

# The shape of the relationship between income and self-assessed health: an international study

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**Background** The relationship between income and health is usually thought to be curvilinear, but previous studies have yielded inconsistent results. We therefore examined the shape of the relationship between household equivalent income and self-assessed health in seven European countries.

**Methods** Data were obtained from nationally representative health, level of living, or similar surveys in Belgium, Denmark, England, Finland, France, The Netherlands, and Norway and applied to men and women aged 25 years and older in the 1990s. Smooth nonparametric curves were fitted to the data, as well as a spline regression function with three linear pieces connected by two knots.

**Results** A higher household equivalent income is associated with better self-assessed health among men and women in all countries, particularly in the middle-income range. In the higher income ranges, the relationship is generally curvilinear and characterized by less improvement in self-assessed health per unit of rising income. In the lowest income ranges, the relationship is found to be curvilinear in four countries (Belgium, Finland, The Netherlands, and Norway), where the usual deterioration of health associated with lower incomes levels off or even reverses into an improvement.

**Conclusions** Further research is necessary to investigate the background of differences between countries in the shape of the relationship between income and self-assessed health, and should focus on both methodological and substantive explanations. Assuming causality, the results of our study lend some support to the notion of decreasing marginal health returns of a unit increase in income at the higher income ranges.

**Keywords** Income, self-assessed health, inequalities

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Income is strongly associated with health. The relationship between income and health is usually thought to be curvilinear, in the sense that the beneficial health effects of an increase in income seem to be greater at lower income levels than at higher income levels. This is clearly the case in international analyses of national income versus life expectancy at birth: the life expectancy curve rises more steeply in the lower ranges of national income than in the higher ranges.<sup>1</sup> Whether it is also true at the individual level, however, is not entirely clear, because the empirical evidence from industrialized countries is inconsistent. For mortality, both linear and curvilinear associations have been reported. A study from the USA has reported a strongly curvilinear relationship,<sup>2</sup> whereas a study

from Finland has reported a nearly linear association.<sup>3</sup> For morbidity the form of the relationship has been reported to vary between different health measures,<sup>4</sup> although a number of British studies have reported a nonlinear relationship for the most commonly used health indicators such as self-assessed health and long-standing illness.<sup>5–7</sup> In Finland, the evidence supports a more linear association,<sup>8,9</sup> while the evidence from Sweden suggests a curvilinear association.<sup>10</sup>

The shape of the individual-level relationship between income and health is important for several reasons. First, it provides insights into the explanation of income-related health inequalities. If the relationship is strongly curvilinear, in the sense that health declines much more rapidly at lower levels of income, it is likely that the direct effects of a (very) low income (i.e. poverty and other disadvantageous material circumstances) are involved. If, on the other hand, the relationship is more linear in nature, with health declining at a constant rate with declining income, the explanation is more likely to be in terms of more subtle mechanisms, including indirect effects of lower income through behavioural and psychosocial factors, just as in the case of health gradients by occupational class and level of education.<sup>11</sup> Second, the shape of the relationship between individual income and health is also important from a policy perspective. In the case of a curvilinear relationship, with the marginal health benefits of higher incomes diminishing or perhaps even disappearing in the higher income ranges, there would be a powerful argument for income redistribution as a measure to improve average population health. In that case one would expect that at the same level of aggregate income larger income inequalities are related to lower levels of average population health.<sup>12</sup>

This article examines the shape of the relationship between household equivalent income and self-assessed health among men and women using health interview or similar surveys in seven European countries.

## Materials and methods

### Data

Data were obtained from nationally representative health, level of living, or similar surveys from Belgium, Denmark, England, Finland, France, the Netherlands, and Norway. The data cover men and women aged 25 years and older and were compiled in the framework of the SEdHA (Socio-Economic determinants of Healthy Aging) study, a concerted action sponsored by the European Union. Table 1 gives an overview of the countries included, their surveys, and the basic characteristics of each survey. All surveys included in this study contained data from the 1990s. The number of respondents varied widely, and there was also a wide range in the nonresponse rates of the different surveys. Most of the income data were self-reported, but the Finnish and Norwegian data are based on linkage with the tax register. For Belgium, Finland, The Netherlands, and Norway net income was measured, whereas for Denmark, England, and France gross income was used. Income components included in the measurement also differed among countries: while the measurement of income in Belgium, England, Finland, and Norway attempted to be all-inclusive, other countries were less explicit in their questions or excluded one or more components (e.g. all allowances in Denmark, child benefits in The

Netherlands). The appendix contains more detailed information on the way income was measured and categorized.

