Some Methodological Remarks on Self-Rated Health

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Abstract: *Objectives*: In analyses concerned with self-rated health it is common to dichotomise an ordinal-scale health measure and compare different subgroups of a population on basis of odds ratios from logistic regression models. Self-rated health is often explored also in wide age intervals. Since people's health correlates strongly with their age, that approach is empirically problematic, particularly when it comes to determining the cut-off point for dichotomisation and the role of age-dependent covariates. We set out to investigate these issues, and prove them to be practically relevant.

Study design: Using a highly representative data set, the Health 2000 survey in Finland, we focus on ages 35-64 years. Separate analyses are undertaken for this whole age interval, and for three shorter age intervals.

Methods: Self-rated health was in the survey measured on a five-point ordinal scale. We dichotomised the responses in two alternative ways (bad health categorised as "poor" or "fairly poor", and as "poor", "fairly poor" or "average"), and explored the estimated effects of some standard covariates.

Results: When the whole age interval was analysed, the choice of cut-off point for health dichotomisation had only a modest impact on the estimated effects of the covariates. However, with a narrower categorisation of poor health, the effect of educational level, as well as of marital status, was found to be highly age-dependent.

Conclusions: Researchers and health policy practitioners should be aware of the risks for drawing misleading or even incorrect conclusions from studies of self-rated health based on wide age intervals that do not explicitly account for age-dependent covariates.

Keywords: Age-dependent covariates, dichotomisation of self-rated health, odds ratios.

INTRODUCTION

As compared with morbidity and mortality, which can be studied on basis of population-based records, there are no fully covering national registers of individuals' overall health status. To analyse this aspect of health, researchers must use survey-based measures of self-assessed health. Several studies have shown that the way individuals' assess their health interrelates highly with current health status, as well as with future morbidity and mortality [1-4]. Survey-based data on self-rated health, with a reasonably high response rate, consequently appears to be a reliable global measure for biomedically determined health [5,6].

The question involved when people are asked to judge their health is often measured on a five-point ordinal scale. In empirical practice the variable is usually dichotomised and analysed with logistic regression models [7-9]. The dichotomisation implies that some of the original information is lost. Results from studies concerned with this issue are somewhat mixed, but the general conclusion appears to be that self-rated health should be viewed as a continuum that goes from poor to good [10-12]. Categorising the ordinal outcome into a binary response should consequently not have any severe impact on the estimated effects of covariates.

Some methodological consequences have been rather unfairly treated on this concern, however. It is commonly known that health is strongly dependent on age, as there is substantial negative correlation [13-15]. In many empirical analyses, respondents' age is still included simply as a variable of control [8,9, 16-18]. This approach implies that one implicitly disregards the potentially strong role of age-dependence of covariates used in the estimated models, particularly in the case when age intervals incorporated by data are very wide. As we will show, this might have severe consequences for inference made about individuals' health and the issue of how self-rated health should be dichotomised. In the paper we illustrate and discuss these issues with a nationally representative data set.

In addition, we also highlight some aspects that concern the interpretation of variable effects, and remind of two mathematical features of the models that often are used to assess self-rated health. One has to do with the interpretation of odds ratios on basis of logistic regression models. The other concerns the significance levels of estimated parameters. These aspects are well known to statisticians and mathematicians, but appear not to be fully recognised, or perhaps disregarded, by some public health researchers. Our intention is consequently to attempt increasing methodological awareness among people who use data from health surveys.

