Health is more than seeing a doctor

Introduction

After scouring the open science framework looking for datasets to work with, we stumbled upon the National Health Interview Survey (NHIS; 2023), an extensive database covering many health-related variables of the US population. Initially, the abundance of variables in the dataset was quite overwhelming and it was not quite clear where to start. Therefore, we decided to look up on literature that might pertain to the observed variables. Luckily, there was quite a bit of literature to be found on health and socioeconomic status (SES). The following papers were of interest and allowed us to narrow down our focus and ask more guided questions:

- de Hoog N, van Dinther S, Bakker E. Socioeconomic Status and Health-Compromising Behaviour: Is it All About Perception? Eur J Psychol. 2020 Aug 31;16(3):498-513. doi: 10.5964/ejop.v16i3.1840. PMID: 33680195; PMCID: PMC7909503.
- Barakat C, Konstantinidis T. A Review of the Relationship between Socioeconomic Status Change and Health. Int J Environ Res Public Health. 2023 Jun 29;20(13):6249. doi: 10.3390/ijerph20136249. PMID: 37444097; PMCID: PMC10341459.
- Kraft P, Kraft B, Hagen T, Espeseth T. Subjective Socioeconomic Status, Cognitive Abilities, and Personal Control: Associations With Health Behaviours. Front Psychol. 2022 Jan 28;12:784758. doi: 10.3389/fpsyg.2021.784758. PMID: 35153907; PMCID: PMC8831894.

These papers served as inspiration for questions regarding the dataset. We did strive to be somewhat creative and deviate from the usual line of investigation ("does lower SES lead to worse health outcomes?, … "). After some pondering, we decided on the following two questions:

1. Do people with higher SES report better perceived health than their actual health would suggest?
2. Does SES protect against the negative health effects of being uninsured?

Models

<u>Model 1: Do people with higher SES report better perceived health than their actual health would suggest?</u>

The nature of this question lends itself quite well to Structural Equation Modelling (SEM), hence that is what we opted for in our methodology. We describe the model briefly before going over the R syntax that we used to test it.

$$Objective\ Health = \lambda 1 * Diabetes + \lambda 2 * Hypertension + \varepsilon 1$$

$$Perceived\ Health = \lambda 3 * Self\text{-}Rated\ Health + \lambda 4 * Depression + \lambda 5 * Life\ Satisfaction + \varepsilon 2$$

This model has two latent variables where the first, *Objective Health*, is based on actual medical diagnoses (diabetes and hypertension) and the second, *Perceived Health*, is defined as a combination of self-rated health, depression category, and life satisfaction. The following two lines:

$$Perceived\ Health = \beta 1 * Education\ Level + \beta 2 * Poverty\ Level + \beta 3 * Objective\ Health + \zeta 1\mu$$

$$Objective\ Health = \beta 4 * Education\ Level + \beta 5 * Poverty\ Ratio + \zeta 2$$

estimate the effect of SES (made up by *Education Level* and *Poverty Ratio*) on both O*bjective* and *Perceived Health* and ask whether *Perceived Health* is partly explained by O*bjective Health* but also shaped independently by SES. All R code that was used in the data-analysis can be found on Altay-Aaron-Rumeysa/CaseStudies: Cases Studies in the Analysis of Experimental Data, group Altay/Rumeysa/Aaron..

The model is interesting in that it allows the simultaneous testing of several confirmatory and/or exploratory hypotheses: (1) *Do high-SES individuals report feeling healthier than their low-SES counterparts, even when having similar physical health conditions?* To the best of our knowledge, this specific question has not yet been investigated, making this study potentially the first to empirically investigate this dynamic. In a related study, however, Kezer and Cemalcilar (2020) did find that high-SES individuals tend to overestimate their self-perceived health beyond what their objective health would predict. (2) *Is more formal education associated with higher self-reported health?* Various prior studies have consistently demonstrated this association. However, work done by D'Uva et al. (2008) and Tizzani and Gauvin more recently (2024b) pointed to potential reporting biases as it relates to self-reported health outcomes, which may overestimate results and therefore also potential associations with other constructs, such as educational level. (3) *Is objective health indicative for subjective health ratings?* This has indeed been found by prior studies to be the case (Mackenbach et al., 2008; Ostrove et al., 2000), with effect sizes ranging from 0.30 - 0.50 (Hinz et al., 2022). (4) *Does having a higher income correlate with increased self-reported health outcomes?* According to a study performed by Bonner et al.

