Is the SF-6D a good predictor of subsequent mortality in Scotland?

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ABSTRACT

Background/Aim: The literature has shown self-rated health (SRH) - as measured using a single item response - to be an independent predictor of mortality. The SF-6D is a measure of SRH and, as yet, no study has investigated its predictive ability for subsequent mortality. This study aims to substantiate or otherwise the notion that SRH predicts mortality regardless of the way in which it is measured.

Data/Methods: Data were drawn from The Lothian Health Survey with 6091 participants, all aged over 16, followed-up over 15 years. Individuals' SF-6D scores are included as a continuous variable within the data set, but the scores were split into four SRH categories labelled 'excellent', 'good', 'fair', and 'poor'. Cox regression was then used to analyse the association between SRH and mortality. In addition, sub-group analysis was carried out to ascertain the robustness of the findings and to evaluate how the predictive ability of SRH varied according to the following groups; gender, age, and social class. The analysis adjusted for a number of covariates including education, deprivation, and presence of longstanding or chronic illness.

Results: Compared to those with 'excellent' SRH, individuals who rated their health as 'poor' (HR=1.47; 95% CI=1.25-1.72) or 'fair' (HR=1.22; 95% CI=1.10-1.36) had a significantly higher risk of mortality. Such findings were consistent across all subgroups, although there was some variation in the level of risk between groups.

Conclusions: The SF-6D is found to predict mortality. This enhances the belief that, irrespective of the measurement tool, SRH carries mortality risk information.

Introduction

"Health planners and policy makers are increasingly asking for a feasible method to identify vulnerable persons with the greatest health needs." (DeSalvo et al, 2005 – pg 267). It may be said that those at risk from mortality are amongst those with the greatest health need and, as such, the research undertaken here could potentially have direct policy relevance. If those with poor SRH are found to be at greater risk of mortality, then such findings could be used in addition to clinical judgements when assessing an individual's need for healthcare[1]. In addition, Mossey and Shapiro (1982) argue that a measure of SRH is not only easy to obtain, but is also inexpensive relative to formal clinician assessment. As a consequence, SRH is potentially a practical instrument to aid clinical decisions.

Here, the short form 6-dimensions (SF-6D) will be used to measure SRH, thus making this study distinct. It is believed that no prior research has investigated the capability of the SF-6D (a cardinal measure of SRH) to be an appropriate predictor of mortality, with the vast majority of previous studies tending to measure the predictive ability of SRH with respect to ordinal SRH[2]. However, using these ordinal SRH measures as a means of identifying those groups at risk is not a method accepted and recognised by medical professionals (Idler et al, 2000). Health professionals are also said to be sceptical of preference-based measures of health. Despite this, it is hoped that the use of the SF-6D to measure SRH might help change these views, since individuals are forced to assess their health in a more structured manner where the domains of health to be considered are pre-defined.

Literature review

Socio-economic status (SES) and measures of social networks/support are regularly incorporated within mortality studies, together with more 'obvious' risk factors such as alcohol/drug use, weight, and health status (Idler and Benyamini, 1997). Under the heading of health status, individuals are often asked to assess their own health; for example, do you rate your health 'very poor', 'poor', 'average', 'good', or 'excellent'? As Idler and Benyamini go on to explain, even these seemingly basic global measures of health seem to encompass their own and independent mortality risks, and may pick up

[1] It is appreciated that those with the greatest mortality risk may not necessarily have the greatest need for healthcare, for example where no healthcare exists to aid their recovery.
[2] In the vast majority of literature SRH is measured through questions such as "In general, would you say that your health is excellent, good, fair, or poor?" (Frankenberg and Jones, 2004 – pg 441).

various 'symptoms' that may be left unaccounted for by conventional medical care[3]. However, not until 1982 did any coherent evidence emerge to support the relationship between SRH and mortality. Mossey and Shapiro (1982) said of their study:

> "These findings provide empirical support for the long held, but inadequately substantiated, belief that the way a person views his health is importantly related to subsequent health outcomes [e.g. death]." (Mossey and Shapiro, 1982 – pg 800)

In 1997, Idler and Benyamini published a review of the SRH-mortality literature. They identified 27 community-based studies all of which assessed the SRH-mortality relationship. The association between poor SRH and an increased mortality risk was deemed to be independent of age, seriousness of various health conditions, behavioural (e.g. lifestyle), and biological (e.g. increased blood pressure) risk factors. In 1999, Idler and Benyamini published an update to their initial review that included SRH-mortality studies published between 1995 and 1998.

After conducting a review of the post-1998 literature it became apparent that there is a substantial body of evidence to support the notion that SRH is a strong predictor of mortality. The SRH-mortality relationship was found to exist across a variety of different populations, settings, age groups, and follow-up periods. Furthermore, the findings were consistent regardless of the statistical methods used, and also after the inclusion of a variety of covariates.

