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Comparing the Predictive Power of Subjective and Objective Health Indicators: Changes in Handgrip Strength and Overall Satisfaction with Life as Predictors of Mortality

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ABSTRACT

Self-reported measures of health are generally treated as weak measures of respondents' objective health status. On the other hand, most surveys use self-reported health to measure health status and to determine the effects of a range of other socio-economic characteristics of the local environment on individual health. It is therefore of interest to the public health research community to verify the validity of self-reported health data. We do this by analyzing data from a longitudinal household panel survey: the German Socio-Economic Panel Study (SOEP). In 2006, and again in 2008, hand grip strength was measured as part of the SOEP. The hand grip data can be compared with other indicators of health and well-being from the SOEP survey.

In a first step, we examine short-term mortality outcomes predicted by changes in hand grip strength. Then we compare the predictive power of the results with those of a subjective indicator of well-being: overall life satisfaction. We find that both measures are related to mortality risk. However, the effects are quite independent. Thus we argue that changes in hand grip strength and overall life satisfaction capture two different aspects of health status and its changes. We therefore test this hypothesis by correlating the indicators with other survey-based health measures that were also taken in the SOEP in 2006 and 2008.

Keywords: grip strength, subjective health status measures, mortality, subjective well-being, SOEP
JEL Classification: C81, I12, J14

INTRODUCTION

In general, the health measures used in panel surveys are based on survey questions. For example, respondents are asked to assess their health or report their satisfaction with their own health. The use of objective measures and biomarkers in surveys is still a relative rarity. The German Socio-Economic Panel Study (SOEP) began collecting data on hand grip strength in 2006, repeating this measure again in 2008 and in 2010 (not yet released). 4,021 respondents from all age groups and 1,416 respondents aged 60 and older participated in the tests in 2006 and 2008.

In this paper, we analyze the relationships among different health measures on mortality within the one-year interval from 2008 to 2009. Our intention is to gain insight into the (predictive) power of different health measures.

As expected, the decline in grip strength over two years was a significant predictor of upcoming death for the older age group (due to the small number of death events, this test was not possible for younger age groups). But surprisingly, subjective measures of individual well-being—such as overall life satisfaction—are also able to predict death with comparable predictive power. And, even more interestingly, in a multivariate model we found that the latter effect is independent of the effect of hand grip strength.

BACKGROUND

One major aim of longitudinal studies is to investigate life events and the life histories of individuals within their specific social and economic contexts. It is therefore important to separate individual traits and abilities from structural and environmental influences. Health and physical fitness is difficult to measure in social surveys. Most measures are based on self-assessments, which are inherently less accurate than the results of medical examinations ("objective measures").

In order to overcome the weaknesses of subjective self-reporting, survey developers have attempted to incorporate "objective" health measures into large surveys. Ideally, such measures should be easy for interviewers to conduct. Body mass index, calculated based on body weight and height, is one such measure. Another is hand grip strength.

Hand grip strength is an objective measure that is easy to take. It is seen as a health indicator that indicates overall muscular strength (Lauretani et al. 2003; Rantanen et al. 1994; Bohannon 2001; Innes 1999). It is non-invasive but reliable and therefore appropriate for use in social surveys. Thus, grip strength can complement the self-reported health and subjective well-being indicators generally used in surveys.

Grip strength is strongly associated with important health-related outcomes. Low grip strength has been shown to increase the likelihood of future disability and to indicate post-operative complications or the need for extended medical care (Bohannon 2008). Ling et al. (2010) have shown that low hand grip strength is associated with other functional limitations, for example, cardiovascular disease. Furthermore, low grip strength is a very consistent predictor of all-cause mortality (Metter/Talbot/Schrager et al. 2002; Rantanen et al. 2000; Bohannon 2008)

Generally, grip strength is measured at a certain point in time to predict, for example, the probability of an individual's death in the near future. Ling et al. (2010) take two measures—at the ages of 85 and 89—and calculate the relative loss of hand grip strength. Not surprisingly, hand grip strength at age 89 predicts upcoming death better

than at age 85. The relative loss of hand grip strength also significantly increases the risk of mortality, but the coefficient (hazard ratio) is not as high as the coefficient of the individual cross-sectional measures at ages 85 and 89.