(2017), this was indeed the case in Canada, thus, in the present study, we can investigate whether the same observation could be made in the US. (5) Etc.

Model 2: Does SES protect against the negative health effects of being uninsured?

Another way to ask this question would be 'Is the impact of being uninsured on self-rated health smaller among individuals with higher SES? To test this, we used the following model:

$$\textit{Self-Rated Health} = \beta 1 * \textit{SES Score} + \beta 2 * \textit{Health Insurance} + \beta 3 * (\textit{SES Score} \times \textit{Health Insurance}) + \varepsilon$$

Where, *Self-Rated Health* is measured by *SES Score* (a composite SES index based on *Education Level* and *Poverty Ratio*), *Health Insurance* (a binary insurance status variable with 1 = insured and 0 = uninsured) and *SES Score* × *Health Insurance*, the interaction term between *SES* and *Health Insurance*. While β2 will give us an idea of whether being uninsured harms health overall, β3 will tell us whether SES could potentially buffer against that harm. If β3 shows statistical significance, then we conclude that *SES Score* modifies the effect of *Health Insurance* on *Perceived Health*.

As opposed to model 1, this model is a regular moderated regression. Its R syntax is straightforward and can similarly be found on Altay-Aaron-Rumeysa/CaseStudies: Cases Studies in the Analysis of Experimental Data, group Altay/Rumeysa/Aaron..

This question is of relevance as it transcends the regular notion of health as strictly encapsulated by medicine or psychology. It asks whether socioeconomic factors can act as a buffer against health risks that are in themselves closely related to other socioeconomic factors (being uninsured). The choices we make on a daily basis are perhaps the most important factor in determining our health, however, unfortunately we do not choose what SES we are born into. Given the correlation between SES and health (Barakat & Konstantinidis, 2023; de Hoog et al., 2020), clearly there is more at play than merely decision-making at the individual level. Next to fields like medicine and psychology, policy makers and public health research also have a great responsibility resting on their shoulders concerning the general health of the population. Finally, this analysis could be especially valuable regarding the efficacy of the federal Medicaid public health insurance program—which saw significant expansion under former president Obama in 2010 as part of the Affordable Care Act.

A justified question at this point would be: why use a composite SES score for model 2 and not for model 1? First, it is a practical requirement of interaction testing that we need a single SES variable to multiply with insurance status. We cannot (and we have tried) do the following:

*(Education Level + Poverty Ratio) * Health Insurance*

without defining how the interaction components combine. On the other hand, in model 1, for the sake of interpretation, we keep *Education Level* and *Poverty Ratio* separate in the model as it allows to check which of the two is more predictive of health (i.e., are their effects similar or different across *Objective/Perceived Health*?).

Results

Model 1

We tested whether subjective health perception is shaped by objective health measures and SES, the latter of which, if significant, would suggest a social "performance" of health. We set up a SEM in which *Objective Health* was a latent variable measured by *Diabetes* and *Hypertension* diagnoses. *Perceived Health* was a latent variable measured by *Self-Rated Health*, *Depression* score and *Life Satisfaction*. *Objective* and *Perceived Health* were regressed on *Education Level* and *Poverty Ratio*, with *Perceived Health* also regressed on *Objective Health*.

We first look at some fit indices to see if the model fits the data well. We have $\chi^2(10) = 1128.34$, $p < .001$. This index tells us whether our model differs significantly from the observed data and we see no significant *p*-value, hence we conclude there to be no difference between the two models. The CFI = 0.919, which compares our model to a baseline model where all variables are uncorrelated. This index ranges from 0 to 1 and the higher the number, the better the fit. Rules of thumb for this index generally are that ≥ .90 is acceptable and ≥ .95 is excellent. Other indices laid out by the model similarly fall within acceptable ranges and we therefore conclude that the model fits the data reasonably well.