MATERIALS AND METHODOLOGY

Self-Rated Health and Age

The data we use come from the Health 2000 survey in Finland, which is a nationally representative investigation of

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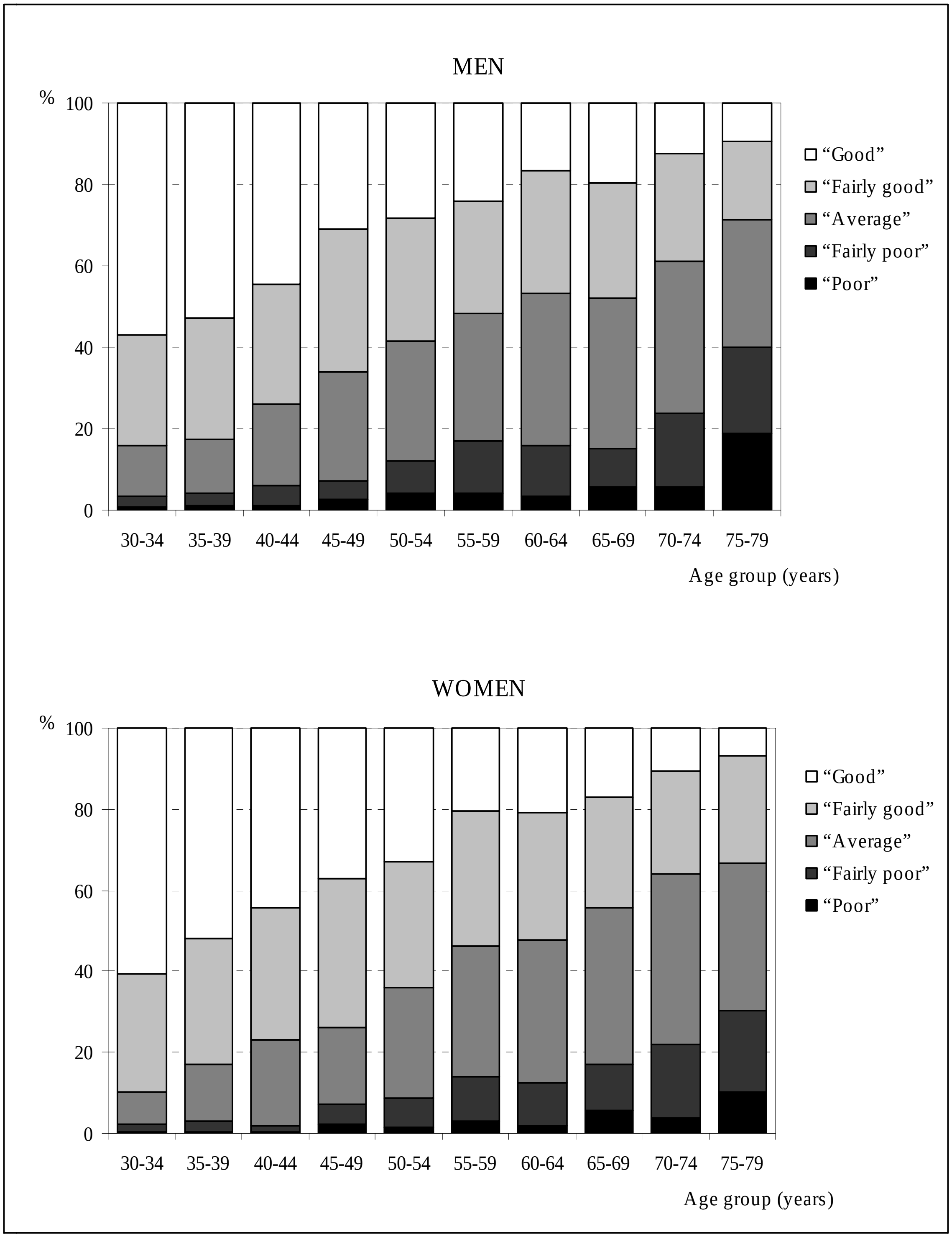

Fig. (1). Distribution of self-rated health by age group and sex.

different aspects of health in the Finnish population aged over 30 years [19]. Reliability of these data is very high. The response rate was as high as 87 per cent, and the total number of respondents was over 8,000. Self-rated health was measured by the question: "Would you describe your current health status as good, fairly good, average, fairly poor, or poor?". The distribution of responses in different age categories for each sex is given in Fig. (**1**).