We used household equivalent income as our independent variable. Household equivalent income was calculated by summing the yearly income of all household members and then dividing this sum by the square root of the household size. For countries in which income was measured in classes, we took the mid-point of the income class but calculated the income level of the lowest class as two-thirds of its upper limit and the income level of the highest class as four-thirds of its lower limit. In order to make absolute incomes roughly comparable across countries we converted national currencies into US dollars using 1999 purchasing power parities (PPP).

We used self-assessed health (SAH) as a health indicator. This measure was available in all surveys and was measured in a nearly identical way in all surveys by use of a single-item question ('How is your health in general?') with answer categories on a five-point nominal scale, mostly in the form of 'very good', 'good', 'fair', 'bad', 'very bad'. In the analysis we used the five-point scale as a continuous outcome (with 'very good' being counted as 1 and 'very bad' as 5) and calculated average values of self-assessed health per level of income.

### Analyses

We started the analysis in an exploratory way, by fitting smooth nonparametric curves to the data. Several techniques were examined but these generally led to the same results. We finally selected the LOESS-function as provided by the S-Plus package for presentation.<sup>13</sup> This is a locally weighted regression smoother, in which the income axis is divided into very small parts and linear regression lines are fitted to each part. The central parts of these regression lines are then combined, so that each income value adds one fitted value to the smoothed line. In order to avoid extreme sweeps at the lower and upper ends of the curve, the LOESS-function was forced to end in small stretches of a straight line. The analysis assumes normally distributed residuals and uses ordinary least squares for fitting. Analyses were carried out separately for men and women and were corrected for age by a separate LOESS-function.

After inspection of the LOESS-functions we constructed parametric models in order to be able to characterize the form of the relationship between income and self-assessed health quantitatively, and to test differences between countries statistically. The LOESS-functions suggested that over the middle part of the income range the relationship with self-assessed health is generally approximately linear. In some countries, however, the curve seemed to bend at lower and/or at higher incomes, and we therefore decided to fit a spline with three linear pieces, where the knots were restricted to the first and last quartiles of the income range.<sup>14</sup> We decided to impose these restrictions because a more freely chosen model would make it impossible to compare the results among countries. For example, if one would let the number of segments (and knots) be determined entirely by the statistical significance of the results, countries with larger surveys (Table 1) would get a model with more segments (and knots), even if the shape of the relationship between income and self-assessed health were similar. This would make it impossible to compare the steepness of the slope of a certain segment among countries. Also, if one did not impose restrictions on where the (fixed number of)

**Table 1** Countries and surveys included in the study

Country	Survey	Year	No. of people in analysis	Non-response rate (%)	Income data			
					Source	Components	Classification	Income unknown (%)
Belgium	Belgium Health Interview Survey	1997	6 565	40	Self-report	Net	Continuous	5
Denmark	The Danish Health and Morbidity Survey	1994	3 534	22	Self-report	Gross	11 groups	4
England	Health Survey for England	1997	6 671	29	Self-report	Gross	31 groups	11
Finland	Survey on Living Conditions in Finland	1994	7 530	27	Tax register	Net	Continuous	0
France	Enquête sur la Santé et les Soins Médicaux	1991–92	6 419	34	Self-report	Gross	10 groups	7
The Netherlands	Permanent Survey on Living Conditions	1997–99	22 144	43	Self-report	Net	Continuous	18
Norway	Health Survey	1995	6 706	25	Tax register	Net	Continuous	0

knots were laid, countries could get a model with two knots in the lower income range and no knot in the higher income range, and vice versa. This would make it impossible to compare the degree of curvature in a certain part of the income range among countries. Because in most countries the bends identified by visual inspection clearly fell within the first and last quartiles of the income range, we chose these as restrictions for the segmented spline analysis.

