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Dörte Heger[1]

Decomposing Differences in Health and Inequality using Quasi-Objective Health Indices

Abstract

People in Canada and the U.S. often make claims regarding whose country has a better health system. Several researchers have attempted to address this question by analysing subjective health in the two countries, thus assuming a common definition of "good" health. Using data from the Joint Canada/U.S. Survey of Health, I generate quasi-objective health indices and show that Canadians and Americans define "good" health differently. After controlling for reporting heterogeneity, health differences between Americans and Canadians are eliminated for intermediate health statuses, while health differences at the tails of the health distribution lead to slightly better average population health in Canada. In both countries, income and education gradients increase steeply with poor health.

JEL Classification: C43, I13, I14, I18

Keywords: Public health; inequality; Oaxaca-Blinder decomposition

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1 Introduction

Being able to compare individuals' health statuses is crucial to assessing the quality of health systems and to evaluating health outcomes across different countries or population subgroups. Particular attention has been given to the comparison of health in the U.S. and Canada because of differences in their health systems and their geographic and cultural proximity (see, for example, Eng and Feeny, 2007; Guyatt et al., 2007; O'Neill and O'Neill, 2007; and Sanmartin et al., 2004). However, comparable health measures are rare. To address this problem, this paper constructs quasi-objective health indices, which allow for an unbiased comparison of health and health gradients in the U.S. and Canada along the health distribution.

Until recently, the two striking differences between the Canadian and American health systems were the extent of coverage and the method of funding.[1][2] While the Canadian health system is publicly funded and provides universal[3] coverage for all Canadians, similar systems - Medicare and Medicaid - exist in the U.S. only for certain subgroups: the population aged 65 and above, individuals under a certain income level, and disabled individuals. Other Americans often receive health insurance benefits for themselves and their families through their employers. Individuals without employer-sponsored plans can purchase private insurance. Prior to 2014, about 14% of Americans had no insurance coverage (OECD Health Data 2015). These differences have yielded significant differences in health spending. In 2013, per capita health expenditure amounted to US$ 8,713 (16.4% of GDP) in the U.S., out of which 52% were privately funded, compared to only US$ 4,351 (10.2% of GDP) per capita and 29% private health expenditures in Canada.[4] Whether such differences in spending and in the structure of the system translate into differences

[1]In March 2010, President Obama signed into law the Patient Protection and Affordable Care Act (PPACA), which significantly expanded health insurance coverage in the U.S. by introducing an individual mandate that requires Americans to either buy insurance or pay a penalty starting in 2014.

[2]Health care is administered by states in the U.S. and by provinces and territories in Canada, leading to slight differences in the extent of coverage within each country. Due to data limitations, this paper only focuses on cross-country differences in coverage.

[3]Dental care and prescription drugs are not covered universally, though supplemental coverage is often provided by employers.

[4]OECD Health Data 2015. Values adjusted for purchasing power.

in health outcomes is still debated. While general health measures such as life expectancy at birth (81.5 years for Canadians, 78.7 years for Americans) and infant mortality (4.8 deaths per 1,000 live births in Canada, 6.1 in the U.S.)[5] slightly favour Canada, O'Neill and O'Neill (2007) argue that these measures are misleading as they reflect the higher proportion of immigrants and higher number of pre-term births in the U.S., rather than differences in general health or in the quality of the health systems.

In addition, the choice of health measure and empirical method might influence the results of health comparisons (Makdissi et al., 2011). A prevalent measure of individuals' health is self-assessed health (SAH), which is simple to collect from population surveys and can predict various objective health outcomes (Maddox and Douglass, 1973; Idler and Benyamini, 1997; Dowd and Zajacova, 2010).[6] However, using subjective health measures implicitly assumes that everybody shares the same understanding of "good" health, which has been challenged by recent research (Etilé and Milcent, 2006; Lindeboom and van Doorslaer, 2004; Jürges, 2007; and Bago d'Uva et al., 2008a).

Reporting styles have been shown to differ within countries by income (Etilé and Milcent, 2006), demographic characteristics such as age and gender (Lindeboom and van Doorslaer, 2004) and employment status (Kerkhofs and Lindeboom, 1995), as well as across countries (Jürges, 2007; Bago d'Uva et al., 2008a) leading to reporting heterogeneity in self-assessed health measures. As a result, much effort has gone into obtaining internationally comparable data on health outcomes and comparable health measures to increase the comparability of cross-country studies (Sadana et al., 2000, 2002). One approach is to use vignettes, where survey respondents not only have to rate their own health but also the health of a hypothetical person described to them (Bago d'Uva et al., 2008b). Using this information, one can correct for reporting differences between individuals. However, not all surveys provide this information and the vignette approach

[5] All figures are from OECD Health Data 2015; 2011 values.

[6] A commonly used measure is respondents' self-assessment of their general health status based on a five-point scale poor, fair, good, very good, or excellent in the "American version", and very bad, bad, fair, good, and very good in the "European version" (Bolin et al. 2010).

relies on strong underlying assumptions.[7]

An alternative approach controls for reporting heterogeneity by using objective health measures such as biomarkers (Dowd and Zajacova, 2007) and grip strength (Ziebarth, 2010; Jürges, 2007), or composite health measures such as the Health Utility Index Mark 3 (HUI3) (van Doorslaer and Jones, 2003; Eng and Feeny, 2007) and the Short Form (36) Health Survey (SF-36). These indices are sometimes referred to as "quasi-objective", as they still rely on self-reports of physical or mental health problems (Ziebarth, 2010). However, there are several arguments in support of their use. First, the responses are considered to be more objective than general SAH as they refer to conditions diagnosed by a health professional or address a very specific aspect of an individual's health (Lindeboom and Kerkhofs, 2009). Second, self-reports might provide information that is unobtainable from other sources and may be used if other sources are unavailable or too expensive to collect (Maddox and Douglass, 1973). Given that medical diagnoses are usually unavailable to researchers, using individuals' stated diagnoses is widely accepted (Pfarr et al., 2012).

