Older Mother's Health and Adult Children's Education: Conceptualization of Adult Children's Education and Mother-Child Relationships

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Highlights

- Adult children's education is best conceptualized and measured as the proportion of all children with higher education degrees in the contemporary United States context.

- Higher levels of adult children's education are associated with better mental and physical health among older mothers.

- Neither extent of contact nor quality of mother-child relationships moderate the association between adult children's education and older mother's health.

Abstract

An emerging body of research extends the well-documented education-health gradient to examine associations between adult children's education and parents' physical health. This study contributes to this literature by (1) providing a more concrete conceptualization of adult children's education in the context of the family, (2) examining the effects of adult children's education on older mothers' physical and mental health, and (3) investigating potential moderating effects of the quality of mother-child relationships. Data come from Within-Family Differences Study which includes 543 older mothers who reported on their adult children. Results indicate that the best measurement of adult children's education is the proportion of children with a bachelor's degree, that higher levels of adult children's education are associated with lower levels of depressive symptoms and a lower likelihood of an activity limitation among older mothers. The quality of mother-child relationships, however, did not moderate the observed associations.

Keywords: adult children's education; mother's health; mother-child relationships

1. Introduction

An emerging body of research extends the well-documented education-health gradient to examine associations between adult children's education and parents' health. Studies find a robust inverse association between adult children's levels of education and parent mortality, as well as parents' activity limitations (De Neve and Harling, 2017; Friedman and Mare, 2014; Torssander, 2014, 2013; Yahirun et al., 2017, 2016; Yang et al., 2016; Zimmer et al., 2016, 2002). These associations have been documented among older populations in a diverse group of countries including China (Yang et al., 2016), Finland (Elo et al., 2018), Mexico (Yahirun et al., 2017, 2016), South Africa (De Neve and Harling, 2017), Sweden (Torssander, 2014, 2013), Taiwan (Zimmer et al., 2007, 2002), and the United States (Friedman and Mare, 2014; Wolfe et al., 2018), that capture a range of levels of economic development and extents of social welfare policies.

These past studies, however, are limited in three respects. First, previous studies have adopted a variety of approaches to conceptualizing and measuring adult children's education with limited theoretical consideration. Second, past studies have focused on physical health or mortality and have not analyzed whether adult children's education may also support the mental health of their aging parents. Third, past studies have not explored whether different aspects of parent-child relationships (e.g., the extent of contact and quality of the relationships) moderate the association between adult children's education and parents' health.

This study addresses these gaps through a theoretical treatment of how to conceptualize and measure adult children's education and an analysis of a uniquely suited source of data, the Within-Family Differences Study (WFDS), which includes detailed information on mother-child relationships. The analysis assesses both mental and physical health outcomes (depressive

symptoms and activity limitations) and draws on a rich array of measures of mother-child relationships that capture how frequently mothers interact with their children as well as how close or strained mother's relationships with their children are.

1.1 Conceptualizing adult children's education

Past studies have used a variety of different measures of adult children's education to investigate the association with parents' health. Some studies measure adult children's education as the highest degree completed among a set of children (e.g., Torssander, 2014; Wolfe et al., 2018), other studies measure adult children's education as the education level of the first-born (e.g., Torssander, 2013), and yet other studies adopt more complex measurements that capture proportions of adult children with different years of schooling or degree levels (e.g., Friedman and Mare, 2014; Yahirun et al., 2017, 2016). Although most studies report that different measures of adult children's education were explored in preliminary analyses and led to similar results, the preliminary analyses are not reported and there is little substantive discussion to guide the measurement decisions. The limited conceptual consideration and differences in measurement of adult children's education across studies provide little guidance for future research and make it difficult to compare results across studies.

[Figure 1 here]

For families with multiple children, there are two dimensions to consider when conceptualizing and ultimately constructing a measure of adult children's education: (1) the extent to which education is treated as reflecting human capital (typically measured in years of education completed) or as a credential (typically measured in attained degree) and (2) how to aggregate the education levels of multiple children to construct a family-level measure (see

Figure 1). For the first dimension, research on the education-health gradient typically links human capital to knowledge and psychosocial-based mechanisms and a credential perspective to income and occupation-based mechanisms (Liu et al., 2013; Mirowsky and Ross, 2003). The most systematic empirical study to date found evidence for both processes in an analysis of the functional form of education and the association with risk of mortality (Montez et al., 2012), which is consistent with studies finding multiple mechanisms linking education and health (Cutler and Lleras-Muney, 2008). The same considerations—multiple mechanisms reflecting both human capital and credential processes—likely hold for the relationship between adult children's education and parents' health (see discussion of mechanisms below), though it is possible that in some contexts either human capital or credential mechanisms will carry more weight.