In the remainder of this paper, we conduct a first analysis of the grip strength measures used in the German Socio-Economic Panel Study (SOEP). We then compare the predictive power of these measures with that of subjective health measures taken in SOEP.

DATA AND EMPIRICAL FRAMEWORK

Data set

The data set used here is the German Socio-Economic Panel (SOEP), an annual household panel study. Started in 1984, the SOEP now includes more than 20,000 respondents from nearly 10,000 households and is representative for the population of Germany (Wagner et al. 2007; Siedler et al. 2011). In addition to a range of indicators addressing diverse social and economic issues, the SOEP also contains various self-reported health measures including the generic health measure SF12, self-assessed health (SAH), satisfaction with health, and measures of well-being such as overall life satisfaction (Headey et al. 2010; Ziebarth 2010). The grip strength measure was introduced in 2006 and was repeated in 2008 and again in 2010. The data on the 2010 panel wave have not yet been released. In any case, further follow-ups are planned for 2012 and beyond.

Method

In the SOEP, hand grip strength was first measured in 2006. A random subsample of 5,528 out of 32,304 individuals in 2006 were selected to take part (Schupp 2007). The response rate was close to 96%, so that there were 5,307 participants in 2006. Hand grip strength was measured with the *Smedley S Dynamometer TTM Tokio 100kg*. In 2008, the measure was repeated for 4,021 of the former participants. Thus the longitudinal stability was 75.8%. And for 1,437 people, hand grip strength was measured for the first time. A detailed documentation of the SOEP hand grip strength measure is provided by Ambrasat and Schupp (2010).

In our analysis, we concentrate on the population 60 years and older. In this group, we have 1,178 complete measures in both years. Twenty of these individuals aged 60+ died before the next follow-up in 2009. We take the absolute values in grip strength and the change over the two years between 2006 and 2008 to predict approaching death. To this end, we use logistic regression analysis. It is advisable to control for age and sex because of reporting heterogeneity in survey health measures. As Ziebarth (2010) demonstrated, there is significant gender-age-related reporting heterogeneity in all survey-based subjective health measures and even in the generic health measure SF12.

Variables

In both waves, hand grip strength was measured twice on each hand. In our analysis, we take the average of both values of the self-reported dominant hand. Here, dominant hand means the right hand for right-handed people and the left hand for left-handed people. We then calculated the differences between both years:

Difference: *dgripstr= gripstr08 – gripstr06*

Values above 0 show, for the dominant hand, increasing grip strength and values below 0 decreasing grip strength between 2006 and 2008.

Additionally, we calculated the relative change:

Relative change: r*dgripstr= (gripstr08 – gripstr06)/gripstr06*100*

Multiplication by 100 transforms the value to the percentage scale.

Besides the grip strength measure, we have different survey-based health indicators at hand (see Ziebarth 2010; Andersen et al. 2007).

Satisfaction with health (SwH):
Respondents were asked "How satisfied are you with your health?". The answer scale ranges from 0 (*totally unhappy*) to 10 (*totally happy*). This 0,10-scale, which is also applied for the question on satisfaction with life in general (see below), is common in medical practice for measuring the intensity of pain. According to the literature it was introduced by McCaffery and Beebe (1993).

Self-assessed health (SAH):
Here respondents are asked to describe their health status on a five-point scale, ranging from 1 (*bad*) to 5 (*very good*).
Both satisfaction with health and self-assessed health are included as subjective health measures.

Physical and mental health:
A more objective measure is the generic health measure, SF12. It consists of two subscales which are generated on the basis of 12 health-related items. Due to the method (factor analysis with varimax rotation), the two subscales, physical health and mental health, are independent.

In addition, *life satisfaction* is reported by SOEP respondents (Headey et al. 2010).
Overall life satisfaction is measured by way of a single question about the respondent's well-being: ''How satisfied are you with your life, all things considered?'' Respondents are asked to answer on a scale ranging from 0 (completely dissatisfied) to 10 (completely satisfied). Overall life satisfaction is not an actual health measure, but it is associated with the other subjective health measures.