In ages under 45 years there are few people who categorise their health as worse than "average", while this proportion increases notably with age and is about 40 per cent in ages 75-79 years in men, and approximately 30 per cent in women. Thus the circumstances involved may vary markedly across age groups. The implication of a given cut-off point for the dichotomisation of self-rated health on the specific health distribution to be studied is therefore highly dependent on age. This variation cannot be fully accounted

Table 1. Variable Distributions by Age Group and Sex (%)

	Men				Women			
	All ages	**35-44 years**	**45-54 years**	**55-64 years**	**All ages**	**35-44 years**	**45-54 years**	**55-64 years**
Marital status								
Single	24.4	26.4	23.2	23.3	26.4	22.9	25.8	31.9
With partner	75.6	73.6	76.8	76.7	73.6	77.1	74.2	68.1
Educational level								
Basic	34.2	19.4	37.5	49.5	32.7	15.5	33.5	54.1
Secondary	40.2	50.4	37.6	30.0	30.7	37.3	29.7	23.6
Higher	25.6	30.2	24.9	20.4	36.6	47.2	36.8	22.3
Municipality type								
Rural	24.0	22.0	24.2	26.6	22.7	23.9	21.3	23.3
Semi-urban	16.1	17.2	15.8	15.2	13.3	11.7	14.5	13.7
Urban	59.8	60.8	60.0	58.2	64.0	64.4	64.2	63.0
Total n	2,181	772	856	553	2,322	815	880	627

for by incorporating age as a simple covariate, i.e. as a pure main effect, in the statistical models to be estimated.

Interpretation of Odds Ratios and Levels of Significance

Logistic regression is today the most common method applied in empirical analyses that use dichotomous dependent variables and, in general, categorical explanatory variables. In exponentiated form, the values of the estimated parameters then give the ratio of the odds for an event in one subcategory and the odds for the event in another subcategory. This is the odds ratio. Being based on the logistic transformation, odds (ratios) have the nice feature that they can take any positive value, and they always stay in the range for what is feasible. This property is desirable from a statistical point of view and always works in a purely mathematical setting.

It is essential to note, however, that the size of the odds ratio is dependent on the probability of the event [20]. In case the event is rare, such as poor health among youngsters, the odds ratio (for two subgroups) is roughly equal to the ratio of the probabilities of the event (for the two subgroups). When the event is more common, such as poor health among elderly, this equality does not hold.

This commonly known statistical property is exemplarily discussed and formally treated in many statistical text books; see e.g. [21]. Since we feel that the issue has been disregarded by quite many analyses in the public health area, we want to illustrate it with some numerical examples from our data.

Among men aged 35-44 years, 12.7 per cent of those with basic education rated their health as poor or fairly poor, as compared with 3.0 per cent of those with higher education (see Table **2** in the next subsection). This implicates that the odds ratio of bad health (bad versus non-bad) is 4.7 [(12.7/87.3)/(3.0/97.0)]. Hence men with basic education have almost five times as high odds of reporting bad health than those with higher education.

In ages over 55-64 years, the proportion with bad health is 22.3 per cent for men with basic education. To achieve the same odds ratio of 4.7, the proportion of men with higher education who report their health as bad would need to be only 5.7 per cent. In reality, they amount to 10.6 per cent, which result in an odds ratio of only 2.4. Hence the odds ratio is 2.3 units smaller, in spite that the absolute differential is 2.0 percentage units larger [(22.3-10.6)-(12.7-3.0)].

There exists no unique answer to the question of what differences are "equally large"; see e.g. [22-24]. The less common is an event, the greater is the possibility for a large relative differential. In cases where the probability of an event varies markedly across subgroups, it is consequently highly essential that researchers are aware that interpretation of empirical results is problematic.