First, looking at our latent variables, we see that *Diabetes* and *Hypertension* load 0.484 and 0.607 on *Objective Health* respectively, while *Self-Rated Health*, *Depression* severity and *Life Satisfaction* load .809, 0.273 and 0.438 respectively on *Perceived Health*. Our indicators load well on the latent variables which suggests they do capture real variation in health conditions. *Perceived Health*, given the large contribution of *Self-Rated Health* and somewhat moderate contributions of *Depression* and *Life Satisfaction* suggests that it is mostly about subjective physical health and life satisfaction, instead of mental health.

Now for the main results, we observe that *Objective Health* was positively associated with *Education Level* (β = 0.053, $p < .001$) and *Poverty Ratio* (β = 0.133, $p < .001$; see figure 1A). As expected, *Objective Health* was strongly predictive of *Perceived Health* (β = –0.481, $p < .001$; see figure 1B). Finally, we observe that perceived health was also independently predicted by *Poverty Ratio* (β = –0.282, $p < .001$; figure 1C), but not significantly by *Education Level* (β = 0.010, $p = .16$). Figure 2 shows factor loadings and the different pathways tested.

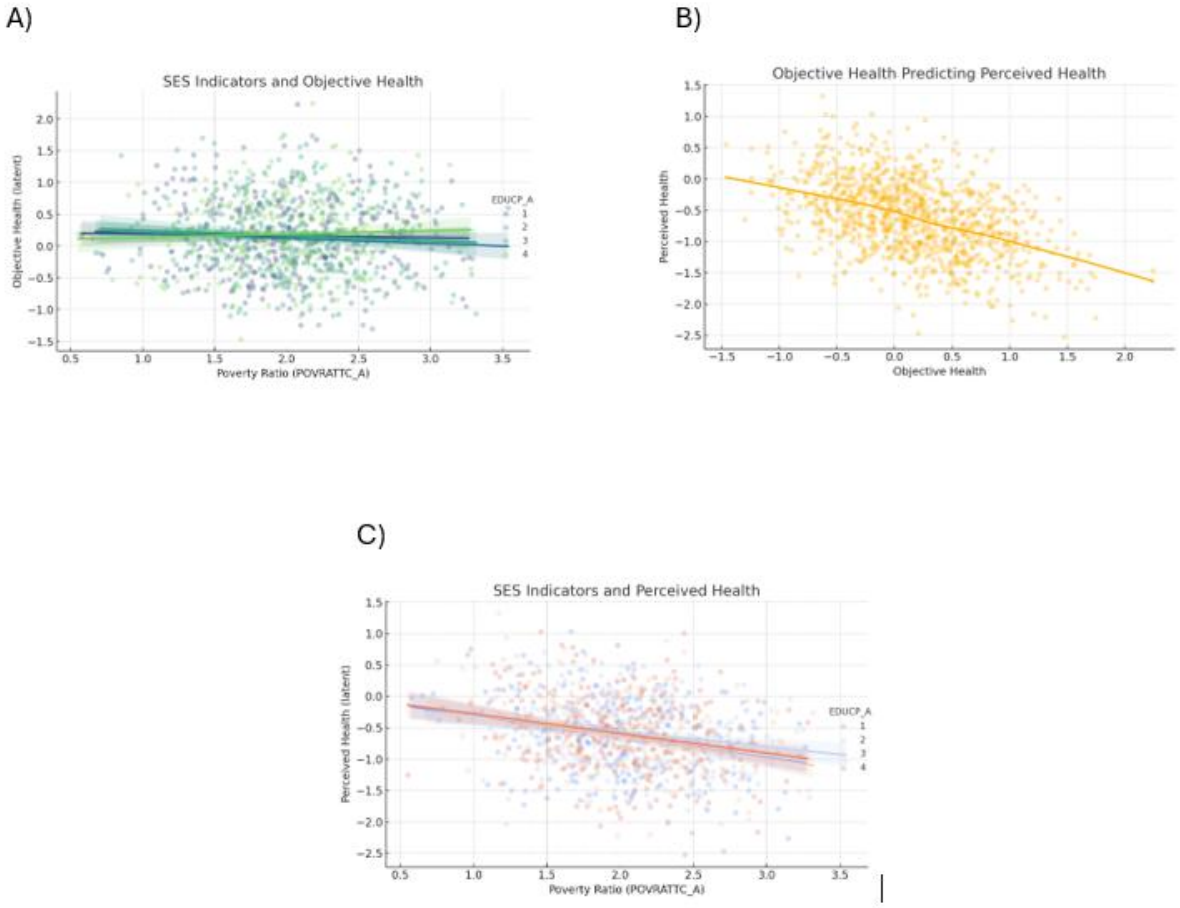

Figure 1. A) *Objective Health* predicted by SES indicators poverty ratio and education. Though the effects are relatively small, they are statistically significant. B) Perceived health as a function of *Objective Health*. Note that *Objective Health* is defined as a function of diabetes and hypertension. Consequently, higher values of *Objective Health* are worse in terms of health outcomes. C) Perceived health as a function of poverty ratio and education.