The second dimension concerns how best to aggregate the levels of education in families with multiple children in order to capture the resources or knowledge available in the family unit as a whole.[1] There are numerous options for aggregation, but in practice two stand out as having clear links with substantive considerations. The first option involves identifying the maximum level of education among the set of adult children. This approach, which can be thought of as a threshold or non-cumulative approach, is based on the idea that adult children's education represents a non-cumulative resource such that having at least one child with high levels of education provides benefits and additional children with equivalently high levels of education do not provide additional benefits. Studies which measure adult children's education as the highest level among all of the children or the level of education of the eldest child implicitly adopt this

[1] It might appear that an alternative approach would be to avoid aggregation and conduct a multilevel analysis in which each parent-child dyad is the unit of analysis. In this case, however, the outcome, parents' health, only varies at the family level and thus the multilevel framework collapses to a specific form of an aggregate analysis.

approach (e.g., Torssander, 2014, 2013; Wolfe et al., 2018; Zimmer et al., 2007, 2002). The second option involves constructing a measure that captures the average level of education among the adult children. This approach, which can be thought of as a cumulative approach, is based on either the idea that adult children's education provides a cumulative resource or that family dynamics may be such that having a higher proportion of children with high levels of education increases the odds of realizing any benefits. In general, one would expect that conceptualizing adult children's education as an average (the cumulative approach) will be preferred in the presence of multiple mechanisms and potential family dynamics that could involve strained relationships, but there may be some social contexts in which the threshold approach would be sufficient (e.g., in social contexts in which filial piety is a strong cultural norm).

Combining the two dimensions results in four possible measures (see figure 1). We compare the effect size and the model fitting of the four measurements in the U.S. sample and evaluate which approach is better in each dimension (human capital vs. credential and cumulative vs. threshold).

1.2 Adult children's education and parents' health

Despite the lack of conceptual clarity and consistency of measurement, research has shown a consistent association between adult children's education (or more broadly, adult children's socioeconomic position) and parent mortality. Specifically, this body of work has found sizable negative associations between adult children's education and parent mortality net of several measures of parent socioeconomic resources and other sociodemographic characteristics (De Neve and Harling, 2017; Friedman and Mare, 2014; Torssander, 2014, 2013;

Wolfe et al., 2018; Yahirun et al., 2017; Yang et al., 2016; Zimmer et al., 2016, 2007). Studies examining activity limitations also typically find sizable negative associations net of a number of sociodemographic and socioeconomic covariates (Yahirun et al., 2017, 2016; Zimmer et al., 2002).

Several mechanisms have been proposed as potential explanations for why adult children's education could be beneficial for their parents' physical health. In broad strokes, the different mechanisms can be divided into two classes: those that focus on resources and those that focus on knowledge. The most commonly discussed resource-based mechanism, particularly among studies focusing on lower income countries, concerns the transfer of financial resources (De Neve and Harling, 2017; Friedman and Mare, 2014; Yahirun et al., 2017, 2016; Yang et al., 2016). More educated children, on average, have access to better jobs and thus should have more financial resources that could be used to support their aging parents' health, especially in the absence of health insurance or other state-sponsored health care programs, than less educated children. Alternatively, children with lower levels of education may draw on financial resources from their parents, thus diverting parents' resources that could be used to support their own health and potentially representing a significant source of social stress that could also undermine parents' health. Another resource-based mechanism linking adult children's education and parents' health involves the provision of direct care (Friedman and Mare, 2014; Torssander, 2014; Yang et al., 2016). It is possible that adult children with higher levels of education are in a better position to provide care for parents in poor health than are children with lower levels of education; however, evidence from studies of adult children and caregiving suggests that the opportunities for direct care may be limited as more educated children are more likely to live

further away from their parents and to face higher opportunity costs of providing care (Laditka and Laditka, 2001; Machin et al., 2012).

