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Title: Adult Child Schooling and Older Parents' Cognitive Outcomes in the Survey of Health, Aging and Retirement in Europe (SHARE): a Quasi-Experimental Study

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Abbreviations: 2SLS, two-stage least-squares regression; CASP-12, The Control, Autonomy, Self-Realization and Pleasure-12 scale; CI, confidence interval; CSL, compulsory schooling law; DAG, directed acyclic graph; ISCED, international standard classification of education; IV, instrumental variable; LMIC, low and middle-income country; OLS, ordinary least squares regression; SES, socio-economic status; SHARE, Survey of Health, Aging and Retirement in Europe

ABSTRACT

A growing body of research suggests that adult child educational attainment benefits older parents' cognitive outcomes via financial (e.g. direct monetary transfers) and non-financial (e.g. psychosocial) mechanisms. Quasi-experimental studies are needed to circumvent confounding bias. No such quasi-experimental studies have been completed in higher income countries, where financial transfers from adult children to aging parents are rare. Using data on 8159 adults ≥ 50 years in the Survey for Health, Aging and Retirement in Europe (2004/2005), we leveraged changes in compulsory schooling laws as quasi-experiments. Each year of increased schooling among respondents' oldest children was associated with better verbal fluency (β: 0.07, 95% CI: 0.02, 0.15) scores; overall associations with verbal memory scores were null, with mixed and imprecise evidence of association in models stratified by parent gender. We also evaluated associations with psychosocial outcomes, as potentially important mechanisms. Increased schooling among respondents' oldest children was associated with higher quality of life scores and fewer depressive symptoms. Our findings present modest albeit inconsistent evidence that increases in schooling may have an 'upward' influence on older parents' cognitive performance even in settings where financial transfers from adult children to their parents are uncommon. Associations with parents' psychosocial outcomes were more robust.

INTRODUCTION

The fast pace of global aging has lent urgency to efforts to identify scalable, population-level factors that may reduce the burden of age-related diseases, including Alzheimer's disease and related disorders .[1,2] Much scholarship has focused on educational attainment as a population-level and modifiable determinant of cognitive aging amenable to policy interventions.[1,3,4] This research has largely focused on the influence of one's own educational attainment, with some studies also considering the "downward" intergenerational influences of parental educational attainment on their children's cognition.[5,6] More recently, social scientists

have considered how the education of adult children may have "upward" intergenerational impacts on the cognitive aging of their older parents.[7-9] This nascent area of inquiry has the potential to inform new population-level targets related to the socio-economic resources of working-age adults that may in turn benefit older parents' cognitive outcomes.

Adult child socio-economic status may influence parents' late-life health, including their cognitive performance, via a range of interlinked economic and non-economic mechanisms.[7] Economic mechanisms may be in the form of direct financial transfers from children to their parents or via indirect financial transfers that occur in the form of resource sharing (e.g. co-residing in a household) or payments for older parents' health and long-term care.[9,10 11] Such transfers might improve older parents' psychological wellbeing via reduced poverty and family financial strain, which could contribute to better cognitive performance.[12] More indirect resources related to health-care may contribute to better, prevention or more timely treatment of chronic health conditions (e.g. hypertension, diabetes),[13] which could lead to improved cognitive outcomes. Even in the absence of financial transfers, higher education among adult children may be linked to higher levels of social engagement with older parents[9] or an improved sense of social standing, which may also have a positive impact on parents' psychosocial wellbeing[14] and, consequently, their cognitive outcomes.[9,10,15]

Residual confounding is a substantial concern in observational studies of the association between adult child SES and parents' health. [7,16,17] Unmeasured dimensions of parents' (respondents') socio-economic status may influence both the education of their children, given the strong intergenerational transmission of socio-economic status,[18,19] and their own late-life cognitive performance (see DAG in Web Figure 1).[3,6] To address this potential confounding bias, two prior studies[10,15] based in China and Mexico leveraged changes in compulsory schooling

laws (CSLs) that would have impacted the adult children of current older adult cohorts as quasi-experiments. Both studies found that longer schooling of adult children was associated with large improvements in cognitive performance scores among older parents.[10,15]