Even after accounting for *Objective Health*, individuals with a higher SES, particularly a higher income, reported higher *Perceived Health*. These results support the idea that perceived health is not shaped only by clinical status but also by social position.

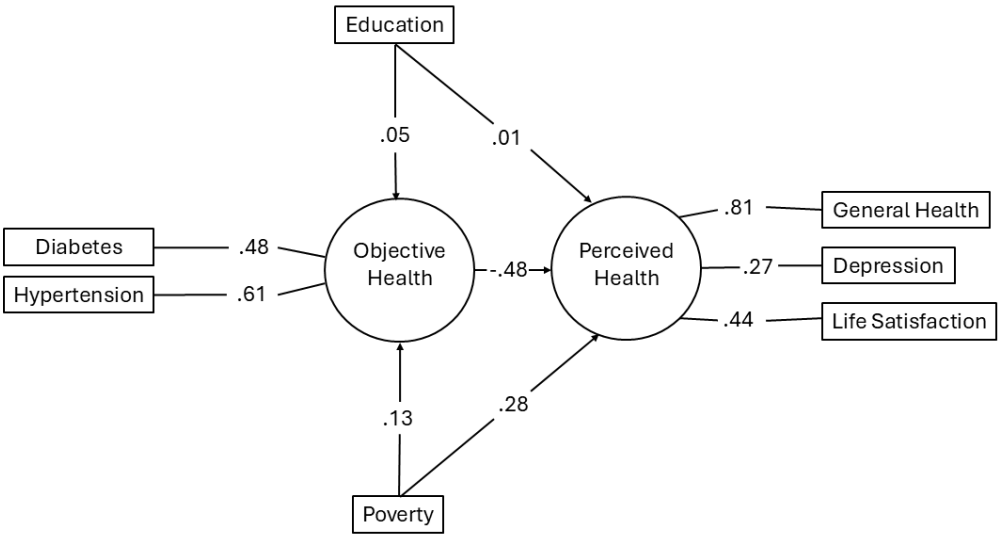

Figure 2. Schematic representation of the Structural Equation Model. Observed variables are shown as rectangles, latent variables as ovals.

Model 2

Here we tested whether *SES* moderates the relationship between *Health Insurance* and *Perceived Health*. Towards this end, we used a regular regression model with an interaction term. First, we looked at the estimates. *SES Score* shows marginal significance (β = -0.030, p = .057). The negative loading seems to suggest that higher SES predicts worse self-rated health, which is unusual. However, given that we included an interaction term, the main effect of *SES* must be interpreted only when *Health Insurance* = 0 (i.e., when being uninsured). In summary, though the effect is not signifact, amongst the uninsured, higher SES individuals tend to report worse perceived health—which is an interesting observation. Why might this happen? It may be, for example, that higher SES individuals compare themselves to a higher standard of health, leading them to rate themselves lower despite having similar objective health statuses. Additionally, higher educated people might be more aware of subtle health problems and rate themselves more critically as a consequence. Finally, the group itself (uninsured x high SES) is somewhat of an odd ball out. These people are certainly rare (since most get coverage through their employers) and the model might not be able to capture the unusual nature of this variation. *Health Insurance* was statistically significant (β = 0.077, p = 0.005), confirming that insured individuals report better perceived health.