RESULTS

Basic Results
Figure 1 shows the decline in grip strength over age, separated between women and men. The values for men are substantially higher than those for women. Men's average grip strength is over than 50% higher than women's grip strength. Grip strength also decreases with age. On average, grip strength decreases by 0.6 kg per year for men and by 0.4 kg per year for women over the age of 60.

The grip strength values for both measures in 2006 and 2008 as well as the change in grip strength over these two years and the relative change are shown in Table 2. The mean values and the standard deviations are presented for six age groups.

Regarding the means, there is no obvious change in grip strength from 2006 to 2008. This might seem surprising since the participants got older over the two years under observation. On the other hand, two years are a short period and grip strength does not decrease in all age groups equally. Figure 2 shows that there is a large difference between respondents who died in 2009 and those who did not die. For those who died, hand grip strength decreased markedly in the last two years before death.

So our basic assumption is supported that above-average loss in hand grip strength predicts upcoming death. This thesis will be tested further in a logistic regression model.

In Table 3, Model 1 presents the results of a logistic regression that models the probability that a participant will die prior to the 2009 follow-up of the SOEP survey. For this analysis, we distinguish between two explanatory variables: absolute grip strength in 2008 and the change in grip strength between 2006 and 2008. The first finding is that grip strength is a significant predictor of imminent death. Both absolute grip strength in 2008 and the change in grip strength between 2006 and 2008 reduce the risk of death in the following year significantly. But, crucially, the change in grip strength is a much better predictor of the outcome. The odds ratio is 0.88 to 0.96 and the t-value, at 3.35, indicates significance on the 0.999 level. So the change of grip strength is a better predictor for mortality than the absolute value at a particular year.

Comparison with overall life satisfaction
To compare hand grip strength in detail with subjective survey measures, we use overall life satisfaction. Respondents were asked to assess their overall life satisfaction on a scale of 0-10, where zero is the lowest and 10 the highest value.

Table 3 shows that the self-assessed "overall life satisfaction" also predicts the event quite well. But here the effect is significant only for the 2008 level of life satisfaction and not for the change from 2006 to 2008.

The integrated model shows a third finding: grip strength and overall life satisfaction predict death independently of one another. None of the effects become weaker in the integrated model. Instead, the coefficients are quite stable when controlling for sex and age. One can conclude that grip strength and life satisfaction show different and separate aspects of mortality. This finding is supported by the fact that grip strength and life satisfaction are not correlated, as Table 4 shows. But what does this mean? In order to understand the result that grip strength and life satisfaction reflect different aspects of mortality, we compare these measures with other health measures. Table 4 shows correlation coefficients for different health measures in the SOEP. Physical health (PCS) and mental health (MCS) are generic measures. They are independent factors (dimensions) of the SF12 inventory. Self-assessed health (SAH) and "satisfaction with health" are subjective measures. Life satisfaction is a subjective measure of well-being.

Obviously, the different health measures are strongly correlated. The correlation coefficients are comparatively high and significant. With changes in hand grip strength, however, these coefficients are lower and partly significant. The correlation of changes in grip strength with physical health is only 0.06, with self-assessed health 0.06, with satisfaction with health 0.05, and with overall life satisfaction only 0.01. The correlations with hand grip strength 2008 are only slightly higher. Cross-sectional hand grip strength value is correlated more strongly with the other subjective measures than the change in hand grip strength.

These findings show that the change in grip strength is separated from other health measures and refers to a different aspect of individual health. While the other subjective health measures and well-being measures may indicate one dimension of health status, changes in hand grip strength indicate a different dimension of health status. However, what they mean precisely is not totally clear at this point.

A second look at the correlation matrix (Table 4) reveals further details. Because physical health (PCS) and mental health (MCS) are two dimensions of one scale (SF12) obtained through factor analysis with varimax rotation, they are initially uncorrelated. While the subjective health indicators SAH and satisfaction with health are more strongly

associated with physical health dimensions, overall life satisfaction is more strongly correlated with the mental health component.

