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Decomposing socioeconomic differences in self-rated health and healthcare expenditure by chronic conditions and social determinants

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Abstract

Background Lower socioeconomic status is associated with lower self-rated health and higher healthcare expenditure. This study identifies which chronic conditions and social determinants contribute most to socioeconomic differences in self-rated health and healthcare expenditure.

Methods Registry and survey data combining 3 socioeconomic indicators (income, education, and financial welfare), 26 social determinants, 20 chronic conditions, age, sex, self-rated health, and healthcare expenditure for 135,183 Dutch individuals aged 25–65, were linked at individual level. Oaxaca-Blinder decomposition analyses were conducted to quantify the relative contributions of chronic conditions and social determinants to socioeconomic differences in self-rated health and healthcare expenditure.

Results Poorer self-rated health and higher healthcare expenditure among lower income groups were partly attributable to a higher prevalence of chronic conditions (33% and 70%, respectively). Acid-related disorders, cardiovascular diseases and psychological disorders contributed most to both differences in self-rated health and healthcare expenditure. Social determinants almost completely accounted for income differences in self-rated health. Social determinants explained more than the observed difference in healthcare expenditure between income groups, suggesting that, when adjusted for social determinants, lower income groups would have lower healthcare expenditure than higher income groups. Including both chronic conditions and social determinants in a single decomposition indicated that income security & social protection (28%), social & human capital (26%), and chronic conditions (23%) were equally important to income differences in self-rated health. For healthcare expenditure, chronic conditions and social determinants each accounted for approximately half of the socioeconomic differences.

Conclusions Social determinants outside the healthcare sector accounted for almost all of the socioeconomic differences in self-rated health. This highlights the need for integrated policies across multiple domains, such as the social, economic and healthcare sector, to reduce avoidable health inequalities. Given that socioeconomic differences in healthcare expenditure were primarily associated with chronic conditions, prioritizing prevention of chronic

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conditions among lower socioeconomic groups can potentially reduce healthcare spending within this group and improve the healthcare system's sustainability and affordability.

Keywords Health inequalities, Healthcare expenditure, Socioeconomic status, Decomposition

Background

Despite universal health coverage available in many European countries, lower socioeconomic status (SES) within countries still strongly correlates with poorer self-rated health (SRH) and higher healthcare expenditure (HCE) [1, 2]. As chronic conditions are associated with SES, SRH and HCE [3–6], their prevalence likely underlies socioeconomic status related differences (SES-differences) in SRH and HCE. However, research on the extent to which chronic conditions contribute to SES-differences is limited, as is research on which specific conditions contribute most. Studies examining specific causes of death associated with educational differences in mortality provide relevant insights, consistently identifying cardiovascular diseases and cancers as the most important contributors to these differences [7–10].

In addition to the prevalence of chronic conditions and illness, other determinants contribute to SES-differences in SRH. The well-known Dahlgren & Whitehead model illustrates that health and health inequalities are shaped by social determinants, which describe the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life [11, 12]. These non-medical factors, such as social and community networks, living and working conditions, also interact with more proximal personal characteristics, constitutional factors, and individual lifestyle factors. Several empirical studies addressing the relation between health inequalities and these social determinants have shown that work factors, lifestyle factors, income, education, age, capabilities, material factors, psychosocial factors, and behavioral factors have contributed to socioeconomic inequalities in self-reported health status [13–20].

In line with the idea of the social determinants of health, the World Health Organization (WHO) identified five key areas affecting socioeconomic health equity in 2019: health services, income security & social protection, living conditions, social & human capital, and employment & working conditions [21]. Their EU-country level decomposition analysis, taking into account these five areas, showed that all social determinants statistically significantly contributed to SES-differences in SRH, with income security & social protection and living conditions contributing most. A similar study conducted at the national level in Wales, found that income security & social protection and social & human capital were the most important contributors [22].

In contrast to SES-differences in health status, less is known about social determinants underlying SES-differences in HCE in high income countries. A recent systematic review in OECD countries with universal health systems yielded mixed results on whether the examined determinants contributed to SES-differences in healthcare utilization and HCE [23]. When correlations were observed, the direction of their impact was often inconsistent. These mixed findings could have been driven by heterogeneity of included studies. In a recent Canadian study, household characteristics (e.g. female headed household and households with seniors) were, in addition to SES-indicators, identified as the most important determinants contributing to higher out-of-pocket expenditure among poorer households [24].

The Netherlands is a high-income country with universal health coverage and places a strong emphasis on health system solidarity [25]. For example, patient cost sharing and private healthcare spending are among the lowest among high income countries [26]. Furthermore, a strong primary care system aims to improve equity in accessibility. The Dutch health system is characterized by relatively low hospital utilization and a large publicly funded long-term care system [27]. Dutch healthcare expenditure is above the EU average but with lower-than average cost growth over the last decade. Dutch men and women generally rate their health higher than the EU average [28], but considerable variation exists, for example, among SES-groups. This provides a relevant case study with low formal institutional barriers to care, enabling a focus on disentangling SES and health-related determinants of SES-differences in both SRH and HCE.

While the contribution of social determinants to socioeconomic health inequalities has been examined quite extensively, there is limited research exploring the contribution of these determinants to SES-differences in HCE within universal health coverage systems. In addition, studies examining the contribution of chronic conditions to SES-differences in SRH and HCE remain particularly scarce. This study addresses these gaps by decomposing SES-differences in HCE and exploring their links with social determinants and chronic conditions. Decomposing SES-differences in SRH and HCE by chronic conditions and social determinants enhances our understanding of these disparities. Whereas the WHO performs decomposition analyses aggregated across countries [21], this study focuses specifically on the Netherlands, offering detailed insights at the national level. This country-specific approach identifies target points,

such as chronic conditions and social determinants, where health improvements and cost reductions could be achieved through tailored (preventive) policies and interventions. Therefore, this study aims to answer the following research question: “Which chronic conditions and social determinants contribute most to SES-differences in SRH and HCE in the Netherlands?”. For chronic conditions, we relied on the medication data categorization of Huber, Szucs [29] to distinguish 22 chronic conditions and for social determinants we used the WHO framework of five key areas affecting health equity to select and categorize social determinants in decomposing SES-differences in SRH or HCE. We selected SRH and HCE as complementary outcomes to capture distinct yet interconnected dimensions of socioeconomic differences. SRH reflects perceived overall health, while HCE represents the financial resources allocated to address healthcare needs. Their linkage is, among others, supported by the framework from Levesque, Harris [30], which illustrates how healthcare needs translate into utilization and expenditure, often shaped by socioeconomic factors.

Methods

Data

In this cross-sectional study, we decomposed SES-differences in both SRH and HCE among respondents of the Dutch Health Monitor 2022. The Dutch Health Monitor (DHM) is conducted every four years (with an extra round in 2022) by Statistics Netherlands (CBS), the Dutch National Institute for Public Health and the Environment (RIVM), Municipal Health Services (GGD'en), and Dutch National Umbrella Organisation of the Municipal Health Services and Regional Medical Assistance Organisations (GGD GHOR) among a random sample of persons aged 18 years and older living in private households ($n = 364,557$) [31, 32]. Targeted oversampling in groups with lower expected response rates and mixed-mode data collection (online survey and at home interviews) were employed to maximize representativeness of the sample. The response rate in 2022 was 33%. Survey weights based on sex, age, marital status, country of origin, household size, income, region, and municipality were applied to generate a representative sample of the Dutch population. This study selects the working population (aged 25–64 years) for analysis. We merged DHM survey data with routinely collected registry data at the individual level provided by Statistics Netherlands, Vektis and Dutch National Health Care Institute. Statistics Netherlands functioned as a trusted third party, enabling the secure linkage of datasets while ensuring individuals' privacy according to Dutch law (Statistics Netherlands Act 2003).

Measures

Self-reported health and healthcare expenditure

The two outcome measures were SRH and total HCE (in 2021 euros) at the individual level. In the DHM, respondents rated their health on a five-point scale (very good, good, okay, bad, very bad), which was later categorized as a binary outcome (0 = very bad, bad, okay; 1 = good, very good).

Individual healthcare expenditures, provided by Vektis, included all expenditures that have been reimbursed by the health insurance company for all types of care covered by the mandatory benefits package, including actual reimbursed cost, and cost of mandatory or voluntary deductibles paid by the insured. Expenditures excluded out-of-pocket payments and non-submitted invoices [33]. The broad benefits basket of mandatory health insurance covers the majority of essential medical care, medicines and medical devices or aids [25].