In formula form:

$$Y = \alpha + \beta_1 \cdot HH + \beta_2 \cdot (HH - \gamma_1)_+ + \beta_3 \cdot (HH - \gamma_2)_+$$

where

$(X)_+$  stands for  $X$  if  $X > 0$ , 0 otherwise;

$\alpha$  is expected SAH when  $HH = 0$ ;

$HH$  is household equivalent income;

$\beta_1$  is the slope in the part up to the knot  $HH = \gamma_1$ ;

$\beta_1 + \beta_2$  is the slope in the part between knots  $HH = \gamma_1$  and  $HH = \gamma_2$ ;

$\beta_1 + \beta_2 + \beta_3$  is the slope in the part after knot  $HH = \gamma_2$ .

As this is not a linear model (both  $\gamma$  and  $\beta$  have to be estimated), fitting was done with a grid search, restricted to the lowest and highest quartiles. To get confidence limits we bootstrapped the datasets 100 times and took the 2.5 and 97.5 percentiles of the parameter estimates.

Because of limited space, we do not present graphs of the segmented spline models in this article. Interested readers are referred to additional web figures available at *IJE* Online, which present, for each country–gender combination, the original datapoints, the fitted LOESS-function, and the fitted spline model.

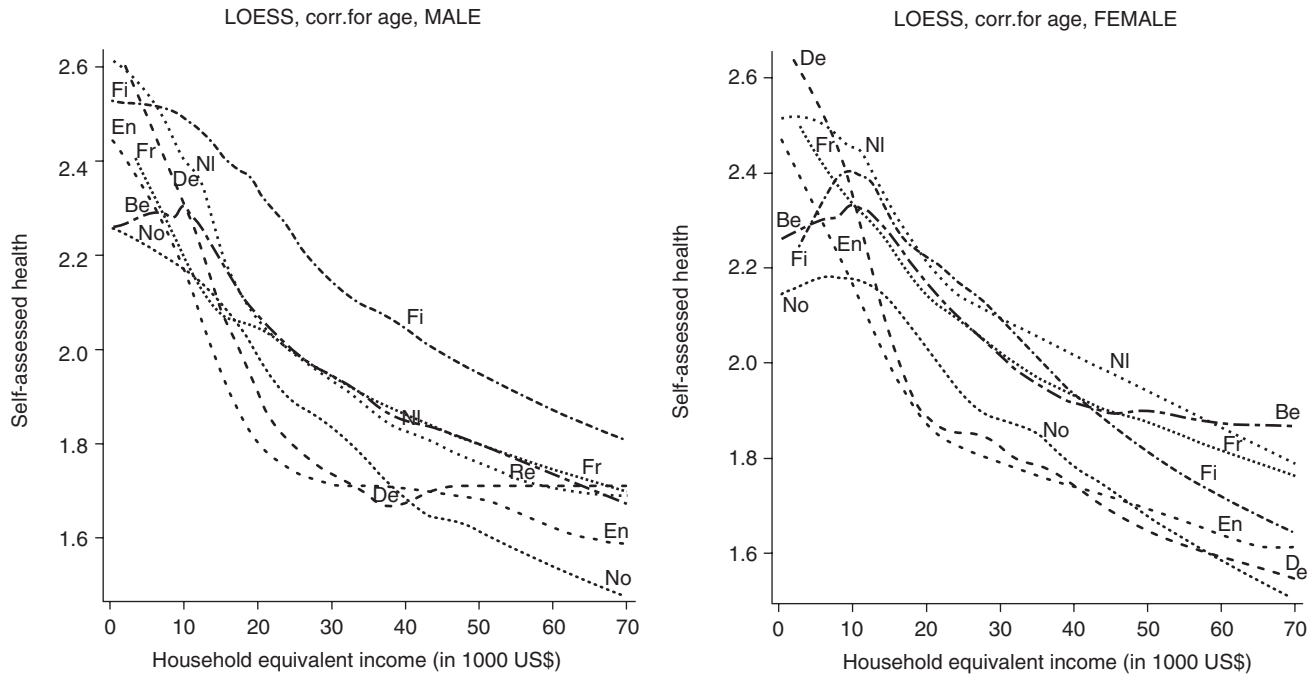
## Results

Figure 1 shows the form of the relationship between income and self-assessed health on the basis of the LOESS regression smoother, for men and women separately. Generally, self-assessed health improves with higher income levels, but the curves are

