The association between self-rated health and mortality in different socioeconomic groups in the GAZEL cohort study.

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Abstract

Objectives Self-rated-health (SRH) is considered a valid measure of health status as it has been shown to predict mortality in several studies. We examine whether SRH predicts mortality equally well in different socioeconomic groups.

Methods Data (14879 men and 5525 women) are drawn from GAZEL, a prospective cohort study of French public utility workers. Data on SRH and the socioeconomic measures (education, occupational position and income) were taken from the baseline questionnaire (1989), when the average age of individuals was 44.2 years (SD = 3.5). Mortality follow-up was available for a mean of 17.2 years and analysed over the first 10 years and over the entire follow-up period. Associations between SRH and mortality were assessed using Cox regression models using the Relative Index of Inequality (RII) to summarize associations.

Results The RII for the association between SRH and mortality over the first 10 years was 6.78 (95% confidence interval (CI)=3.33-13.81) in the lowest occupational group and 2.10 (95% CI = 0.97-4.54) in the highest. For income, the RIIs were 8.82 (95% CI=4.70-16.54) for the lowest and 1.80 (95% CI=0.86-3.80) for the highest groups respectively. Findings over the full follow-up period were similar. The association between SRH and mortality was weaker in the high occupation and income groups, both in the short and the long term. The results for education were similar but generally weaker than for the other socioeconomic measures.

Conclusions The predictive ability of SRH for mortality weakens with increasing socioeconomic advantage among middle-aged individuals. Thus SRH appears not to measure "true" health status in a similar way across socioeconomic categories.

Keywords: mortality, socioeconomic factors, occupation, income, education

Self-rated-health (SRH) refers to a single-item measure of health status where individuals are asked to rate their own health. This subjective assessment of health status has been shown to be highly predictive for mortality(1-3) in different cultures(3-7) and in different age groups(8-10). It is an important research tool, allowing a simple question to monitor population health. Attempts have been made to understand whether this one item question is associated with mortality in a similar manner in different population sub-groups, with particular attention paid so far to the moderating influence of gender. Although a review of early studies appeared to show stronger SRH mortality associations in men(3), more recent work suggests no effect modification by gender, particularly in non elderly populations(11;12). Research also suggests that age itself might modify this association, the predictive ability of self-rated health for mortality has been shown to decrease with increasing age(11;13).

The role played by socioeconomic factors like education, occupational position or income in moderating the association between self-rated health and mortality remains relatively unexplored. Research suggests that socioeconomic variables influence SRH, in that adverse socioeconomic profiles are associated with poorer self-ratings of health status(14-17). However, whether the association between SRH and mortality varies as a function of socioeconomic variables has only been examined in a couple of published studies(11;18). Both studies use Swedish data, the first paper concluded that occupation position did not moderate the association between SRH and mortality(11), and the second paper drew the same conclusion for income and education(18).

The objective of our study is to examine a range of socioeconomic measures – education, occupational position and income – in order to assess their role in moderating the association between SRH and mortality. Similar associations would suggest that the self-rated health scale is being interpreted and used in a similar way across different population sub-groups. In other words, the thresholds and the determinants being used to judge one's health would be similar in different sub-groups. As the association between SRH and mortality has been shown to be stronger in the short term(12;19), we will examine the moderating influence of socioeconomic measures both in the short and long term.

MATERIALS & METHODS

Data are drawn from the GAZEL study. This cohort was established in 1989, on employees of France's national electricity and gas company: Electricité de France-Gaz de France (EDF-GDF). Further details of this study can be found elsewhere(20). At baseline,

20625 (15011 men and 5614 women), aged 35-50, gave consent to participate in this study. The study design consists of an annual questionnaire used to collect data on health, lifestyle, individual, familial, social and occupational factors and life events. Various sources within EDF-GDF provide additional data about GAZEL participants. Occupational and personal data are updated through human resources department files. Medical data on sick leaves and incidence of cancer and coronary heart diseases come from the company's Health Insurance Department. Occupational physicians collect data on working conditions and occupational exposures. Sources outside EDF-GDF provide data on causes of death, health care use, and hospitalizations.

