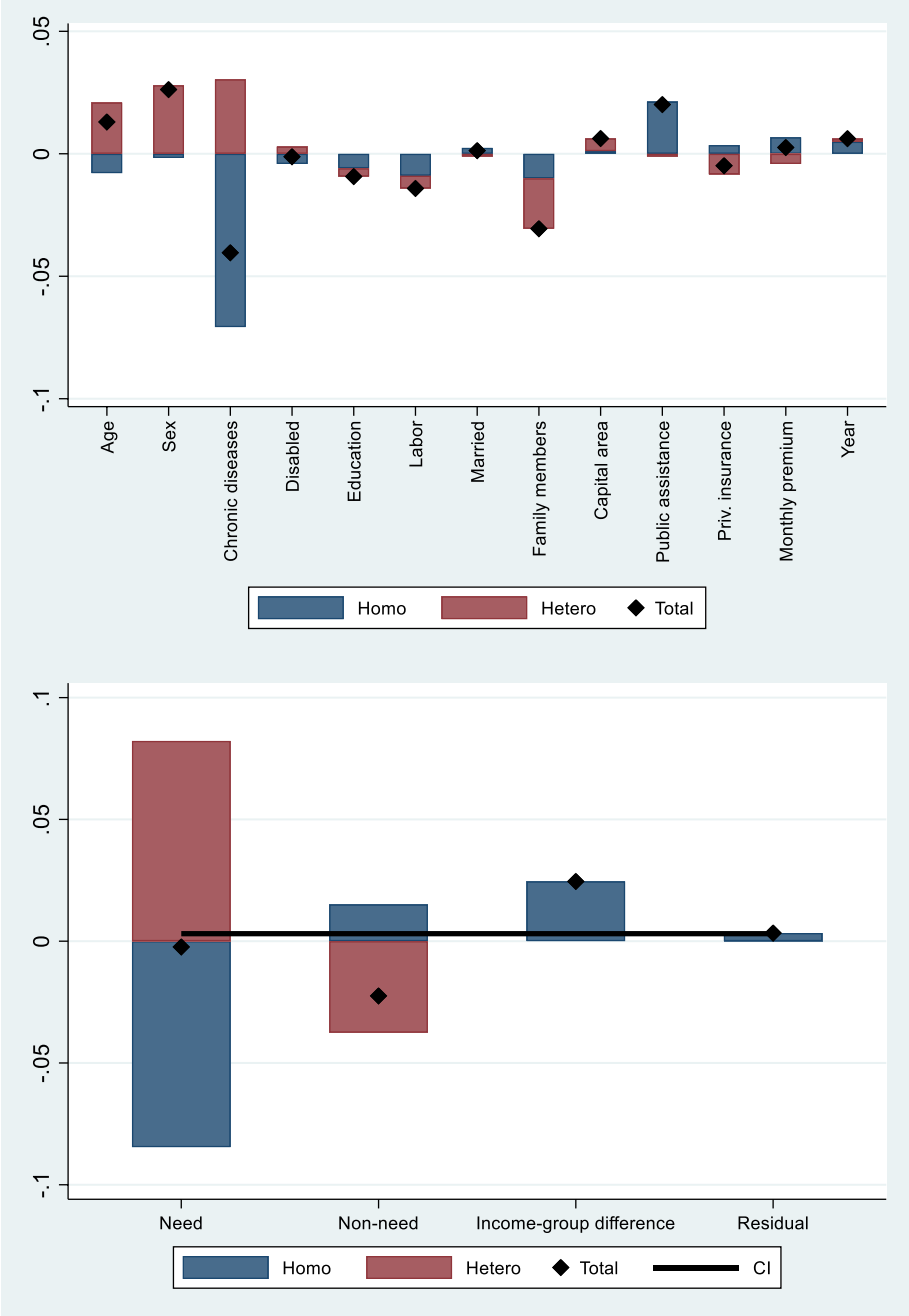

Fig. 7 Decomposition results for total amount of medical spending

factors contribute in a longitudinal setting using an extended decomposition analysis, allowing for heterogenous responses across income groups. The empirical findings are summarized and discussed as follows: First, we find a disproportionate concentration of overall health care utilization among the poor over the short and long run. Income-group differences and non-need determinants, such as marital status and private health insurance, make larger pro-poor contributions to inequality in inpatient care use, while the prevalence of chronic diseases greatly pushes outpatient care utilization in a pro-poor direction. Income-related inequality in emergency care use is mostly explained with the contribution of non-need determinants, such as the number of household members, as well as health status as a need factor, proxied by the distribution of chronic diseases. The pro-poor concentration of health care utilization and its decomposition results suggest that poor people consume more health care services because they are likely to be in physically worse condition