Another important point is that the level of statistical significance for an odds ratio is a direct function of the underlying probability of the event. The smaller probability, the larger number of observations is needed in order to achieve the same level of statistical significance for any given odds ratio estimated. Take, for instance, a case where the overall proportion of people reporting bad health is around 10 per cent. In case an odds ratio of, say, 1.3 (for two arbitrary subgroups) can be regarded as different from 1.0 at the 95 per cent level of statistical significance ($p<0.05$), there needs to be at least 1,000 observations in each group. In case the overall probability of bad health is roughly 30 per cent, only half the number of observations is needed.

Whether or not one can obtain statistically significant results does not consequently depend solely on the number of observations and the size of the odds ratio, but also on the overall probability of the event. This implicates that larger sample sizes, or alternatively larger differences in odds ratios, are needed to obtain statistically significant

Table 2. Percentage of People Reporting "Poor" or "Fairly Poor" Self-Rated Health, and "Poor","Fairly Poor" or "Average" Self-Rated Health, respectively, by Age Group, Sex and Sociodemographic Characteristic

	% Reporting "Poor" or "Fairly Poor"				% Reporting "Poor, "Fairly Poor"or "Average"			
	All ages	**35-44 years**	**45-54 years**	**55-64 years**	**All ages**	**35-44 years**	**45-54 years**	**55-64 years**
MEN								
Marital status								
Without partner	13.0	9.3	14.1	17.1	42.7	31.9	43.7	58.1
With partner	8.9	3.7	8.5	16.3	33.2	18.1	36.2	48.6
Educational level								
Basic	16.4	12.7	13.1	22.3	49.0	34.7	45.5	60.9
Secondary	7.1	3.6	9.3	10.8	31.9	21.9	36.3	47.0
Higher	5.5	3.0	5.6	10.6	23.1	13.3	29.1	31.9
Municipality type								
Rural	9.9	3.5	9.7	17.7	41.6	23.5	42.0	61.9
Semi-urban	9.9	7.5	8.9	15.5	35.8	24.8	39.3	47.6
Urban	9.8	5.1	10.1	16.1	33.0	20.3	36.0	46.6
Total	9.9	5.2	9.8	16.5	35.5	21.8	38.0	50.8
Total n	2,181	772	856	553	2,181	772	856	553
WOMEN								
Marital status								
Without partner	10.3	5.3	10.1	15.0	36.6	24.1	37.0	48.0
With partner	6.3	1.4	7.0	12.4	29.7	18.9	28.9	46.6
Educational level								
Basic	10.8	4.8	11.2	12.7	43.3	32.5	37.3	52.5
Secondary	6.7	3.0	8.0	12.2	29.5	19.7	33.0	43.2
Higher	4.8	1.0	4.6	15.7	22.7	16.4	23.8	37.9
Municipality type								
Rural	7.8	2.6	8.6	13.7	34.3	22.1	36.9	47.3
Semi-urban	6.5	2.1	7.0	10.5	29.8	20.0	26.6	45.3
Urban	7.4	2.3	7.8	13.7	30.9	19.4	30.1	47.3
Total	7.4	2.3	7.8	13.2	31.5	20.1	31.0	47.0
Total n	2,322	815	880	627	2,322	815	880	627

differentials among healthier (younger) people than among less healthier (older) people.

Age-Dependent Covariates

Implications of age-dependent covariates are not unique to empirical analyses of self-rated health. They are still highly relevant in this context, because age intervals included in analyses are often wide, or there is some comparison of research findings from studies based on different age categories. To illustrate the general methodological problems on this account, we adopt three commonly used variables, but the implications can of course be generalised also to other covariates. The first two, marital status and educational level, are presumably age-dependent, but of different reasons. The third variable is an aggregate measure of the environment in which an individual lives, here proxied by the level of urbanisation. This cannot reasonably be assumed age-dependent.