Measures

All measures, apart from mortality, are drawn from the baseline questionnaire in 1989.

Demographic factors: age and sex.

Socioeconomic measures: Education was measured using a 3-level hierarchic variable: primary (school leaving age approximately 11 years), lower secondary (those without the final school degree, the *baccalauréat*, taken at around 18 years of age), and higher secondary or tertiary education. Occupational position was taken from the employer's records of grade of employment at baseline. This was a three level variable: unskilled workers, skilled workers and managers. Income was self reported ("what is the net monthly income of your household") at baseline and composed of the following categories: less than 1600 , 1600-2600 euros, greater then 2600 euros, referred to as low, medium and high level in the text and tables that follow.

Self rated health was assessed by the following question: "How would you judge the state of your general health?" The participants responded on an 8-point Likert scale, anchored by 1='very good' and 8='very poor'.

Mortality: Vital status data on all participants are obtained annually from EDF-GDF itself as it pays out retirement benefits. Mortality data were available to 5th October 2006, a mean of 17.2 years. Short-term deaths were classified as having occurred in the first 10 years (Year 0-9) of follow-up and long-term mortality was seen as deaths occurring over the entire follow-up period.

Statistical analysis

The association between SRH and mortality was examined using Cox regression in order to model survival time subsequent to assessment of SRH for each individual. This

association was modelled using a summary measure called the Relative Index of Inequality (RII). The RII is a regression based measure, calculated by creating a scale from 0 to 1 to indicate the two extremes of an underlying SRH distribution. A value of 0 represents the best SRH and 1 represents the worst SRH. Each SRH category (very good to very poor) covers a range on this scale that is proportional to the number of individuals who endorsed that SRH category (or Likert scale-point) and it is given a value on the scale corresponding to the cumulative midpoint of its range. This procedure transforms a hierarchical categorical variable (here an 8-point Likert scale) into a continuous variable, ranging from 0 to 1. The resulting Cox regression using the transformed SRH variable as a predictor estimates the hazard ratio for the worst SRH compared to the best SRH; the estimation takes into account data from all SRH categories and the index is weighted to reflect the size of these categories. Thus, an RII of 1.5 indicates that the mortality hazard between the extreme ends of the SRH distribution is 1.5 times higher for the worst compared to the best SRH; an RII of 1.00 would indicate equal mortality hazard.

The association between SRH and mortality using the RII was first examined in analyses stratified by the socioeconomic variable in question: education, occupational position and income. In subsequent analyses, we tested for the presence of a linear trend for the association between SRH and mortality across the SEP categories. This was done by fitting an interaction term between two continuous variables: the SRH scale and the SEP measure, recoded as 0-1-2. This single continuous interaction term tests for heterogeneity across the three SEP groups, specifically the linear part of the overall heterogeneity.

In order to ensure that the results were not artefacts of the use of the RII, we conducted further analyses using SRH as a dichotomous variable; the first three of the 8-point SRH scale were considered to be an indication of "good" health and the subsequent 5 points that of "poor" health. Sensitivity analyses where the cut point was varied gave very similar results to those presented here. The hazard ratios for "poor" versus "good" self-rated health were estimated using Cox regression,

RESULTS

Of the 20625 participants (15011 men and 5614 women) at baseline, 14879 men (99.1%) men and 5525 women (98.4%) responded to the question on SRH. The men were on average 44.9 years old (SD = 2.9) and the women 42.1 years old (SD = 4.2). 5.2% (N=1061) of the 20404 individuals who had responded to the SRH question at baseline died during the follow-up period. 10.2% (N=23) of the 221 individuals, a larger proportion ($p<0.0001$) of

participants who did not respond to the SRH question had died. The analysis in relation to some measures, income in particular, is on smaller numbers due to missing data.