Of the identified studies, none were conducted in Scotland. Also, no studies have investigated the predictive ability of the SF-6D for subsequent mortality. As such, and even though there is seemingly unanimous evidence regarding the SRH-mortality relationship, this study will provide an important addition to the SRH-mortality literature, especially if the findings are ever to be incorporated into healthcare decision making within Scotland.

[3] Of course, using the SF-6D rather than an 'all encompassing' SRH measure may mean missing out on some health problems that are not covered by the SF-6D.

Methods

Sample

Lothian Health Survey (LHS) data is to be used for this research. Lothian is situated in South East Scotland and is made up of the following areas; Edinburgh city, East Lothian, Midlothian and West Lothian.

In 1993, a general population health survey was commissioned by Lothian Health - the health authority for the Lothian area (Cohen et al, 1996) – with self-complete questionnaires despatched to 9828 Lothian residents. The health survey was conducted with several aims, one of which was the acquisition of an overall indication of SRH status within the region (Cohen et al, 1995). The Lothian Community Health Index[4] was used as the sampling frame for the survey, from which equal sized random samples were taken from the following age groups; 16-44, 45-64, 65-74, and 75plus.

Measures

Survival

The General Register Office (GRO) for Scotland is responsible for the registration of all births and deaths within Scotland (GRO, 2008). Owing to the fact that all respondents were followed up by GRO, the number of deaths occurring within the sample were reliably and accurately recorded. The death certificates were then passed on to the relevant LHS representatives so that survey records could be updated.

Self-reported health (SRH)

The SF-6D will be used to measure SRH. The LHS contains individual's SF-6D scores for the 1993 wave of the survey. Since respondents are required to complete the questionnaires themselves, they are said to be providing a self-reported measure of health.

The 1993 data for the SF-6D has been acquired through the completion of the SF-36 questionnaire, which have since been converted to SF-6D scores. The SF-6D is included as a continuous variable

[4] The community health index is a centrally held file with details of Lothian residents registered with a GP.

within the data set. However, the SF-6D scores will be split into the following categories; ‘poor’ SRH contains those with an SF-6D score of less than 0.5, ‘fair’ SRH represents 0.5-0.7, ‘good’ SRH represents 0.7-0.85, and ‘excellent’ SRH represents an SF-6D score of more than 0.85. The cut off points were chosen after scrutinising Table 4 of Brazier et al’s (2002) paper. Justifications for the choices are available on request, along with examples of health states within each SRH category.

The choices also ensured each category had an approximately equal number of respondents. The exception was the category for ‘poor’ SRH where significantly fewer individuals were contained. This decision was taken on the basis that classifying an SF-6D score of more than 0.5 as ‘poor’ would be somewhat misleading. Hereafter, SRH and levels of SRH refer to the four categories (outlined above) created from the SF-6D continuous variable.

Covariates

The Lothian health survey contained information on a number of variables, including demographic information such as age, sex, and education. Covariates that are thought to affect both SRH and mortality were included in the analysis, and a full list of these is available on request. However, the less self-explanatory variables will be briefly outlined below.

Health problems: This variable contains information on whether the individual had suffered from any of the following health problems; musculoskeletal, circulatory (heart/stroke), mental (including depression), respiratory, and diabetes.

Deprivation: In order to control for an individuals level of deprivation, the Scottish Index of Multiple Deprivation (SIMD) variable has been included in the analysis. The SIMD measures levels of deprivation using the following domains; current income, employment, health, education, geographic access to services and housing, and crime (SIMD, 2006). Those who score poorly on these domains will, by definition, have a poor SIMD score.

Social class: The social class of the respondent may affect their mortality risk. To control for this possibility, a social class variable within the Lothian Data set was utilised. A number of dummy variables were created, with social class categorised under the following types of profession; ‘professional’, ‘intermediate’, ‘skilled’, ‘skilled manual’, ‘unskilled’, and ‘no occupation’.

Statistical analysis

Cox regression analysis will establish the association between SRH and subsequent mortality during the 15-year follow-up period. The output from Cox proportional hazard models is shown in the form of Hazard Ratios (HRs). This hazard ratio is the ratio between the predicted risk for individuals in one group and the predicted risk for individuals in another group, holding all other things constant. As such, HRs indicate the capacity of SRH for predicting mortality. A larger hazard ratio signifies greater predictive ability of SRH for mortality (Huisman et al, 2007).

As pointed out by Brissette et al (2003), using Cox regression analysis has several advantages over other techniques when studying mortality data. Logistic regression models will only take into account whether or not the event (e.g. death) occurs within the observation period, with no consideration regarding the timing of the event. Conversely, Cox regressions incorporate the timing of the event, so acknowledge whether the event occurred early or late within the observation period. This is important since death occurring early in the period is indicative of higher risk. A further advantage of using Cox regression over logistic models is that Cox analyses include cases where the mortality status of individuals cannot be determined at the *end* of the observational period. Any cases lost in follow-up are still considered at risk from the event (e.g. death) for as long as they are in the study, and are then considered ‘censored’ at the point where the loss to follow-up occurs.