Moreover, self-reported health conditions and limitations can be used to derive detailed and more objective measures of health directly from the data. Jürges (2007) and Pfarr et al. (2012) show that SAH measures are not comparable across European countries and construct health indices to correct for reporting heterogeneity. Using data from the Joint Canada/U.S. Survey of Health (JCUSH) from 2002-03, which has been specially designed to compare health outcomes between the two countries, I construct a health index similar to Jürges (2007), by estimating the effects of various health conditions on SAH but also allow for cross country reporting differences by age, gender, education level, and immigrant status. For comparison and to increase the robustness of my results, I construct a second health index using principal component analysis (PCA-index), which

[7] Using the English Longitudinal Survey of Ageing (ELSA) Bago d'Uva et al. (2011) show that the two necessary assumptions that form the foundation of the vignette approach are often not satisfied: "Vignette equivalence", meaning the described health state is perceived the same by all respondents, and "response consistency", requiring respondents to use the same scale to rate their own health and the health status described in the vignette, are violated in the authors' sample in all but one tests.

is another common method used to aggregate health information into one index (see, for example, Poterba et al. (2010), Cutler et al (2013)). Both methods yield very similar results, which makes it less likely that my findings depend on the empirical specification.

Using the constructed health indices, this paper asks two questions. First, how does general health status compare between Canada and the U.S. once reporting heterogeneity is controlled for? Second, how do income-health and education-health gradients differ between the two countries and along the health distribution? By answering these questions, the paper adds a North American perspective to cross-country reporting heterogeneity, which has, for the most part, focused on European countries.[8] Further, my health indices allow to study the effect of socioeconomic status on health along the health distribution and goes beyond previous studies (Eng and Feeny, 2007; Makdissi and Yazbeck, 2014; Sanmartin et al., 2004; O'Neill and O'Neill, 2007). I find Americans and Canadians to be in very similar health for intermediate health levels with some differences in the tails. Americans more often suffer from poor health, Canadians are more often in excellent health. In both countries, socio-economic gradients increase steeply with poor health. While the relationship between educational attainment and health is slightly stronger in the U.S., this difference only results in very minor health differences between the two countries.

The remainder of the paper is organized as follows. Section 2 describes the data. Section 3 presents the construction of the health indices and compares objective health status between the U.S., and Canada. Socioeconomic inequality in health and how this inequality compares between the two countries is assessed in Section 4. Section 5 concludes.

[8] A notable exception is Bago d'Uva et al.(2008), who examine Asian countries.

2 The Joint Canada/U.S. Survey of Health

I use data from the Joint Canada/U.S. Survey of Health (JCUSH) 2002-03. The survey is specifically designed to obtain comparable data between the U.S. and Canada and contains information on physical and mental health, income, education, and demographic characteristics.[9] Data was collected by computer-assisted telephone interviews from 3,505 Canadians and 5,183 Americans aged 18 to 85 living in households to obtain reliable national estimates for three age groups (18 to 44, 45 to 64 and 65 years and older), by sex.[10]

Available health measures include chronic conditions such as asthma, high blood pressure, or diabetes, mental and emotional problems, the pain level, further health problems and conditions such as back problems or whether the individual has ever suffered from a heart attack. Prevalence levels by country are shown in Table 1. Table 2 presents summary statistics of the socioeconomic, demographic and health care utilization variables. Education is grouped into four categories: less than high school, high school graduate or equivalent, college graduate (trades certificate, vocational school, community college, or CEGEP[11]) and university graduate (university or college certificate, including below bachelor). Household income (in US$10,000, corrected for purchasing power).[12] is adjusted for household size by dividing by the square root of the number of household members. After deleting observations with missing information, my sample includes 7,749 individuals with complete health information, which are used for the construction of the indices. Some additional missing values exist in non-health related variables, which are only used in the further decomposition analysis. After deleting observations with missing information in these additional variables, 7,664 individuals remain for further analysis.

[9]The questionnaire is the same for both countries except for questions on health insurance coverage and race, owing to differences in the health systems and population composition, respectively.

[10]Overall response rates are 65.5% for the Canadian sample and 50.2% for the U.S. sample. For more information, see the user guide published by Statistics Canada and United States National Center for Health Statistics (2004).

[11]CEGEPs (Collège d'enseignement général et professionnel) are public general and vocational colleges in Quebec, Canada.

[12]Canadian dollars are converted using the average purchasing power parity of actual individual consumption in 2002 and 2003 (US$1=CAD$0.816, OECD.Stat (2012)).

Table 1: Prevalence of health conditions by country

	Canada	US
Asthma	0.066	0.072
Arthritis**	0.156	0.174
High blood pressure***	0.132	0.173
Pulmonary disease***	0.009	0.017
Diabetes***	0.046	0.063
Heart disease	0.036	0.042
Cronoary disease	0.015	0.017
Angina*	0.021	0.016
Has had heart attack	0.030	0.028
Back problems*	0.104	0.089
Lung problems	0.019	0.017
Weight problems***	0.007	0.017
Needs equipment*	0.042	0.050
Mobility limitations**	0.039	0.049
Other	0.151	0.139
Takes prescription drugs**	0.541	0.568
Depressed		
0	0.890	0.883
1	0.013	0.013
2	0.015	0.016
3	0.022	0.021
4	0.029	0.032
5	0.031	0.035
Emotional problems		
0**	0.827	0.803
1	0.148	0.157
2***	0.025	0.040
Pain		
0	0.836	0.827
1	0.046	0.049
2	0.055	0.052
3**	0.034	0.046
4	0.029	0.027
Difficulties with activities		
0	0.743	0.732
1	0.172	0.159
2***	0.084	0.109
Cognitive problems		
0***	0.738	0.706
1	0.197	0.210
2***	0.064	0.084
N	3,169	4,580

***, **, * denote differences at the 1%, 5%, and 10% significance level. Depressed, emotional problems, pain, difficulties with activities and cognitive problems are ordered from no problems (0) to increasingly severe problems.

Table 2: Summary statistics by country

	Canada	US
Education		
Less than high school ***	0.187	0.109
High school[1] * **	0.309	0.377
College ***	0.219	0.140
University ***	0.284	0.373
Household income (in 1000 US$; if > 0) ***	2.374	2.541
Household income top coded *	0.068	0.081
Household income missing ***	0.254	0.307
Female	0.504	0.517
Age/10	4.436	4.463
Age squared/100	22.481	22.667
Immigrant ***	0.193	0.160
Caucasian ***	0.824	0.726
Marital status		
Married/Partner[1]	0.660	0.645
Widowed	0.052	0.056
Separated/Divorced ***	0.075	0.105
Single *	0.213	0.194
Doctor consultaions		
0[1]	0.169	0.176
1-3	0.475	0.476
4-11	0.262	0.269
12+ **	0.094	0.080
Hospital nights		
0[1]	0.916	0.906
1-4	0.056	0.062
5+	0.028	0.032
No insurance ***	0.000	0.114
N	3,143	4,521

[1]Reference category. Household income is right censored at US$106,000.
***, **, * denote differences in means at the 1%, 5%, and 10% significance level.