steeper in the lower than in the higher income ranges. This curvilinearity can be seen in Belgium, Denmark, England, France, and The Netherlands, but it is less clear in Finland and Norway, particularly among women. In addition, Belgium, Finland, The Netherlands, and Norway show another nonlinearity at the lowest income levels, where the decline of self-assessed health associated with lower incomes levels off, or where health actually improves below ~\$10 000 annual household equivalent income. Although this nonlinearity is present among both men and women, it appears to be stronger among women.

Tables 2 and 3 present the parameter estimates obtained with the segmented spline model. Because we imposed a model with two knots, three segments were fitted, each with its own slope. Table 2 presents some information about the knots and about the statistical significance of the difference between the slopes of the first and second segments, and the second and third segments, respectively. In some countries the slope of the first segment differs statistically significantly from that of the second segment: Belgium (men and women), Finland (women only), The Netherlands (women only), and Norway (women only). This first knot represents the levelling-off or reversal of the income–health association we observed in Figure 1. For most populations there is a reasonable correspondence between the position of the first knot as estimated in the segmented spline analysis and the curvature suggested by the LOESS-function. Belgian men are an exception: because of the restrictions imposed on the lower end of the LOESS-function, the curvature occurs at a higher income level than the more freely chosen spline model suggests (see additional web figures). In the other countries there appears to be little reason for imposing the first knot (or for interpreting its position).

The second knot connects two segments with statistically significantly different slopes in nearly all countries. This shows that there is a measurable change in the steepness of the curve in the upper income range in all countries. Although the second knot has been restricted to lie within the fourth quartile of the income distribution, its position varies substantially among countries in terms of absolute income. For most countries,



**Figure 1** The form of the relationship between household equivalent income ('000 dollars, PPP-adjusted) and self-assessed health. Key: Be, Belgium; De, Denmark; En, England; Fi, Finland; Fr, France; NI, The Netherlands; No, Norway

**Table 2** Parameter estimates: knots and differences between slopes

	First knot ['000\$ (95% CI)]	P-value first vs second slope	Second knot ['000\$ (95%CI)]	P-value second vs third slope
<b>Men</b>				
Belgium	0 (0–10)	0.02	40 (29–74)	0.00
Denmark	17 (6–19)	0.34	33 (32–42)	0.02
England	7 (3–10)	0.30	29 (26–29)	0.00
Finland	10 (6–15)	0.18	34 (28–54)	0.00
France	13 (5–13)	0.08	64 (26–78)	0.08
The Netherlands	7 (0–28)	0.07	57 (52–83)	0.00
Norway	10 (5–18)	0.86	45 (34–52)	0.00
<b>Women</b>				
Belgium	12 (0–16)	0.01	35 (28–47)	0.00
Denmark	15 (4–15)	0.18	51 (28–51)	0.16
England	6 (2–8)	0.92	26 (25–29)	0.00
Finland	10 (7–11)	0.01	38 (24–58)	0.00
France	9 (5–12)	0.90	35 (25–55)	0.00
The Netherlands	7 (0–16)	0.01	63 (54–98)	0.00
Norway	5 (5–15)	0.02	46 (31–70)	0.00

P-values: two-tailed test.

however, Figure 1 shows that this knot does not correspond with a clear bend in the curve, but rather signifies a gradual change in its steepness. Thus, there appears to be little point in trying to interpret its exact location.