In addition to resource-based mechanisms, past studies have also proposed two knowledge-based mechanisms that could link adult children's education and parents' health. The first involves knowledge about how to navigate the health care system that comes with higher education (Friedman and Mare, 2014; Torssander, 2014, 2013). The second stems from the transmission of healthier lifestyles or behaviors from adult children to their parents (Friedman and Mare, 2014). Higher levels of education are known to be associated with healthier lifestyles or more broadly engaging in a healthier profile of behaviors (e.g., lower rates of smoking, moderate drinking, and more frequent exercise) (Cockerham et al., 2017; Lawrence, 2017). It is possible that more educated adult children pass on or encourage their parents to adopt the health promoting behaviors or general healthy lifestyles they have developed.

These resource-based and knowledge-based mechanisms provide plausible explanations for the relatively strong associations between adult children's education and parent's physical health observed in past studies. Most of these same mechanisms have the potential to be applicable with respect to parents' psychological health as well as their physical health. For instance, financial resources that come with higher levels of adult children's education could help alleviate some of the stresses of older age that could undermine parents' mental health. In addition, greater knowledge of mental health concerns and mental health care that could come from higher educated adult children may also support parents' mental health. Finally, if more highly educated adult children are able to pass on healthier lifestyles to their parents, then this could also help improve parents' quality of life and general mental well-being.

Thus, we examine whether adult children's education is positively associated with older mothers' physical and mental health.

1.3 Parent-child relationships as potential moderators

The various proposed mechanisms linking adult children's education and parents' health generally require parent-child contact to transmit resources, knowledge, health promoting behaviors, and social support. As such, one would expect that both the amount of contact parents have with their children and the degree of emotional closeness or conflict would moderate the association between adult children's education and parents' health. The quality of parent-child relationships is associated with intergenerational contact, and, in particular, older parents are likely to interact more with adult children with whom they have closer relationships (Lawton et al., 1994; Silverstein et al., 1995). A higher frequency of contact and better relationships with adult children should help facilitate any transmission of knowledge or resources from adult children to their parents, thus strengthening the association between adult children's education and parents' health. Most past studies adjust for the number of adult children and the gender composition of adult children (i.e., the proportion of sons or daughters in the family) in analyzing the association between adult children's education and parents' health. None, however, have examined parent-child relationships, either as potentially important covariates or as moderators.

Thus, we (1) examine whether controlling for mother-child relationship variables changes the effects of adult children's education on mothers' health and (2) test whether these variables moderate the association between adult children's education and mothers' health.

2. Method

2.1 Data

The data for this study come from the first wave of the Within-Family Differences Study (WFDS), which includes a sample of mothers 65–75 years of age with at least two living adult children. Massachusetts city and town lists were the source of the sample of mothers. Massachusetts requires communities to keep city/town lists of all residents by address. Town lists also provide the age and gender of residents. The investigators drew a systematic sample of women aged 65–75 from the town lists from 20 communities in the greater Boston area. The interviewers completed interviews with 566 mothers between 2001 and 2003, which represented 61% of those who were eligible for participation, a rate comparable to that of similar surveys in the 2000s (Wright and Marsden, 2010). In the interviews mothers provided extensive information about each of their adult children, including details about their relationships. For a more detailed description of the WFDS see http://web.ics.purdue.edu/~jsuitor/within-family-differences-study/study.html.

The analytic sample for the study includes 543 mothers who reported on all of their adult children (mean = 3.8 children in one family) at wave 1. Six mothers who never married were excluded and 17 mothers were excluded due to missing data.

2.2 Measures

2.2.1 Outcomes

Depressive symptoms. The Center for Epidemiological Studies Depression (CES-D-SF) Short Form Scale was used to measure depressive symptoms (Ross and Mirowsky, 1984). The CES-D-SF includes 7 measures asking respondents how often in the past week they have felt a certain way with a range from 0 = rarely or none of the time (less than 1 day) to 3 = most or all

of the time (5-7 days). The measures are: (1) everything I did was an effort, (2) I had trouble getting to sleep or staying asleep, (3) I felt lonely, (4) I felt sad, (5) I could not get going, (6) I felt I could not shake off the blues, and (7) I had trouble keeping my mind on what I was doing. The scale was created by taking the average of the 7 items (Cronbach's alpha = .78).

Activity limitation. It was measured as an indicator based on a question asking respondents: "Do you have any health conditions or difficulties that limit your activities or things you can do?" 0 = no activity limitation and 1 = have at least one activity limitation.