To our knowledge, no such quasi-experimental studies of parents' cognitive outcomes or relevant cognitive aging risk factors have been conducted in high-income countries. There may be important differences in these settings, where older parents average higher socio-economic status (e.g. lower late-life poverty);[20] receive few direct financial transfers from their adult children;[21,22] and tend to have more access to formal long-term care and other social protections[20,23] as compared to older parents in low- and middle-income countries. Given these contextual differences, older European adults may rely much less on the economic and non-economic resources of their family members to support health and long-term care and other needs in late life. Resource substitution theory[24] suggests that for individuals who are more highly resourced due to higher individual socio-economic status or other structural advantages, there may be fewer returns to socio-economic mobility in the subsequent generation.

In the present study, we leveraged the substantial changes in compulsory schooling enacted throughout Europe in the 20th century as quasi-experiments to evaluate the effect of increased schooling among adult children on parents' cognitive performance. While these CSLs have been utilized in quasi-experimental studies of the association between own education and late-life economic and health outcomes in Europe,[25-28] they have yet to be employed to evaluate the effect of adult child education on parents' late-life health, including late-life cognitive performance. We also evaluate the effect of increased schooling among adult children on select psychosocial outcomes for older parents, which may serve as potential mechanisms underlying any associations with older parents' cognitive outcomes.

Given contextual differences (e.g. a low prevalence of child-to-parent financial transfers), we expect that associations may be of smaller magnitude in Europe as compared to those reported in the two prior studies based in in LMICs. Alternatively, associations of similar magnitude to those reported in other settings might suggest that non-financial mechanisms are at play or that the upward intergenerational influence of increased schooling is similar for parents whose children stand to benefit from changes in compulsory schooling laws across settings.

DATA AND METHODS

Data come from the Survey of Health and Retirement in Europe (SHARE) study. The SHARE data have been described in detail elsewhere.[29] Briefly, at the first wave (2004-2005) the SHARE surveyed community-dwelling adults 50 years and older and their spouses of any age from 11 European countries plus Israel. Interviews were done via face-to-face interviews, with interviewers using computer-assisted personal interviewing (CAPI) The overall household response rate was 61.8% (n =30421).

We first limited the analytic sample to 22963 respondents 50 years and older in the 9 countries that passed national-level compulsory schooling laws (CSLs) in years that would have plausibly affected the schooling duration of their adult children (see Web Table 1 and Web Appendix 1 for a summary of the CSLs; see Web Figure 2 for the derivation of the analytic sample).

We further limited the analytic sample to respondents whose oldest child was born in the first 10 birth cohorts (i.e. birth years) to be affected by the CSL, which we considered to be the "treated" group, or in the 10 birth cohorts that would have just missed being influenced by the CSL (n = 8539). Finally, we excluded those missing data on cognitive outcomes, adult child schooling, or confounder variables, for a final analytic sample of 8159 for analyses of cognitive

outcomes. Our analytic samples for analyses of psychosocial outcomes (n = 8035 for depressive symptoms; n = 5097 for quality of life) were smaller due to additional nonresponse on these outcome measures. Quality of life was assessed via a leave-behind pencil-and-paper questionnaire, resulting in a higher rate of non-response.

Cognitive Performance

Cognitive performance was assessed at baseline. Immediate verbal memory was assessed by asking respondents to listen to a list of 10 words and immediately recall the list. Delayed verbal memory was assessed by asking respondents to repeat the same list of words after a delay of approximately 5 minutes.

Verbal fluency was assessed by asking respondents to list as many unique animals as they could within a 60-second time frame (range: 0-63 for the analytic sample). For each measure of cognitive performance, we calculated z-scores using the analytic sample means and standard deviations. We additionally calculated an overall score equal to the sum of z-scores for each cognitive performance task divided by the number of tasks.