3 Objective health indices

To address the problem of comparing health or health inequality across countries without a comparable measure of health, I construct objective health indices. I construct two indices to rule out that my results are driven by the construction of the health measure. While the first method is based on an empirical model to compute the effect of quasi-objective health conditions on an underlying measure of health, the second method relies on the quasi-objective health information without imposing any specific structure.

3.1 The SAH-Index

Following Pfarr et al. (2012) and Jürges (2007), I use SAH in a generalized ordered probit regression to estimate the effect of various health problems on overall health. Moreover, I control for additional factors that might influence answering behaviour. These include age (linear and quadratic term), education, immigrant status and a country dummy. SAH, the dependent variable, is measured in five categories from "poor" (0) to "excellent" (4), thus takes on the values 0, 1, ..., 4. The probability that SAH will take on a certain value is given by:

$$Pr(SAH = 0) = \Phi(-X\beta_0), \tag{1}$$

$$Pr(SAH = j) = \Phi(-X\beta_j) - \Phi(-X\beta_{j-1}),\ j = 1, ..., 3,$$

$$Pr(SAH = 4) = 1 - \Phi(-X\beta_3),$$

where X is a set of exogenous variables and $\Phi()$ is the cumulative standard normal distribution function.

In this general specification, the coefficients β are allowed to vary for each outcome of SAH. To construct a comparable health index, I restrict the model and only allow non health related variables to vary across outcomes to account for possible differences in reporting styles. For all health variables, I assume constant coefficients, that is I impose the proportional odds/parallel line assumption.[13]

Categorical health variables are transformed into a set of dummy variables, indicating different levels of severity. Estimating the model for the entire sample forces the impact of a certain condition to be the same in each country. This assumption ultimately allows one to isolate the effect of reporting heterogeneity, since objective health becomes comparable across individuals.[14] While it is possible for the impact of a disease to vary across countries (e.g. due to treatment options), this difference is arguably very small between the U.S. and Canada (O'Neill and O'Neill, 2007).

Results for the health variables are shown in Table 3. The regression coefficients for the variables with varying cut-points are shown in Table A1 in the Appendix.[15]. The coefficients indicate how much each health problem affects the probability of stating a certain SAH category while all other variables are held constant at their means. Thus the negative coefficients of the health variables reflect that suffering from a health condition decreases the probability of being in good health. I construct the SAH-index as the linear prediction from the ordered probit regression. The predicted value for each variable states the "disability weight" of the health problem, i.e. it states how much the condition reduces health. To simplify interpretation, I normalize the index to lie between 0 and 1, such that 0 refers to the worst observed health state and 1 signifies perfect health. The normalized disability weights are shown in Table 4. Being in severe pain and suffering from diabetes is associated with the largest disability. Somewhat surprisingly, relatively low disability weight are found for having had a stroke or suffering from some depressive symptoms. Relatively low disability weights for severe health problems are plausible if co-morbidities between different conditions reduce the negative health effect of an additional

[13] I use the Stata command gologit2 (Williams, 2006).

[14] This assumption has been questioned (Rebelo and Pereira, 2011) and I formally address this problem in Subsection 3.3.

[15] McFadden's pseudo R-squared for the ordered probit regression is 0.17

Table 3: Ordered probit results: health variables

	Coef.	Std. Err.
Asthma	-0.256***	(0.063)
Arthritis	-0.156***	(0.048)
High blood pressure	-0.325***	(0.046)
Pulmonary disease	-0.535***	(0.161)
Diabetes	-0.568***	(0.071)
Heart disease	-0.459***	(0.099)
Cronoary disease	-0.404**	(0.171)
Angina	-0.214	(0.139)
Has had heart attack	-0.092	(0.123)
Back problems	-0.166***	(0.056)
Lung problems	-0.438***	(0.146)
Weight problems	-0.246 *	(0.135)
Needs equipment	-0.129	(0.107)
Mobility limitations	-0.339***	(0.113)
Other	-0.343***	(0.047)
Takes prescription drugs	-0.138***	(0.039)
Depressed		
1	-0.154	(0.132)
2	-0.121	(0.133)
3	-0.292**	(0.116)
4	-0.121	(0.107)
5	-0.275***	(0.105)
Emotional problems		
1	-0.300***	(0.048)
2	-0.507***	(0.095)
Pain		
1	-0.188**	(0.074)
2	-0.441***	(0.075)
3	-0.572***	(0.084)
4	-1.056***	(0.129)
Difficulties with activities		
1	-0.285***	(0.047)
2	-0.236***	(0.064)
Cognitive problems		
1	-0.196***	(0.042)
2	-0.319***	(0.070)
N	7,749	

***, **, * denote significance at the 1%, 5%, and 10% level.

Table 4: Disability weights

	SAH-Index	PCA-Index
Asthma	-0.044	-0.023
Arthritis	-0.027	-0.054
High blood pressure	-0.056	-0.049
Pulmonary disease	-0.091	-0.072
Diabetes	-0.097	-0.047
Heart disease	-0.078	-0.072
Cronoary disease	-0.069	-0.079
Angina	-0.037	-0.081
Has had heart attack	-0.016	-0.076
Back problems	-0.028	-0.027
Lung problems	-0.075	-0.060
Weight problems	-0.042	-0.017
Needs equipment	-0.022	-0.073
Mobility limitations	-0.058	-0.075
Other	-0.059	-0.04
Takes prescription drugs	-0.024	-0.051
Depressed		
1	-0.026	-0.026
2	-0.021	-0.028
3	-0.050	-0.030
4	-0.021	-0.034
5	-0.047	-0.044
Emotional problems		
1	-0.051	-0.028
2	-0.087	-0.045
Pain		
1	-0.032	-0.040
2	-0.075	-0.047
3	-0.098	-0.058
4	-0.180	-0.076
Difficulties with activities		
1	-0.049	-0.046
2	-0.040	-0.074
Cognitive problems		
1	-0.033	-0.027
2	-0.054	-0.046

health problem.