Socioeconomic status

We used disposable household income, standardized for household composition [34], as the main indicator for SES because it directly reflects the economic and material resources available to a household and is most reflective of recent socioeconomic changes [35]. Household income was categorized into quintiles for all Dutch citizens. This implies that the income quintiles in the DHM population may be unequally sized (see Table 1). We used educational level and financial welfare as alternative SES-indicators to check robustness. According to Statistics Netherlands, the highest completed level of education was categorized as low (lower vocational educational level, lower secondary educational level or less), moderate (intermediate vocational educational level or higher secondary educational level) or high (higher vocational educational level or university) [36]. Missing data for education was supplemented with self-reported education data from DHM for 28% of the study population. Household financial welfare derived from the Dutch Tax Administration tax filings [37], combined standardized household income and net household wealth (assets minus debts). Households were ranked by cumulative income and wealth shares within the entire Dutch population, then grouped into quintiles. Because the DHM is a sample of the Dutch national population, welfare quintile sizes in the study population may not be equality sized.

Drug use for chronic conditions

Following Huber, Szucs [29], a total of 22 chronic conditions were identified using drug registry data from the Dutch National Health Care Institute. The drug registry data included all prescribed medications, issued to individuals and reimbursed under the mandatory health insurance, through public pharmacies at the Anatomical

Table 1 Weighted descriptive information of the Dutch health monitor aged 25–65

Variable	Total weighted sample N (%)	Lowest income quintile n (%)	Highest income quintile n (%)
Total	6,773,662 (100%)	519,569 (100%)	2,457,314 (100%)
Confounders			
Sex			
Male	3,332,078 (49.2%)	231,914 (44.6%)	1,272,285 (51.8%)
Female	3,441,584 (50.8%)	287,655 (55.4%)	1,185,029 (48.2%)
Age			
25–29	723,461 (10.7%)	63,213 (12.2%)	188,385 (7.7%)
30–34	789,222 (11.7%)	48,956 (9.4%)	217,322 (8.8%)
35–39	785,163 (11.6%)	43,057 (8.3%)	273,770 (11.1%)
40–44	790,492 (11.7%)	39,608 (7.6%)	320,972 (13.1%)
45–49	824,516 (12.2%)	41,248 (7.9%)	369,787 (15.0%)
50–54	997,012 (14.7%)	69,884 (13.5%)	456,640 (18.6%)
55–59	965,407 (14.3%)	98,245 (18.9%)	383,220 (15.6%)
60–64	898,389 (13.3%)	115,356 (22.2%)	247,217 (10.1%)
Socioeconomic indicators			
Disposable household income^a			
Quintile 1	519,569 (7.7%)	519,569 (100%)	-
Quintile 2	749,369 (11.1%)	-	-
Quintile 3	1,132,963 (16.7%)	-	-
Quintile 4	1,914,447 (28.3%)	-	-
Quintile 5	2,457,314 (36.3%)	-	2,457,314 (100%)
Educational level			
Low	1,006,335 (14.9%)	169,407 (32.6%)	195,934 (8.0%)
Middle	2,508,218 (37.0%)	213,886 (41.2%)	713,043 (29.0%)
High	3,259,109 (48.1%)	136,276 (26.2%)	1,548,337 (63.0%)
Household financial welfare			
Quintile 1	680,611 (10.0%)	395,263 (76.1%)	
Quintile 2	950,613 (14.0%)	91,862 (17.7%)	796 (0.0%)
Quintile 3	1,470,434 (21.7%)	16,866 (3.2%)	141,084 (5.7%)
Quintile 4	1,790,112 (26.4%)	13,248 (2.5%)	778,431 (31.7%)
Quintile 5	1,881,893 (27.8%)	2330 (0.4%)	1,537,004 (62.5%)
Outcome measures			
Self-reported health			
(Very) good	4,981,683 (73.5%)	234,212 (45.1%)	2,038,974 (83.0%)
Moderate or (very) poor	1,791,979 (26.5%)	285,357 (54.9%)	418,340 (17.0%)
Healthcare expenditure			
Mean	€1977	€3908	€1529
Median	€320	€1008	€250

^a Income quintile based on the income distribution of the total Dutch population

Therapeutic Chemical (ATC) 4th classification level (chemical, pharmacological, or therapeutic subgroups) [38]. If the classification of Huber, Szucs [29] was more precise than the available ATC-4 level, all drugs within the corresponding ATC-4 group were included. The 20 chronic conditions included in the analysis were: acid-related disorders, bone diseases, cancer, cardiovascular diseases, diabetes mellitus, epilepsy, glaucoma, gout and hyperuricemia, HIV, hyperlipidemia, intestinal inflammatory diseases, iron deficiency anemia, migraines, pain, Parkinson's disease, psychological disorders, psychoses, respiratory illness, rheumatologic conditions and thyroid

disorders. Dementia and tuberculosis were excluded due to too insufficient case numbers within the study population.

Social determinants

Figure 1 shows the operationalization of the social determinants using the WHO framework. We strived for comparability with this framework by selecting appropriate indicators, balancing availability, relevance to the Dutch context, avoiding collinearity and statistical significance in the univariate decomposition model [21]. Collinearity was determined using Cramer's V statistic, with

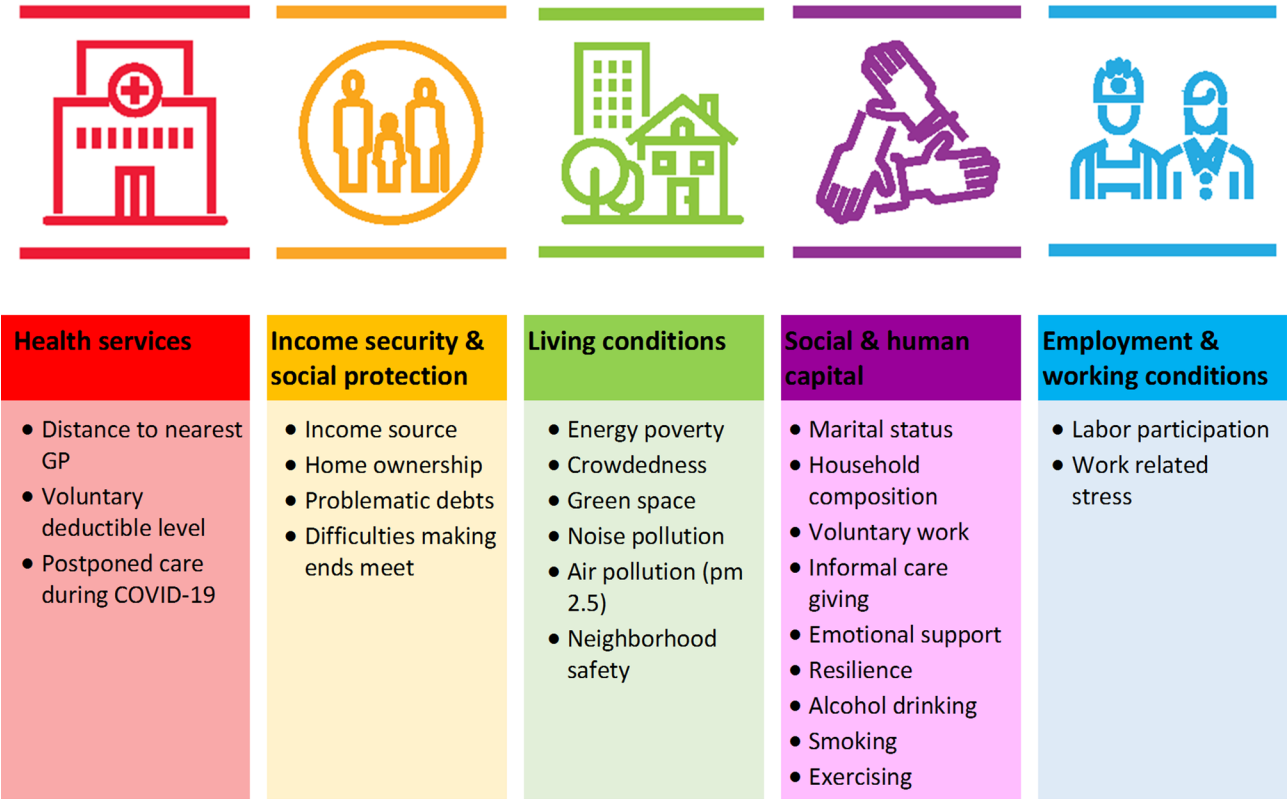


Fig. 1 Overview of the social determinants used to operationalize the WHO framework [21]

a maximum allowable correlation of 0.7. If the Cramer’s V statistic was larger than 0.7, we retained the indicator that was statistically significant in the univariate model or deemed most relevant.