and the chronic disease prevalence always becomes a large negative contributor. This finding is consistent with some of the previous studies such as Lee and Shaw [15] and Kim et al. [9]. It is important for health care policy in Korea to focus more on improvement in the health status and well-being of low-income groups. Additionally, this study demonstrates that household characteristics and private health insurance as non-need determinants also make a heterogeneously substantial contribution to pro-poor inequalities in health care use. These contributors could worsen the pro-poor concentration if the economic disparity between unmarried and married people or small and large families were to increase due to the demographic transition, given their negative association with health care utilization. Likewise, the growing popularity of private health insurance among higher income groups could also exacerbate the disproportionate tendency toward the poor.

By contrast, income-related inequalities in health care spending unveil insightfully different patterns, depending on types of care services, although total amount of medical care expenses is almost equal across the population, regardless of income level. Inpatient care expenses are biased toward the poor, and the decomposition result shows that non-need factors, such as household characteristics and private health insurance, and the direct effect of income-group differences contribute to most of the income-related inequality. This implies that higher spending especially on inpatient care may be a heavy financial burden to low-income people. Although the cost-sharing for insured inpatient care is set at the relatively lower rate of 20% and the cost-sharing ceiling scheme also works for insured care services, extra payments for uninsured services such as special treatments and room charges account for a large amount of high out-of-pocket expenditure on hospitalization [18].[28] Lee and Shaw [15] and Kim et al. [9] point out that poor people are likely to be provided with less sufficient or advanced care services, as the quality and intensity of care increase in direct proportion to income level, which could bring about longer periods of hospital stays with higher spending for them. Furthermore, an increase in the out-of-pocket payment for inpatient care is highly correlated with the probability of facing catastrophic health expenditure that could occur more often among vulnerable low-income groups [15, 18]. Thus, additional financially supportive measures should be provided for low-income people to mitigate their heavy burden of inpatient care spending and prevent them from suffering economic hardship. This may also lead to institutional issues in terms of the charging of inpatient care services. On the other hand, we find that long-run inequality favors the better-off in outpatient care expenses, while the direct contribution of income-group differences accounts for the largest share of overall pro-rich inequality. This finding implies that people in high-income groups are more likely to spend costly services for outpatient care, including uninsured services with the help of voluntary private health insurance, which currently brings about a policy debate on how to regulate uninsured health care services and the growing market for private health insurance. Nevertheless, the expansion of income disparity should be alleviated even from a perspective of health care policy, as a large part of pro-poor inequalities in inpatient care services are also driven by income-group differences.

This study has some limitations. First, the need and non-need determinants of health care utilization and spending, as defined above, might omit other potentially influential variables. For example, as noted, potential needs for health care services could include such variables as subjective health status, mental health condition, and lifestyle-related risk factors, which are not fully available for analysis. Other possible non-need factors could include such socioeconomic variables as individual expected rate of copayment or out-of-pocket payment, health insurance premium rate, and distance to nearest health care facilities, which are all difficult to calculate from the available dataset. Nevertheless, the residual components in decomposition analysis that are explained by a set of omitted or unobservable factors show small enough contributions, owing to the detailed specification allowing for heterogeneity. Secondly, individual heterogeneity is adjusted for only by sampling weights, although one of the benefits of using panel data is being able to control for individual fixed-effects as time-invariant unobserved heterogeneity. However, employing the fixed-effects model usually has the side effect of cancelling out other time-invariant variables, such as gender and educational attainment which contributions are preferred to be estimated in decomposition analysis. Again, relatively small contributions of residual components may imply that individual fixed-effects are also sufficiently small. Finally, as outcome measures in this study are defined by general types of health care (i.e., inpatient, outpatient, and emergency care), they do not take into account differences in quality of care. Decomposition results suggest that people in low-income groups are likely to utilize insured basic care services that are necessary for them, while the better-off tend to use and spend more on premium services, especially in outpatient care, that are not usually covered by national health insurance. Room remains for future research on examining socioeconomic inequalities in the use of quality-adjusted care services in the context of universal coverage.

[28] Many Korean citizens try to lessen their financial burden of inpatient care utilization due to additional uninsured services by purchasing private health insurance. However, the elderly and low-income individuals who need more health care services are less likely to be enrolled in private health insurance (i.e., more likely to be driven out of the market) because of price discrimination and redlining [12].