Table 3 presents the parameters for the slopes of the second and third segments. For example, for Belgian men the slopes of the second segment is estimated to be  $-0.17$  (95% CI:  $-0.12, -0.23$ ), indicating that \$10 000 additional household equivalent income is associated with a decrease of 0.17 points of self-assessed health (scaled from 1 for 'very good' to 5 for 'very bad'). For men and women, the slopes of the second segment are negative in all countries, indicating better self-assessed health at higher income levels within this middle-income range, which

covers at least half of the total income distribution. Among men, all slopes have approximately the same steepness, with the exceptions of England, which has a steeper slope, and France, which has a less steep slope. For women, the slopes are about as steep for men. England again has the steepest slope.

Some of the slopes of the third segment are negative, and others are positive, but the 95% confidence intervals include the null-value in all cases, indicating large uncertainty due to sampling variation. Nevertheless, the slope of the third segment has a less negative value than that of the second segment in all countries. This suggests less improvement of self-assessed health per unit of rising income in the higher income ranges in most countries. Denmark is the only country where there is an indication of

**Table 3** Parameter estimates: slope of second and third segment

	Slope of second segment [‘0000\$ (95% CI)]	Slope of third segment [‘0000\$ (95% CI)]
<b>Men</b>		
Belgium	-0.17 (-0.12, -0.23)	-0.01 (-0.08, 0.41)
Denmark	-0.20 (-0.11, -0.32)	0.03 (-0.05, 0.26)
England	-0.29 (-0.22, -0.36)	-0.01 (-0.03, 0.02)
Finland	-0.19 (-0.16, -0.25)	-0.05 (-0.11, 0.06)
France	-0.09 (-0.04, -0.17)	0.02 (-0.09, 0.22)
Netherlands	-0.20 (-0.25, -0.14)	-0.00 (-0.00, 0.00)
Norway	-0.18 (-0.13, -0.24)	-0.00 (-0.04, 0.05)
<b>Women</b>		
Belgium	-0.18 (-0.13, -0.25)	-0.00 (-0.06, 0.15)
Denmark	-0.11 (-0.04, -0.34)	0.62 (-0.30, 137.0)
England	-0.27 (-0.22, -0.34)	0.00 (-0.02, 0.02)
Finland	-0.18 (-0.14, -0.26)	-0.07 (-0.12, 0.02)
France	-0.16 (-0.12, -0.24)	-0.04 (-0.08, 0.03)
Netherlands	-0.24 (-0.25, -0.22)	-0.00 (-0.00, 0.00)
Norway	-0.15 (-0.12, -0.26)	-0.02 (-0.08, 0.07)

deteriorating self-assessed health with rising incomes in the higher income ranges, particularly for women, but this deterioration is not statistically significant.

## Discussion

### Summary of the main findings

The aim of this study was to examine the shape of the relationship between household equivalent income and self-assessed health in seven European countries. The main findings can be summarized as follows.

- (i) A higher household equivalent income is associated with better self-assessed health in all countries and both genders, particularly in the middle-income range.
- (ii) In the higher income ranges, the relationship is generally curvilinear and characterized by less improvement in self-assessed health per unit of rising income. This curvilinearity can be observed in all countries.
- (iii) In the lowest income ranges, the relationship is found to be curvilinear in Finland, The Netherlands, Norway, and Belgium. In these four countries, the deterioration in self-assessed health per unit of declining income levels off or reverses into an improvement at the lowest incomes, particularly among women.

### Evaluation of data and methods

Before we turn to possible substantive explanations for the observed patterns, it is necessary to discuss the effects of differences between countries in the measurement of income, particularly measurement by self-report versus tax register, and measurement of gross versus net income. We used income data as they are available in national health, level of living, and similar surveys, and differences in the measurement of income among countries may preclude a substantive interpretation of differences among countries in the shape of the income–health relationship.

The four countries in which we found clear curvilinearity in the lowest income ranges all had net instead of gross household income, and two of them had tax register instead of self-reported income data. This suggests that differences among countries in the shape of the relationship in the lower income

ranges might be due to differences in the way income was measured. For example, self-employed people might report a very low net income while their business generates substantial gross income, and if these people are in relatively good health, their presence in the group with very low net incomes will raise the average level of health in that group (i.e. lower the average value of self-assessed health in our analysis).