2.2.2 Independent variables

Adult children's education. In this study, all mothers have at least two children, so there are multiple ways to measure adult children's education. Mothers reported on their adult children's education as series of thresholds for highest grade completed: (1) eighth grade or less, (2) 1 to 3 years of high school, (3) high school graduate, (4) vocational/non-college post high school, (5) 1 to 3 years of college, (6) college degree, and (7) graduate work. For years of schooling, the thresholds of grades completed were recoded as follows: (1) eighth grade or less = 8 years, (2) 1 to 3 years of high school = 10 years, (3) high school graduate = 12 years, (4) vocational/non-college post high school = 14 years, (5) 1 to 3 years of college = 14 years, (6) college degree = 16 years, and (7) graduate work = 19 years. For the selected degree completed, the analysis relies on an indicator for children who had a bachelor's degree, a particularly significant degree threshold.[2]

[2] Preliminary analyses explored a three-category measure with (1) less than high school, (2) high school degree but less than a bachelor's degree, and (3) a bachelor's degree, but found no differences between the first two categories with respect to mother's health.

Four possible measures were created based on the two dimensions discussed above (see Figure 1). *Mean years of children's education variable* was measured using average years of education of all children in a family. *Maximum years of children's education variable* was calculated using years of education of the most educated child in a family. *Proportion of children attained a bachelor's degree variable* was measured using proportion of children who attained a bachelor's degree in a family. *At least one child attained a bachelor's degree variable* was measured as 0 = no child in the family attained a bachelor's degree and 1 = at least one child in the family attained a bachelor's degree.

2.2.3 Moderators

This study explores five measures of mother-child relationships surrounding the frequency of contact and quality of relationships between mothers and their adult children. The first measure captures a geographic dimension and is constructed as *the proportion of adult children living within 2 hours of their mother*. The next two measures capture the average frequency of *face-to-face* and *phone contact* between mothers and their adult children with a range from 0 = never to 6 = every day. The final two measures capture the average relationship quality between mothers and their adult children along two dimensions – *closeness* and *strain* each based on a single item – which range from 1 = low to 4 = high.

2.2.4 Controls

The analysis also adjusts for a number of mothers' characteristics that may be related to adult children's educational attainment and mother's health. These include *mother's age*, *race* (1 = white, 0 = non-white), *marital history* (0 = married, 1 = divorced, 2 = widowed), and *level of*

education (0 = less than high school, 1 = high school graduate or vocational school, 2 = some college, 3 = a college degree or higher). Further, the models also adjust for three children's characteristics: *The number of adult children*, *the proportion of daughters among the adult children*, and *the proportion of adult children who are married*.

2.3 Analytic strategy

The analysis proceeds with three steps. The first step involves identifying the best measure of adult children's education with respect to the association with mother's health. To do so, the analysis relies on model fit statistics (R-squared, AIC, and BIC) and standardized coefficients from regressing depressive symptoms and activity limitations on the four different measures of adult children's education. Based on the results of the first step, the second step involves fitting a series of regression models that include the best performing measure of adult children's education (model 1) and adjust for characteristics of the mothers and children (model 2) and then mother-child relation measures (model 3). This step provides an estimate of the net association between adult children's education and mother's health. The final step of the analysis involves introducing interaction terms between adult children's education and each of the measures of mother-child relations to the fully adjusted models. For activity limitations logit models are used and the interactions are tested via second differences using Stata's margins postestimation command (Ai and Norton, 2003; StataCorp, 2017). All of aspects of the analysis were completed using Stata v15 and all of the code is maintained at a publicly available website to facilitate replication and extensions to the analysis ([identifying link omitted]).

2.4 Sensitivity analyses

1. Missing data on independent variables were imputed with multiple imputation by chained equations (von Hippel, 2007). A comparison of results in the imputed data and listwise deletion data found no substantial difference.

2. Mothers' household income was not included in the models because it has too many missing cases. We ran models with imputed mothers' household income and found no change in results. Thus, we did not add mothers' household income in our models.

3. Mothers' self-rated health was included as a control in the models predicting depressive symptoms. No noticeable difference was found.

3. Results

3.1 Descriptive statistics

On average mothers reported 1.61 on the depressive symptoms scale and a little under 40 percent reported having some activity limitation (see Table 1). Mothers reported an average of almost 4 living adult children. Regarding the four measures of children's education: (1) the average proportion of children with a bachelor′s degree across family is 0.47; (2) the average years of children's education is 14.6 years; (3) the proportion of at least one child with a bachelor′s degree across family is 0.69; (4) the average years of education of the most educated child in a family is 16 years. On average, about 75 percent of children within each family lived within 2 hours of their mother. Across mothers, adult children averaged between visiting a little over once a month and talking on the phone a little over 2 to 3 times per month.