Psychosocial Outcomes

Past-month depressive symptoms was assessed at SHARE baseline with the 12-item EURO-D scale.[30] The scale asks respondents to report whether or not they experienced twelve symptoms, including depressed mood, fatigue and irritability, with scores ranging from 0 (no symptoms) to 12. The EURO-D scale has been shown to be a reliable measure of late-life depressive symptoms, and strongly correlated with other depressive symptoms measures such as the CES-D.[31]

Subjective quality of life was measured at baseline with the Control, Autonomy, Self-Realization and Pleasure (CASP)-12 scale.[32] This abbreviated version of the original CASP-19

scale[33] was developed for SHARE. Respondents were presented with a number of statements that measured the four CASP domains e.g. “Look forward to each day”, “Feel full of energy”. Statements were measured with a 4-item Likert scale of whether the respondents’ experiences corresponded with a given statement often (1), sometimes (2), rarely (3), or never (4). Items were reverse coded such that higher scores reflected higher quality of life, with a range between 12 and 48. Internal reliability for the scale ranged from 0.56 to 0.76 across the four domains.[32] Because prior psychometric studies have suggested that the CASP-12 assesses a single latent factor, our study focused on associations with the overall scale.[32]

Adult Child Schooling

At baseline SHARE respondents provided information on the highest degree attained for up to four living children ≥ 16 years (94.3% had ≤ 4 children). This information was reclassified into years of schooling following the UNESCO international standard classification of education (ISCED).[34] We considered our primary exposure as the years of schooling attained by oldest child. We considered the schooling duration of oldest daughters and oldest sons separately, given prior evidence of gender-specific pathways of impact.[9] As an alternative, we considered the highest educated child as the index child, following prior literature.[15]

Instrumental Variables

We followed two complementary approaches to generate our instrumental variables. First, we used information on respondents’ country of residence and their oldest child’s year of birth to create a binary variable indicating whether the respondents’ oldest child was born in the 10 birth cohorts first affected by the CSL vs. the 10 birth cohorts that would have just missed being impacted by the same law. Birth cohort bounds are commonly applied in analyses that leverage CSLs in the European context given that other CSLs and related social policies were

adopted frequently throughout the 20th century.[27,28] We chose the oldest child as our primary index child because conceptually, if oldest children benefitted from a given CSL, the remaining children should have also benefitted from the same CSL.

Second, we followed Brunello and authors[28] by using a continuous instrumental variable indicating the distance between the oldest child's birth year and the first birth cohort impacted by the CSL in a given country. The instrumental variable, z, was calculated as $z = (b - \bar{b}_k)$, where b is the birth year of the respondents' oldest child and $\bar{b}_k$ is the birth year of the first birth cohort impacted by the CSL in country k. We applied the same 10-year birth cohort bounds such that values on this continuous instrumental variable ranged from -9 to 9. This latter specification allows for greater precision.

Confounders

We controlled for respondents' demographic characteristics and lifecourse socio-economic status (SES) measures as well as characteristics of respondents' spouses, if relevant. All models included country fixed effects as well as an interaction between respondents' country of residence and their birth year in order to account for country-specific time-trends. Further details on the confounder variables and a DAG are included in Web Appendix 2 and Web Figure 3.