The interaction term between *SES* and *Health Insurance* showed a strong siginifanct effect (β = -0.136, p < .001), hinting that SES does indeed modify the effect of *Health Insurance*

on *Perceived Health*. The negative loading means that among low-SES individuals, being insured improves perceived health more strongly, while among high-SES individuals, insurance coverage has less of an impact (possibly because they already access care through other means, e.g., private or through employers). This supports the notion that insurance protects the vulnerable most effectively. Table 1 shows the different combinations of the interaction terms and their effects on perceived health, while Figure 3 plots the interaction visually.

SES level	Insurance	Effect on perceived health
Low	No	Worse health ratings
Low	Yes	Substantial improvement
High	No	Moderate health, minimal SES effect
High	Yes	Slight improvement, smallest gain

Table 1. Interaction effects of SES and *Health Insurance* on *Perceived Health*. Among low-SES individuals, being insured was associated with substantially better *Perceived Health*. Among high-SES individuals, the benefit of insurance on *Perceived Health* was smaller and less meaningful. Among the uninsured, *Perceived Health* did not improve with higher SES — and in fact, may slightly decline, possibly reflecting differences in expectations or access to alternative care. The greatest disparities in *Perceived Health* were observed between low-SES uninsured and low-SES insured individuals.

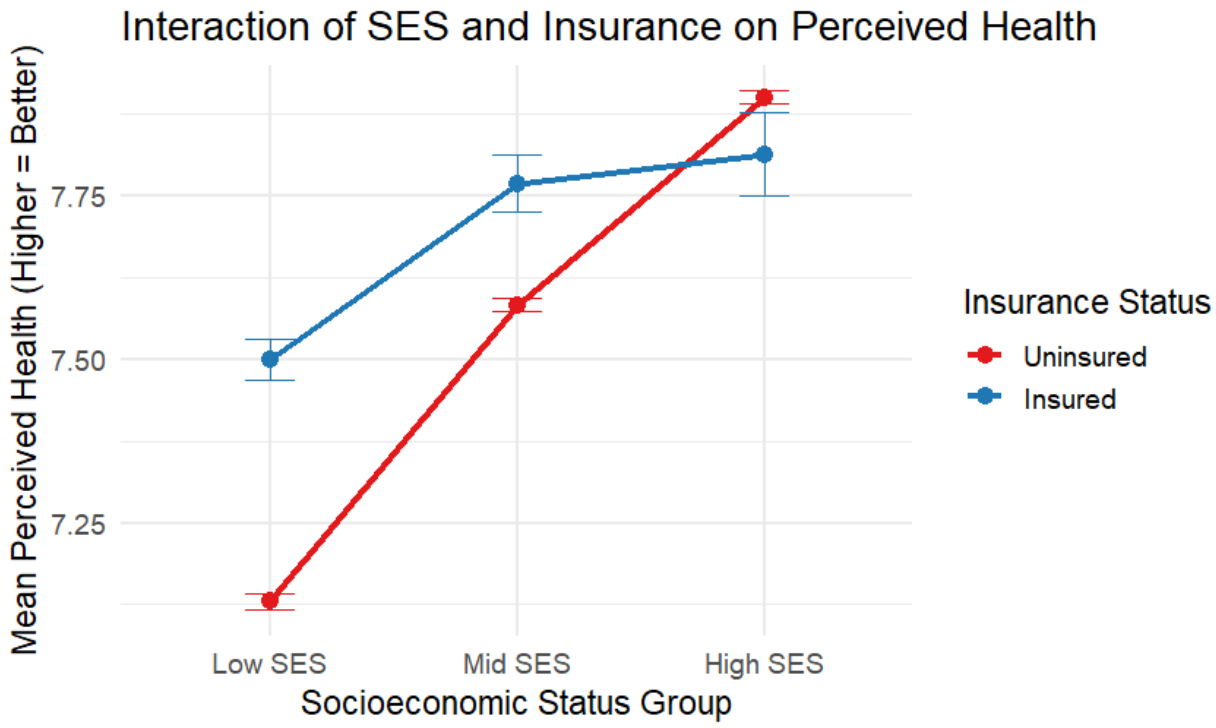

Figure 3. Visual representation of the interaction effect between *Insurance Status* and *SES* on perceived health.