Table 1 presents the descriptive statistics for men and women. A majority of men had lower secondary education (66.4%), were skilled workers (55.7%) and were in the medium income group (47.2%). There were the expected social inequalities in self-rated health; better education, occupational position and income were all associated with better self-rated health. The socioeconomic profile of women, using measures of education and income, was similar and here again there were similar social inequalities in self-rated health. Table 1 also shows the proportion of participants who had died during the first 10 years and the entire follow-up period. Mortality in men was higher, both in the short (HR=1.66; 95% CI = 1.27-2.16) and the long term (HR=1.80; 95% CI = 1.51-2.14). The association between SRH and short-term mortality was similar (p=0.98) in men (RII = 3.96; 95% CI = 2.71-5.78) and women (RII = 4.10; 95% CI = 1.70-9.88). The association between SRH and mortality over the total follow-up period was also not different (p=0.16) in men (RII = 2.80; 95% CI = 2.21-3.56) and women (RII = 1.81; 95% CI = 1.03-3.17). The lack of sex differences in the association between SRH and mortality and the small number of deaths in some socioeconomic categories in women (Table 1) led us to combine men and women for further analyses.

Table 2 presents the results showing the association between SRH and mortality as a function of socioeconomic position. The short term mortality among participants with a primary education with the worst self-rated health at baseline was over fifteen times greater (RII = 15.39; 95% CI = 5.00-47.32) than participants with primary education with the best self-rated health. In the high education group (higher secondary and tertiary education), short term mortality among participants with the worst self-rated health was 3.5 times greater (RII = 3.45; 95% CI = 1.51-7.88). The linear trend of decreasing association between SRH and mortality with increasing levels of education was stronger over the total follow-up period (p=0.03) compared to short-term mortality (p=0.07).

Among unskilled workers (Table 2) SRH was associated with mortality, both in the short (RII=6.78; 95% CI = 3.33-13.81) and long term (RII=3.83; 95% CI = 2.40-6.12). However, among managers (Table 2) there was no consistent evidence of an association between SRH and mortality in the short term (RII = 2.10; 95% CI = 0.97-4.54) or over the total follow-up period (RII = 1.23; 95% CI = 0.75-2.03). The linear trend across the measure of occupational position showed a weakening of the association between SRH and mortality with increasing social position as measured by occupational position, both in the short (p=0.02) and the long term (p=0.002). The results with the measure of income were similar

(Table 2); the strongest associations between SRH and short (RII= 8.82; 95% CI = 4.70-16.54) and long term mortality (RII= 3.87; 95% CI = 2.62 – 5.73) were in the low income group. The test for linear trend suggests that the predictive power of SRH for short ($p<0.0001$) and long term mortality ($p<0.0001$) decreases with increasing income levels.

Table 3 presents results showing the association between the dichotomised measure of SRH and mortality. SRH predicts mortality in all three education groups with the associations being strongest in the group with primary education in the short (HR = 3.19; 95% CI = 1.79-5.67) and the long term (HR = 2.38; 95% CI = 1.64-1.83). However, the linear trend of decreasing associations between SRH and mortality with increasing levels of education was not strong in either the short ($p=0.22$) or the long term ($p=0.07$). The results for occupational position and income are similar to those obtained using the RII, SRH does not predict mortality in the most socially advantaged group. The test for linear trend for both these measures indicates that the predictive ability of SRH for mortality decreases with increasing levels of income and occupational position.

DISCUSSION

This study shows that socioeconomic variables are important modifiers of the association between self-rated health and mortality. A single measure of self rated health was used to predict mortality in middle-aged individuals drawn from a large prospective cohort study of public utility workers in France. The results relating to the three socioeconomic indicators – education, occupational position and income - show that the predictive power of self-rated health is weakest in the most advantaged group, both in the short-term and over the entire follow-up period. Although the SRH-mortality relationship has been widely examined, few attempts have been made to examine factors that modify this relationship and the conditions under which it "strengthens, weakens or disappears"(13). Our results show that socioeconomic factors are important modifiers of this association among middle aged individuals. Although the SRH-mortality association is stronger at the shorter follow-up period, the effect modification by socioeconomic measures is equally strong in the short and long follow-up period.

Associations between SRH and mortality have usually been examined by comparing the worst category ('very poor' SRH) to the best category ('very good' SRH) despite evidence of a dose-response relationship(3). This approach has been popular as it provides a summary index of the association between SRH and mortality. However, the results can be misleading since only the extreme categories are compared, so attempts have been made to use

information from all SRH categories. One modification is to dichotomize the measure by grouping the first two or three categories as 'good' SRH and the others as 'poor' SRH and then comparing these two groups. The RII, a further modification, is a summary measure that has the advantage of comparing mortality risk at the extremes of the SRH distribution but is estimated using data from all SRH groups and is weighted to account for the size of these groups(21;22).