The overall level of education has increased notably in the Finnish population during past decades. Higher-educated people in a younger birth cohort may therefore not be equally selected with regard to health as higher-educated people in an older birth cohort. Age-variation in the effect of education on health, as observed at the cross section level, could therefore be an artefact of increased possibilities for gaining education over time, thus reflecting an interrelation with persons' birth cohort and not only their current age [25-26].

Marital status, on the other hand, is a variable whose *meaning* may differ across age categories. In younger ages, single people are generally those who have not yet formed a family, whereas in higher ages single people often are those who previously had a partner, or never will form a family. The direction of causality may also vary across ages. In younger ages, marital status could, to a greater extent than in higher ages, be a result of health rather than vice versa. In higher age groups causality may largely run in the other direction. Since reversed causality is a problem even if one follows the same cohort over time, variation in the estimated impact of marital status on health across age groups should therefore be regarded primarily as a pure age, and not a cohort, effect.

To focus on a relatively homogenous group with individuals, for whom the concept of self-rated health is fairly similar, we have for the multivariate analysis to come restricted the data to the age interval 35-64 years. Variable distributions, for all these ages and each 10-year age interval, are provided for men and for women in Table **1**. We can see that particularly in women there has been a dramatic increase in the overall level of education over time, as younger people in these cross sectional data are much higher educated than older ones. The proportion of single people in the data tends to be fairly constant across age groups, which is not the same as saying that the *effect* of marital status on self-rated health is similar across age groups.

Table 3. Odds Ratios for Bad Health by Choice of Cut-Off Point for Dichotomisation, Results of Multivariate Logistic Regression Models for Men and Women, respectively

	BAD HEALTH: "Poor"+"Fairly Poor"				**BAD HEALTH: "Poor"+"Fairly Poor"+"Average"**			
	All ages	**35-44 years**	**45-54 years**	**55-64 years**	**All ages**	**35-44 years**	**45-54 years**	**55-64 years**
MEN								
Marital status								
Without partner	1.4	2.1	1.6	1.0	1.5	1.9	1.3	1.3
With partner	1	1	1	1	1	1	1	1
Educational level								
Basic	2.7	4.1	2.5	2.5	2.5	2.9	1.9	3.1
Secondary	1.3	1.1	1.7	1.0	1.6	1.7	1.4	1.8
Higher	1	1	1	1	1	1	1	1
Municipality type								
Rural	0.8	0.6	0.8	0.9	1.3	1.1	1.2	1.6
Semi-urban	0.9	1.8	0.8	0.8	1.1	1.3	1.1	0.9
Urban	1	1	1	1	1	1	1	1
Total n	2,181	772	856	553	2,181	772	856	553
WOMEN								
Marital status								
Without partner	1.5	3.7	1.5	1.2	1.3	1.3	1.5	1.1
With partner	1	1	1	1	1	1	1	1
Educational level								
Basic	1.6	4.0	2.6	0.8	2.0	2.4	1.9	1.9
Secondary	1.4	2.6	1.8	0.8	1.4	1.2	1.6	1.3
Higher	1	1	1	1	1	1	1	1
Municipality type								
Rural	1.1	1.4	1.1	1.0	1.2	1.2	1.4	0.9
Semi-urban	0.8	0.8	0.8	0.8	0.9	1.0	0.8	0.9
Urban	1	1	1	1	1	1	1	1
Total n	2,322	815	880	627	2,322	815	880	627

Estimations for the whole age interval include age dummies for 45-54 and 55-64 years.

Table **2** gives the proportion of people having reported poor or fairly poor health, and poor, fairly poor or average health, respectively, in the different age categories for men and for women. Our attention is at these two alternative cut-off points for the dichotomisation of self-rated health, as they are the most commonly adopted in empirical analyses.