Health services

Health service determinants included the distance to the nearest general practitioner (GP), the voluntary deductible level and having postponed healthcare during the COVID-19 pandemic. The distance to the nearest GP indicates whether the distance to the nearest GP by road was less than or greater than 1 km in 2022 [39]. The voluntary deductible level (€0/100–400/500) indicates the voluntary deductible a person agreed to for their health insurance in addition to the mandatory deductible of €385 in 2021 [33]. Insurance companies may offer a lower premium for the mandatory basic health insurance in exchange for a higher voluntary deductible level. In the DHM, respondents indicated whether they had experienced one or more appointments with a health-care provider being postponed or cancelled during the COVID-19 pandemic (yes/no).

Income security & social protection

Income security & social protection included source of income, home ownership, problematic debts and

self-reported difficulties in making ends meet. The primary source of household income in 2022 was categorized as wages from employment, director shareholder income, self-employed, financial assistance or property or rents [34]. Homeownership indicated whether a person owned a home in 2022 [34]. Problematic debts indicated whether a person belonged to a household with registered problematic debts in 2021 following the definition of Statistic Netherlands [40]. Finally, in the DHM, respondents were asked whether they had any (major) difficulties in making ends meet (yes/no).

Living conditions

Living conditions included energy poverty, crowdedness, green space, noise pollution, air pollution and neighborhood safety. Energy poverty indicated whether the household’s energy bill exceeded more than 10% of the household’s disposable income in 2021 (yes/no) [41]. Crowdedness indicated the ratio of home’s living area per household member in 2021 [41]. A household is considered overcrowded when the house is smaller than 20 m2 per household member (yes/no). Green space indicated whether an individual lived in an area with a low (less than 20%), moderate (20–50%) or high level (more than 50%) of green space, as measured in 2020 [42]. Noise pollution indicated whether an individual lived in an area

where less than 2%, 2–5%, 5–10%, or more than 10% of the population experienced more than 60 dB noise pollution within 24 h, as measured in 2016 [43]. Air pollution indicated the average level of particulate matter ($PM_{2.5}$) in the air per neighborhood in 2019. Air pollution was categorized as very good ($PM_{2.5} < 10$), good ($10 \leq PM_{2.5} < 20$), moderate ($20 \leq PM_{2.5} < 25$) and poor ($PM_{2.5} \geq 25$) [44]. Neighborhood safety measures were obtained from the Leefbaarometer 2020 [45]. Low safety and high safety were defined as respectively 0.25 standard deviations below or above the mean safety score (average safety).

Social & human capital

Social & human capital included marital status, household composition, voluntary work, informal caregiving, emotional support, resilience, alcohol drinking, smoking, and exercising. Marital status indicated whether someone was married, divorced, widowed or unmarried in 2022 [46]. Household composition indicated being part of a one-person household, couple with/without children living at home, one parent family or another type of multiple-person household [34]. The DHM provided information on whether a person participated in voluntary work (yes/no), provided informal care (yes/no), missed emotional support (yes/no), reported (very) low resilience (yes/no), was a heavy drinker (at least one day a week 6 units or more for men and 4 units or more for women; yes/no), was currently smoking (yes/no), and met physical activity norms (yes/no).

Employment and working conditions

Employment and working conditions included labor participation and work related stress. Labor participation indicated the number of months of paid work in the last four years (2018–2022) and was categorized as 0% (no labor participation or missing data), 1–24%, 25–49%, 50–74%, 75–99% and 100% [47]. Experience of work related stress was measured within the DHM (yes/no).

Statistical analysis

Oaxaca blinder decomposition

The statistical Oaxaca-Blinder decomposition method allows for the examination of the relative contribution of independent variables to the mean differences of the dependent variable between two groups [48]. The method can estimate to what extent the differences in the mean predicted outcome are due to differences in the mean value of the independent variables between the groups (i.e. differences in X , referred to as “the explained part”) or, alternatively, to what extent these differences are due to a differential effect of the independent variables on the dependent variable between the groups or to unobserved factors (i.e. differences in β , referred to as

“the unexplained part”). The Oaxaca-Blinder decomposition can be written as:

$$\Delta Y = (E(X_A) - E(X_B))\beta^* + E(X_A)(\beta_A - \beta^*) + E(X_B)(\beta^* - \beta_B),$$

where ΔY refers to the difference in the dependent variable between group A and group B, X is a vector of the independent variable values, β_A and β_B are vectors of regression coefficients from a regression including, respectively, only group A or B, and β^* refers to the pooled regression estimate for group A and B. Here, $(E(X_A) - E(X_B))\beta^*$ refers to the explained part and $E(X_A)(\beta_A - \beta^*) + E(X_B)(\beta^* - \beta_B)$ refers to the unexplained part [48–51].

The Oaxaca-Blinder decomposition is limited in its ability to provide causal interpretation of the estimates. In other words, this method cannot predict how differences in SRH or HCE would change if differences in chronic conditions and/or social determinants were reduced [51]. The unexplained part of the Oaxaca-Blinder decomposition seeks to determine the differential impact of independent variables. However, any transformation of the independent variables (X), for example, through mean centering or the choice of an omitted/base category, results in changes to the intercept and coefficients (β) within the unexplained part, also known as the “transformation problem” [48]. Addressing this issue by transforming effects into deviations from the mean or applying alternative weighting structures remains inherently arbitrary [48, 52, 53], and this renders the estimates of the unexplained part to be inappropriate to interpret. To approximate the differential effects of independent variables on SRH or HCE between the lowest and highest income groups, regression model estimates stratified by income were compared (referred to as “differential associations”).

Application of Oaxaca-Blinder decomposition and regression models

Applied to our study aims, the Oaxaca-Blinder decomposition method decomposes the mean differences in the log odds of SRH and logarithmic HCE between the lowest and highest income quintile. It indicates how much of the differences in the two outcome measures between low and high income groups are due to a different prevalence of chronic diseases and/or a different distribution of social determinants. All categorical variables were normalized to ensure that the results were independent of the choice of the reference category. Applied to our research setting, the Oaxaca-Blinder regression formula for SRH and HCE, respectively, is written as:

$$\Delta SRH = (E(X_{LIG}) - E(X_{HIG}))\beta^* + E(X_{LIG})(\beta_{LIG} - \beta^*) + E(X_{HIG})(\beta^* - \beta_{HIG}),$$

$$\Delta HCE = (E(X_{LIG}) - E(X_{HIG}))\beta^* + E(X_{LIG})(\beta_{LIG} - \beta^*) + E(X_{HIG})(\beta^* - \beta_{HIG}),$$

where ΔSRH and ΔHCE refer to differences in SRH and HCE, respectively, between the lowest income group (LIG) and the highest income group (HIG). X is a vector of values for the social determinants and/or chronic conditions. β_{LIG} and β_{HIG} are vectors of regression coefficients derived from separate regression models for the lowest and highest income groups only, respectively. β^* denotes a vector of the pooled regression estimates combining data from both the lowest and highest income groups.

The results were divided into three parts, each containing a Oaxaca-Blinder decomposition and regression models with SRH or HCE as the dependent variable. In the first part of the analysis, we apply the Oaxaca-Blinder method to decompose the contribution of chronic conditions on SES-differences in SRH or HCE. It indicates how much of the differences in the two outcome measures between low and high income groups are due to a different prevalence of chronic diseases. The remaining inequality could be interpreted as “the difference in healthcare expenditure if low and high income groups had the same prevalence for these chronic conditions”, which is then suggested to be due to a differential effect of having chronic conditions on SRH or HCE or unobserved factors that influence SRH or HCE. Regression models with chronic conditions and SRH or HCE stratified by income groups were conducted to provide an indication of which chronic conditions showed a differential association between the lowest and highest income group.

