Socioeconomic inequalities in hand-grip strength in 10 European countries: the SHARE study

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Introduction
Muscle strength declines with increasing age among both men and women, and this also applies to upper extremity muscle strength as measured by hand-grip strength. Reduced hand-grip strength is a strong predictor of various features of aging, including disability, morbidity and mortality, and is therefore often used as an indicator of frailty.

In the analysis reported here we have studied the relationship between hand-grip strength and various indicators of socio-economic status. Like many other health aspects, hand-grip strength is likely to be associated with socio-economic status, but as yet very few studies have looked at this relationship. The purpose of our analysis was to measure the strength of the relationship between socio-economic status and hand-grip strength in a large sample of elderly persons in Europe, and to identify the main determinants contributing to this relationship. We were particularly interested to know whether the factors mediating this relationship resemble those for other health outcomes, such as self-reported health or mortality.

Data and methods
We used data collected during the first wave of the SHARE study, and used the pooled dataset including data from 10 European countries. Hand-grip strength was measured using a handheld dynamometer twice in both hands; the maximum of these four hand-grip strength measurements was used in the analysis. We used three indicators of socio-economic status: education (UNESCO classification; three levels); income (household equivalent income; quintiles), and wealth (household equivalent total net worth; quintiles).

We did four rounds of multivariate, linear regression analyses, in which we calculated the difference in hand-grip strength between socio-economic groups with adjustment for (1) confounders (age, height, cognitive orientation, country) only, (2) confounders plus health variables (specific chronic diseases, mobility limitations, and visual impairments), (3) confounders plus behavioural and psychosocial variables (smoking, alcohol consumption, depression, expectations), and (4) confounders plus health variables plus behavioural and psychosocial variables. All analyses were conducted with SAS version 8.2.
Results
After adjustment for confounding, hand-grip strength was only weakly associated with education (fig. 1), and we therefore decided not to proceed with explanatory analyses for this socio-economic variable. Hand-grip strength was, however, strongly associated with both income (fig. 2) and wealth (fig. 3). Associations were slightly stronger for men than for women.

The association between income and hand-grip strength is partly due to the fact that elderly with higher levels of income less often have health problems which may lead to loss of muscle strength. The lower prevalence of specific chronic diseases only marginally contributes to the association, but both the lower prevalence of mobility impairments and that of visual impairments partly explain the higher hand-grip strength among elderly with higher levels of income (fig. 4). Of the behavioural and psychosocial variables, only depression makes a sizable contribution to the association between income and hand-grip strength (fig. 5). Taken together, the investigated determinants explain about half of the higher hand-grip strength among elderly with higher levels of income, with health variables making the largest contribution (fig. 6).

Largely similar results were obtained for wealth versus hand-grip strength (fig. 7, 8 and 9). As in the case of income, after adjustment for all the variables included in the analysis, there remain sizable differences in hand-grip strength between elderly with different levels of wealth.

Discussion
Elderly with a lower socio-economic status have lower hand-grip strength, which is likely to indicate a higher level of frailty, and to predispose to a higher frequency of a variety of health problems, including disability, morbidity, and mortality. It is interesting to note that this association seems to be stronger for income and wealth on the one hand, than for education on the other hand. This is rather unusual, because many health problems are more strongly socially patterned on the basis of education than on the basis of income, even among the elderly (until now, wealth has not often been studied). This suggests that material living circumstances are relatively more influential for (the decline of) hand-grip strength than for (the decline in) other health aspects among the elderly.

Part of the association appears to be mediated by the higher frequency of health problems among elderly with a low socio-economic status. A higher prevalence of mobility impairments statistically accounts for a sizable part of the association, but it is good to be aware of the fact that in this cross-sectional analysis it is impossible to distinguish between an effect of mobility impairments on muscle strength (e.g. through less use of muscles), and an effect of muscle weakness on mobility. Only longitudinal studies can resolve this issue, but on the basis of previous studies it is likely that both mechanisms play a role.

Looking at functional measures like hand-grip strength may bring new perspectives to the study of socio-economic inequalities in health, which has previously mostly focused on either self-reported measures of subjective
health, or on measures of (specific) morbidity and mortality. Our analysis suggests that socio-economic inequalities in functional measures have partly different explanations, as illustrated by our finding that the lower prevalence of smoking does not contribute to the explanation of the higher hand-grip strength in the upper socio-economic groups. This is remarkable, because smoking is a widely found determinant mediating the relationship between socio-economic status and health, almost regardless of the health outcome used.

This analysis does not exhaust the analytic opportunities of the SHARE study, even if restricted to the data collected during the first wave. We therefore propose to continue this analysis in order to involve a larger number of potential determinants, and to identify possible entry-points for interventions and policies which may help to reduce the prevalence of frailty among elderly with a lower socio-economic status.
**Figure 1.** Absolute differences in maximum grip strength according to educational level among men and women in Europe, adjusting for confounders (age, country, height and orientation). With 95% confidence intervals.
Figure 2. Absolute differences in maximum grip strength according to income quintile among men and women in Europe, adjusting for confounders (age, country, height and orientation). With 95% confidence intervals.

**Men**

**Women**
Figure 3. Absolute differences in maximum grip strength according to wealth quintile among men and women in Europe, adjusting for confounders (age, country, height and orientation). With 95% confidence intervals.
Figure 4. The contribution of health variables to income quintile absolute differences in maximum grip strength among men and women aged 50 and over in Europe. With 95% confidence intervals for the fully adjusted model.
Figure 5. The contribution of behavioural and psychosocial variables to income quintile absolute differences in maximum grip strength among men and women aged 50 and over in Europe. With 95% confidence intervals for the fully adjusted model.
Figure 6. The contribution of both health variables ('direct factors') and behavioural/psychosocial variables ('distal factors') to income quintile absolute differences in maximum grip strength among men and women aged 50 and over in Europe. With 95% confidence intervals for the fully adjusted model.
Figure 7. The contribution of health variables to wealth quintile absolute differences in maximum grip strength among men and women aged 50 and over in Europe. With 95% confidence intervals for the fully adjusted model.
Figure 8. The contribution of behavioural and psychosocial variables to wealth quintile absolute differences in maximum grip strength among men and women aged 50 and over in Europe. With 95% confidence intervals for the fully adjusted model.
Figure 9. The contribution of both health variables (‘direct factors’) and behavioural/psychosocial variables (‘distal factors’) to wealth quintile absolute differences in maximum grip strength among men and women aged 50 and over in Europe. With 95% confidence intervals for the fully adjusted model.