3.2 The Principal Component Analysis-Index

The second health measure is based on a principal component analysis (PCA) of the set of health variables. This method has, for example, been used by Poterba et al. (2010), who find that such an index can be a good predictor of mortality. PCA is a statistical technique used to reduce the dimensionality of data, to identify patterns while retaining the largest amount of information possible. The principal components of some zero-mean variables x_1, x_2,...,x_n, is a set of linear combinations of theses variables, $a_1'x$, that solves the following problem:[16]

$$\begin{aligned} a_1 &= \arg \max_{||a||=1} Var[a'x] \\ &\vdots \\ a_k &= \arg \max_{\substack{||a||=1, \\ a \perp a_1,...,a_{k-1}}} Var[a'x]. \end{aligned} \tag{2}$$

Solving the eigenproblem for the covariance matrix $\Sigma = Var[x]$ gives:

$$\Sigma a = \lambda\, a, \tag{3}$$

which yields the principal component weights, a, scores, $a'x$, and eigenvalues $\lambda_1 \geq ... \geq \lambda_n$ (Kolenikov and Angeles, 2009).

PCA assumes normality of the included variables. Thus, a key issue is how to deal with binary or ordinal variables. I use a method proposed by Kolenikov and Angeles (2009) based on polychoric and polyserial correlations. In a comparison, the authors find that their method is preferable to the commonly used alternative, outlined in Filmer and Pritchett (2001), of transforming ordinal variables into a set of dummy variables. To

[16] Variables with non-zero means need to be mean centred before PCA can be performed.

estimate polychoric correlation matrices, it is assumed that discrete variables are obtained from an underlying latent normally distributed variable. In a first step, the categorizing thresholds are computed. In a second step, the likelihood function is maximized with respect to the categorizing thresholds and polychoric correlation factors (see Kolenikov and Angeles (2009)). The computed correlation matrix is then used in the eigenvalue problem of Equation 3.

I use the first principal component, $\Sigma a_1 = \lambda_1 a_1$, as the PCA-index.[17] Results are shown in Table A2 in the Appendix. As before, I reverse the sign and normalize the index to lie between 0 and 1, such that 0 refers to the worst observed health state and 1 signifies perfect health. The normalized disability weights are shown in Table 4. Similar to the SAH-index, severe pain is associated with a high disability weight in the PCA-index. In addition, the PCA-index rates suffering from coronary disease and angina as severely reducing health, while asthma and weight problems receive a very low disability weight. By construction, PCA disability weights increase with the severity of the condition, whereas the SAH disability weights may increase or decrease.

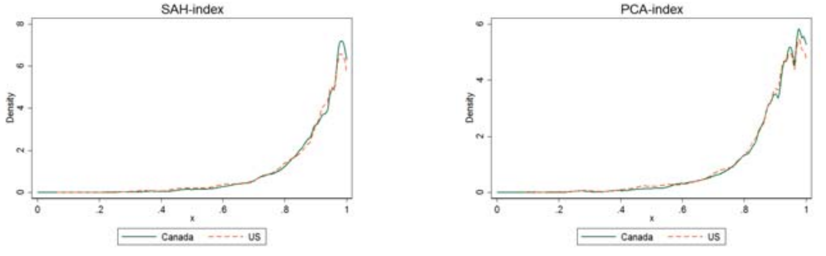
Kernel densities of the indices are shown in Figure 1 by country. Most individuals are in good health, thus the distributions are strongly skewed. While the distributions are for the most part very similar, a higher share of Canadians has a health status close to 1. Based on a two-sample Kolmogorov-Smirnov tests for equality of distribution functions, the distribution functions between countries differ at the 5% significance level for the SAH-index and at the 1% significance level for the PCA-index.

3.3 Oaxaca-Blinder Decomposition

To address the issue of heterogeneous health effects of certain health problems across countries, I perform an Oaxaca-Blinder decomposition of my health indices to test for possible differences in the disability weights between Canada and the U.S. (Oaxaca, 1973;

[17]The first principal component gives the direction of the greatest variability in the data, i.e. it minimizes the residual sum of squares of a regression of the data onto this line (Kolenikov and Angeles, 2009).

Figure 1: Health distribution by country



Blinder, 1973). I estimate health index HI for country i by the linear model

$$HI_i = X_i'\beta_i + \epsilon_i,\ \ E(\epsilon_i) = 0,\ \ i \in \{Can, US\} \tag{4}$$

separately for the U.S. and Canada. X contains the health information (as a set of dummy variables) used to construct the health indices and a constant. The decomposition makes use of the property of the linear model that

$$E(HI_i) = E(HI'\beta_i + \epsilon_i) = E(HI'\beta_i) + E(\epsilon_i) = E(X_i)'\beta_i, \tag{5}$$

since $E(\beta_i) = \beta_i$ and $E(\epsilon_i) = 0$ by assumption.

Equation 5 allows to decompose the predicted mean outcome difference D,

$$D = E(HI_{Can}) - E(HI_{US}), \tag{6}$$

into three components: the endowment effect (E), the difference in coefficients (C), and the interaction term (I).[18] Formally,

$$D = \underbrace{[E(X_{Can}) - E(X_{US})]'\beta_{US}}_{E} + \underbrace{E(X_{US})'(\beta_{Can} - \beta_{US})}_{C} + \underbrace{[E(X_{Can}) - E(X_{US})]'(\beta_{Can} - \beta_{US})}_{I}. \tag{7}$$

Equation 7 can be estimated using OLS estimates of the parameters and replacing the expected values by the respective sample averages (Firpo et al. 2007).

Differences in the prevalence of conditions are captured by the endowment effect, whereas differences in the impact of conditions on health are explained by the difference in coefficients.[19] Finally, the interaction term states the difference in means caused by differences in the prevalence of conditions and difference in coefficients occurring together. The validity of the health indices discussed above relies on the assumption that the difference in coefficients is negligible.

The results of the Oaxaca-Blinder decompositions are shown in Table 5. For each health index, the cross-country difference in health can almost entirely be explained by endowment differences. Both the differences in coefficients and the differences caused by the interaction effect are negligible, thus supporting the assumption that the impact of a disease is the same for each country. On average, health is slightly higher in Canada relative to the U.S. with a difference of 0.011 for each of the indices, which is in line with findings by Makdissi and Yazbeck (2014). The slightly lower average health predicted by the PCA-index might be caused by the fact that PCA disability weights increase with the severity of the condition and possible diluting effects of co-morbidities are ignored.

A difficulty that arises with the use of health indices is how to interpret score differences. As a benchmark, I apply the criteria used for the HUI3 index and consider a score difference of 0.01 as potentially clinically important and a difference of 0.03 as

[18] Estimation of the three components is performed using the Stata command oaxaca introduced in Jann (2008).

[19] Equation 7 uses the U.S. as a reference point; that is it measures the resulting difference if the U.S. had Canada's prevalence of conditions and coefficients (Jann, 2008).