Our results relating to the moderating influence of socioeconomic variables were quite similar in analyses using the RII and SRH as a binary variable. Results using the binary variable differ slightly for the measure of education in that the predictive power of SRH for mortality does not show a linear decrease with increasing education when analysed using the binary measure of SRH. However, the associations between SRH and mortality did weaken with increasing level of education. Education is not a strong marker of socioeconomic position in this cohort. Only 11% of participants have tertiary education (university degree) and nearly 70% have only lower secondary education. The RII calculation for mortality in the primary education group (Table 2) is based on few deaths leading to a wide confidence interval. In terms of other two socioeconomic measures, there are no differences in the results using the two different methods of analyses: SRH did not predict mortality among the most advantaged group, defined by occupational position and income. Furthermore, the predictive power of SRH declined with increasing levels of income and occupational position.

Two previous studies that have examined this issue have reported no differences in the predictive ability of self-rated health in different socioeconomic groups(11;18). Our results are strikingly different; the associations between SRH and mortality were weaker in the most advantaged group. We undertook further analyses to check the veracity of our results. We calculated age and sex standardised mortality rates and absolute risk differences in mortality in the dichotomised measure of SRH as a function of the socioeconomic variables. This analysis was undertaken to ensure that the relative associations shown in Table 3 held when examined in absolute terms. The absolute risk differences in mortality (Appendix 1) between those with good SRH compared to those with poor SRH was much greater in the disadvantaged group, for all three socioeconomic indicators used here.

The two previous studies whose findings are contrary to ours(11;18) use Swedish data. It is highly unlikely that the discrepancy in results is due to cultural differences in the social patterning of SRH; European comparisons show similar social inequalities in self-rated health in all the countries examined(23;24). However, both these studies are different to ours in terms of the wide age range examined. One paper included participants who were between 16

and 85+ years old(11), and the other between 20-84 years old(18). The follow-up period for mortality in both studies was around 20 years; most deaths in the analyses are likely to have been among the older individuals. Both these studies and many others have shown the association between SRH and mortality to be weaker at older ages(1;2;11;13;25). There is also some evidence to suggest that the strength of the association between SRH and mortality in the elderly weakens over time(8;13;26). Thus, it is possible that our results showing the modifying influence of socioeconomic indicators on the association between SRH and mortality are specific to middle aged individuals. It is also possible that the moderating influence of social class is diluted in analyses when the SRH mortality association is examined without stratifying the analyses by age-group.

Future research is needed to confirm our findings and to explore the reasons behind the differential predictive ability of SRH in different socioeconomic groups. Three main hypotheses can be put forward to explain the weaker predictive ability of SRH in different population sub-groups. The first links it to differences in the distribution of chronic diseases (27); the higher socioeconomic groups could have less serious (or less serious versions of the same) chronic conditions. The "milder versions" of chronic conditions might be reflected in morbidity measures like SRH but are not reflected in mortality; creating a weaker association between SRH and mortality in these advantaged groups. The second relates to greater stoicism in socially disadvantaged groups and a greater willingness in the more advantaged groups to factor in less serious ailments in response to global questions on health(28). Such reporting tendencies would create a stronger association between SRH and mortality in the socially disadvantaged group. Finally, the "vulnerability hypothesis"(29-31) suggests that higher risk of death in the disadvantaged group creates stronger associations between SRH and mortality in that group, the stronger SRH-mortality association would simply be an artefact of greater mortality in this group. Thus differences in the distribution or severity of chronic diseases, 'over-reporting' in the advantaged socioeconomic group and greater overall vulnerability of the disadvantaged social group are all potential explanations of the weaker predictive ability of SRH in the advantaged socioeconomic group. Previous research on other measures of morbidity provides some support for stoicism(31) and for underreporting of illness(32) among socially disadvantaged groups.