Appendix A

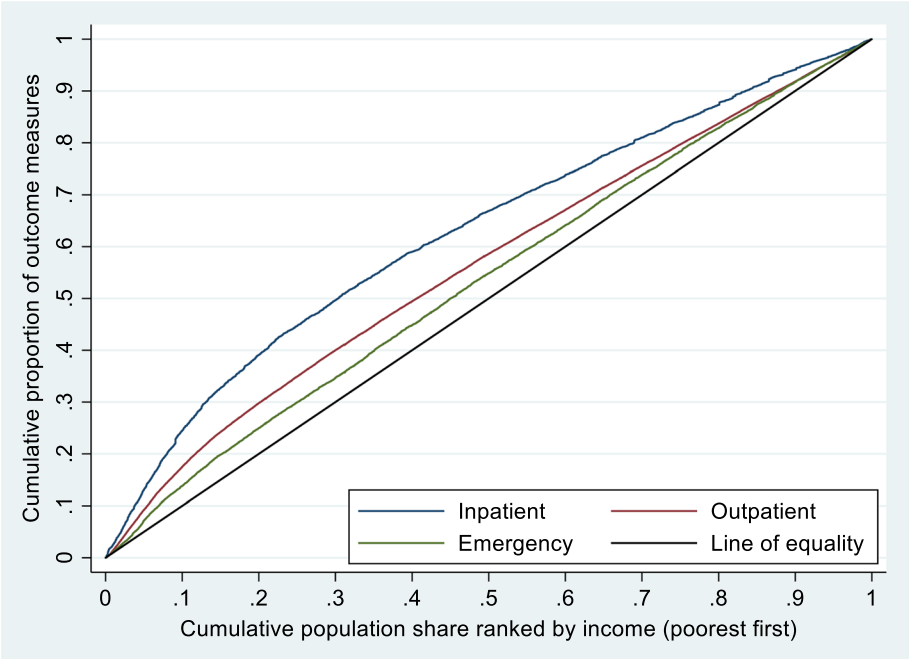

Fig. 8 Concentration curves for health care utilization

Appendix B

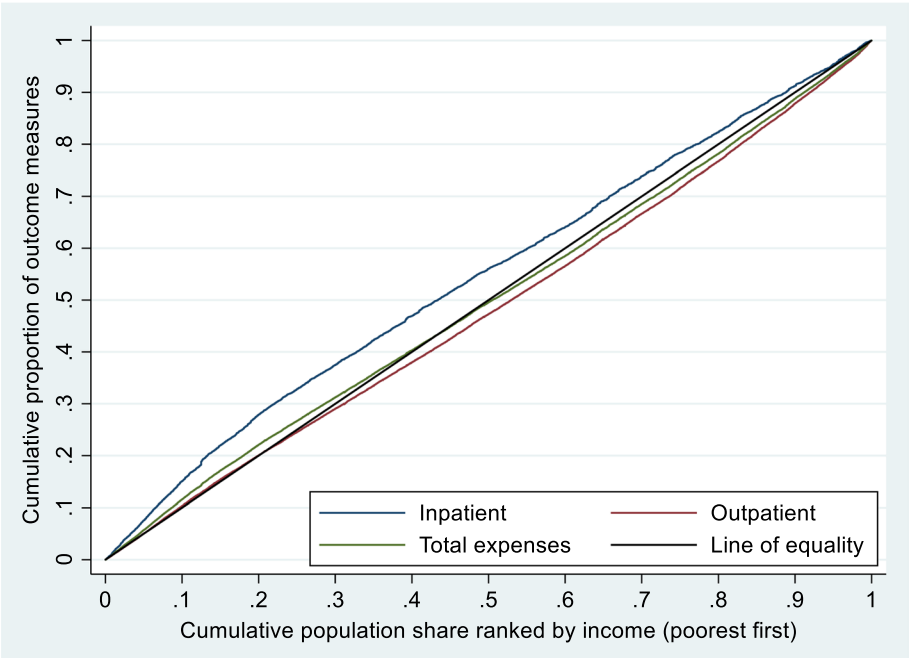

Fig. 9 Concentration curves for health care spending

Appendix C

Table 4 Decomposition results for health care utilization

	Inpatient care						Outpatient care						Emergency care					
	Homo	**(%)**	**Hetero**	**(%)**	**Total**	**(%)**	**Homo**	**(%)**	**Hetero**	**(%)**	**Total**	**(%)**	**Homo**	**(%)**	**Hetero**	**(%)**	**Total**	**(%)**
Need																		
Age	-0.062	24.21	0.192	-75.56	0.130	-51.35	0.007	-5.32	-0.028	21.89	-0.021	16.57	0.029	-40.76	-0.032	44.61	-0.003	3.84
Female	0.003	-1.30	0.111	-43.50	0.114	-44.80	-0.002	1.57	0.009	-6.97	0.007	-5.40	0.002	-3.20	0.044	-60.54	0.046	-63.74
Chronic diseases	-0.066	25.82	-0.080	31.43	-0.145	57.25	-0.081	62.85	-0.027	20.97	-0.108	83.83	-0.051	70.15	-0.027	37.49	-0.078	107.64
Disabled	-0.043	16.81	-0.004	1.69	-0.047	18.50	-0.004	3.21	0.0009	-0.69	-0.003	2.52	-0.007	10.33	0.002	-2.64	-0.006	7.69
Total need	-0.167	65.54	0.218	-85.94	0.052	-20.39	-0.080	62.32	-0.045	35.20	-0.125	97.51	-0.026	36.52	-0.014	18.91	-0.040	55.43
Non-need																		
Lower education	-0.019	7.55	0.025	-10.00	0.006	-2.45	-0.034	26.38	0.002	-1.62	-0.032	24.75	-0.029	40.10	0.021	-29.19	-0.008	10.91
Higher education	0.005	-1.85	0.009	-3.45	0.013	-5.29	-0.002	1.82	-0.005	3.56	-0.007	5.38	-0.002	3.10	0.003	-3.55	0.0003	-0.46