Table 5: Oaxaca-Blinder Decomposition

	SAH-Index		FA-Index	
	Coef.	Std. Err.	Coef.	Std. Err.
Mean health status in Canada	0.896	0.002	0.889	0.002
Mean health status in the U.S.	0.882	0.002	0.879	0.002
Difference in health statuses	0.011	0.003	0.011	0.003
Difference in health statuses explained by:				
Endowment effect	0.011	0.003	0.011	0.003
Coefficient effect	8.85e-10	5.53e-10	4.19e-10	4.19e-10
Interaction effect	-1.49e-10	1.58e-10	5.01e-11	1.33e-10

clearly clinically important (Horsman et al., 2003).[20] Hence, average health in the U.S. and Canada is only potentially different from a clinical perspective.

3.4 Cross-country reporting heterogeneity and differences in objective health

This section compares the health indices with SAH to analyze reporting differences between the U.S. and Canada. Cross-country reporting heterogeneity is present if comparisons based on SAH yield different results than comparisons based on the objective health indices. To test for country-specific reporting styles, I construct (for each index) an adjusted general health variable (adjusted SAH) by dividing the index distribution into five intervals according to the categories of SAH. The threshold values for each interval can be arbitrary, but need to be the same across respondents. I compute the cut-off points such that the share of respondents reporting to be in a given health category is the same for SAH and for the newly construced variables.[21] This way, individuals are assigned a health category using the average respondent's definition of health (Jürges, 2007).

Table 6 shows the (weighted) percentages of people reporting the different categories

[20] I implicitly assume here that changes in the HUI3 and in our health indices are comparable. As the HUI3 and our indices have similar distributions and are highly correlated (80% and 74% for the SAH-index and the PCA-index, respectively) this assumption does not seem overly strong.

[21] If, for example, 3% of all respondents reported to be in poor health, the cut-off point between poor and fair is the third percentile of the (unweighted) health index distribution of both countries combined.

of adjusted SAH by country and standardized by age and sex. In line with the findings by Jürges (2007), cross-country differences in self-reported health become smaller for adjusted SAH. In particular, I no longer find a significant difference in intermediate health statuses between Canadians and Americans once reporting heterogeneity is controlled for. However, both indices indicate that Americans more often suffer from poor health than Canadians but more Canadians are in excellent health, which is contrary to the finding based on self-reported health. Without adjustment, Americans report "fair" and "excellent" health more frequently, but "very good" health less frequently than Canadians.

Table 6: SAH and adjusted SAH categories

	All		Insured		White	
	Canada	US	Canada	US	Canada	US
SAH						
poor	2.89	3.23	2.89	3.31	2.82	2.73
fair	7.56***	9.67***	7.56**	9.06**	7.70	7.26
good	27.14	26.25	27.14*	25.16*	25.69	25.40
very good	37.56***	33.61***	37.56**	34.46**	38.36	36.18
excellent	24.86**	27.23**	24.86***	28.00***	25.44**	28.43**
SAH-Index						
poor	2.21***	3.47***	2.21***	3.57***	2.19*	2.88*
fair	7.63	8.19	7.63	8.28	7.85	8.15
good	25.83	25.73	25.83	25.67	26.61	26.33
very good	41.17	41.63	41.17	42.45	41.03	42.95
excellent	23.16*	20.98*	23.16***	20.03***	22.32**	19.68**
PCA-Index						
poor	2.30***	3.37***	2.30***	3.56***	2.34	2.97
fair	7.38	7.98	7.38	8.16	7.75	7.97
good	25.62	25.77	25.62	26.13	26.51	26.83
very good	37.05	37.84	37.05	38.34	36.99	38.72
excellent	27.65**	25.04**	27.65***	23.81***	26.42**	23.51**
N	3,169	4,580	3,169	4,105	2,654	3,531

***, **, * denote significant difference between the U.S. and Canada at 1%, 5%, and 10%. Age and sex adjusted percentages.

As a sensitivity analysis, I repeat my analysis but exclude uninsured Americans; it does not change my general findings. When I restrict the sample to whites only (to account for the different proportions of non-whites in the two countries), the samples become more homogeneous and the cross-country health differences become smaller. However, the finding that the health indices show Canadians to be more often in excellent health while the self-reported measure states the opposite remains.

4 Socioeconomic inequality

Above results show that Americans and Canadians differ in their response behaviour when it comes to SAH. As a consequence, health comparisons based on self-reports misstate actual differences in population health between the two countries. For my further empirical analysis, I rely on the objective health indices introduced above to be able to make unbiased cross-country comparisons. I first analyze socioeconomic inequality within each country and present graphical results, then I test whether inequality differs between countries. Each time, I focus on the effect of socioeconomic factors across the health distribution.

There are several reasons to expect income and education to be positively correlated with health. Highly educated people may find it easier to navigate through the health system, communicate their medical needs or follow a treatment plan. In addition, healthy behaviours such as physical activity, healthy body weight and non-smoking are strongly linked with higher education (O'Neill and O'Neill, 2007; Jürges, 2009). With respect to income, more affluent people can better afford insurance coverage or treatments that are not covered under their insurance plan. Similarly, costly services inaccessible to lower-income individuals, such as personal training or nutritional advice, may facilitate a healthy lifestyle. While a public health system tries to eliminate socioeconomic health inequality as much as possible, interconnections between health and socioeconomic status make it difficult for any health system to overcome socioeconomic differences in health outcomes. For this reason, and because my analysis relies on a cross-section of individuals, I do not attempt a causal interpretation of the relationship between socioeconomic status and health.

4.1 Health gradients

Using the health indices introduced above, I analyze socioeconomic inequality in the U.S. and Canada by estimating education-health and income-health gradients for the two countries. Such socioeconomic gradients in health describe the universally found link between a lower socioeconomic position and worse health outcomes (Feinstein, 1993). I estimate socioeconomic gradients by the unconditional quantile regression estimator proposed by Firpo et al. (2009), which allows me to analyze the effect of income and education on different percentiles of the (unconditional) distribution of the health indices. Contrary to ordinary least squares (OLS) regression analysis, which looks at average effects, this approach does not force the effect of socioeconomic status on health to be the same for individuals in poor and in good health. Hence, I can determine whether the correlation between socioeconomic status and health is different for individuals with different health levels.