Besides the fact that health deteriorates notably with age, the table also reflects that the covariates have large effects on health. For instance, in men aged 35-64 years, 16.4 per cent of those with basic education report their health to be "poor" or "fairly poor", as compared with only 5.5 per cent of those with higher education. The fundamental question of interest is then to what extent the impact of these variables depend on which age groups are analysed and the choice of cut-off point for the dichotomisation of self-rated health. To explore these issues, we estimated multiple logistic regression models for the odds of reporting bad health versus good health. By sex and shift of cut-off point for the dichotomisation, models were fitted for the whole age interval and for each 10-year age group. Separate estimations by age group were undertaken, instead of models that incorporate interactions with age [cf. 27], simply to facilitate readability of the results.

We concentrate on discussing the estimated effects of the parameters, not their levels of statistical significance which are a function of the number of observations. With a larger sample standard errors of the parameters would naturally be smaller. Confidence intervals for the parameters are reported in Table **A1** in the Appendix.

RESULTS

Results of the model fits are summarised in Table **3**. The two models for the whole age interval give the impression that the choice of cut-off point for dichotomisation of self-rated health does not matter much for the estimated effects of the covariates. The impact of marital status and educational level is practically the same irrespective of cut-off point for both men and women. The effect of level of urbanisation, on the other hand, changes sign when we shift the cut-off point in men. With the narrower categorisation there is positive correlation between (good) health and (higher level of) urbanisation, whereas the opposite is the case according to the less narrow categorisation.

Conclusions alter dramatically when we study age intervals separately, however. For both sexes, there are evident age-specific effects of marital status when the cut-off point separates "poor" and "fairly poor" from the other response alternatives. At lower ages, people with a partner have substantially better health than singles, whereas this effect is less marked at higher ages. This variation across age groups becomes less emphasised when the cut-off point is shifted to include also those who reported their health to be "average".

For women we can see the same pattern also with regard to the estimated effects of educational level. The beneficial impact of higher education on health is clearly smaller in higher age categories in case the cut-off point excludes "average" from being considered as bad health, whereas the interrelation is much weaker in case the cut-off point is shifted. For men, shifting the cut-off point has only a minor impact in this respect.

The variable that measures level of urbanisation has a modest impact on self-rated health in women and the outcome is not sensitive to the shift of cut-off point. In men the parameters exhibit somewhat greater variation, but they cannot be interpreted in any consistent manner.

DISCUSSION AND CONCLUSION

The overall purpose of this paper has been to illuminate some inherent methodological problems associated with studies of self-rated health, particularly those that use data on wide age intervals. We have still primarily been concerned with proving their empirical relevance, not with aiming at explicit solutions and recommendations.

Our discussion departed from the commonly used method of estimating odds ratios for bad (or good) health based on logistic regression models. We show that, since individuals' health condition deteriorates markedly with age, interpretation of the effects of standard covariates included in the models becomes quite hazardous. As the impact of the covariates also can be age-dependent, there is an obvious risk to end up in making incorrect inferences.

Our empirical examples show that the specific cut-off point chosen for the dichotomisation of self-rated health have practical implications for the impact of health determinants. If focus of analysis is at the very low end of the health distribution, so that the response alternative "average" is assigned to the good-health category, the effects of the covariates used turned out to be highly dependent on age. The beneficial impact of educational level and having a partner, respectively, was smaller at higher ages than at lower ages. Variation across age categories was less emphasised if the cut-off point was shifted, so that poor health also includes "average" and thus contain a wider left-hand tail of the health distribution.

The strong age-dependence of marital status when focus is on very poor health is presumably because there are relatively few persons in this bad health category, and selection from health to marital status – saying that people with poor health have not formed a family – is strongest in the lower age categories. At higher ages it is reasonable to expect that a considerable proportion of these people had died. If dichotomisation is undertaken to equalise the health groups in size, this mechanism does not stand out in the same evident manner.