[Table 1 here]

3.2 Four measures of adult children's education

As shown in Table 2, among the four models predicting depressive symptoms, both models of the cumulative approach (i.e., the proportion of children with BA and mean years of education) are clearly preferred to models of the threshold approach (i.e., at least one child with BA and max years of education) with BIC differences ranging from around 5 to 8, which are around the ballpark of strong evidence (6-10) for better model fitting (Kass & Raftery, 1995). The same pattern is observed with activity limitations, but the difference in model fit is larger and more clearly supports the advantage of the cumulative approach. Regarding the dimension of mechanisms, with one exception, models of the credential approach (degree) are slightly preferred to models of the human capital approach (years) with BIC differences ranging from around 1 to 3, which barely qualify as positive evidence (2-6) for better model fitting. Overall, the model combing the cumulative approach and the credential approach (i.e., the proportion of adult children with a bachelor's degree) is the best fitting model.

Regarding the effect size, the magnitude and p-value of the standardized coefficients show trends to support the same conclusion of the model fits, this trend is especially evident in activity limitations. The credential approach (degree) is better in terms of magnitude and p-value compared to the human capital approach (years), whereas even larger difference in magnitude and p-value is found to be in favor of the cumulative approach (average) over the threshold approach (highest). It is important to notice that the difference between the coefficients is not statistical significant. However, this statistical insignificance is expected because all four measurements capture the same construct (i.e., children's education). This is not to say that the difference between four measurements is not important. As shown in the case of activity limitation, the standardized coefficients of ranging from -.33 ($p<.001$) to -.15 ($p>.05$). This

means that the effect of education changes from highly statistically significant to insignificant, depending on the choice of the education measurement. We will discuss the theoretically meaning of the measurement difference in the discussion.

In sum, the results indicate that a measure that takes account of the education levels of all adult children (the cumulative approach) as opposed to just the most educated adult child (the threshold approach) is preferred, but the credential approach (degree) is only weakly preferred over the human capital approach (years). And the best performing measurement is the proportion of adult children with a bachelor's degree, which combines the cumulative approach and the credential approach. The analysis proceeds with the proportion of adult children with a bachelor's degree and considers this further in the discussion below.

[Table 2 here]

3.3 Adult children's education and older mother's health

Figure 2 illustrates the unstandardized coefficients for proportion of adult children with a bachelor's degree from a series of regression models—linear for depressive symptoms and logistic for activity limitations (see Table A1 in Appendix 1 for the complete set of coefficients). The first model is a bivariate model and provides the unadjusted association between adult children's education and mother's depressive symptoms and activity limitations respectively. The second model adjusts for characteristics of mothers (mother's age, education, race, and marital history) and children (number of children, proportion of daughters, and proportion married) that are potential confounders. The third model adjusts for mother-child relation measures (geographic proximity, frequency of visits, frequency of phones, closeness with mothers, and strains with mothers).

As shown in Figure 2, greater proportion of children with a bachelor's degree is associated with fewer depressive symptoms and lower odds of having any activity limitation. These associations remain after adjusting for characteristics of mothers and children. The degree of attenuation from including controls is larger for depressive symptoms than for activity limitations. Finally, adjusting for the mother-child relation measures had little effect on the coefficient for adult children's education. Thus, in the final models, the proportion of children with a bachelor's degree maintains a net association with depressive symptoms and activity limitations respectively.

[Figure 2 here]

To gain a sense of the substantive magnitude of the association between children's education and mothers' health, predicted values for depressive symptoms and predicted probabilities for having any activity limitation were calculated based on the final model. Figure 3 illustrates the predicted values and probabilities with 95 percent confidence intervals in addition to the marginal distribution of the proportion of adult children with a bachelor's degree along the x-axis. The figure indicates that mothers who have no children with a bachelor's degree are predicted to have approximately a score of 1.7 on depressive symptoms and a 46 percent chance to have any activity limitation. In contrast, mothers who have all children with a bachelor's degree are predicted to have approximately a score of 1.5 on depressive symptoms and 31 percent chance to have any activity limitation. Although the 0.2 decrease in depressive symptoms may seem to be small, this effect size is equivalent to the effect size of mothers' own education on their depressive symptoms.

[Figure 3 here]

3.4 Mother-child relations as controls and moderators

As shown in figure 2, controlling for mother-child relations has minimal effect on the association between children's education and mothers' health.