In the second part of the analysis, we apply the Oaxaca-Blinder method to decompose the contribution of social determinants on SES-differences in both SRH and HCE. A logit regression model was fitted for the binary outcome measure SRH, while HCE was log-transformed. These models indicate how much of the differences between low and high income groups in the two outcome measures are due to a different distribution of social determinants. The remaining inequality could be interpreted as “the difference in the log odds of SRH or logarithmic HCE if low and high income groups had the same distribution of social determinants” or unobserved differences. Regression models with social determinants as independent variables were conducted to examine their differential association between the lowest and highest income group.

In the third part of the analysis, we conducted the decomposition analysis with chronic conditions alongside

the social determinants to examine the additional value of expanding the WHO model with chronic conditions. Additionally, regression models with both chronic conditions and social determinants were conducted.

The regression models were performed within the DHM sample, stratified by individuals belonging to the lowest and highest income group. For SRH, logistic regression models were conducted with a quasi-binomial distribution and logit link. To correct for the right-skewed distribution of HCE, generalized linear models with Gaussian distribution and identity link function were fitted on the natural logarithm of HCE.

Confidence intervals (CI) were set at 95%. Data preparation and regression analyses were conducted using R version 4.1.2. Oaxaca-Blinder decomposition was conducted using STATA 18.

Sensitivity analyses

To test for robustness across SES-indicators, the analyses were repeated using educational level and financial welfare in addition to income as SES-indicators. Furthermore, to test the consistency of the relative contribution of social determinants among individuals with chronic conditions, we stratified the Oaxaca-Blinder decomposition analyses of differences in SRH between low and high income groups by the social determinants into five specific chronic conditions: cardiovascular diseases, acid-related disorders, migraines, psychological disorders and rheumatologic conditions. These five chronic conditions represent conditions with smaller and larger income differences, lifestyle-related conditions and mental health-related conditions, while having a sufficiently large prevalence to perform analyses.

Results

Descriptive statistics

Table 1 lists the weighted descriptive statistics for demographics, socioeconomic indicators and outcome measures to be representative of the Dutch national population. A total of 135,183 DHM respondents aged between 25 and 64 years old had complete data, representing approximately 6.8 million Dutch individuals. Additional file 1 shows the unweighted descriptive statistics and the weighted descriptive statistics for the distribution of chronic diseases and social determinants used in the decomposition analyses.

Decomposition of income differences in SRH and HCE by chronic conditions

Figure 2 shows the Oaxaca Blinder decomposition of differences in the log odds of SRH between low- and high-income groups by chronic conditions. The first panel shows that 45% of the lowest income group and 83% of the highest income group reported a (very) good health

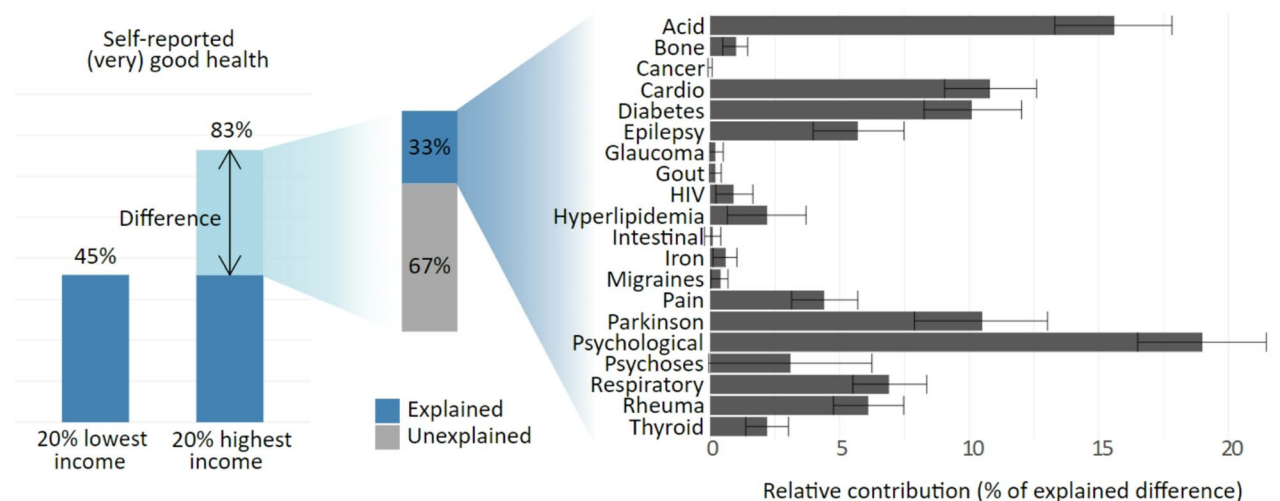


Fig. 2 Decomposition of income differences in reporting a (very) good health status by chronic conditions

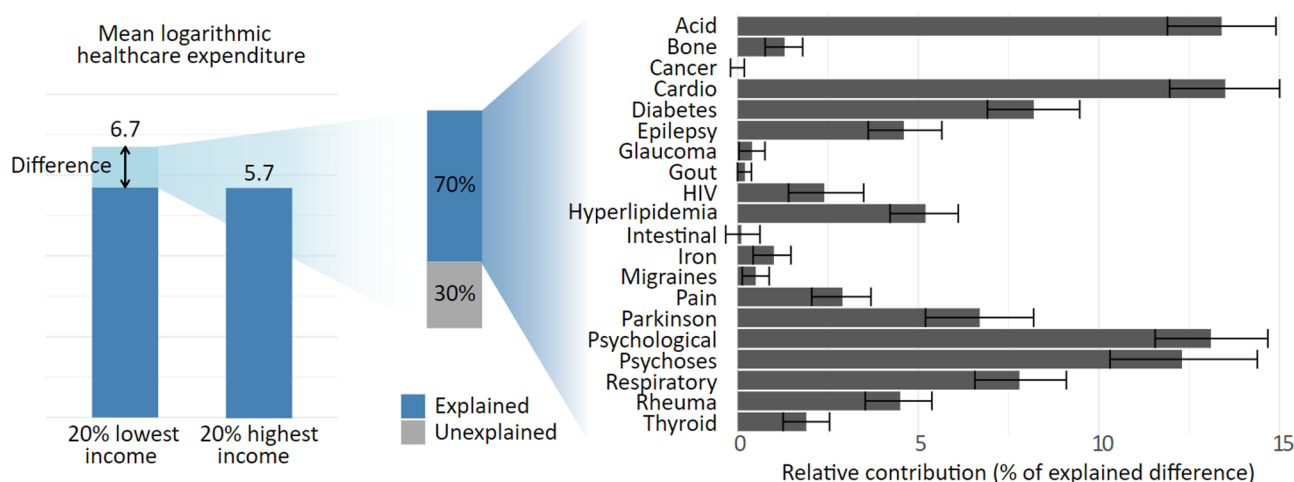


Fig. 3 Decomposition of income differences in HCE by chronic conditions

status. One-third of this 38%-point difference between income groups could be attributed to differences in the prevalence of chronic conditions (second panel). This implies that two-thirds of the difference in probability of reporting good health between the lowest and highest income quintile cannot be attributed to differences in the prevalence of the chronic conditions included. The prevalence of psychological disorders (19%), acid related disorders (16%), cardiovascular diseases (11%), Parkinson disease (10%) and diabetes mellitus (10%) contributed most to the explained part of income differences in log odds of SRH (third panel). For example, under the assumption of causality, had the prevalence of psychological disorders been the same for both the lowest and highest income quintile, the difference in log odds of SRH would have been 2.4%-points smaller ($0.38 \times 0.33 \times 0.19$). The regression models stratified by income suggested that the association between bone disease, intestinal

inflammatory disease, iron deficiency anemia, and psychoses and reporting a (very) good health status was stronger among the lowest income group than the highest income group (Additional file 4). The association between cancer and SRH was stronger for the highest income group compared to the lowest income group.

Figure 3 shows the Oaxaca Blinder decomposition of differences in mean logarithmic HCE between low- and high-income groups by chronic conditions. The lowest income group had higher mean logarithmic HCE than the highest income group (6.7 and 5.7 respectively; first panel). Approximately 69% of the gap in mean logarithmic HCE could be attributed to differences in the prevalence of chronic conditions (second panel). Cardiovascular diseases (13%), acid-related disorders (13%), psychological disorders (13%), and psychoses (12%) contributed most to the explained part of income differences in mean logarithmic HCE (third panel). The association

between diabetes mellitus, epilepsy, glaucoma, iron deficiency anemia, thyroid disorders and HCE was stronger for the highest income group compared to lowest income group (Additional file 4). Conversely, the association between human immunodeficiency virus (HIV) and HCE was stronger among the lowest income group compared to the highest income group.