Cox Model construction

Three regression models will be run. Model 1 will analyse the predictive ability of SRH for mortality without adjusting for covariates. Model 2 will then display the HR for each level of SRH after controlling for a small number of demographic variables. Finally, Model 3 will then control for the full list of covariates, for example, the presence of other diseases/illness, social class, and deprivation. Including such variables is intended to significantly improve the fit of the model and help establish whether SRH is indeed an independent predictor of mortality.

In order to test the robustness of the findings, the SF-6D will also be treated as a dichotomised variable, where 1 equals ‘excellent’ and ‘good’ SRH and 0 equals ‘fair’ and ‘poor’ SRH. This will further clarify whether those with poorer SRH are indeed at a greater risk of mortality.

Having conducting a review of the literature, SRH was also found to be a good predictor within various subgroups. Therefore, beyond simply looking at the sample as a whole, subgroup analysis will be carried out. Subgroup analysis will hopefully demonstrate the consistency of the overall findings. However, conducting such analysis will also offer an indication as to what extent the predictive ability of SRH varies between these various subgroups. Any variation, along with possible reasons for this variation, can then be discussed. This will be interesting especially since evidence for differences across subgroups is mixed (e.g. van Doorslaer and Gerdtham, 2003; Singh-Manoux et al, 2007).

Results

Results from the Cox regression analysis are presented in Table 1 (see appendix). When reporting the hazard ratio (HR) for levels of SRH, the reference case is always 'excellent' SRH.

The results from Model 1 show that lower SRH leads to a greater risk of mortality. Self-reporting 'fair' health carries approximately twice the risk (HR=1.88, 95% CI=1.71-2.06) of mortality than does 'excellent' SRH. For 'poor' SRH, this risk is over three-fold (HR=3.30, 95% CI=2.87-3.79). 'Good' SRH appears not to carry an additional survival risk, since the HR is insignificant.

Model 2 (the partially adjusted model) shows the hazard ratios for SRH after the inclusion of a small number of demographic variables. Those who rated their health as 'fair' were found to have a 47% (HR = 1.47; 95% CI = 1.34-1.61) greater risk of mortality than those who reported their health as 'excellent', while those rating their health as 'poor' had two times greater risk of mortality (HR = 2.01; 95% CI = 1.74-2.31). The difference between those who reported 'good' and 'excellent' was not statistically significant. Furthermore, being older carries a greater risk of mortality, being female reduces risk of mortality, while leaving school after 17 years of age is associated with a reduced mortality risk when compared to those leaving before their 16th birthday.

Including a full list of covariates improves the model fit and Model 3 hereafter denotes the adjusted model. After controlling for a full list of covariates, Model 3 demonstrates that the difference in mortality risk between those reporting 'good' and 'excellent' was still found to be insignificant. Yet the hazards ratios for those reporting 'fair' (HR = 1.22; 95% CI = 1.09-1.36) and 'poor' (HR = 1.47; 95% CI = 1.25-1.72) were still significant. Although the HRs were reduced after including all the covariates, the key finding is that SRH is found to be an independent predictor of mortality.

In addition, a number of the other covariates were significantly related to a greater risk of mortality. Both being male and getting older were found to carry an increased mortality risk. Further, it was reassuring to find that having a longstanding illness (*'illness'*) was indicative of a higher risk of mortality (HR = 1.31; 95% CI = 1.19-1.44), as was having a major health problem (*'health prob'*) (HR = 1.29; 95% CI = 1.19-1.41). It is reasonable to assume that individuals with either of the above problems would in general have a higher risk of death. Therefore, if these results had been insignificant, doubt may have been cast on the reliability of the findings. Even more interestingly, 'poor' SRH seems to carry more of a mortality risk than having one of the major health problems. It was also found that those having previously been admitted to hospital were more likely to die than those who had not. Finally, being in a higher social class was found to reduce mortality risk compared to those with no occupation.

In sum, these results have demonstrated that SRH (measured using the SF-6D) does indeed act as an independent predictor of mortality in the Lothian region of Scotland. Those indicating both a 'poor' and 'fair' level of SRH have a significantly greater risk of mortality than those reporting 'excellent' health. In order to demonstrate the robustness of these findings, the SF-6D was split into a dichotomised variable (*results table available if required*). It can be seen that reporting a low (less than the mean SF-6D score of 0.757) SF-6D score results in a 1.18 (1.06-1.32) higher risk of mortality than reporting a high SF-6D score. Although this represents a very simplistic additional robustness check, the reliability of the results has been further established.