Among the measures of mother-child relations, the only one with a net association with depressive symptoms is the average level of strain in the relationships between mothers and their adult children. No net associations for mother-child relations are evident with activity limitations (see Table A1 in Appendix 1). Despite the lack of main effects, it is possible that the mother-child relations moderate the observed associations between adult children's education and depressive symptoms and activity limitations. A series of models, however, that introduced interaction terms between proportion of children with a bachelor's degree and each mother-child relation measure one at a time revealed no evidence of moderation (table not shown, available upon request). Thus, the net association between adult children's education and mother's physical and mental health does not appear to vary systematically across different mother-child relations.

4. Discussion

This study joins and extends an emerging body of work examining the effects of adult children's education on their mothers' health through a conceptual and empirical consideration of the measurement of adult children's education, an examination of physical and mental health outcomes, and an assessment of the potential role of mother-child relations as controls for and moderators of the link between adult children's education and mothers' health.

Past studies have adopted several different approaches to operationalizing adult children's education with limited theoretical consideration (Torssander, 2014; Wolfe et al., 2018;

Yahirun et al., 2017). The lack of consistency in the measurement of adult children's education limits generalizability, makes it difficult to compare results across studies, and may lead to an underestimation of the net association between adult children's education and mothers' health. This study finds that an approach that captures levels of education among all of the adult children (the cumulative approach) is preferred over one that only considers the education levels of the most educated child (the threshold approach). This is consistent with the possibility that adult children's education represents a cumulative resource (i.e., the more adult children with higher levels of education, the better) and/or the possibility that having multiple children with higher levels of education may increase the odds of the beneficial transfer of resources or knowledge in the potential presence of family conflicts. This finding may also in part reflect the social context of the WFDS mothers – i.e., a relatively recent cohort (as compared with some other studies of adult children's education and parents' health) with adult children who may have benefited from the expansion of higher education in the United States during the second half of the twentieth century. In other social contexts with more limited opportunities for higher education or in contexts with a greater cultural emphasis on filial piety it is possible that the education levels of the most educated child would perform equally as well. Nonetheless, it is difficult to imagine a context in which the education levels of the most educated child would *outperform* a measure that takes into account the education levels of all adult children.

This study found weak support for a measurement based on the credential approach (degree) as opposed to the human capital approach (years of schooling). The inability to clearly distinguish between the two approaches likely in part reflects a limitation of the measure of adult children's education in the WFDS. In particular, we had to assign years of schooling to various thresholds for grades completed. Although these assignments did not have a perfect overlap with

educational degrees, they still missed the full range of years of schooling. The inability to clearly distinguish between the two approaches may also reflect the possibility that both credential- and human capital-based processes are operant in the links between adult children's education and mothers' health (Montez et al., 2012). Additional research is needed to determine whether one or another approach is generally preferred and to determine whether the preferred approach varies across social contexts as described above.

This study confirmed past findings regarding the association between adult children's education and mother's physical health, namely activity limitations, and also identified a new association between adult children's education and mothers' mental health, namely depressive symptoms. In addition, this study found both associations to remain after adjusting for a broader array of measures of mother-child relations than have previously been examined in past studies (Yahirun et al., 2017, 2016; Zimmer et al., 2016). Thus, this work contributes to the growing body of work documenting an association between adult children's education and parents' health. As with earlier work, an important limitation stems from the inability to address all potential confounders (e.g., mothers' genetic endowments and/or psychosocial resources that may impact both their health and their children's levels of education) and therefore the association should not be interpreted as a causal effect. More work is needed using innovative research designs to establish causal effects and to elucidate potential mechanisms underlying the relationship between adult children's education and parents' health.

Finally, this study tested whether various aspects of mother-child relations – adult children's geographic proximity, frequency of contact, and quality of relationships with their mothers – moderated the association between adult children's education and mother's health and found no evidence of moderation. This is surprising giving the likely importance of factors such

as geographic proximity, frequency of contact, and the quality of relationships for mechanisms proposed as underlying the relationship between adult children's education and parents' health. The lack of evidence of moderation may reflect two possibilities. First, it is possible that the "average" relationships mothers have with their adult children misses important one-on-one relationship dynamics that could impact the transfer of resources. Second, the lack of variability in frequency of contact and quality of relationships with their mothers (see Table 1) requires larger sample sizes to detect the difference. Future research need to address the above two possibilities to reach a more convincing conclusion regarding the moderating effect of mother-child relations.