In an additive model of health,

$$HI_i = X_i'\beta_i + \epsilon_i,\ E(\epsilon_i) = 0,\ i \in \{Can, US\}, \tag{8}$$

where X stands for the socioeconomic, demographic and health care utilization-related variables described in Section 2, the gradients are given by the unconditional quantile partial effect (UQPE)

$$UQPE = \frac{\partial q_\tau}{\partial x}. \tag{9}$$

q_τ denotes the τth quantile of the health index, HI, and x denotes socioeconomic status, which is measured by household income and educational attainment to compute the income-health and education-health gradients, respectively. The UQPE for income, for example, states the effect on the health index at the τth quantile from a small increase in household income, while all other variables are held constant.

Let F_{HI} stand for the distribution of the health index. The estimation of the UQPEs relies on the influence function (IF), which gives the influence of an individual observation on the quantile τ, and the recentred influence function (RIF). For quantile τ, the IF is given by

$$IF(HI; q_\tau, F_{HI}) = \frac{\tau - I(HI \leq q_\tau)}{f_{HI}(q_\tau)}, \tag{10}$$

where f_{HI} denotes the density function of the health index and $I()$ is an indicator function which equals 1 if its argument is true and 0 otherwise. The recentred influence function is defined by

$$RIF(HI; q_\tau, F_{HI}) = IF(HI; q_\tau, F_{HI}) + q_\tau, \tag{11}$$

which in expectation is equal to q_τ.

Firpo et al. (2009) show that the UQPEs are given by the parameter estimates of the "unconditional quantile regression", an ordinary least squares regression of the estimated RIF on the control variables. Their method yields consistent estimates if $Pr[HI > q_\tau | X = X_i]$ is linear in X_i, where X denotes the control variables (Firpo et al., 2009).

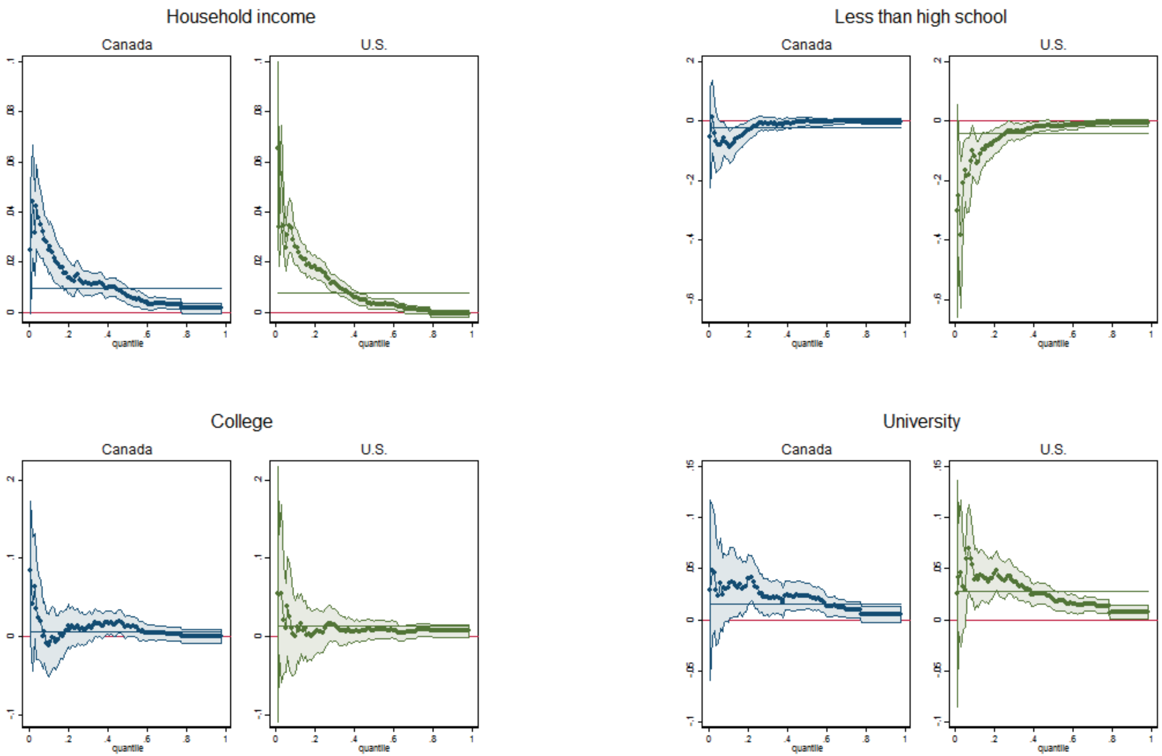
The density functions required for the estimation of the RIF are estimated using Gaussian kernel. As the distributions of the health indices are strongly skewed to the left with most people being in relatively good health, I follow Silverman (1986) to avoid oversmoothing and calculate the optimal bandwidth, h, as

$$h = 0.9\, min(\hat{\sigma}, IQR/1.349)\, n^{-1/5},$$

where $\hat{\sigma}$ is the standard deviation, IQR is the interquartile range defined by the difference between the third and first quartiles of the health index, and n is the sample size. The formula yields optimal bandwidths of 0.02. As I am interested in comparing socio-economic inequality across the U.S. and Canada, I run separate regressions for each country.[22]

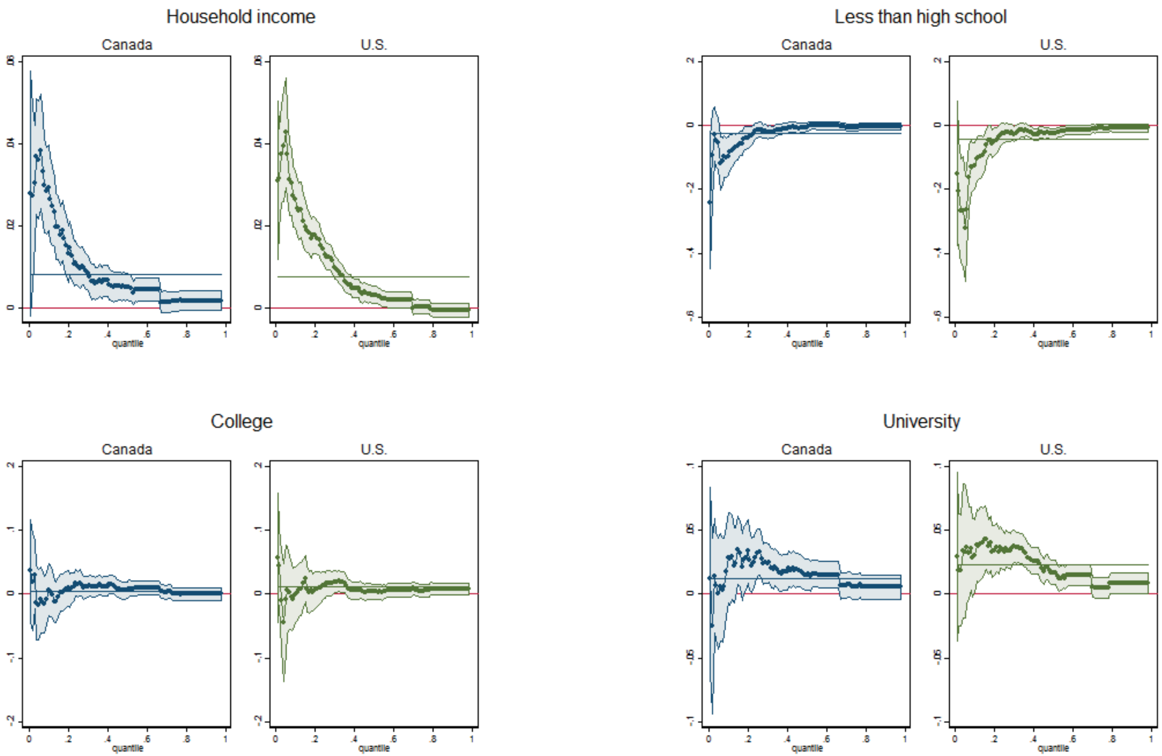
[22] I use the Stata program rifreg to estimate the unconditional quantiles. The program is downloadable from Nicole M. Fortin's homepage http://faculty.arts.ubc.ca/nfortin/datahead.html.