Unfortunately, our dataset does not permit a direct comparison between the health associations of gross and net household income, but previous analyses have suggested that this measurement issue does not explain the curvilinearity in the lowest income ranges. A comparison for The Netherlands indicated no difference in shape of the income–self-assessed health relationship between gross and net income.<sup>15</sup> In addition, analyses for Great Britain<sup>6</sup> and Sweden<sup>10</sup> have indicated that the shape of the relationship between net household income and health does not change substantially upon controlling for other socioeconomic variables including employment status, suggesting that it is not the presence of some specific socioeconomic group in the lower income range that explains the reversal of the association. Nevertheless, measurement biases cannot be excluded, and further methodological as well as substantive research into this nonlinearity in the lowest income ranges is certainly necessary. Such further explorations should take into account the fact that in our analysis this curvilinearity occurs more often or more strongly among women than among men and should also pay attention to the possible effects of redistributive social policies.

One could raise similar questions about differences between countries in the strength and shape of the relationship in the higher income ranges. The two countries where the relationship flattened rather sharply, Denmark and England, had gross income data. Because of income taxes, the health effects of an extra unit of gross income can be postulated to be smaller than the health effects of an extra unit of net income, but this is not confirmed by Table 3. Countries with gross income measures do not systematically have steeper slopes in the second (middle) segment of the income range than countries with net income measures. Nevertheless, we cannot exclude the possibility that the sharper bends in the curves for Denmark and England are due to their analyses being based on gross income, and that the association is actually modified by (progressive) income taxation. Again, this is much more than a measurement issue, and further methodological and substantive studies with more detailed data are necessary.

Income is partly determined by previously achieved educational qualifications and occupational status, and to the extent that these factors are independent determinants of health they could be seen as confounders of the income–health relationship.<sup>3</sup> Furthermore, income may be partly determined by pre-existing ill-health because, particularly among those of working age, ill-health may lead to early retirement and a consequent loss of income.<sup>16</sup> We have not been able to adjust for educational level, occupational class, or employment status, and it therefore remains to be seen whether the relationships that we found still hold after adjustment. Previous studies that have assessed the impact of adjustment have found that although the strength of the relationship between income and health is attenuated, the shape remains more or less similar.<sup>2–4,8,10</sup>

In our analysis we have treated self-assessed health as a quantitative variable, not as a nominal variable. In order

to check whether this could have an effect on the results, we reran some of the analyses using logistic regression, taking 'less-than-good' self-assessed health as a dichotomous outcome variable. This revealed very similar shapes of the income–self-assessed health relationship (results not shown).

We combined nonparametric (LOESS-functions) and parametric (segmented spline models) methods in our analysis. Whereas the LOESS-functions imposed only a few restrictions on the data, the segmented spline models imposed more (a fixed number of segments, with knots constrained to the first and fourth quartiles of the income distribution). These restrictions were imposed in order to create a minimum of comparability among countries for the parameter estimates. As shown by the supplementary figures (available at *IJE* Online), models fitted reasonably well, but because of the constraints the fit was not always perfect. The main problems have already been mentioned in the 'Results' section and do not invalidate the main observations summarized above.

It should be noted that all our analyses are based on cross-sectional data, and that it is impossible to infer causal relationships on the basis of these results alone. Longitudinal analyses that eliminate, or adjust for, possible reverse causation (ill-health leading to low income) have also found strong associations between income and measures of health. In addition, they have shown that long-term income and wealth are more strongly related to health than current income,<sup>17–19</sup> suggesting that the income–health relationship may actually be underestimated in cross-sectional analyses such as the ones we report here. Furthermore, these longitudinal studies indicate that the causes of the association between income and health are likely to be related to life-time accumulation of disadvantage.

Our results show that differences in the shape of the association between men and women are relatively small. Partly this similarity may reflect our measurement of income. We used a household-based income measure, which reflects household consumption power more accurately than individual income since it takes into account the disposable incomes earned by all members of the household as well as income transfers. Accordingly, this measure eliminates income differences between men and women, and therefore may underlie the relative gender similarity in the shape of the association between income and health.