CONCLUSIONS

Using data from the German Socio-Economic Panel Study (SOEP), which up to now provides two observation points for hand grip strength (2006 and 2008), we have shown that hand grip strength significantly predicts the mortality risk of dying within one year after the last measure was taken. Moreover, the change in hand grip strength during the two last years predicts the same event much better.

And, equally interestingly, the subjective well-being measure of overall life satisfaction impacts the mortality risk as well, but in a different way. The effects of hand grip strength and overall life satisfaction are largely independent. They refer to different aspects of mortality. On the one hand, hand grip strength indicates overall muscular strength and is therefore limited to physical aspects of health. Overall life satisfaction, on the other hand, reflects more the mental dimension of health and well-being.

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Tables

Table 1
Summary statistics for dependent and explanatory variables (2006 and 2009)

	SOEP grip strength subsample total	SOEP grip strength subsample age >= 60
Age	51.9	71.0
Sex (female)	52.60 %	52.33 %
Height		
Female	165	163
Male	177	174
Weight		
Female	69.6	71.1
Male	84.3	82.9
BMI		
Female	25.7	26.8
Male	26.8	27.2
died before 2009 survey	21	20
Health Indicators		
satisfaction with health	6.56	5.88
self assessed health SAH		
very good	7.26 %	1. 91 %
Good	39.88 %	24.81 %
Satisfactory	34.19 %	44.17 %
Poor	15.25 %	22.83 %
Bad	3.42 %	6.29 %
state of health affects …		
ascending stairs (greatly)	11.13 %	23.41 %
tiring tasks (greatly)	15.44 %	29.87 %
stay in hospital last year (yes)	11.42 %	16.97 %
sf12		
Physical Health (NBS: N(50;10) scaled)	49.0	43.2
Mental Health (NBS: N(50;10) scaled)	51.6	53.0
grip strength (in kg)	**37.6**	**32.4**
Female	29.4	24.9
Male	46.6	40.3
change of grip strength (2006-2008)	**0.42**	**-0.05**
Overall life satisfaction	7.01	6.95
N	**4021**	**1178**

Source: SOEP v26

Table 2
Hand grip strength 2006 and 2008 over age and sex

	Female								
Age (2006)	**Gripstr06**		**Gripstr08**		**Change in gripstr**		**relative change**		**obs**
	mean	sd	Mean	sd	mean	sd	mean	sd	
60-64	28.5	5.6	28.4	5.3	-0.1	5.3	1.4	18.9	122
65-69	26.0	5.9	25.9	5.6	-0.0	5.5	3.4	26.6	173
70-74	24.7	6.0	24.8	5.1	0.0	5.3	3.9	24.6	97
75-79	22.5	5.4	22.6	6.0	0.2	3.4	1.5	20.7	65
80-84	18.6	5.1	18.0	5.6	-0.5	3.3	-1.3	26.5	45
85 and older	18.2	6.1	17.5	5.3	-0.7	4.3	1.1	30.6	23
	Male								
Age (2006)	**Gripstr06**		**Gripstr08**		**Change in gripstr**		**relative change**		**obs**
	mean	sd	Mean	sd	mean	sd	mean	sd	
60-64	43.7	8.0	43.5	8.8	-0.2	6.8	0.6	17.8	124
65-69	42.2	8.2	42.1	8.6	-0.1	7.3	1.5	20.4	179
70-74	39.7	7.1	40.2	8.0	0.4	6.6	2.7	21.0	104
75-79	35.7	8.3	35.7	7.5	-0.1	5.5	1.7	17.2	69
80-84	32.7	8.0	31.3	9.6	-1.4	7.0	-3.7	21.8	25
85 and older	27.3	6.9	28.5	8.9	1.2	6.0	5.7	23.6	11
Source: SOEP v26									

Table 3

Grip strength, overall life satisfaction, and mortality (2006 and 2008)

logistic regression dep. Var: died in 2009	m1 odds ratio	m2 odds ratio	m3 odds ratio	m4 odds ratio
grip strength 2008	**0.96***			
	(-1.97)			
change of grip strength	**0.88*****		**0.87*****	**0.87*****
2006-2008	(-3.35)		(-3.46)	(-3.35)
overall life satisfaction 2008		**0.69***	**0.63*****	**0.69****
		(-2.56)	(-4.11)	(-3.24)
change of life satisfaction		0.83		
2006-2008		(-1.17)		
Controls				
age				1.13***
				(4.01)
sex				0.42
				(-1.68)
N	1019	1019	1019	1019

t-values in brackets
"change of gripstr" without positive values; all positive values are recoded to 0.
Source: SOEP v26