Statistical Analyses

We used two-stage least squares (2SLS)[35] estimation to evaluate the quasi-experimental association between increased schooling among oldest children on parents' scores on each of the cognitive tests. We adopt the monotonicity assumption, that increases in mandatory schooling would not lead any children to have less schooling than they otherwise would complete. Under this assumption (and conventional IV conditions), the IV estimate is interpretable as the effect of additional schooling completed by the oldest child due to the policy among those whose children

complied with the CSL change. We compared these estimates to those generated via conventional Ordinary Least Squares regression; we additionally provide non-parametric estimates using targeted maximum likelihood estimation.[36]

For the 2SLS approach, our first-stage estimates were generated with a linear model regressing the years of schooling completed by the oldest child (or oldest daughter) on the birth cohort-based instrumental variable and covariates (see Web Appendix 3 for equations). We evaluated the strength of our instrument via the Kleibergen-Paap Wald F-statistic test;[37] all primary analyses had a first-stage F-statistic above the conventional cut-off of 10 (Web Table 2). Our second stage model regressed respondents' cognitive z-scores on the predicted value of schooling for their oldest child, generated with the first-stage regression, and the same set of covariates as the first-stage model. In the models for the overall sample, we clustered standard errors at the household level.

We conducted these same analyses using our second instrument, the continuous measure of distance from the CSL across the 20 eligible birth cohorts. In order to indirectly shed light on potential mediators of our main associations of interest, we replicated the same procedures for our two psychosocial outcome measures. We additionally estimated parent gender-stratified models, given prior evidence of heterogeneity in the association between adult child schooling duration and late-life health for older mothers and fathers .[15,38] In order to understand whether our observational results generalized to respondents and European countries excluded from our primary analyses, we generated OLS estimates for the all respondents in all European countries included in the baseline wave of SHARE. Finally, given the fact that the Swedish schooling reform was rolled out in some regions prior to national-level implementation (see Web Appendix 1), we repeated analyses without Swedish respondents.

RESULTS

Descriptive

Respondents were an average of 68.5 years old (± 8.8; range: 51-99), majority women (58%), and reported a mean of 2.6 living children (± 1.4) (Table 1). Respondents reported that they had achieved an average of 8.6 years of education (± 4.4), but that their oldest children had completed a mean of 12.3 (± 3.6) years of schooling (with similar average years completed by oldest daughters and sons). The average age of respondents' oldest children was 43.6 (± 7.9: range: 26-55).

We also present descriptive characteristics by treatment status on the binary IV (Web Table 3); there were differences across demographic characteristics, including respondents' own age and education, which we controlled for in our analyses. The descriptive characteristics for the subsample included in the analysis of quality of life (Web Table 4) were similar to those for the analytic sample in our primary analysis.

First-Stage Regression Results

Our first-stage estimates (Web Table 5) indicated that the binary instrumental variable based on exposure to CSL reforms was associated with an additional 0.64 years of schooling among oldest children overall (95% Confidence Interval (CI): 0.41, 0.86; $\overline{\beta}$: 0.86, 95% CI: 0.61, 1.11 for oldest daughters; $\overline{\beta}$: 0.47, 95% CI: 0.21, 0.73 for oldest sons). We show the discontinuity in average years of adult child schooling duration before and after CSL changes in Web Figures 4-6. First-stage point estimates for the highest educated child were of smaller magnitude but 95% confidence intervals were overlapping with those generated for our primary analyses (Web Table 5).

Oldest Child Schooling Duration and Parents' Cognitive Scores

OLS regression estimates (not based on IV) suggested that each additional year of schooling among the oldest child was associated with better cognition for their parents, with small but relatively consistent results across all cognitive outcomes (e.g. β: 0.02, 95% CI: 0.01, 0.02 for the overall cognitive performance z-score, Table 2).

In IV models, we found that each one-year increase in schooling for SHARE respondents' oldest children was associated with improved verbal fluency (β: 0.07, 95% CI: 0.02, 0.12) z-scores when using the continuous IV; estimates were similar but less precise when using the binary IV (Table 2, Figure 1 Panel C). Associations with immediate and delayed verbal recall and overall cognitive performance scores were null in overall models.

In models stratified by parent gender (Web Table 6, Figure 2), there was evidence of association between increased adult child schooling and higher delayed verbal recall z-scores among older fathers (β: 0.05, 95% CI: -0.03, 0.13, Figure 2 Panel B) but lower immediate verbal recall z-scores for older mothers (β: -0.04, 95% CI: -0.11, 0.02, Figure 2 Panel A); 95% confidence intervals crossed the null in both cases.