Subgroup analysis

The main results in Table 1 demonstrated that age, gender and social class have an impact on mortality risk. However, in order to further ascertain the robustness of the general findings, subgroup analysis was carried out, with the sample stratified according to the following groups; gender, age, and social class. This subgroup analysis will also give an indication as to whether the predictive ability of SRH varies across subgroups. In the interest of readability, when displaying the results from the subgroup analysis, only the hazard rates of interest – SRH - will be presented (see appendix) (*full tables of results available on request*). For each subgroup, all three models were run. For dependable conclusions to be drawn from survival analysis, it is deemed important to conduct multivariate analysis and include a number of other risk factors. Therefore, only the notable results from Model 3 will be described within the text. Finally, it must be noted that the corresponding variable to each specific subgroup will be removed from the regression equation when carrying out the relative analyses.

Gender (Table 2 – see appendix)

The difference in mortality risk between those reporting 'good' and 'excellent' health was found to be insignificant for both males and females. Within Model 3, the hazard ratio for males reporting 'fair' SRH was 1.41 (95% CI = 1.20-1.65). However, for the female subgroup, the difference in risk of mortality between those reporting 'fair' and 'excellent' SRH was found to be insignificant. For individuals reporting 'poor' health, the HRs for both genders were found to be significant; 1.72 (1.34-2.21) for males and 1.33 (1.08-1.63) for females. Table 2 also shows that the respective HRs were reduced after including more covariates into the model, a feature to be expected. In sum, SRH seems to be an independent predictor of mortality for both genders, although the predictive ability may be stronger for men.

Age (Table 3 – see appendix)

For the 16-24 age group, the HR for those with 'poor' health was 8.91 (95% CI = 1.42-55.79) in Model 3. 'Fair' or 'good' health was not found to represent an increased risk of mortality. In contrast, for the 45-64 age groups, the HR associated with both 'poor' and 'fair' health was found to be statistically significant in Model 3. 'Fair' health represents a 1.67 times greater risk of mortality (1.17-2.38) and 'poor' health brings with it a 1.78 times increased risk (1.03-3.09). In Model 3 for the 65-74 age group, the HRs for 'fair' and 'poor' SRH were 1.34 (1.11-1.61) and 1.76 (1.33-2.34) respectively.

Finally, in Model 3 for over 75 age group, reporting ‘poor’ health was found to carry a significantly different mortality risk (HR = 1.32; CI= 1.07-1.62) . However, the HR for ‘fair’ health was not found to be significant and, even more interestingly, the HR for ‘good’ health was shown to be significant at the 10% level. This implied that reporting ‘good’ health corresponded to a lower risk of mortality than that of those reporting ‘excellent’ health. This result represents something of an anomaly.

After limiting the sample for the various age groups, SRH was still found to predict mortality. Additionally, the evidence perhaps suggests that, owing to the higher HRs among the lower age groups, SRH may be a greater indicator of mortality risk the younger the person is.

Social class (Table 4 – see appendix)

In Model 3, ‘good’ SRH was not found to carry an additional mortality risk. The exception was the ‘no occupation’ social class group where ‘good’ SRH was found to carry a lower mortality risk.

For the professional group, the HR for ‘fair’ SRH is 2.49 (95% CI = 1.17-5.29), while the HR for ‘poor’ health was found to be 4.64 (1.07-20.15). Restricting the sample to those in intermediate professions resulted in the following HRs (‘fair’, HR = 1.59; CI = 1.19-2.13; ‘poor’, HR = 2.02; CI = 1.33-3.05). Interestingly, for the ‘skilled’ occupational groups, the SRH HRs were not significant in the adjusted model. After stratification for the ‘skilled-manual’ and ‘unskilled’ social classes, the results were once again familiar, with ‘fair’ and ‘poor’ SRH found to pose a significantly greater risk of mortality in the adjusted model. As with the 75plus age group, results from the ‘no occupation’ group stood out. ‘Good’ SRH was found to carry a reduced risk of mortality when compared to ‘excellent’ SRH. In addition, ‘fair’ SRH was no longer significant.

As expected, moving from the unadjusted to the adjusted model tended to diminish the predictive power of SRH for mortality. However, the overall pattern is a common one, with SRH again found to predict mortality across social class groups. Interestingly though, the HRs are greater for the ‘higher’ social classes. As such, the predictive ability of SRH appears to be greater for these ‘higher’ social classes.

Results summary

SRH is found to be an independent predictor of mortality, with ‘fair’ and ‘poor’ SRH found to carry a significantly greater risk of mortality than ‘excellent’ SRH. Subgroup analysis was then conducted to assess the robustness of these findings. Unfortunately, conducting sub-group analysis inevitably reduces the sample size which in turn can reduce the precision of the findings. Such a problem was evident for the ‘professional’ group where only 256 individuals were included. It is therefore important to treat results with the subgroup analysis with caution.

However, in nearly all the subgroups, the results tended to mirror those from the whole sample. In general, ‘good’ SRH was not found to represent an increased risk, while ‘fair’ and ‘poor’ SRH was indicative of a higher mortality risk. In addition to ascertaining the robustness of the overall findings, the subgroup analysis has shown that the predictive ability of SRH tends to vary between subgroups. This is a potentially important finding and, as such, possible explanations will be put forward in the following section, as well as discussing the policy implications of these findings.