5. Conclusion

This study contributes to the literature on children's education and mothers' health by providing guidelines on the measurement of children's education. The results indicate that a measure that takes account of the education levels of all adult children (the cumulative approach) as opposed to just the most educated adult child (the threshold approach) is preferred, but the credential approach (degree) is only weakly preferred over the human capital approach (years of schooling). In the contemporary United States context, the best measurement of children's education in a family is the proportion of children with a bachelor's degree, which adopts the cumulative approach and the credential approach.

This study found that older mothers who have a higher proportion of adult children with a bachelor's degree have lower levels of depressive symptoms and are less likely to have any activity limitation. The results are consistent with and extend an emerging body of work

examining how socioeconomic resources can flow from children back to their parents at older ages, an underappreciated process in intergenerational work on health.

Although we found that mother-child relations – adult children's geographic proximity, frequency of contact, and quality of relationships with their mothers – did not moderate the association between adult children's education and mother's health, more studies are needed to reach a more convincing conclusion.

References

Ai, C., Norton, E.C., 2003. Interaction Terms in Logit and Probit Models. Econ. Lett. 80, 123–129.

Cockerham, W.C., Bauldry, S., Hamby, B.W., Shikany, J.M., Bae, S., 2017. A Comparison of Black and White Racial Differences in Health Lifestyles and Cardiovascular Disease. Am. J. Prev. Med. 52, S56–S62.

Cutler, D., Lleras-Muney, A., 2008. Education and Health: Evaluating Theories and Evidence, in: Making Americans Healthier: Social and Economic Policy as Health Policy. Russell Sage Foundation, New York, pp. 29–60.

De Neve, J.-W., Harling, G., 2017. Offspring Schooling Associated with Increased Parental Survival in Rural KwaZulu-Natal, South Africa. Soc. Sci. Med. 176, 149–157.

Elo, I.T., Martikainen, P., Aaltonen, M., 2018. Children's Educational Attainment, Cccupation, and Income and Their Parents' Mortality. Popul. Stud. 72, 53–73.

Friedman, E.M., Mare, R.D., 2014. The Schooling of Offspring and the Survival of Parents. Demography 51, 1271–1293.

Laditka, J.N., Laditka, S.B., 2001. Adult Children Helping Older Parents: Variations in Likelihood and Hours By Gender, Race, and Family Role. Res. Aging 23, 429–456.

Lawrence, E.M., 2017. Why Do College Graduates Behave More Healthfully Than Those Who Are Less Educated? J. Health Soc. Behav. 58, 291–306.

Lawton, L., Silverstein, M., Bengtson, V., 1994. Affection, Social Contact, and Geographic Distance Between Adult Children and Their Parents. J. Marriage Fam. 56, 57–68.

Liu, S.Y., Buka, S.L., Kubzansky, L.D., Kawachi, I., Gilman, S.E., Loucks, E.B., 2013. Sheepskin Effects of Education in the 10-Year Framingham Risk of Coronary Heart Disease. Soc. Sci. Med. 80, 31–36.

Machin, S., Salvanes, K.G., Pelkonen, P., 2012. Education and Mobility. J. Eur. Econ. Assoc. 10, 417–450.

Mirowsky, J., Ross, C.E., 2003. Education, Social status, and Health. Routledge, New York.

Montez, J.K., Hummer, R.A., Hayward, M.D., 2012. Educational Attainment and Adult Mortality in the United States: A Systematic Analysis of Functional Form. Demography 49, 315–336.

Ross, C.E., Mirowsky, J., 1984. Components of depressed mood in married men and women. The Center for Epidemiologic Studies' Depression Scale. Am. J. Epidemiol. 119, 997–1004. https://doi.org/10.1093/oxfordjournals.aje.a113819

Silverstein, M., Parrott, T.M., Bengtson, V.L., 1995. Factors that Predispose Middle-Aged Sons and Daughters to Provide Social Support to Older Parents. J. Marriage Fam. 57, 465–475.

StataCorp, 2017. Stata Statistical Software: Release 15. StataCorp LP, College Station, TX.

Torssander, J., 2014. Adult Children's Socioeconomic Positions and Their Parents' Mortality: A Comparison of Education, Occupational Class, and Income. Soc. Sci. Med. 122, 148–156.