Oldest Child Schooling Duration and Parents' Psychosocial Outcomes

OLS estimates indicated that more years of schooling among the oldest child were associated with better quality of life and fewer depressive symptoms for their older parents (Table 3).

In IV analyses, each one-year increase in the schooling duration of SHARE respondents' oldest children was associated with improved quality of life scores (β: 0.75, 95% CI: -0.02, 1.51 using the binary IV; β: 0.75, 95% CI: 0.25, 1.25 using the continuous IV; Table 3, Figure 3 Panel A) and fewer depressive symptoms (β: -0.21, 95% CI: -0.43, -0.02 using the binary IV; β:

-0.10, 95% CI: -0.24, 0.05 using the continuous IV; Table 3, Figure 3 Panel B). There were no differences by parent gender (Web Table 6).

Sensitivity Analyses

Across cognitive and psychosocial outcomes, findings were similar when separately evaluating increased years of schooling for oldest daughters and oldest sons (Web Tables 7 – 10). Findings were of larger magnitude but less precise when instead focusing on the highest educated child as the index (Web Table 11). OLS estimates were very similar when including all respondents included in the baseline wave of SHARE, including all birth cohorts and European countries (Web Table 12). Finally, across all outcomes, the magnitude of some estimates differed but the 95% confidence intervals were overlapping when instead using a non-parametric estimator (Web Table 13) and when removing Swedish respondents from our analytic sample (Web Table 14).

DISCUSSION

In this population-based quasi-experimental study, we found that increased schooling duration among adult children contributed to improved performance on an measure of verbal fluency for older parents in nine European countries. We additionally found associations with improved quality of life and lower depressive symptoms; these are commonly proposed as important non-financial mechanisms underlying the association between adult child schooling duration and older parents' cognitive outcomes. CSL changes have long been used to evaluate the quasi-experimental association between own education and late-life health[4,39] – and particularly in Europe, where there were substantial changes in school-leaving policies throughout the 20th Century.[26,27] Ours is the first quasi-experimental study to our knowledge to

evaluate the association between increased adult child schooling duration and parents' cognitive outcomes in a high-income setting.

Our estimates were more modest and inconsistent than those found in the two prior studies[10,15] on this topic, which found that each year of increased schooling was associated with increased verbal memory scores among older parents by between 0.07 SD and 0.11 SD in China and Mexico and increased verbal fluency scores by an estimated 0.17 SD in Mexico. In our study, each additional year of adult child schooling was associated with a 0.07 SD increase in older parents' verbal fluency scores and associations with verbal memory scores were null for respondents' overall and of small magnitude and inconsistent in gender-stratified models. To place these findings in context, quasi-experimental studies – including those using SHARE data – consistently report that that each additional year of one's *own* schooling is associated with an increase of between 0.10 and 0.15 SD on late-life cognitive performance scores.[40,41] The estimates from prior studies therefore suggest that adult child schooling duration is as important for older adults' late-life cognition as their own schooling duration – a surprisingly large estimates – whereas our largest estimates are less than half the magnitude of what would be expected for own years of schooling.

The differences between ours and prior studies could have been driven by contextual differences, including the very rare occurrence of child-to-parent financial transfers, higher average socio-economic status, and greater state-sponsored social protections among older respondents in Europe as compared to their counterparts in LMICs. [20-23] These factors may have meant that increased schooling among adult children was less impactful for older parents' outcomes in a setting where older adults were less reliant on the financial resources of their children. In addition, the CSLs we focused on were typically increases of 1 or 2 years, whereas

the CSLs leveraged in the prior studies increased mandatory schooling by 3 years, which may have contributed to a smaller magnitude of association in our study.