Among women the effect of educational level on health was also strongly age-dependent, whereas the pattern in men was somewhat less emphasised. An obvious reason to this sex differential is that the overall increase in educational levels in the Finnish population has been more pronounced in women than in men. Whereas as much as 54 per cent of the women aged 55-64 years lacked education above basic level, and the share with higher education was only 22 per cent, the corresponding numbers in ages 35-44 years were 15.5 and 47 per cent, respectively. The correlation between education and health does not arise only from people's level of education as such, but reflects also differences in health selection across birth cohorts. The estimated effect of educational level on health is consequently affected also by changed educational opportunities in the population over time [cf. 25,26].

One should still note that with the narrower categorisation of poor health, variation in odds ratios across age groups interrelates with the general level of self-rated health. Conclusions about variable effects might therefore be different if the focus is on differences in absolute levels.

The odds ratios varied less when the cut-off point for dichotomisation included a broader measure of bad health than when it contained a less broad measure could easily be interpreted as that the former cut-off point is more stable and reliable and thus to be preferred in empirical analyses. However, one might also argue that it does not manage to reflect potential interrelations between age, health and the covariates. The choice of cut-off point cannot consequently be dictated by how the parameters behave, but according to theoretical underpinnings, and particularly if bad health or good health is in focus.

One important issue that we have not explicitly discussed, but which has been explored by others [28,29], is whether different subgroups of the population assess their health in a similar manner. This issue might have consequences also for the choice of cut-off point for dichotomisation, which should be recognised.

To conclude, we want to emphasise that self-rated health is a useful tool for understanding biomedically determined health, and for predicting morbidity and mortality, given that one is aware of the problems involved that may lead to incorrect inference. Our intention with this paper has consequently been to pinpoint some of the problems involved, rather than to criticise previous empirical findings.

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APPENDIX

Table A1. 95% Confidence Intervals for the Parameters in Table 3

	BAD HEALTH: "Poor"+"Fairly Poor"				**BAD HEALTH: "Poor"+"Fairly Poor"+"Average"**			
	All ages	**35-44 years**	**45-54 years**	**55-64 years**	**All ages**	**35-44 years**	**45-54 years**	**55-64 years**
MEN								
Marital status								
Without partner	1.1-2.0	1.1-4.2	1.0-2.7	0.6-1.7	1.2-1.8	1.3-2.7	0.9-1.8	0.9-2.0
With partner								
Educational level								
Basic	1.8-4.2	1.6-10.3	1.3-4.8	1.3-4.9	1.9-3.2	1.7-4.9	1.3-2.8	1.9-4.9
Secondary	0.8-2.0	0.4-2.8	0.9-3.4	0.5-2.2	1.2-2.0	1.0-2.6	0.9-2.0	1.1-3.0
Higher								
Municipality type								
Rural	0.6-1.2	0.2-1.6	0.5-1.5	0.5-1.6	1.0-1.6	0.7-1.7	0.8-1.6	1.1-2.4
Semi-urban	0.6-1.4	0.8-3.9	0.4-1.6	0.4-1.6	0.8-1.4	0.8-2.1	0.7-1.6	0.5-1.5
Urban								
WOMEN								
Marital status								
Without partner	1.1-2.2	1.4-9.6	0.9-2.6	0.7-2.0	1.0-1.6	0.9-1.9	1.1-2.1	0.8-1.5
With partner								
Educational level								
Basic	1.1-2.4	1.1-14.7	1.4-5.0	0.5-1.4	1.6-2.5	1.5-3.8	1.4-2.7	1.2-2.8
Secondary	0.9-2.1	0.8-8.7	0.9-3.7	0.4-1.5	1.1-1.7	0.8-1.8	1.1-2.3	0.8-2.0
Higher								
Municipality type								
Rural	0.7-1.6	0.5-4.2	0.6-2.0	0.6-1.8	0.9-1.4	0.8-1.8	1.0-1.9	0.6-1.4
Semi-urban	0.5-1.4	0.2-3.9	0.4-1.8	0.4-1.7	0.7-1.1	0.6-1.7	0.5-1.2	0.5-1.4
Urban								

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