Labor participation	-0.032	12.73	0.047	-18.30	0.014	-5.57	-0.005	4.24	-0.003	2.15	-0.008	6.39	-0.007	10.32	0.019	-26.44	0.012	-16.12
Married	-0.003	1.31	-0.072	28.35	-0.075	29.66	0.002	-1.69	0.016	-12.36	0.018	-14.05	0.002	-3.40	0.003	-4.59	0.006	-7.99
Family members	0.001	-0.59	-0.017	6.60	-0.015	6.01	-0.009	7.09	0.007	-5.48	-0.002	1.61	-0.010	14.18	-0.052	72.01	-0.062	86.19
Capital area	-0.010	3.95	0.030	-11.76	0.020	-7.81	-0.002	1.18	0.014	-10.66	0.012	-9.48	-0.005	6.31	0.007	-9.50	0.002	-3.19
Public assistance	-0.041	16.09	0.008	-3.07	-0.033	13.02	-0.006	4.92	-0.001	0.79	-0.007	5.71	-0.017	24.07	-0.002	2.63	-0.019	26.70
Priv. health ins	-0.012	4.72	-0.058	22.64	-0.070	27.36	0.0005	-0.41	-0.010	8.14	-0.010	7.72	-0.004	5.24	-0.014	19.60	-0.018	24.84
Monthly premium	0.016	-6.11	-0.015	6.06	0.0001	-0.06	0.001	-1.09	0.001	-0.84	0.002	-1.92	0.009	-12.34	-0.009	13.02	-0.0005	0.68
Years	-0.006	2.35	0.033	-12.90	0.027	-10.55	0.007	-5.27	0.007	-5.38	0.014	-10.65	0.007	-9.19	0.015	-20.99	0.022	-30.18
Total non-need	-0.102	40.16	-0.011	4.16	-0.113	44.32	-0.048	37.17	0.028	-21.70	-0.020	15.47	-0.057	78.38	-0.009	12.99	-0.066	91.38
Income-group difference					-0.191	75.30					0.016	-12.75					0.032	-44.71
Residual					-0.002	0.77					0.0003	-0.23					0.002	-2.09
Total CI					-0.254	100.00					-0.129	100.00					-0.072	100.00