Differences could have been due to the choice of the "index" child for the primary analysis. In both prior studies, the highest educated child served as the index, while estimates with alternative index children (e.g. the lowest educated child) were of smaller magnitude or null. We also generated larger estimated associations with verbal fluency scores (e.g. 0.12 SD for verbal fluency z-scores; 0.10 for delayed verbal recall z-scores) when we focused on the highest educated child. These larger point estimates may have been because that children in a given family with the propensity to be the highest educated may have already been achieving higher than minimum schooling prior to CSL changes; higher "non-compliance" among this group may have been reflected in our smaller first-stage estimates for highest educated children as compared to the oldest children. Non-compliance with the CSL changes (i.e., smaller first stage estimates) make the IV estimate more responsive to small violations of the exclusion restriction, i.e., small violations could lead to large net biases. Further research that directly harmonizes studies from different settings is needed to disentangle contextual vs. measurement-related drivers of cross-study differences.

The reasons for differing associations across cognitive performance tasks in our study is unclear. Given our relatively low precision and wide, overlapping confidence intervals, we cannot rule out chance as the explanation for differences in estimates across domains. Verbal memory performance tasks – and particularly the immediate verbal recall task – appeared to have lower variability and associations may have been biased by stronger ceiling effects. Future studies should continue to replicate analyses across studies in order to investigate whether there is true heterogeneity in the impact of adult child schooling on parents' cognitive outcomes by

cognitive domain. We similarly are not able to draw definitive conclusions about the differences by parent (respondent) gender, given limited precision. We did note differences in first-stage estimates by child gender, suggesting that adult daughters of respondents in this sample may have benefitted more from increases in minimum schooling laws. However, our second-stage results suggest that the returns of increased schooling among daughters and sons were similar for older parents.

Our findings support the hypothesis that the modest associations between adult child education and parents' cognitive performance might be explained at least in part by psychosocial pathways. Our findings are consistent with prior observational studies of adult child education and parents' depressive symptoms based in Taiwan and the U.S.[12,42] In the only other quasi-experimental study on this topic, Ma[10] found no association between increased adult child schooling duration and past-week depressive symptoms for older Chinese adults, but a robust association with their ratings of life satisfaction. Both depressive symptoms and quality-of-life are important endpoints themselves, but also have important implications for cognitive aging: late-life depression is one of the most important modifiable risk factors for dementia.[1] Higher quality of life has also been linked to late-life cognition and dementia risk, as well as higher social engagement and fewer chronic health conditions, which are associated with cognitive aging.[32,43-45] However, there may be other important mechanisms at play and future research should formally quantify the extent to which associations between adult child schooling duration and parents' cognitive outcomes are mediated by psychosocial vs. alternative (e.g. financial, behavioral) pathways.

Limitations

Estimates generated from the instrumental variables approach are interpreted as the local average treatment effect; in our case, this would be the quasi-experimental association between increased child schooling duration and parents' cognitive outcomes for families whose children increased their years of schooling because of the change in compulsory schooling laws. Estimates are therefore not generalizable to families whose children's education was not affected by the compulsory schooling law, for example because they would have achieved higher than the minimum levels of schooling regardless of the compulsory schooling laws or because they dropped out of the minimum level of schooling even with the new laws in place. In addition, our study excluded SHARE participants in countries with no CSL change during the relevant time period or whose oldest child was not born within the relevant birth cohort bounds, potentially reducing external validity. In particular, estimates might not be generalizable to other birth cohorts or historical time periods. Despite these limits to external validity inherent in our instrumental variables analyses, we found consistent evidence of association in observational estimates including those generated for all cohorts and European countries included in the baseline SHARE wave.

We also note limitations related to exposure classification and the selection of the "index" child. Respondents classified as "unexposed" in our analysis could have had younger children who were exposed to the CSL, leading to exposure misclassification and potentially biasing our estimates towards the null. However, we have already outlined potential concerns with our alternative analyses focused on the highest educated child as the index.