Discussion

General findings

The findings of this paper are comparable to the majority of previously published SRH-mortality studies. Owing to the consistency of previous findings, this was almost to be expected. However, this paper was the first to assess the predictive ability of the SF-6D for subsequent mortality so it can be considered, to a certain extent, reassuring that this alternative measure of SRH has led to comparable conclusions.

However, and contrary to this, it is worth noting that Wannamethee and Shaper (1991) had argued that after the inclusion of a comprehensive set of risk factors, the predictive ability of SRH for mortality is minimal. Here, despite the predictive power of SRH being reduced after the inclusion of a full list of covariates, the results were still found to be significant. Studies by Bosworth et al (1999) and Brissette et al (2003) also found the results remained significant after the inclusion of a more extensive range of risk factors.

Interestingly, in every model run, reporting ‘good’ health was not found to carry a significantly different mortality risk to those having reported ‘excellent’ health. Initially, this may appear surprising, yet could partly be attributed to the possible ‘floor effect’ of the SF-6D (see Brazier et al, 2002). To understand this, consider that the majority of SF-6D scores are found towards the upper end of the 0-1 scale. As such, a large number of people will be reporting very similar scores in terms of the ‘actual number’ on the 0-1 scale. Therefore a situation may have arisen where those in the ‘good’ health category (0.7-0.85 on SF-6D) may have rather similar health to those deemed to have ‘excellent’ health (0.85+). Further scrutiny is perhaps required to establish where exactly on the SF-6D scale would be the cut-off point that more appropriately recognises those who actually have ‘perceived’ excellent health. In sum, there is may be a grey area within this study design where the ‘good’ and ‘excellent’ health groups perhaps overlap and, as such, the health levels are not distinct enough to carry a different mortality risk.

Perhaps a more simple explanation for the lack of variation in mortality risk between to top two health categories is that being in ‘good’ health and ‘excellent’ health do, in reality, carry a similar risk. Intuitively, those in perceived good health are not often considered at risk from mortality. Contrast this with individuals with ‘poor’ SRH. They are likely to have answered with the lowest response on some SF-36 domains and, as a result, may have a problem that is serious enough to be correlated with subsequent mortality. A number of previous studies also found that there was no significant difference in the mortality risk of the top two SRH categories (e.g. Bosworth et al, 1999; Lee, 2000; Huisman et al, 2007). Although this indicates that the results here may not be an unusual feature within SRH-mortality studies, it is still recommended that an explanation be sought. This could be an area of future research.

Earlier, it was noted that ‘poor’ SRH carried a higher mortality risk than having one of the major health problems. This is potentially a significant finding, and one which strongly points to towards the usefulness of SRH in resource allocation. Those with major health problems are rightly allocated appropriate healthcare resources, but if those with ‘poor’ health carry an even greater mortality risk, then perhaps the resource allocation process should be updated to reflect this?

Gender

Although there was a strong relationship between SRH and mortality among both men and women, a slight gender variation in the predictive power of SRH was found. Both 'poor' and 'fair' SRH was found to be more predictive of subsequent mortality for men than it was for women.

Interestingly though, similar results have been found previously (see Grant et al, 1995; Heistaro et al, 2001; Heidrich et al, 2002). Deeg and Kriegsman (2003) also found SRH to be more predictive of mortality amongst men. They explained this by suggesting that women's SRH assessments gave greater consideration to disabling health problems, whereas men's assessments were thought to focus on lifestyle factors and mortality risks. Once again however, it is important to remember that in SRH-mortality studies like that conducted by Deeg and Kriegsman (2003), SRH is assessed through a single question. This would leave greater scope for variation in the interpretation of one's own health. Using the SF-6D to measure SRH may reduce this possibility owing to the structured format of the questionnaire.

A number of studies have suggested that men have higher mortality rates but lower morbidity rates relative to women (e.g. Franks et al, 2003). Within the literature, this is referred to as the 'morbidity paradox' (Gorman and Read, 2006), or within health the 'gender paradox' (Riley, 1990). Such a paradox may explain the slight differences in the predictive ability of SRH between genders. If the paradox is to be believed, women may report lower levels of SRH relative to men, but will not suffer the mortality rates that these levels are 'expected' to represent. This may explain why the risk of mortality is lower for a given SRH level within the female population.

Age

It is interesting to note the variations in predictive power of SRH between the different age categories. Within the 16-44 age group, reporting 'poor' health carried a nine times greater risk of mortality than reporting 'excellent' health. For the 45-64 and 65-74 age groups, this risk was just less than two-fold, yet for the 75 and older age group, 'poor' health only carried a 1.3 times greater risk. The pattern illustrates that the predictive ability of SRH for mortality seems to drop as age rises. Such findings are consistent with those found by Burstrom and Fredlund (2001), who also found that SRH had greater predictive ability in the lower age groups.