Percentages (%) refer to each factor's share of total CI

Appendix D

Table 5 Decomposition results for health care spending

	Inpatient care						Outpatient care						Total medical care					
	Homo	(%)	Hetero	(%)	Total	(%)	Homo	(%)	Hetero	(%)	Total	(%)	Homo	(%)	Hetero	(%)	Total	(%)
Need																		
Age	-0.029	31.94	0.044	-48.30	0.015	-16.35	-0.0009	-2.56	0.013	36.37	0.012	33.81	-0.008	-257.69	0.021	680.04	0.013	422.36
Female	0.0005	-0.51	0.044	-48.86	0.045	-49.37	-0.003	-6.97	0.022	59.02	0.019	52.05	-0.002	-55.95	0.028	908.34	0.026	852.38
Chronic diseases	-0.075	82.75	0.012	-13.05	-0.063	69.70	-0.070	-191.34	0.039	107.79	-0.030	-83.55	-0.071	-2299.53	0.030	987.12	-0.040	-1312.41
Disabled	-0.016	18.10	0.011	-11.92	-0.006	6.18	0.0002	0.65	0.0003	0.69	0.0005	1.34	-0.004	-134.95	0.003	96.16	-0.001	-38.79
Total need	-0.120	132.29	0.111	-122.13	-0.009	10.16	-0.073	-200.22	0.074	203.86	0.001	3.65	-0.085	-2748.12	0.082	2671.66	-0.002	-76.47
Non-need																		
Lower education	-0.003	2.80	-0.0005	0.54	-0.003	3.34	-0.004	-11.85	-0.004	-11.85	-0.009	-23.70	-0.004	-121.32	-0.004	-120.44	-0.007	-241.76
Higher education	0.003	-3.64	-0.004	4.94	-0.001	1.30	-0.004	-10.75	0.003	7.25	-0.001	-3.50	-0.002	-71.38	0.0003	11.18	-0.002	-60.20
Labor participation	-0.021	23.17	0.023	-25.20	0.002	-2.03	-0.004	-11.95	-0.013	-36.18	-0.018	-48.14	-0.009	-290.41	-0.005	-169.35	-0.014	-459.76
Married	0.001	-1.30	-0.034	37.23	-0.033	35.93	0.003	7.76	0.008	22.51	0.011	30.27	0.002	79.08	-0.001	-36.90	0.001	42.18
Family members	-0.008	8.26	-0.035	38.88	-0.043	47.14	-0.011	-29.12	-0.007	-20.52	-0.018	-49.64	-0.010	-325.98	-0.021	-668.03	-0.031	-994.01
Capital area	-0.005	5.33	0.004	-4.07	-0.001	1.25	0.003	9.02	0.008	20.58	0.011	29.60	0.001	35.39	0.005	167.67	0.006	203.06
Public assistance	0.020	-22.42	-0.003	3.37	0.017	-19.05	0.022	59.45	-0.0006	-1.51	0.021	57.94	0.021	691.47	-0.001	-37.65	0.020	653.82
Priv. health ins	-0.005	5.65	-0.017	18.35	-0.022	24.00	0.007	19.47	-0.0001	-0.17	0.007	19.30	0.004	114.92	-0.008	-273.11	-0.005	-158.19
Monthly premium	0.016	-17.98	-0.006	6.75	0.010	-11.23	0.003	9.37	-0.004	-9.90	-0.0002	-0.53	0.007	218.67	-0.004	-135.03	0.003	83.64
Years	0.002	-2.03	0.006	-6.59	0.008	-8.62	0.006	16.12	-0.003	-7.14	0.003	8.97	0.005	159.64	0.001	41.68	0.006	201.32
Total non-need	0.002	-2.17	-0.067	74.20	-0.065	72.03	0.021	57.52	-0.013	-36.94	0.007	20.58	0.015	490.08	-0.038	-1219.98	-0.022	-729.90
Income-group difference					-0.015	16.97					0.023	62.46					0.025	797.68
Residual					-0.0008	0.83					0.005	13.32					0.003	108.68
Total CI					-0.091	100.00					0.036	100.00					0.003	100.00

Percentages (%) refer to each factor's share of total CI

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Author's contributions
This manuscript was solely authored by Yuichi Watanabe.