The central research question addressed in this paper is whether the association between a subjective and an objective evaluation of health is different in different socioeconomic groups. Our results show clear differences and it appears unlikely that health-related selection could explain the results. There is no health-related downward social

mobility in EDF-GDF. In the face of ill health an employee is offered a less strenuous occupation but retains his or her occupational grade and salary level. Even if individuals in poor health were selected into the socially disadvantaged groups the fact that they then go on to assess their health more accurately, leading to stronger associations between SRH and mortality, brings us back to the issue of discrepancy between objective and subjective assessments of health. More work on the processes that lead individuals to assess their own health is required to understand these results. This would involve research on social comparison processes and whether these work differently in different socioeconomic groups. It is worth noting that there is greater variation in the SRH scores in the socially disadvantaged group (Table1), suggesting greater heterogeneity in this group. Those from the disadvantaged social group are likely to witness more ill health and premature mortality among family, friends and peers. Further research is required to investigate whether the greater heterogeneity in the disadvantaged group allows individuals to reach more accurate assessments of their own health as their social comparison group is more diverse.

There is an important caveat related to the results reported here. GAZEL is an occupational cohort and all participants have stable jobs. It is, therefore, difficult to extrapolate the findings to the general population which includes unemployed individuals. Nevertheless, the great strength of GAZEL is the inclusion of a wide range of occupations, including blue-collar workers. Research based on the entire EDF-GDF population, from which the GAZEL cohort is drawn, shows much lower mortality among the EDF-GDF employees compared to the French general population(33;34). Thus the "healthy worker effect" is clearly present among the EDF-GDF employees. However, it is important to note that the social gradient in mortality in EDF-GDF is similar to that in the French general population(33;34).

The results reported here are important because self-rated health has been used extensively to report social inequalities in health. For these reports to estimate accurately the "true" extent of inequalities in health, it is necessary that SRH measure health in a similar way across socioeconomic categories. This underlying assumption appears not to be supported in our data. Thus, the use of self-rated health to estimate social inequalities in health might provide conservative estimates of these inequalities.

KEY MESSAGES

The predictive ability of SRH for mortality weakens with increasing socioeconomic advantage among middle-aged individuals. These effects are stronger for occupational position and income compared to education.

The use of self-rated health to estimate social inequalities in health might provide conservative estimates of the "true" extent of inequalities.

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TABLE 1. Self rated health (SRH) and subsequent mortality in the GAZEL cohort.

	MEN				WOMEN			
	N (%)	Self-rated health Mean (SD)	Died during first 10 years N (%)	Died during follow-up N (%)	N (%)	Self-rated health Mean (SD)	Died during first 10 years N (%)	Died during follow-up N (%)
education								
Primary	947 (6.5%)	3.14 (1.53)†	44 (4.6%)	97 (10.2%)	399 (7.4%)	3.19 (1.46)†	7 (1.8%)	17 (4.3%)
Lower secondary	9687 (66.4%)	2.98 (1.31)†	246 (2.5%)	593 (6.1%)	3710 (69.0%)	3.07 (1.37)†	49 (1.3%)	108 (2.9%)
Higher secondary & tertiary	3948 (27.1%)	2.87 (1.26)†	67 (1.7%)	183 (4.6%)	1264 (23.5%)	2.88 (1.31)†	10 (0.8%)	28 (2.2%)
Total	14582	2.96 (1.32)	357 (2.4%)	873 (6.0%)	5373	3.03 (1.36)	66 (1.2%)	153 (2.8%)
Occupational position								
Unskilled	2070 (13.9%)	3.23 (1.49)†	87 (4.2%)	192 (9.3%)	1460 (26.5%)	3.16 (1.43)†	26 (1.8%)	47 (3.2%)
Skilled	8276 (55.7%)	2.97 (1.32)†	202 (2.4%)	521 (6.3%)	3594 (65.2%)	3.00 (1.35)†	38 (1.1%)	98 (2.7%)
Managers	4520 (30.4%)	2.84 (1.22)†	80 (1.8%)	189 (4.2%)	460 (8.3%)	2.87 (1.27)†	5 (1.1%)	12 (2.6%)
Total	14866	2.97 (1.32)	369 (2.5%)	902 (6.1%)	5514	3.03 (1.37)	69 (1.3%)	157 (2.8%)
Income								
Low	3495 (24.3%)	3.13 (1.41)†	129 (3.7%)	293 (8.4%)	1176 (22.6%)	3.19 (1.47)†	23 (2.0%)	55 (4.7%)
Medium	6789 (47.2%)	2.96 (1.31)†	154 (2.3%)	379 (5.6%)	2262 (43.5%)	3.07 (1.36)†	19 (0.8%)	47 (2.1%)
High	4109 (28.5%)	2.82 (1.24)†	74 (1.8%)	193 (4.7%)	1763 (33.9%)	2.86 (1.28)†	17 (1.0%)	39 (2.2%)
Total	14393	2.96 (1.32)	357 (2.5%)	865 (6.0%)	5201	3.02 (1.36)	59 (1.1%)	141 (2.7%)