An explanation could be that younger people who perceive their health to be 'poor' are probably more likely to be seriously ill (and as such have a greater mortality risk) than an older person who perceives their health to be 'poor'. In other words, an elderly person may report in the lowest level in physical functioning domains of the SF-6D, giving them a low SRH score, but doesn't mean they are necessarily close to death. If, on the other hand, a younger individual reported such difficulties, this may represent a more serious health problem with implications for subsequent mortality.

Social class

The results from the skilled social class group represent something of anomaly. Compare the unadjusted/partially adjusted models to the fully adjusted model; a similar pattern emerges across all groups with the HRs of 'poor' and 'fair' health tending to remain significant. However, for the skilled group, the move from the partially adjusted model to the fully adjusted model for some reason produces insignificant results. No logical explanation can be found for this. It is equally difficult to explain why, for those with no occupation, reporting 'good' health carries a reduced risk of mortality to that from reporting 'excellent' health. This result has to be rationalised as an anomaly.

In order to expand this research and fully investigate how the predictive ability of SRH varies by social class, an interaction term for social class and SRH could be included within the regression. Such methods have been used in previous research (see Beam-Dowd and Zajacova, 2007; Singh-Manoux, 2007) where it was found that the predictive ability of SRH varied between social groups. To an extent, the results from the basic analysis conducted here told a similar story since, in the adjusted model, the HR for 'poor' SRH was 4.64 for the professional group and only 1.35 for those with no occupation. This *loosely* implies that those in higher social groups are more able to take into account 'mortality relevant' information into account when they filled out their SF-36 questionnaires. This may be because they are more highly educated and have higher incomes and with that have greater health knowledge. Based on both previous literature and the unsophisticated results here, it seems apparent that SRH does not seem to measure 'true' health in the same way across different groups[5]. Thus, some groups may be more precise when inadvertently 'predicting' their risk of death through the use of SRH measuring tools.

[5] Although there may be no such thing as 'true' health, it could alternatively be argued that instead, those in higher social classes may assess their own health in a *relatively* more similar way to 'objective' health assessment.

To summarise, SRH was found to be an independent predictor for mortality in the Lothian region of Scotland, with individuals reporting ‘poor’ and ‘fair’ health found to be at greater risk of mortality than those reporting ‘excellent’ health. Such findings were consistent across subgroups. However, the *strength* of predictive ability was found to vary slightly across the different groups. This may simply be a result of the inevitably different reference points from which an individual assessed their own health. Such an explanation is suitably summed up by Sen (2002);

> “One problem with relying on the patient’s own view of matters that are not entirely sensory lies in the fact that the patient’s internal assessment may be seriously limited by his or her social experience”. (Sen, 2002 – pg 860)

Policy relevance

It has been suggested that SRH might be used alongside ‘objective’ clinical health assessments. In 2004, Idler and colleagues (2004) claimed to have provided the strongest evidence yet of the variation between professional assessment and individuals own assessment. They concluded that SRH includes additional knowledge about a disease that only the sufferer experiences. This personal knowledge is “developed and refined by the firsthand experience of illness...” (Idler et al, 2004 – pg 351). As such, it seems apparent that SRH offers something extra, and using the SF-6D as an alternative SRH measure has lent support to the argument in favour of introducing SRH in healthcare resource allocation.

However, as argued by O’Reilly et al (2005), the predictive ability of SRH varied across regions. Further, the subgroup analysis here suggested that predictive ability might vary across population subgroups. If SRH did not predict mortality similarly for all groups/areas, then it seems extremely unlikely that any policy change would occur, since any specific change in policy tailored towards specific areas/groups is likely to be a politically unviable option.

Another argument against the use of SRH within healthcare resource allocation stems from the purely subjective nature of SRH. It is intuitively obvious that if the public were made aware of the use of SRH as a supplement to clinical decisions, then those filling in the SRH questionnaires could tailor their responses to best meet their desires. Essentially, they could report their health as ‘poor’ in the knowledge that this may give the impression they are at greater risk of mortality and so may get preferential treatment[6].

Finally, from a purely practical point of view, when would SRH questionnaires be filled in? How long are individuals' SRH levels relevant for? However, it was not the aim of this paper to suggest ways in which such a measure could be used in reality; this paper was only intended to assess the predictive ability of SRH (as measured using the SF-6D) for mortality. It is suggested that evaluating the practicality of implementing SRH into policy should be the concern of future research.

Future research

In the previous paragraph, questions were raised as to how long individuals' SRH scores would be valid for. With this in mind, further analysis could focus on how *changes* in SRH predict mortality? The Lothian health survey is conducive to such research since a second wave of the survey was conducted in 1996. Using Cox regression analysis, individuals' 1993 SF-6D scores could be compared to their scores in 1996 to see how changes in SRH predict mortality.