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Availability of data and materials
The Korea Health Panel Survey data are provided upon request to the Korea Institute for Health and Social Affairs. Additional information is available at https://www.khp.re.kr:444/eng/main.do.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Allanson P, Gerdtham U-G, Petrie D. Longitudinal analysis of income-related health inequality. J Health Econ. 2010;29(1):78–86.
2. Chun CB, Kim SY, Lee JY, Lee SY. Republic of Korea: health system review. Health Syst Transit. 2009;11(7):1–184.
3. Erreygers G. Correcting the concentration index. J Health Econ. 2009;28(2):504–15.
4. Erreygers G, Van Ourti T. Measuring socioeconomic inequality in health, health care and health financing by means of rank-dependent indices: a recipe for good practice. J Health Econ. 2011;30(4):685–94.
5. Jones AM, López Nicolás A. Measurement and explanation of socio-economic inequality in health with longitudinal data. Health Econ. 2004;13(10):1015–30.
6. Jones AM, López Nicolás A. Allowing for heterogeneity in the decomposition of measures of inequality in health. J Econ Inequal. 2006;4(3):347–65.
7. Kakwani N, Wagstaff A, van Doorslaer E. Socioeconomic inequalities in health: measurement, computation and statistical inference. J Econ. 1997;77(1):87–103.
8. Kim D, Shin H, Kim C. Equitable access to health care for the elderly in South Korea: is income-related inequality in health care utilization more pronounced? Res Aging. 2012;34(4):475–96.
9. Kim DJ, Youn HM, Lee JA, Chae HR. Measurement of inequalities in health care utilization in Korea using Korea health panel. Health Soc Welfare Rev. 2014a;34(3):33–58 [in Korean].
10. Kim D, Kang A, Chae H. Equity in health and health care utilization of the elderly in Korea - is the income-related inequality more pronounced in the elderly population? Working Paper. Seoul: Korea Institute for Health and Social Affairs; 2014b.
11. Kim E, Kwon S, Xu K. Has income-related inequity in health care utilization and expenditures been improved? Evidence from the Korean National Health and Nutrition Examination Survey of 2005 and 2010. J Prev Med Public Health. 2013;46(5):237–48.
12. Ko H. Moral hazard effects of supplemental private health insurance in Korea. Soc Sci Med. 2020;265:113325.
13. Kwon S, Lee TJ, Kim CY. Republic of Korea: health system review. Health Syst Transit. 2015;5(4):1–102.
14. Kutzin J. Health financing for universal coverage and health system performance: concepts and implications for policy. Bull World Health Organ. 2013;91(8):602–11.
15. Lee WY, Shaw I. The impact of out-of-pocket payments on health care inequity: the case of national health insurance in South Korea. Int J Environ Res Public Health. 2014;11(7):7304–18.
16. Lee Y, Kim S, Kim SY, Kim G. Ethical consideration of national health insurance reform for universal health coverage in the Republic of Korea. Asian Bioethics Rev. 2019;11:41–56.
17. Lu JR, Leung GM, Kwon S, Tin KYK, van Doorslaer E, O'Donnell O. Horizontal equity in health care utilization evidence from three high-income Asian economies. Soc Sci Med. 2007;64(1):199–212.
18. Mathauer I, Xu K, Carrin G, Evans DB. An analysis of the health financing system of the Republic of Korea and options to strengthen health financing performance. Review of the Korean Health Financing System. Geneva: World Health Organization; 2009.
19. O'Donnell O, Van Doorslaer E, Wagstaff A, Lindelöw M. Analyzing health equity using household survey data: a guide to techniques and their implementation. Washington DC: World Bank; 2008.
20. OECD. Health at a glance 2019: OECD indicators. Paris: OECD Publishing; 2019.
21. Ohkusa Y, Honda C. Horizontal inequity in health care utilization in Japan. Health Care Manag Sci. 2003;6(3):189–96.
22. Shin J. Private health insurance in South Korea: an international comparison. Health Policy. 2012;108(1):76–85.
23. Toyokawa S, Murakami K, Kaneto C, Kobayashi Y. Access to health care and horizontal equity. J Health Soc. 2012;22(1):69–78 [in Japanese].
24. Van de Poel E, van Doorslaer E, O'Donnell O. Measurement of inequity in health care with heterogeneous response of use to need. J Health Econ. 2012;31(4):676–89.
25. Wagstaff A. The concentration index of a binary outcome revisited. Health Econ. 2011;20(10):1155–60.
26. Wagstaff A, Paci P, van Doorslaer E. On the measurement of inequalities in health. Soc Sci Med. 1991;33(5):545–57.
27. Wagstaff A, van Doorslaer E, Watanabe N. On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. J Econom. 2003;112(1):207–23.
28. Watanabe R, Hashimoto H. Horizontal inequity in healthcare access under the universal coverage in Japan; 1986–2007. Soc Sci Med. 2012;75(8):1372–8.
29. Watanabe Y. Longitudinal analysis of income-related inequalities in health care under universal coverage in Korea. IDE Discussion Paper No.909. Chiba: Institute of Developing Economies (IDE-JETRO); 2023.
30. WHO. The world health report: health systems financing: the path to universal coverage. Geneva: World Health Organization; 2010.
31. WHO and World Bank. Tracking universal health coverage: 2017 global monitoring report. World Health Organization and International Bank for Reconstruction and Development / The World Bank; 2017. https://www.who.int/publications/i/item/9789241513555.

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