Decomposition of income differences in SRH and HCE by social determinants

Figure 4 shows the Oaxaca Blinder decomposition of differences in log odds of SRH between the lowest and highest income group by social determinants. Similar to Figs. 2 and 45% of the lowest income group and 83% of the highest income group reported a (very) good health status. 97% of gap in the probability of reporting a good health status between low and high income groups could be attributed to a different distribution of social determinants. Income security & social protection (36%) and social & human capital (29%) contributed most to the explained part of income differences in log odds of SRH. The detailed Oaxaca Blinder decomposition indicated that especially labor participation (24%), financial difficulties (18%), and resilience (17%) were the main drivers of the difference in the log odds of SRH (Additional file 2 - Fig. 1).

123% of the gap in mean logarithmic HCE could be attributed to a different distribution of social determinants (Fig. 5). This means that, under the assumption of causality, the highest income group would have had higher mean logarithmic HCE than the lowest income group if both groups had the same distributions in social determinants. In other words, the highest income group

would likely have spent more on healthcare than the lowest income group if both groups experienced the same social conditions. Social & human capital (33%) and income security & social protection (24%) contributed most to the explained part of income differences in mean logarithmic HCE. The detailed Oaxaca Blinder decomposition indicated that especially household composition (37%), labor participation (21%), and income source (19%) made the largest contributions (Additional file 2 - Fig. 2).

Associations between the social determinants and SRH or HCE among the lowest and highest income group were, overall, quite comparable, suggesting no significant difference in the association of social determinants with SRH or HCE (Additional file 4).

Decomposition of income differences in SRH and HCE by chronic conditions and social determinants

The decomposition analyses by chronic conditions (Figs. 2 and 3) and social determinants (Figs. 4 and 5) were combined in Fig. 6 for SRH and Fig. 7 for HCE. Combined, the prevalence of chronic conditions and distribution of social determinants accounted for 96% of the health gap and 120% of the gap in mean logarithmic HCE between the lowest and highest income groups. Income security & social protection, employment and working conditions, and chronic conditions contributed approximately equally to income differences in the log odds of SRH (28%, 26% and 23% respectively). Half of the gap in mean logarithmic HCE was driven by the difference in prevalence of chronic conditions between the lowest and highest income group (50%). At the determinant level, labor participation (20%), financial difficulties (16%) and

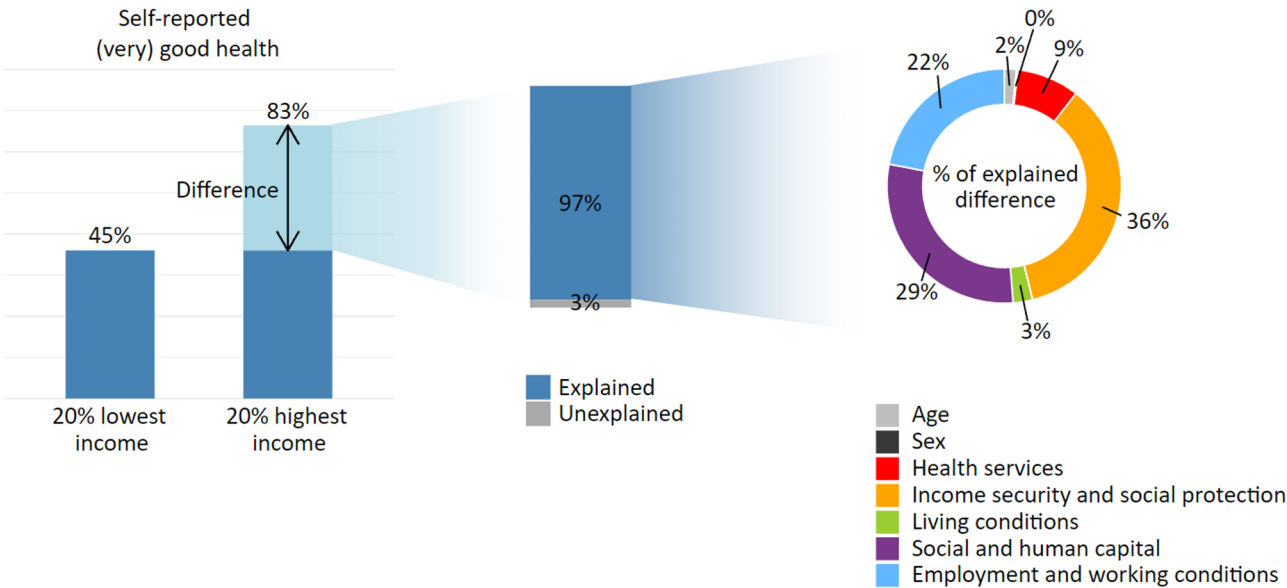


Fig. 4 Decomposition of income differences in in reporting a (very) good health status by social determinants