Figure 2: Education-Health and Income-Health Gradients: Results using the SAH-index



Shaded areas indicate the 95% confidence interval of the UQPE estimates. The OLS gradients are statistically significant at the 1% level for "less than high school", "university" and "household income" in both countries. The college OLS-gradient is significant at the 5% level in the U.S. The country specific OLS estimates are statistically different at the 5% level for "Less than high school" and "University".

Figure 3: Education-Health and Income-Health Gradients: Results using the PCA-index



Notes: Shaded areas indicate the 95% confidence interval of the UQPE estimates. The OLS gradients are statistically significant at the 1% level for "less than high school", "university" and "household income" in both countries. The college OLS-gradient is significant at the 5% level in the U.S. The country specific OLS estimates are statistically different at the 10% level for "Less than high school" and "University".

The results for the income and education variables for both OLS and unconditional quantile regressions are shown in Figure 2 for the SAH-index and in Figure 3 for the PCA-index. In both Canada and the U.S., socio-economic status is strongly associated with better health but the correlation is much stronger for lower levels of health. An increase in household income of US$10,000 for all households would increase the health status (as measured by either index) of people in the lowest health decile by approximately 0.03 in both countries, which is considered clinically important. The median health level would only improve by less than 0.01, which is no longer clinically important. The OLS estimates of the income-health gradients are statistically different from zero but only marginally important in a clinical sense. As OLS estimates an average effect, the estimate cannot capture the influence of the initial health level on the gradient.

The gradients for less than high school and university education are generally slightly steeper in the U.S. than in Canada for low health outcomes, though the differences are not statistically significant. In particular for individuals with less than high school education in the U.S., the association between low health status and educational attainment is striking. In Canada, the effects are somewhat smaller, but still clinically important. Compared to high school graduates, college graduates have similar health outcomes.

4.2 Differences in socioeconomic inequality

Above results present socioeconomic health gradients separately for each country. A comparison of the magnitude of socioeconomic inequality between the two countries based on these health gradients is difficult, however, as the population in the U.S. differs from the one in Canada in the distribution of educational attainment and income as shown in Table 2. Such endowment differences will have consequences for health outcomes even with equal levels of socioeconomic inequality.

In this subsection, I quantify cross-country differences in socioeconomic inequality by assessing its effect on health outcomes while controlling for differences in population characteristics. Specifically, I test whether health outcomes between Canada and the

U.S. differ because of different population characteristics or because the effects of these characteristics on health differ. The methodology relies on an extension of the Oaxaca-Blinder decomposition by Firpo et al. (2007). In their paper, the authors introduce a two-stage procedure based on a reweighting method and RIFs, which extends the Oaxaca-Blinder method from the mean to any distributional statistic of interest.

In the first stage, the distribution of the health index HI in country i, is constructed under counterfactual endowments (i.e. using country j's population characteristics) by reweighting the data. Under the assumption of ignorability and common support, reweighting identifies the difference between the distributions due to endowment differences and due to differences in the coefficients.[23]

In the second stage, the distribution of interest is expressed in terms of the expected value of its RIF. Using the law of iterated expectations, the unconditional quantile q_τ can be expressed as

$$q_\tau = E(RIF(HI; q_\tau, F_{HI})) = E_X[E(RIF(HI; q_\tau, F_{HI})|X)] = E[X]\beta, \tag{12}$$

which generalizes the Oaxaca-Blinder decomposition to any distributional statistic and allows the detailed decomposition by each variable of interest.

As before, I focus on different quantiles of the health distribution. Using Firpo et al.'s (2007) reweighting method, I construct counterfactual health distributions that would occur had Canada and the U.S. the same population composition and decompose the observed difference in health levels between the U.S. and Canada in differences caused by the endowment effect (differences in the population composition) and differences caused by the coefficient effect (differences in the effect of the explanatory variables) at each decile. While differences in endowments due to differences in the population composition

[23]Ignorability assumes that the error term is independent across groups (Canada and the U.S.) given the covariates. Overlapping support requires the probability of belonging to group j strictly lies between zero and one, conditional on the covariates (Firpo et al. 2007). Overlapping support does not hold for the health insurance dummy as all Canadian respondents have health insurance. However, this does not affect the interpretation of the overall decomposition or the detailed decomposition with respect to the socioeconomic variables.

may lead to different health levels given the same level of inequality, differences in the coefficients of the socioeconomic variables reflect differences in the degree of inequality between the two countries. The interaction effect captures differences in health outcomes as a result of differences in endowments and coefficients occurring together.

The decomposition results are shown in Table 7. I report results for the 25th, 50th, and 75th quantile of the health distribution. Average health is higher in Canada, though the effect decreases with better health. The endowment effect is negative, hence health status in the U.S. would decrease in the counterfactual situation that the U.S. had Canada's endowments. Yet, the size of the effect is small and becomes negligible as health improves. The coefficient effect is potentially clinically important at the 25th quantile and for the SAH-index also at the 50th quantile, suggesting that differences in coefficients significantly contributes to the difference in health outcomes. The contribution of the socioeconomic variables can be further analyzed by the detailed coefficient effect. As Oaxaca-Blinder decomposition for categorical variables is sensitive to the omitted category, I normalize the effect for educational attainment and present coefficient effects for all four levels of educational attainment, including the reference category (Jann 2008). Due to the lower correlation between health and education, health level in the U.S. would increase slightly if the U.S. had the same relationship between less than high school completion on health but would increase slightly given the same coefficient effects for college or university education. The direction of the coefficient effect for income is ambiguous.[24] However, none of the effects is clinically important. Thus, while the relationship between educational attainment, and health is slightly stronger in the U.S., these differences only result in very minor differences in population health between the two countries.