It would also be interesting to conduct a similar survey in the Lothian area whereby individuals are asked to rate their health on the more straightforward 4-point scale[7]. If similar conclusions were reached, then we could be even more confident that, not only is the SF-6D an appropriate measure of SRH, but that SRH is an independent predictor of mortality the Lothian region of Scotland. Finally, future research could also be extended to other regions in Scotland in the interests of eventually using SRH within healthcare decision-making on a nationwide scale.

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[6] SRH would be clearly not be used for emergency treatment, but could be introduced when allocating elective/social services type treatment. For example, one may report 'poor' health to get preferential treatment.

[7] E.g. "In general, would you say that your health is excellent, good, fair, or poor?" (Frankenberg and Jones, 2004 – pg 441).

Conclusion

The aim of this study was to establish whether the SF-6D is a good predictor of subsequent mortality. The results would then substantiate or otherwise the notion that SRH predicts mortality, regardless of the way in which it is measured.

The Lothian health survey contained SF-6D scores for all those who completed the survey in 1993. These scores were then split into four categories that represented different levels of SRH. Cox regression analysis was then used to assess the predictive ability of these different levels of SRH over a follow-up period of 15 years.

The findings of this study are in keeping with the majority of the research in this area, since SRH is indeed found to be an important predictor of mortality. When compared to ‘excellent’ SRH, reporting both ‘poor’ and ‘fair’ SRH carried a significantly greater risk of mortality. These results held after the inclusion of a number of covariates, and are consistent across the following subgroups; gender, age, social class.

It has been suggested that SRH be incorporated within healthcare decision-making. However, although the SF-6D perhaps provides medical professionals with a more structured and transparent method of measuring SRH, it must be stressed that further research is required before such policies can be implemented. An argument enhanced by the fact that the subgroup analysis conducted here has demonstrated variation in the predictive ability of SRH across subgroups. Future work is directed towards further investigating such differences, as well as looking at why these differences occur.

Appendix 1

Table 1: Cox proportional hazards models: Hazard ratios (HR) and 95% confidence intervals (CI) - whole sample.

Whole sample						
Variables	Model 1 (unadjusted)		Model 2 (partially adjusted)		Model 3 (fully adjusted)	
	HR	95% CI	HR	95% CI	HR	95% CI
SRH						
Excellent (base)	1.00		1.00		1.00	
good	0.96	(0.86-1.07)	0.98	(0.87-1.09)	0.93	(0.83-1.05)
fair	1.88***	(1.71-2.06)	1.47***	(1.34-1.61)	1.22***	(1.10-1.36)
poor	3.30***	(2.87-3.79)	2.01***	(1.74-2.31)	1.47***	(1.25-1.72)
Demographics *						
age			1.10***	(1.09-1.10)	1.20***	(1.15-1.25)
female			0.60***	(0.55-0.65)	0.59***	(0.54-0.64)
educ16			0.96	(0.85-1.08)	1.08	(0.96-1.23)
educ17+			0.74***	(0.66-0.84)	0.93	(0.80-1.08)
Covariates *						
selfemp					1.09	(0.83-1.43)
housewife/hus					0.90	(0.74-1.08)
dir/man					0.94	(0.81-1.08)
health prob					1.29***	(1.19-1.41)
illness					1.31***	(1.19-1.44)
SIMD1/4					1.16**	(1.02-1.31)
SIMD2/4					1.12*	(0.99-1.27)
SIMD3/4					1.06	(0.94-1.19)
exphltworse					1.03	(0.92-1.15)
exphltnotsure					0.92*	(0.83-1.01)
hospital					1.16***	(1.07-1.27)
furtraining					0.93	(0.84-1.03)
prof					0.60***	(0.46-0.79)
inter					0.80***	(0.68-0.93)
skilled					0.78***	(0.68-0.88)
skilled_man					0.81***	(0.70-0.93)
unskilled					0.84***	(0.73-0.95)
Observations:			6091		6091	
Failures:			2501		2501	
Log likelihood:			-19361.34		-19266.33	
Chi2 (DF):			3470.22 (7)		3660.23 (25)	
Change in Chi2					190.01	

*** = Significant at 1% level, ** = Sig. at 5% level, * = Sig. at 10% level

*** NOTE: meaning of covariates and the relevant base categories are detailed in Table 5 (see Appendix 2)**

<u>Table 2:</u> Cox proportional hazards models: Hazard ratios (HR) and 95% confidence intervals (CI) by gender.

SRH variables	Subgroup			
	Males		Females	
	HR	95% CI *	HR	95% CI *
Unadjusted (Model 1)				
excellent	1.00		1.00	
good	1.09		0.86*	(0.74-1.01)
fair	2.13***	(1.86-2.45)	1.75***	(1.54-1.99)
poor	3.42***	(2.72-4.29)	3.32***	(2.78-3.97)
Partially adjusted (Model 2)				
excellent	1.00		1.00	
good	1.05		0.91	
fair	1.72***	(1.50-1.98)	1.27***	(1.12-1.44)
poor	2.47***	(1.97-3.11)	1.76***	(1.47-2.10)
Adjusted (Model 3)				
excellent	1.00		1.00	
good	0.97		0.89	
fair	1.41***	(1.20-1.65)	1.08	
poor	1.72***	(1.34-2.21)	1.33***	(1.08-1.63)

*** = Significant at 1% level, ** = Sig. at 5% level, * = Sig. at 10% level

* = Note: To aid clarity, confidence intervals have only been provided where the HR is found to be significant.
All CI's provided within the full tables (see appendix 2)

<u>Table 3:</u> Cox proportional hazards models: Hazard ratios (HR) and 95% confidence intervals (CI) by age group.