Conclusion

In this study, we found that adult children's increased schooling duration was associated with better verbal fluency performance scores for older parents in nine European countries.

Associations with verbal memory scores were null for the sample overall, although there was modest and inconsistent evidence of association between increased adult child schooling and verbal memory scores by older parents' gender. Even our largest results were more modest than estimates from prior studies based in China and Mexico. However, evidence of protective associations with older parents' psychosocial outcomes, which may be important pathways underlying the relationship between adult child education and parents' late-life cognition, were more robust.

Our findings contribute rigorous quasi-experimental evidence to the growing body of research from other global settings suggesting that adult child educationmay have 'upward' intergenerational influences on cognitive aging and related health outcomes for older parents. This nascent line of research adds to the already robust evidence of own educational attainment as a critical determinant of cognitive aging, further reinforcing the importance of education as a population-level investment in improved cognitive health across generations.

Future research should directly compare estimates across settings using harmonized measures and methods to identify contextual vs. measurement-related drivers of cross-study differences. In addition, further quasi-experimental research on this topic should be extended to a broader set of dementia risk factors across varied settings, including longitudinal cognitive decline, and health behaviors and chronic health conditions.

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Table 1. Descriptive characteristics, older European adults 50+ years in the Survey on Health, Aging and Retirement in Europe (2004/2005) whose oldest child was in the first birth cohorts to just benefit from or just miss benefitting from a change in compulsory schooling laws (n = 8159)

Characteristic	No.	Mean (SD)
Respondent demographic characteristics, baseline		
Age		68.71 (8.68)
Female	4731	
Born in country of current residence	7720	
Marital status		
Married	5882	
Never Married	92	
Divorced	456	
Widowed	1729	
Spouse age[a]		67.48 (8.97)
Total number of living children		2.59 (1.39)
Respondent and Family Life-course Socio-Economic Status		
Respondent years of education		8.58 (4.37)
Spouse years of education[a]		8.71 (4.36)
Maternal occupational prestige score		9.29 (16.52)
Maternal occupational prestige score missing	6018	
Paternal occupational prestige score		32.98 (16.19)
Paternal occupational prestige score missing	1032	
Respondent ever worked	7154	
Respondents' occupational prestige score for current/last job		31.42 (20.14)
Respondents' occupational prestige score for first job missing	1701	
Spouses' occupational prestige score		28.33 (21.22)
Spouses' occupational prestige score missing	2354	
Adult child educational attainment		
Years of educational attainment, oldest child		12.30 (3.55)
Years of educational attainment, oldest daughter[b]		12.22 (3.53)
Years of educational attainment, oldest son[c]		12.28 (3.54)
Respondent Cognitive Scores		
Immediate verbal recall (range: 0-10)		4.50 (1.79)
Delayed verbal recall (range: 0-10)		3.01 (1.94)
Verbal fluency (range: 0-63)		17.58 (6.82)
Respondent Psychosocial Outcomes		

Past-month depressive symptoms, EURO-D[d] (range: 0-12)	2.45 (2.31)
Quality of life, CASP-12[e] (range: 12-48)	36.74 (6.26)

Abbreviations: CASP-12, The Control, Autonomy, Self-Realization and Pleasure (CASP)-12 scale. SD, standard deviation.

[a]Limited to those who were married at baseline.
[b]Limited to n = 6227 with at least one adult daughter.
[c]Limited to n = 6218 with at least one adult son.
[d] The EURO-D scale is a measure of past-month depressive symptoms, with scores ranging from 0 (no symptoms) to 12.
[e] Items were reverse coded such that higher scores reflected higher quality of life, with scores ranging from 12 and 48.