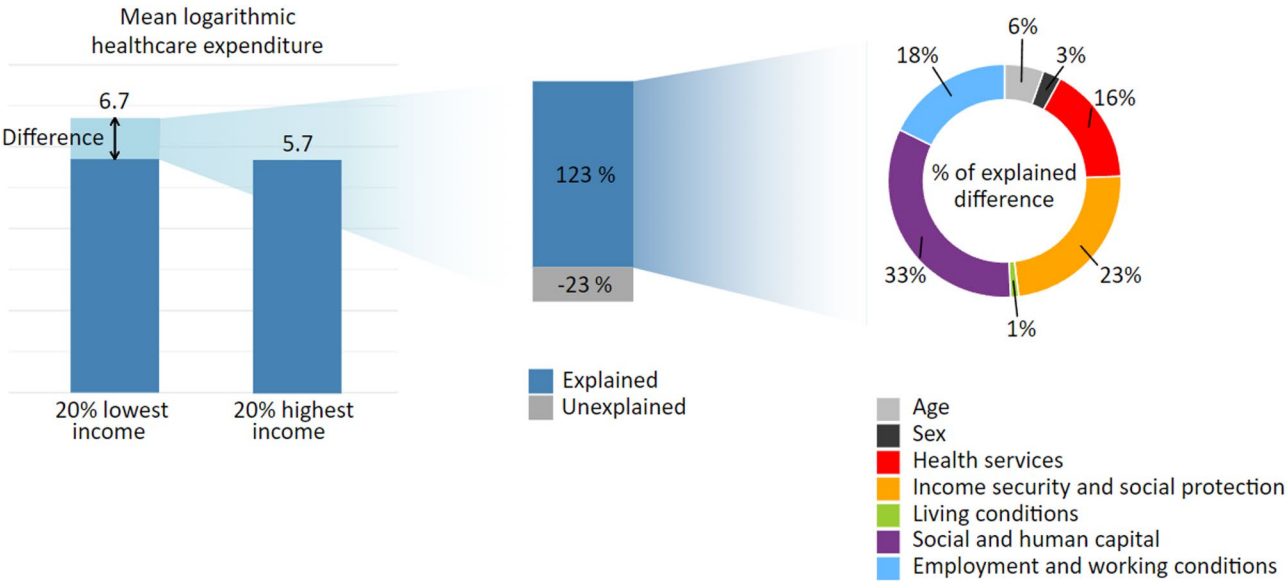


Fig. 5 Decomposition of income differences in HCE by social determinants

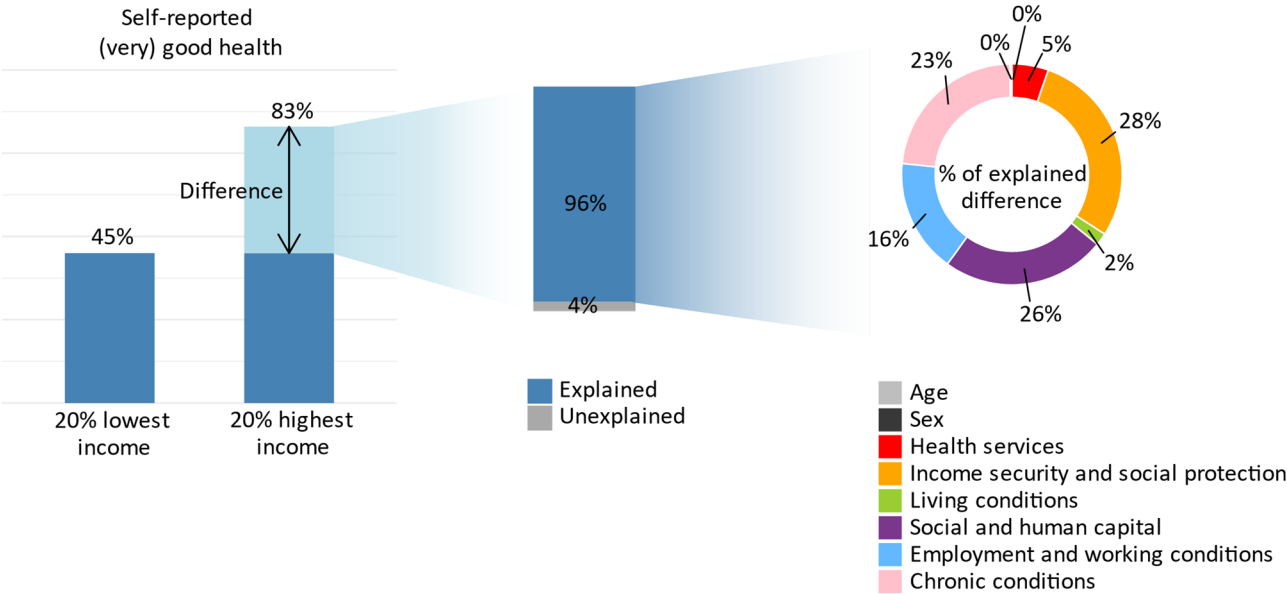


Fig. 6 Decomposition of income differences in (very) good health status by chronic conditions and social determinants

resilience (16%) contributed most to the explained part of income differences in log odds of SRH (Additional file 2– Fig. 3) and household composition (25%) contributed most to income differences in HCE (Additional file 2– Fig. 4).

Sensitivity analyses

To test for robustness across proxies of SES, education and financial welfare were used as alternative SES-indicator instead of income (for detailed results see Additional file 3). For all SES indicators, health status was less favorable in the lowest SES-group. The SRH and HCE

gaps were smallest for educational differences when compared to income and financial welfare (SRH: education 24%-point, income 38%-point, financial welfare 40%-point; HCE: education 0.70, income 1.01, financial welfare 0.92) due to a higher probability of the lowest educational group to report a (very) good health status (57%) and lower mean logarithmic HCE (6.35). Consistent with results using income as a SES-indicator, chronic conditions and social determinants accounted for a large part of the educational and financial welfare differences in both outcomes (SRH and HCE). In particular, financial welfare showed comparable patterns to income. Chronic

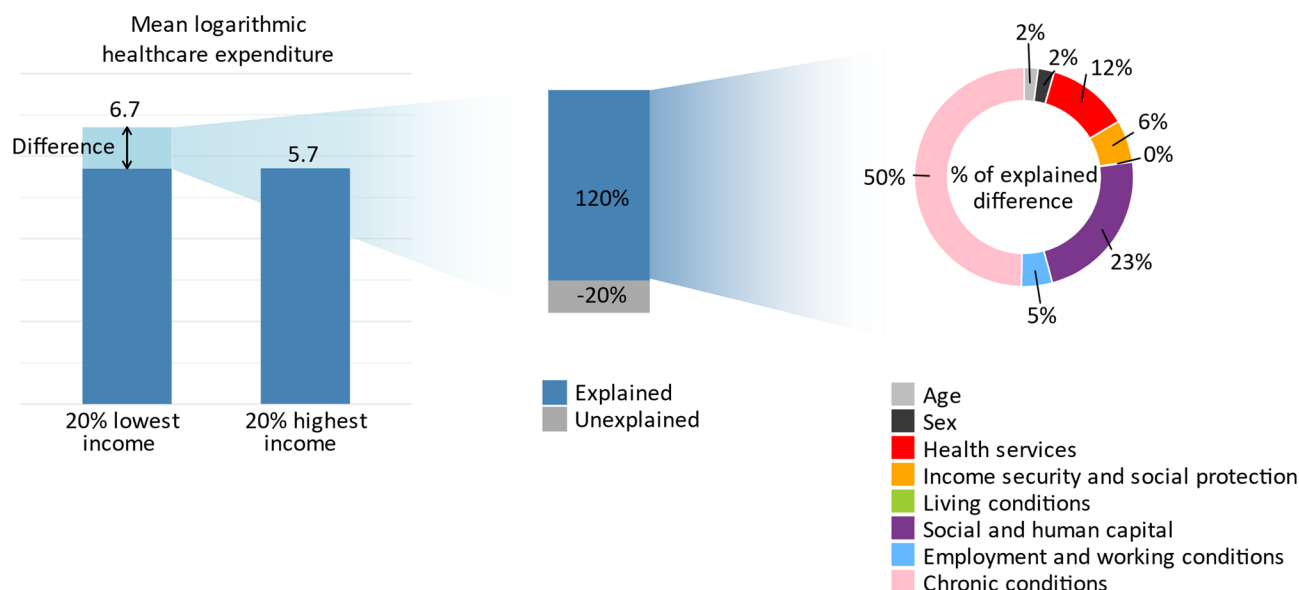


Fig. 7 Decomposition of income differences in HCE by chronic conditions and social determinants

conditions accounted for a larger part of the educational differences in both SRH and HCE (50% and 86% respectively) compared to those for income (33% and 70%) and financial welfare (27% and 66%) differences, whereas social determinants accounted for a smaller part of educational differences in both SRH and HCE (79% and 83% respectively) than for income (97% and 123%) and financial welfare (88% and 92%).

To check whether the contribution of factors was robust among individuals with chronic conditions, we stratified the decomposition of income differences in both SRH and HCE with social determinants as independent variables by chronic conditions (Additional file 5). Social determinants accounted for between 83% (acid-related disorders) and 137% (migraines) of the SRH gap between the lowest and the highest income groups and between 108% (cardiovascular diseases) and 149% (acid-related disorders) of the HCE gap. Overall, income security & social protection, social & human capital and employment and working conditions together contributed for almost all of the explained difference in both the log odds of SRH and mean logarithmic HCE between the lowest and highest income groups for all five chronic conditions. For acid-related disorders and cardiovascular diseases, income security & social protection contributed most. For migraines and psychological disorders, social & human capital contributed most. For rheumatological conditions, income security & social protection contributed most to the SRH gap, while social & human capital contributed most to the HCE gap.

Discussion

This research aimed to identify the medical and non-medical determinants responsible for the large and persistent differences in both SRH and HCE across SES-groups in the Netherlands by applying the Oaxaca-Blinder decomposition method. This method allowed for the quantification of the relative contribution of chronic conditions and social determinants to these differences and provided insights into the most promising areas for policy interventions. When applying income as an SES-indicator, social determinants explained a larger part of the income differences in SRH (97% vs. 33%) and HCE (123% vs. 70%) than the prevalence of chronic conditions. While the real-world effects of equalizing chronic conditions and social determinants remain uncertain—owing to factors such as unobserved confounders, non-linear feedback mechanisms, systemic barriers to healthcare access, behavioral responses, or other structural inequalities—our findings highlight the significant role that social determinants play in driving socioeconomic differences in SRH and HCE. The prevalence of chronic conditions accounted for a larger portion of the difference in mean logarithmic HCE (70%) than in SRH (33%), implying that the use of healthcare is much more disease-related than perceived health. It is plausible that additional health dimensions not encompassed by chronic conditions, such as disability, symptoms or non-chronic conditions, and the subjective valuation of health, also influence SRH [54–57]. These factors, however, were not included in the current research. For both outcomes (SRH and HCE), cardiovascular diseases, acid-related disorders and psychological disorders contributed most. Because the prevalence of some chronic conditions is relatively

low, their contribution to SES-differences in SRH may be limited among the total population. Acid-related medication, such as gastroprotective agents, is often prescribed (preventively) to mitigate side effects of medication for cardiovascular diseases and hyperlipidemia disorders. Therefore, the contribution of acid-related disorders may serve as a proxy for other conditions, such as cardiovascular diseases and hyperlipidemia disorders. Approximately 67% of the difference in the log odds of SRH between the lowest and highest income group could not be attributed to differences in the prevalence of chronic conditions. This unexplained part may reflect unobserved variables or a differential associations between chronic conditions and SRH across groups. Since the decomposition analysis could not differentiate between these two drivers, nor accurately estimate the coefficients of the unexplained part (transformation problem), regression analyses were performed as an alternative and provided some evidence of a differential association between chronic conditions and SRH. This suggested that differences in health may partly arise from differences in the perceived impact or valuation of chronic conditions on SRH. This aligned with previous research demonstrating that health problems have a stronger impact on SRH among better-educated individuals [58].