†Test for trend across socioeconomic category was significant at $p<0.0001$.

TABLE 2. The association between self rated health at baseline (1989) and mortality in different socioeconomic groups

	Died during first 10 years of follow-up	**Died during follow-up**
	RII (95% CI) [†]	**RII (95% CI)** [†]
Education		
Primary	15.39 (5.00-47.32)	4.69 (2.37-9.31)
Lower secondary	3.23 (2.13-4.92)	2.47 (1.90-3.22)
Higher secondary & tertiary	3.45 (1.51-7.88)	1.81 (1.11-2.96)
Test for trend	p=0.07	p=0.03
Occupational position		
Unskilled	6.78 (3.33-13.81)	3.83 (2.40-6.12)
Skilled	3.36 (2.11-5.36)	2.54 (1.91-3.39)
Managers	2.10 (0.97-4.54)	1.23 (0.75-2.03)
Test for trend	p=0.02	p=0.002
Income		
Low	8.82 (4.70-16.54)	3.87 (2.62-5.73)
Medium	2.85 (1.65-4.91)	2.80 (1.98-3.96)
High	1.80 (0.86-3.80)	1.21 (0.76-1.93)
Test for trend	p<0.0001	p<0.0001

[†]Adjusted for age and sex

TABLE 3. The association between binary self rated health and mortality in different socioeconomic groups

	Died during first 10 years of follow-up	**Died during follow-up**
	HR (95% CI) [†]	**HR (95% CI)** [†]
Education		
Primary	3.19 (1.79-5.67)	2.38 (1.64-1.83)
Lower secondary	1.85 (1.47-2.32)	1.58 (1.36-1.83)
Higher secondary & tertiary	1.89 (1.20-2.99)	1.47 (1.11-1.95)
Test for trend	p=0.22	p=0.07
Occupational position		
Unskilled	2.61 (1.78-3.83)	2.02 (1.56-2.61)
Skilled	1.84 (1.42-2.37)	1.60 (1.37-1.88)
Managers	1.40 (0.88-2.20)	1.07 (0.78-1.47)
Test for trend	p=0.02	p=0.005
Income		
Low	2.68 (1.93-3.72)	1.93 (1.56-2.39)
Medium	1.66 (1.23-2.24)	1.61 (1.32-1.95)
High	1.46 (0.94-1.46)	1.21 (0.91-1.61)
Test for trend	p=0.009	p=0.004

[†]Adjusted for age and sex

Appendix1. Self rated health at baseline (1989) and mortality in socioeconomic groups

	Died during first 10 years			
	Age and sex standardized mortality rate /100 000			Absolute difference in mortality between Good-SRH et Poor-SRH
	all	Good-SRH (categories 1-3)	Poor-SRH (categories 4-8)	
Education				
Primary	229.33	90.33	412.10	321.77
Lower secondary	140.68	122.06	181.40	59.34
Higher secondary & tertiary	85.20	75.79	111.59	35.80
Occupational position				
Unskilled	252.97	136.44	394.86	258.42
Skilled	134.69	113.56	179.83	66.27
Managers	80.39	82.03	77.37	-4.66
Income				
Low	210.6	102.51	360.96	258.45
Medium0	107.06	105.40	123.52	18.12
High	107.05	106.10	111.94	5.84