Table 4

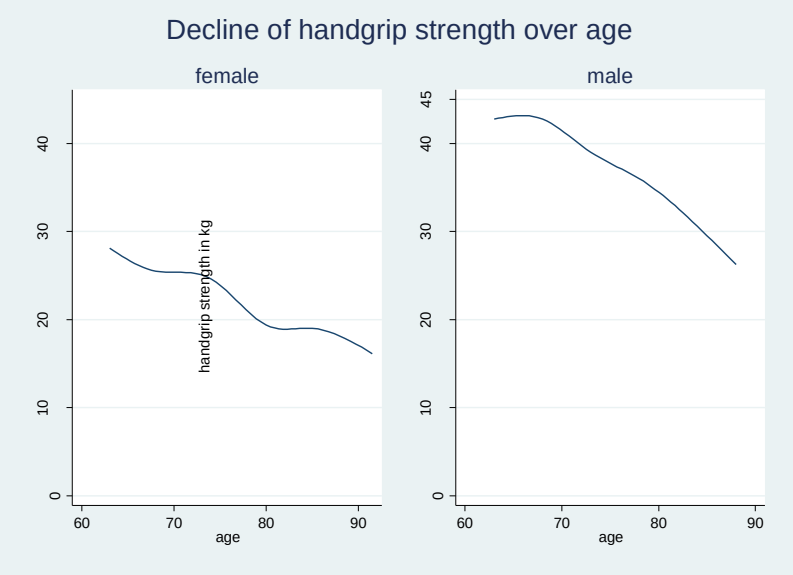
Correlation matrix of SOEP health measures (2008)

	gripstr	dgripstr	PCS	MCS	SAH	SwH	lifesat
grip strength	---						
change in grip strength (dgripstr)	0. 29*	---					
physical health (PCS)	0. 24*	0. 06*	---				
mental health (MCS)	0. 06*	0. 02	-0.06*	---			
Self-assessed health (SAH)	0. 21*	0. 06*	0. 77*	0.24*	---		
Satisfaction with health (SwH)	0. 17*	0. 05*	0. 67*	0.27*	0.77*	---	
Overall life satisfaction (lifesat)	0. 07*	0. 01	0. 28*	0.39*	0.44*	0.52*	---

Source: SOEP v26.

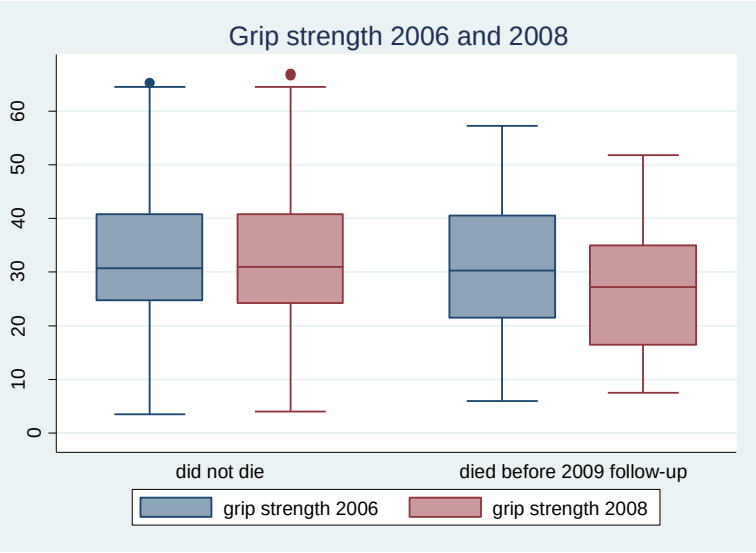
Figures

Figure 1



Source: SOEP v26 (data of 2008)

Figure 2



Source: SOEP v26