### Interpretation

In view of the uncertainties about the interpretation of *differences* in the shape of the relationship between income and self-assessed

health among countries, and until further study has revealed the explanation of these differences, we think it wise to focus on the *similarities*. Our study confirms that the association between household equivalent income and self-assessed health tends to be curvilinear, particularly in the higher income ranges. Although our results lend some support to the general notion of decreasing marginal health returns of increasing income at higher income ranges, they do not clearly point in the direction of one or other explanation. As we noted above, much more rapid health declines with decreasing income at lower levels of income would have suggested an important role for direct effects of a (very) low income, that is, poverty and other disadvantageous material circumstances. Although this was found in some countries, in other countries the relationship levelled off or even reversed, and therefore we certainly cannot conclude that this is a generalized phenomenon. On the other hand, a linear relationship over the whole income range would have been consistent with an explanation in terms of more subtle mechanisms, including indirect effects of lower income through behavioural and psychosocial factors. Although we did find a negative association between income and self-assessed health over a large part of the income range in most countries, it does weaken considerably in the higher income ranges.

Our findings point to the possibility that income redistribution is a means of improving average population health, particularly in those countries with a strongly curvilinear income–health relationship. However, further study is needed to corroborate and refine the evidence supporting this argument. We particularly recommend direct comparisons of income–health associations between analyses that do and do not take into account the effects of progressive income taxation and other redistributive social policies, preferably using longitudinal data.

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#### KEY MESSAGES

- In an analysis covering seven European countries, we found that a higher household equivalent income is associated with better self-assessed health in all countries, among both men and women, particularly in the middle-income range.
- The relationship is generally curvilinear and characterized by less improvement in self-assessed health per unit of rising income in the higher income range. Assuming causality, this suggests that income redistribution may be a means of improving population health.
- In the lower income range, the relationship is also curvilinear in some countries (where the usual deterioration of health associated with lowering income levels off or even reverses into an improvement) but not in others. The explanation of this phenomenon should be the subject of further methodological and substantive investigations.

## Supplementary data

Supplementary data are available at *IJE* Online.

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## Appendix: The measurement of income

### Belgium

*Survey question:* ‘How much a month is the total available income of your household?’

*Answer:* amount in Belgian francs.

*Explanation:* ‘By total available income we understand: net wages and rewards for delivered work (main employment—additional jobs) and net operating income for the self-employed; social benefits like child allowances, unemployment benefits, pensions, disability allowances, . . . supplementary incomes like rent-rolls, annuities, interests . . . The sum of all these incomes of each member of your household is the total available income of your household.’

### Denmark

*Survey question:* ‘What was the total income of your household, before taxes and allowances?’

*Answer:* 11 categories of gross yearly income.

*Explanation:* none.

### England

*Survey question:* ‘Which of the groups on this card represents your (or your wife’s/husband’s/partner’s) combined income from all these sources before any deductions from income tax, national insurance etc. Thinking of the income of your household as a whole, which of the groups on this card represents the total income of the whole household before deductions income tax, national insurance etc.’

*Answer:* Two cards shown, one with categories of income and the other with income bands. The first card lists the following categories of income to be included: ‘earnings from employment or self-employment; state retirement pension; pension from former employer; child benefit; job-seeker’s allowance; income support; family credit; housing benefit; other state benefits; interest from savings and investments e.g. stocks and shares; other kinds of regular allowance from outside your household (e.g. maintenance, students’ grants, rent); no source of income.’ The second card presents 31 categories for weekly, monthly, or annual gross income in pounds from all sources.

*Explanation:* no further explanation.

### Finland

The income data were taken from tax and other registers, following standard specifications on calculating net income after tax deductions and transfers added.

### France

*Survey question:* ‘Can you give me an order of magnitude for the monthly average resources of your household, by classifying yourself in one of the following groups.’

*Answer:* 11 categories of monthly income in francs.