Conclusions

We have tested two models. First, we asked whether people with higher SES report better perceived health than their actual health would suggest (model 1), and second, whether the negative consequences of being uninsured can be buffered by (higher) SES (model 2).

Model 1 showed that *Perceived Health* was significantly predicted by *Objective Health* and *Poverty Ratio*—which falls in line with prior research into this matter (Hinz et al., 2022; Mackenbach et al., 2008; Ostrove et al., 2000); therefore, the present results serve as a replication of said studies. Additionally, we found that people living in the US, just as their northern neighbors in Canada, tend to overestimate their self-reported health as income levels grow.

Surprisingly, *Perceived Health* was not found to be associated with *Education Level*, which argues against what was mostly thought to be well-established knowledge (Faresjö & Rahmqvist, 2010; Ross & Wu, 1995). However, as suggested by D'Uva et al. (2008) and Tizzani and Gauvin (2024b), there might be biases in the way people with various educational levels report their self-reported health, which could lead to artificially inflated associations between education and self-perceived health. Therefore, future research would benefit greatly from proactively addressing these issues.

As it relates to the question of whether high-SES individuals tend to perceive their health more favorably than low-SES individuals, even when objective health outcomes are comparable; the answer seems to be: it depends. When taking SES into account as a whole, the answer—according to our data—is no. However, when only looking at *Income* (and not *Education* Level or *SES* more generally), the answer seems to be yes—people with high SES tend to overestimate their self-perceived health as compared to people with lower SES status.

Finally, these results seem to suggest that individuals do not evaluate their health based solely on medical conditions, but also on their broader social and economic context (de Hoog et al., 2020).

Model 2 showed a strong interaction between *SES Score* and *Health Insurance* status. Specifically, uninsured low-SES individuals reported worse perceived health than their uninsured high-SES counterparts. At the same time, being insured greatly increased their self-perceived health ratings, both in absolute numbers as well as compared to the high-SES individuals. This finding suggests that insurance has diminishing returns as SES becomes higher and confirming the notion that insurance is most impactful for society's most disadvantaged people (McMaughan et al., 2020). Interestingly, in both models, *Education Level* showed weak or no significant effects. *Poverty Ratio*, a more material SES measure, predicted both *Objective* and

Perceived Health, which led us to believe that material deprivation, and not schooling or education, is a key driver of health disparities. However, we do acknowledge that unlike some other studies that *did* find significant associations between education and health outcomes (Balaj et al., 2024; Hayward & Farina, 2023), we were unable to include other potential meaningful and critical variables to our analyses due to the nature of our dataset. Inclusion of such key variables might have also established said relationship between education and perceived or objective health measures.

There are several broader implications we can draw for society and governmental policy. The results show that effective health interventions must address social determinants (poverty, access, living conditions), because purely clinical approaches to health miss the full picture. Further, expanding insurance is indeed necessary but not sufficient. While it does improve perceived health (especially amongst low-SES groups), disparities remain if poverty itself is not addressed. Insurance by itself cannot fix unstable housings or environmental stressors—which was also, at least partially, evidenced by Baicker et al. (2013). These researchers investigated the impact of the Medicaid healthcare system in the US, specifically as it relates to low SES-individuals. This study found no significant benefits as it relates to physical health measures two years later, however, people benefitting from this insurance plan did significantly more often seek out health care services compared to when they were uninsured.

The results show that insurance coverage reaches the biggest payoff among low-income, uninsured populations. Health policies should prioritize these groups to reduce the health disparities more effectively. Despite being among the richest countries globally, the US has a persistent poverty rate of around 11%, which is higher than its peer nations (U.S. Census Bureau, 2024). Further, child poverty far exceeds adult or senior rates (15% vs 10% respectively). Hence, results linking material deprivation to worse perceived health are not simply statistically significant, they are socially meaningful. Further studies looking into a similar line of study could try to focus on the long-term effects of perceived health on objective health to provide evidence and solidify subjective health as a legitimate indicator of population well-being or investigate the impact of social health policies on subjective and objective health across different levels of insurance and SES.

Generative artificial intelligence acknowledgement

In the writing of this paper, large language models (LLMs), such as ChatGPT, were exclusively used to assist in the creation and visual layout of the figures presented in this paper.

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