SRH variables	Subgroup							
	Age 16-44		Age 45-64		Age 65-74		Age 75plus	
	HR	95% CI *	HR	95% CI *	HR	95% CI *	HR	95% CI *
Unadjusted (Model 1)								
excellent	1.00		1.00		1.00		1.00	
good	1.71		1.21		0.98		0.85*	(0.72-1.00)
fair	1.63		2.52***	(1.86-3.40)	1.55***	(1.32-1.81)	1.35***	(1.19-1.53)
poor	16.74***	(4.08-64.46)	3.72***	(2.34-5.92)	2.37***	(1.84-3.06)	1.82***	(1.52-2.18)
Partially adjusted (Model 2)								
excellent	1.00		1.00		1.00		1.00	
good	1.85		1.23		0.99		0.87	
fair	1.59		2.5***	(1.85-3.39)	1.65***	(1.40-1.93)	1.39***	(1.22-1.58)
poor	14.87***	(3.72-59.39)	3.62***	(2.27-5.77)	2.41***	(1.86-3.11)	1.90***	(1.58-2.28)

Adjusted (Model 3)								
excellent	1.00		1.00		1.00		1.00	
good	1.73		1.07		0.92		0.86*	(0.73-1.02)
fair	1.06		1.67***	(1.17-2.38)	1.34***	(1.11-1.61)	1.10	
poor	8.91**	(1.42-55.79)	1.78**	(1.03-3.09)	1.76***	(1.33-2.34)	1.32***	(1.07-1.62)

*** = Significant at 1% level, ** = Sig. at 5% level, * = Sig. at 10% level

* = Note: To aid clarity, confidence intervals have only been provided where the coefficient is found to be significant.
All CI's provided within the full tables (see appendix)

Table 4: Cox proportional hazards models: Hazard ratios (HR) and 95% confidence intervals (CI) by social class.

SRH variables	Subgroup											
	Professional		Intermediate		Skilled		Skilled-manual		Unskilled		No occupation	
	HR	95% CI *	HR	95% CI *	HR	95% CI *	HR	95% CI *	HR	95% CI *	HR	95% CI *
Unadjusted (Model 1)												
excellent	1.00		1.00		1.00		1.00		1.00		1.00	
good	0.86		1.32**	(1.02-1.70)	1.06		1.43**	(1.09-1.89)	0.99		0.67***	(0.54-0.82)
fair	1.60	(0.87-2.97)	2.26***	(1.79-2.85)	2.25***	(1.79-2.84)	1.98***	(1.53-2.55)	1.98***	(1.55-2.52)	1.35***	(1.16-1.58)
poor	8.23***	(2.92-23.20)	5.61***	(3.98-7.92)	3.70***	(2.56-5.34)	3.42***	(2.32-5.05)	2.88***	(2.02-4.10)	2.02***	(1.62-2.53)
Partially adjusted (Model 2)												
excellent	1.00		1.00		1.00		1.00		1.00		1.00	
good	0.83		1.25*	(0.97-1.61)	1.11		1.16		1.13		0.75**	(0.60-0.93)
fair	2.27**	(1.20-4.30)	1.99***	(1.56-2.54)	1.63***	(1.29-2.06)	1.69***	(1.31-2.19)	1.47***	(1.15-1.88)	1.15*	(0.98-1.34)
poor	3.14*	(0.92-10.68)	2.74***	(1.92-3.91)	1.71***	(1.17-2.49)	2.46***	(1.66-3.64)	1.96***	(1.37-2.80)	1.79***	(1.43-2.24)
Adjusted (Model 3)												
excellent	1.00		1.00		1.00		1.00		1.00		1.00	
good	0.72		1.12		0.85		1.10		1.12		0.76**	(0.61-0.95)
fair	2.49**	(1.17-5.29)	1.59***	(1.19-2.13)	1.07		1.48***	(1.11-1.97)	1.36**	(1.03-1.79)	1.02	
poor	4.64**	(1.07-20.15)	2.02***	(1.33-3.05)	0.93		1.67**	(1.08-2.60)	1.70***	(1.13-2.54)	1.35**	(1.05-1.74)

*** = Significant at 1% level, ** = Sig. at 5% level, * = Sig. at 10% level

* = Note: To aid clarity, confidence intervals have only been provided where the coefficient is found to be significant.
All CI's provided within the full tables (see appendix)

**** Reference list available on request ****