*Explanation:* none.

### The Netherlands

*Survey question:* ‘Could you say what your net income was during the past 12 months rounded off in 1000 guilders? If more than one person in your household has his own income, could you please add up all net incomes?’

*Answer:* amount in Dutch guilders.

*Explanation:* This question deals with the net income, that is what remains after deductions of taxes and premiums. You should not count possible child benefits.

## Norway

Based on information from the tax register. Total income is the sum of several different types of income. The following method of calculation is used: net income (according to the central government taxation rules) or basis for surtax on gross income (the highest amount for every individual in the household is

selected). Included in total income are: student loans and grants from the state educational loan fund; housing allowance from the Norwegian national housing bank; family allowance; miscellaneous tax-free social security benefits (including basic benefit, supplementary benefit, maternity benefit, education grants, etc.); parents' tax deduction; other transfers.

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# Commentary: On form, comparability, and levels in the income and health relationship

Johan Fritzell

One important issue in the income and health debate, relates to the form of the association between them.<sup>1–3</sup> The rationale for the interest in this topic is that it involves mechanisms, policy implications, and theory, rather than simply being a methodological, technical question. The article by Mackenbach *et al.* in this issue of *International Journal of Epidemiology* adds to our knowledge of this area by investigating the relation between self-rated health and income through the use of cross-national data.<sup>4</sup> They generally find a curvilinear relation reflecting decreasing marginal health returns of income. In this short note I want to first discuss some methodological concerns, also discussed by the authors. I will thereafter reflect on some more general, substantive implication of this curvilinear association and its relation to the recent heated debate on the assumed relation between income inequality and health.<sup>5,6</sup>

Comparative, cross-national research is in many respects a fruitful enterprise with high potentials. It has sometimes been characterized as a quasi-natural experiment. In principle, cross-national comparisons make it possible to study what role a social factor, like a certain policy, has in producing an outcome, since the counterfactual cases, countries without such a policy, can be contrasted. However, outcomes that are believed to be due to country-specific factors are often seen in many different national settings. The cross-national approach is therefore also a fruitful way to establish empirical regularities across countries.<sup>7</sup> The study by Mackenbach *et al.* is a good point of reference. For the general discussion on income, income inequality and health, it is essential to state if the curvilinear relation is generally observed.

At the same time one should be aware that the pitfalls of cross-national research are formidable. One basic problem concerns data comparability. This is much more difficult in a cross-national study due to factors like language, country-specific

values, cross-national variation in data collection methods, data quality, and sample frame. In brief, cross-national research has a lot of potentials and a lot of pitfalls.

The study by Mackenbach *et al.* also highlights the problems. The study, definitely, uses sophisticated methodology but that can never compensate for poor data comparability. What is most worrisome in this study is precisely this point. Income information is not only collected by different methods (a common problem), but the distributions to be compared across countries are based on different income concepts. The history of comparative income distribution research provides a good illustration. Before the advent of the Luxembourg Income Study (LIS), OECD presented a famous, but now obscure, report on how income inequality varied across OECD countries.<sup>8</sup> The work put into the report was tremendous, but as discussed by commentators,<sup>9</sup> the author had to perform aggregate, secondary analyses on national sources, was unable to analyse the micro-relation between pre- and post-taxes and transfers, and could make no adjustments for household size and structure. No doubt, there are still many difficult comparability problems in LIS, but the general conclusion nowadays is that Sawyer's study was so blurred and erroneous that nobody cites it apart from making similar points as I do here. Comparing pre- and post-welfare state redistribution has a fundamental impact on the degree of inequality. In other words, including taxes and transfers in our measure of income strongly reduce inequality. When examining the relationship between income and health this leads to a less steep slope. Moreover, it is important to realize that the extent of re-ranking as we compare along the income distribution process (from market income to equivalent disposable household income) is substantial, in particular in voluminous welfare states.<sup>10</sup> This means that those we observe as having the lowest income are not necessarily the same people if we compare the distribution pre- and post-welfare state redistribution. This obviously could have consequences for the relationship between income and health, although it is more