Table 2. Comparison of Beta Coefficients and 95% Confidence Intervals from Ordinary Least Squares and Two-Stage Least Squares Regression Evaluating the Association between Oldest Child Educational Attainment and Cognitive Performance *z* Scores for Older Parents aged 50+ in Europe, Survey on Health, Aging and Retirement in Europe, 2004/2005 (n = 8159)

	OLS[a]		2SLS, Binary IV[a]		2SLS, Continuous IV[a]	
Outcome Variable	**β**	**95% CI**	**β**	**95% CI**	**β**	**95% CI**
Immediate verbal recall *z* score	0.017	0.011, 0.023	-0.027	-0.104, 0.050	-0.010	-0.058, 0.038
Delayed verbal recall *z* score	0.013	0.007, 0.019	0.019	-0.062, 0.099	0.018	-0.034, 0.070
Verbal fluency *z* score	0.018	0.012, 0.024	0.045	-0.030, 0.119	0.066	0.017, 0.115
Overall cognitive *z* score	0.016	0.011, 0.021	0.012	-0.048, 0.072	0.025	-0.014, 0.063

Abbreviations: OLS=Ordinary least squares estimation. 2SLS = Two-stage least squares regression, IV = instrumental variable.
[a] Controls: Age, gender, marital status, own education, spouse age (if married), spouse education (if married), total number of kids, whether or not the respondent was born in country of current residence, paternal and maternal occupational prestige, spouse occupational prestige, respondent occupational prestige, whether or not respondent ever worked outside the home, country of residence, and an interaction term between country of residence and respondents' birth year; models cluster standard errors at the household level.

Table 3. Comparison of Beta Coefficients and 95% Confidence Intervals from Ordinary Least Squares and Two-Stage Least Squares Regression Evaluating the Association between Oldest Adult Child Educational Attainment and Psychosocial Outcomes for Older Parents aged 50+ in Europe, Survey on Health, Aging and Retirement in Europe, 2004/2005.

	No.	OLS[a]		No.	2SLS, Binary IV[a]		No.	2SLS, Continuous IV[a]	
Outcome Variable		β	95% CI		β	95% CI		β	95% CI
Quality of Life (CASP-12) [b]	5097	0.196	0.140, 0.252	5003	0.745	-0.024, 1.513	5058	0.745	0.245, 1.245
Past-Month Depressive Symptoms (Euro-D) [c]	8091	-0.036	-0.053, -0.019	8035	-0.208	-0.426, -0.015	8035	-0.095	-0.243, 0.053

Abbreviations: OLS=Ordinary least squares estimation. 2SLS = Two-stage least squares regression, IV = instrumental variable. CASP-12 = The Control, Autonomy, Self-Realization and Pleasure (CASP)-12 scale.

[a] Controls: Age, gender, marital status, own education, spouse age (if married), spouse education (if married), total number of kids, whether the respondent was born in country of current residence, paternal and maternal occupational prestige, spouse occupational prestige, respondent occupational prestige, whether the respondent ever worked outside the home, country of residence; models cluster standard errors at the household level.

[b] Items were reverse coded such that higher scores reflected higher quality of life, with scores ranging from 12 and 48.

[c] The EURO-D scale is a measure of past-month depressive symptoms, with scores ranging from 0 (no symptoms) to 12.

Figure 1. Two-stage least squares and ordinary least squares regression estimates, oldest child schooling duration and older parents' cognitive performance *z* scores in the Survey of Health, Aging and Retirement in Europe (2004/2005). Legend: IV = instrumental variable, OLS = ordinary least squares regression.

Figure 2. Two-stage least squares, oldest child schooling duration and older parents' cognitive performance *z* scores in the Survey of Health, Aging and Retirement in Europe (2004/2005), by parent gender.

Figure 3. Two-stage least squares and ordinary least squares regression estimates, oldest child schooling duration and older parents' psychosocial outcomes in the Survey of Health, Aging and Retirement in Europe (2004/2005). Legend: Legend: IV = instrumental variable, OLS = ordinary least squares regression, CASP-12 = The Control, Autonomy, Self-Realization and Pleasure (CASP)-12 scale, range = 12-48, EURO-D = The EURO-D depressive symptom scale, range = 0-12.