When evaluating the relative contribution of social determinants to SES-differences in SRH, “income security & social protection” and “social & human capital” were the most important contributors across all three SES-measures. These findings were consistent with those reported by Allen, Cotter-Roberts [22]. Labor participation and financial difficulties were the primary drivers of these findings, stressing the importance of job and income security. Stable, paid work may contribute to financial security and social connections that enhance and maintain physical and mental well-being, while financial strain and job insecurity have been linked to adverse mental and physical health outcomes [59–61]. However, this relationship may work both ways as poor health may also hinder labor participation, exacerbating financial strain and related (mental) health issues [62]. Additionally, resilience significantly contributed to income differences in SRH. High resilience levels may aid individuals in better coping with disadvantages and stressors, mediating the effect of stressors on SRH [63–65]. Individuals from lower income groups may face more frequent and severe stressors and have fewer resources to cope with them [66], likely resulting in lower resilience margins. Contrarily to our findings, the WHO Regional Office for Europe [21] observed a larger impact of living conditions, largely driven by housing deprivation. This deviation may be due to relatively low levels and limited variation of housing deprivation and other living conditions in the Netherlands compared to other EU countries

[67], as well as the inadequate capture of these factors in our study, which may have underestimated their role in SES-differences in SRH.

The unexplained part accounted for 3% of the difference in the log odds of SRH, indicating little impact of a differential association of social determinants or unobserved effects. Additionally, the regression models did not show evidence of a differential association. This implies that the two groups would likely exhibit similar levels of SRH if they had comparable distributions of social determinants. Consequently, this strengthens the argument that reducing differences in social determinants could potentially reduce health inequality.

The importance of social determinants to income differences in mean logarithmic HCE is highlighted by the finding that 123% of the difference between the lowest and highest income groups can be attributed to varying distributions of these determinants. Under the assumption of causality, if the lowest and highest income group had the same distributions of social determinants, the highest income group would have had higher HCE than the lowest income group. The large explained income differences in HCE are noteworthy, considering the presence of universal health coverage in the Netherlands. In such a system, SES-differences would typically be expected to reflect health inequalities or artifacts, rather than institutional or systemic factors. This finding points towards potential barriers to healthcare access for lower-income groups, such as long wait times, work-related constraints, or challenges with health literacy [30, 68, 69]. Conversely, higher-income groups may be engaging in overutilization of medical services, including discretionary procedures or preventive care [70, 71]. Another contributing factor may be variations in health-seeking behavior, with lower-income individuals potentially delaying care due to financial or logistical challenges [30, 72]. Additionally, measurement limitations, such as the exclusion of out-of-pocket expenses, could influence these findings. These factors, along with other unmeasured determinants and behaviors, are collectively captured within the unexplained part of the analysis. Similar to SRH, “social & human capital” and “income security & social protection” play an important role in income differences in HCE. Household composition (37%), labor participation (21%) and income source (19%) were the primary contributors to income differences in mean logarithmic HCE, indicating that the financial situation and stability play an important role when using healthcare. For household composition, especially living alone was associated with large differences in HCE between the lowest and highest income groups. Individuals living alone may, under similar conditions, rely more on some parts of the healthcare system due to the absence of a supportive household network [73–75]. Consequently,

they might be more likely to substitute informal care with formal care.

Combining chronic conditions and social determinants into one decomposition yielded additional insights. When social determinants were included alongside chronic conditions, the explained part of income differences in the log odds of SRH increased from one-third to almost 100%. In this combined decomposition, chronic conditions accounted for 23% of the explained part. Although the prevalence of chronic conditions was negatively correlated with SRH, income differences in perceived health were seemingly determined much more by social determinants than by chronic conditions, as income security (28%), social & human capital (26%), and the prevalence of chronic conditions (23%) were approximately equally important to income differences in the log odds of SRH. This indicates that the underlying determinants of health inequality predominantly span the economic, social, and health domains, with each domain contributing an equally sized share.

Adding social determinants alongside chronic conditions when decomposing mean logarithmic HCE, the explained part increased from 70 to 120%, with chronic conditions being the most important attribute (relative contribution of 50%), suggesting a relatively larger and independent role of the prevalence of chronic conditions in income differences in HCE. This suggests that reducing the prevalence of chronic conditions will have a greater impact on income differences in HCE than on SRH. Hypothetically, this could be because the healthcare sector already effectively manages chronic condition symptoms, wherein having a chronic condition only has marginal effects on SRH. Consequently, lowering the prevalence of chronic conditions might decrease the demand for care but may have limited potential to further improve perceived health. However, to the best of our knowledge, there is no evidence currently available to support this hypothesis.

When reasoning the other way around, the explained part of income differences in both outcomes (SRH and HCE) did not change when chronic conditions were included alongside social determinants (from 97 to 96% for the log odds of SRH and 123–122% for mean logarithmic HCE). This suggests a strong correlation between chronic conditions and some social determinants, which could be due to causation (social determinants influencing health) or selection effects (health influencing social determinants) [76, 77].

In addition to providing actionable insights into the role of chronic conditions and social determinants in shaping disparities at the national level, this study lays the groundwork for advancing international comparisons of socioeconomic differences in health and HCE. By contributing to a foundation of comparable national studies,

it sets the stage for broader cross-country analyses that can identify which factors are more or less significant in different countries and link these to variations in social security and healthcare policies, as well as cultural differences (e.g., country-specific reporting of self-rated health [78]) and healthcare system structures. Ultimately, such an approach can help uncover policy levers that are most effective within specific national contexts, highlight best practices across countries, and deepen our understanding of country-level differences in addressing health and healthcare disparities.

Strengths and limitations

This study was the first to use the Oaxaca-Blinder decomposition method to determine the contribution of both chronic conditions and various social determinants to SES-differences in both SRH and HCE. The Oaxaca-Blinder method is especially valuable because it decomposes the contribution of determinants to differences in outcome measures between two groups. Moreover, it is possible to distinguish between group differences that arise from the distribution of the independent variables and those that result from the effects of these independent variables on the outcome measure or from unobserved factors. Due to the unique data infrastructure of Statistics Netherlands, multiple datasets of different sources and surveys could be linked at the individual level. We combined as many as 46 indicators, three measures of socioeconomic status and two outcome measures in several decomposition analyses. In this study, we translated the decomposition analyses of the WHO Regional Office for Europe [21], which included all European WHO-countries, to the Dutch setting, with the potential for regional decompositions. Furthermore, it was possible to extend the analyses of the WHO Regional Office for Europe [21] by including chronic conditions and HCE alongside social determinants and SRH, thereby providing a more comprehensive depiction. However, it was not always possible to exactly replicate the operationalization of the WHO-framework, which constrained comparability. For example, housing deprivation largely contributed to income differences in SRH among WHO countries [21], but energy poverty, as a proxy for housing deprivation, was not statistically significant in our study. Therefore, some omitted variable bias for these indicators may remain, as well as for other potential underlying drivers such as health literacy and childhood socioeconomic status. Nevertheless, we relied on the best available data to incorporate as many relevant indicators as possible and minimize omitted variable bias.

The use of survey data is accompanied by various forms of biases such as non-response bias and reference group bias. The response rate of the DHM was 33%. Survey weights were used to ensure representativeness of the

Dutch population. As a result, the answers of respondents with characteristics that were relatively rare in the DMH were more influential in the analyses. Additionally, 24% of the respondents were excluded because of incomplete data. Furthermore, different SES-groups may assess their health differently. Lower SES-groups are generally more optimistic about their health status compared to higher SES-groups [79–81], for example due to evaluating their health against different implicit standards, which leads to a reference group bias [82]. This bias may have resulted in an underestimation of health inequalities.