[24]The cross-country comparison of the income measure is also made difficult by the necessary transformation of currency and purchasing power, which potentially influences the results.

Table 7: Differences in socioeconomic inequality between the U.S. and Canada

	SAH-Index			PCA-Index		
Quantile	25th	50th	75th	25th	50th	75th
Predicted health status in Canada	0.837***	0.932***	0.982***	0.835***	0.919***	0.972***
	(0.004)	(0.002)	(0.001)	(0.004)	(0.002)	(0.002)
Predicted health status in the U.S.	0.821***	0.920***	0.978***	0.818***	0.913***	0.967***
	(0.004)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)
Difference	0.016***	0.012***	0.004**	0.017***	0.006**	0.005**
	(0.005)	(0.003)	(0.002)	(0.005)	(0.003)	(0.002)
Difference in predicted health statuses explained by:						
Endowments	-0.009**	-0.002	-0.001	-0.007*	-0.003	-0.001
	(0.004)	(0.002)	(0.001)	(0.004)	(0.002)	(0.001)
Coefficients	0.024***	0.015***	0.005***	0.025***	0.008***	0.005**
	(0.005)	(0.003)	(0.002)	(0.005)	(0.003)	(0.002)
Interaction	-0.000	-0.001	-0.000	-0.000	0.000	0.001
	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)
Detailed coefficient effects for:						
Less than high school completion	0.004***	0.001**	0.000	0.002**	0.001**	0.000
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
High school graduation	-0.003	-0.002	0.001	0.001	-0.002	-0.000
	(0.003)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)
College graduation	-0.002*	0.000	-0.000	-0.002	0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
University graduation	-0.005	-0.002	-0.002	-0.004	-0.003**	-0.000
	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)
Household income/1000	-0.003	0.009*	0.003	-0.004	0.005	0.002
	(0.009)	(0.005)	(0.003)	(0.008)	(0.004)	(0.003)

***, **, * denote significance at the 1%, 5%, and 10% level. Standard errors in parentheses. N=7,664.

5 Conclusion

In this paper I construct two objective health indices to control for heterogeneous reporting behaviour and compare health status in the U.S. and Canada. The results show that – despite fundamental differences in the countries' health systems – differences in SAH overstate objective health differences for intermediate health statuses and can largely be explained by different response behaviours rather than by differences in health between Americans and Canadians. Even though reporting differences between the U.S. and Canada are relatively small, the problems related to the use of subjective health measures could easily be magnified for countries that are less similar.

However, health differences in the tails of the health distributions remain. One notable difference is the higher proportion of Americans with low health status. This finding is not driven by a lower health status of minorities or lack of health insurance at the time of the JCUSH interview. Canada's publicly provided health insurance remains nevertheless a possible explanation for this finding, as I cannot observe past periods of being uninsured or the cost of private insurance. Contrary to the SAH measure, objective health measures also show that Canadians are more likely to be in excellent health than Americans. Hence, the much higher per capita health expenditures in the U.S. do not lead to better health for Americans at the very top of the health distribution.

In both countries, income and educational attainment are positively related to health outcomes with much steeper gradients for individuals with poor health. Compared to simple OLS estimates, my results predict a larger effect of socioeconomic variables at the bottom of the health distribution and a smaller effect at the top. This finding is especially important for the design of policies that target socioeconomic health inequalities, as they need to take the differential impact into account in order to attain their goal and to allocate resources efficiently.

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Appendix

Table A1: Ordered probit results with varying cut–points

	poor–fair	fair–good	good–v.good	v.good–exc.
US	0.053	-0.175***	-0.057	0.108***
	(0.088)	(0.052)	(0.038)	(0.039)
Age/10	-0.303*	-0.090	-0.091	-0.170**
	(0.172)	(0.103)	(0.074)	(0.076)
Age squared/100	0.028*	0.008	0.010	0.016**
	(0.015)	(0.010)	(0.007)	(0.008)
Female	0.084	0.014	0.054	0.030
	(0.093)	(0.061)	(0.043)	(0.044)
Less than high school	-0.205	-0.327***	-0.262***	-0.058
	(0.125)	(0.087)	(0.078)	(0.088)
College	-0.056	0.124	0.136**	0.162**
	(0.142)	(0.094)	(0.062)	(0.065)
University	0.309**	0.380***	0.407***	0.293***
	(0.140)	(0.075)	(0.050)	(0.051)
Immigrant	-0.338**	-0.549***	-0.435***	-0.096
	(0.140)	(0.076)	(0.058)	(0.061)
Constant	3.982***	2.508***	1.070***	0.028
	(0.464)	(0.254)	(0.174)	(0.176)
N	7,749	7,749	7,749	7,749

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2: Scoring coefficients

		Coef.
Asthma	0	-0,013
	1	0,174
Arthritis	0	-0,076
	1	0,365
High blood pressure	0	-0,068
	1	0,335
Pulmonary disease	0	-0,009
	1	0,582
Diabetes	0	-0,024
	1	0,366
Heart disease	0	-0,025
	1	0,571
Coronary disease	0	-0,011
	1	0,642
Angina	0	-0,011
	1	0,659
Has had heart attack	0	-0,018
	1	0,604
Back problems	0	-0,020
	1	0,203
Lung problems	0	-0,009
	1	0,482
Weight problems	0	-0,002
	1	0,135
Needs equipment	0	-0,030
	1	0,571
Mobility limitations	0	-0,030
	1	0,587
Other	0	-0,046
	1	0,282
Takes prescription drugs	0	-0,239
	1	0,183
Depressed	0	-0,033
	1	0,182
	2	0,194
	3	0,211
	4	0,244
	5	0,328
Emotional problems	0	-0,050
	1	0,180
	2	0,317
Pain	0	-0,074
	1	0,252
	2	0,312
	3	0,399
	4	0,554
Difficulties with activities	0	-0,125
	1	0,252
	2	0,480
Cognitive problems	0	-0,078
	1	0,148
	2	0,298
N		7,749