Furthermore, the decomposition analysis method is subject to a number of choices and limitations that might have influenced (the interpretation of) the results. First, any transformation of the independent variables causes the intercept and coefficients within the unexplained part to change, making the values arbitrary and inappropriate to interpret (“the transformation problem”) [83]. Therefore, the specific impact of each chronic condition and social determinant on SRH or HCE in different income groups could not be accurately determined by the Oaxaca-Blinder decomposition method. Stratified regression models by SES appeared to be a good alternative to address this methodological limitation of the Oaxaca-Blinder decomposition model. Second, the ratio of the explained to the unexplained part depends on the choice of the counterfactual. Each counterfactual choice renders different results, which is often referred to as the “index problem” [49]. In the absence of a theoretical basis for selecting a counterfactual, the preferred approach is to use the independent variable distribution and coefficients from a pooled regression model [48, 84]. This method was adopted in the present study. However, the impact of alternative counterfactuals on the results cannot be determined without performing the actual analysis, as it depends on the underlying data rather than the method itself. Third, social determinants’ categories each include a set of underlying variables. However, the more variables included, the higher the probability of a larger relative contribution. The social determinant “social & human capital”, and the “chronic conditions” grouping in the combined decomposition model included a relatively large set of underlying variables. Therefore, the contribution of these determinants may have been overestimated in terms of relative contribution, complicating comparability across studies. Fourth, the current study decomposed the mean logarithmic HCE. Taking into account the non-normal distribution of healthcare expenditure, the application of alternative metrics may have been more informative and better fit the distribution of HCE within income groups. Examples of such methods are the decomposition of the median or the distribution of HCE as proposed by Machado and Mata [85]. Non-linear decomposition models may allow researchers to relax

the assumption of linearity between the (transformed) dependent and independent variables. However, given that all of the independent variables in our analysis were categorical, we expect any potential bias from assuming linearity to be minimal. Fifth, the current Oaxaca-Blinder decomposition analyses assess contributions at one point in time. We encourage follow-up research extending the time scale using panel data to model life course accumulation. Sixth, it is important to emphasize that the Oaxaca-Blinder decomposition method identifies associations rather than causal relationships. Potential endogeneity concerns, such as reverse causality between SES, the prevalence of chronic conditions and social determinants may have influenced our findings. For example, while lower SES may contribute to poorer health, chronic conditions could also restrict earning potential, complicating causal inference. Future research could address these challenges by employing longitudinal data, instrumental variable approaches, or experimental designs to better address endogeneity and disentangle causal pathways.

Data constraints and processing could have influenced the findings of the Oaxaca-Blinder decomposition. In our study, chronic conditions were proxied by a binary indicator of single drug use. With the available data, we were unable to assess diseases severity. Moreover, since not all medication is disease-specific the data allowed us to include broad categories of chronic diseases only. The availability of more detailed information would have facilitated a more nuanced approach, such as using diagnoses by the general practitioner, incorporating the duration/amount of drug use or incorporating multimorbidity. This would allow for capturing the severity of chronic conditions more accurately, enhancing the ability to explain health inequalities. Interactions within and between chronic conditions and social determinants could provide insights into specific patterns of problem accumulation and potential leverage points, which were not captured in our main effects decomposition. Additionally, some variables were unavailable for the study year 2022, necessitating the use of data from preceding years. Despite high correlations across years, this may have introduced bias, especially for healthcare expenditure for which 2021 data was the most recent available.

Policy implications

The results showed different key contributors for SES-differences in health and HCE, warranting different policy strategies. Whereas the prevention of chronic diseases offers opportunities for reducing income inequalities in healthcare spending, the potential impact on SRH is much smaller. Health policies aimed at reducing health inequality require a broader perspective on health and wellbeing. The drivers identified by this study can be used as priority areas for broader policies and interventions

to reduce health inequalities. Following Marmot, these social determinants encompass the broader ‘causes of the causes’ and therefore underline the need for an integrated whole system approach to reduce health inequalities [86]. Our findings suggest focusing on addressing the key social determinants of health (e.g. income security and capital enhancing measures targeted at resilience, difficulties in making ends meet and labor participation), as these emerged as major and deeply-rooted drivers of differences in health and HCE across multiple chronic conditions. These efforts could be complemented with condition-specific interventions targeted at high burden chronic conditions that disproportionately affect lower socioeconomic groups, such as cardiovascular diseases and psychological conditions. Our findings call for a Health in All Policies approach in which collaboration, collective responsibility, and joint objectives across multiple domains, such as the social, economic and health sector [87], are leading. This ties in with the health *for* all policies movement where integrated action is stimulated by emphasizing mutual interests and co-benefits of policies for health and other sectors [88]. Examples of international, national (Dutch) and regional integrated policies were recently explored by Jansen- van Eijndt, Gorter [89]. In the healthcare sector, applying a broader perspective would imply that doctors and other healthcare providers should pay much more attention to the wider social context of their patients. Furthermore, the concept of economy of well-being is promising in this respect, as it is a policy orientation and governance approach that aims to put the concept of well-being back at the center of economic systems [90]. By designing social protection and welfare systems based on equity, inclusion and solidarity, a well-being economy approach can facilitate health equality. For example, taxing unhealthy products, initiating labor market programs, enhancing social and welfare architecture or ensuring financial or in-kind support to unpaid carers could be promising strategies to improve overall well-being through a reduction in social inequalities in health and healthcare spending [91]. Although the potential gains may be smaller compared to addressing the root social determinants, the large number of individuals accessing care means that even modest improvements in accessibility or equity within the healthcare system, or other specific healthcare system interventions, could still have a significant overall impact.

Conclusions

This study applied an Oaxaca-Blinder decomposition approach to analyze SES-differences in both SRH and HCE including both chronic conditions and social determinants. In doing so, we translated the decomposition analyses conducted by the WHO Regional Office for Europe [21] to the Dutch setting and extended the

analyses by including chronic conditions and HCE alongside social determinants and SRH. Prioritizing the prevention of chronic conditions among lower SES-groups offers an opportunity for reducing income inequalities in healthcare spending and may contribute to the sustainability and affordability of the healthcare sector. However, the potential impact of preventing chronic conditions on SRH is much smaller, as social determinants accounted for nearly all socioeconomic differences in health. This suggests that policies aimed at reducing health inequality should focus on addressing the underlying broader causes of health inequality, rather than merely improving health and lifestyle without tackling the root issues. Since the social determinants encompassed multiple domains, such as the social, economic and health sector, the approach to reducing health inequality should be equally comprehensive, emphasizing the need for integrated policies.

Abbreviations

ATC	Anatomical Therapeutic Chemical
CI	Confidence interval
DHM	Dutch Health Monitor
EU	European Union
GP	General practitioner
HCE	Healthcare expenditure
HIV	Human immunodeficiency virus
OECD	Organisation for Economic Cooperation and Development
PM	Particulate matter
SES	Socioeconomic status
SES-differences	Socioeconomic status related differences
SRH	Self-rated health
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12939-025-02518-y>.

Supplementary Material 1

Acknowledgements

Not applicable.

Author contributions

IM: Writing– original manuscript draft, Formal analysis, Conceptualization, Methodology, Project administration, Visualization. TJ: Writing– review and editing, Conceptualization, Methodology. EU: Writing– review and editing, Conceptualization, Funding acquisition. Mariëlle Cloin: Writing– review and editing, Conceptualization. JP: Writing– review and editing, Conceptualization, Funding acquisition. NS: Writing– review and editing, Conceptualization, Methodology, Funding acquisition. All authors read and approved the final manuscript.

Funding

This study is funded by the Strategic Program project ‘SOCIETAL’ of the Dutch National Institute for Public Health and the Environment (RIVM).

Data availability

Results are based on non-public microdata from Statistics Netherlands. Under certain conditions, these microdata are accessible for statistical and scientific research.

Declarations

Ethics approval and consent to participate

According to Dutch law, formal approval was not required as this study relied on secondary anonymized data collection in the context of performing statutory tasks. Statistics Netherlands functioned as a trusted third party, enabling the linkage between the datasets, while ensuring the privacy of the involved participants, according to Dutch law (Statistics Netherlands Act 2003).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 7 November 2024 / Accepted: 13 May 2025

Published online: 28 May 2025

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