Torssander, J., 2013. From Child to Parent? The Significance of Children's Education for Their Parents' Longevity. Demography 50, 637–659.

von Hippel, P.T., 2007. Regression with Missing Ys: An Improved Strategy for Analyzing Multiply Imputed Data. Sociol. Methodol. 37, 83–117. https://doi.org/10.1111/j.1467-9531.2007.00180.x

Wolfe, J.D., Bauldry, S., Hardy, M.A., Pavalko, E.K., 2018. Multigenerational Attainment and the Mortality of Silent Generation Women. J. Health Soc. Behav. epub ahead of print.

Wright, J.D., Marsden, P.V., 2010. Survey research and social science: History, current practice, and future prospects, in: Wright, J., Marsden, P. (Eds.), Handbook of Survey Research. Emerald Group, Bingley, UK, pp. 3–26.

Yahirun, J.J., Sheehan, C.M., Hayward, M.D., 2017. Adult Children's Education and Changes to Parents' Physical Health in Mexico. Soc. Sci. Med. 181, 93–101.

Yahirun, J.J., Sheehan, C.M., Hayward, M.D., 2016. Adult Children's Education and Parents' Functional Limitations in Mexico. Res. Aging 38, 322–345.

Yang, L., Martikainen, P., Silventoinen, K., 2016. Effects of Individual, Spousal, and Offspring Socioeconomic Status on Mortality Among Elderly People in China. J. Epidemiol. 1–8.

Zimmer, Z., Hanson, H.A., Smith, K.R., 2016. Offspring Socioeconomic Status and Parent Mortality Within a Historical Population. Demography 53, 1583–1603.

Zimmer, Z., Hermalin, A.I., Lin, H.-S., 2002. Whose Education Counts? The Added Impact of Adult-Child Education on Physical Functioning of Older Taiwanese. J. Gerontol. B. Psychol. Sci. Soc. Sci. 57, S23–S32.

Zimmer, Z., Martin, L.G., Ofstedal, M.B., Chuang, Y.-L., 2007. Education of Adult Children and Mortality of Their Elderly Parents in Taiwan. Demography 44, 289–305.

Figure 1. Conceptualization of Adult Children's Education Along Two Dimensions.

		Mechanism	
		Human Capital	Credential
Aggregation Across Multiple Children	Cumulative	Mean years of schooling	Proportion attained a selected degree (BA)
	Threshold	Maximum years of schooling	At least one child attained a selected degree (BA)

Table 1. Descriptive statistics

	Mean	Std Dev	Range
Outcomes			
Depressive symptoms	1.61	.59	1-4
Any activity limitations	.39		0,1
Children's Education			
Proportion of children with BA	.47	.40	0-1
Average years of children's education	14.57	2.37	8-19
At least one child with BA	.69		0,1
Max years of children's education	16.02	2.66	8-19
Mother Characteristics			
Mother's age	70.88	3.10	66-76
Mother white	.70		0,1
Mother's marital status			
married	.48		0,1
divorced	.17		0,1
widowed	.35		0,1
Mother's education			
less than high school	.23		0,1
high school degree	.35		0,1
some college	.22		0,1
college degree or higher	.21		0,1
Children's Characteristics			
Number of children	3.81	1.82	2-13
Proportion female children	.50	.28	0-1
Proportion married children	.64	.31	0-1
Mother-Child Relations			
Proportion children live within 2 hours	.76	.28	0-1
Average frequency of visits	3.17	1.27	0-6
Average frequency of talk on phone	4.36	1.10	0-6
Average closeness to children	3.24	.73	1-4
Average strain with children	1.85	.82	1-4

Table 2. Standardized coefficients from models predicting depressive symptoms and activity limitation using different measurements of children's education

	Depressive symptoms				Activity limitation			
	Cumulative		Threshold		Cumulative		Threshold	
	Degree	Years	Degree	Years	Degree	Years	Degree	Years
% children with BA	-.12*** (.02)				-.33*** (.09)			
Mean years of education		-.12*** (.03)				-.29** (.09)		
At least one child with BA			-.10*** (.03)				-.20* (.09)	
Max years of education				-.11*** (.03)				-.15 (.09)
N	556	556	556	556	556	556	556	556
R-sq	.04	.04	.03	.03				
AIC	979.12	979.52	987.79	983.91	732.51	735.84	741.52	743.76
BIC	987.76	988.16	996.43	992.55	741.15	744.48	750.17	752.40

* p<.05, ** p<.01, *** p<.001

Figure 2. Effects of proportion of children with BA on depressive symptoms and activity limitation

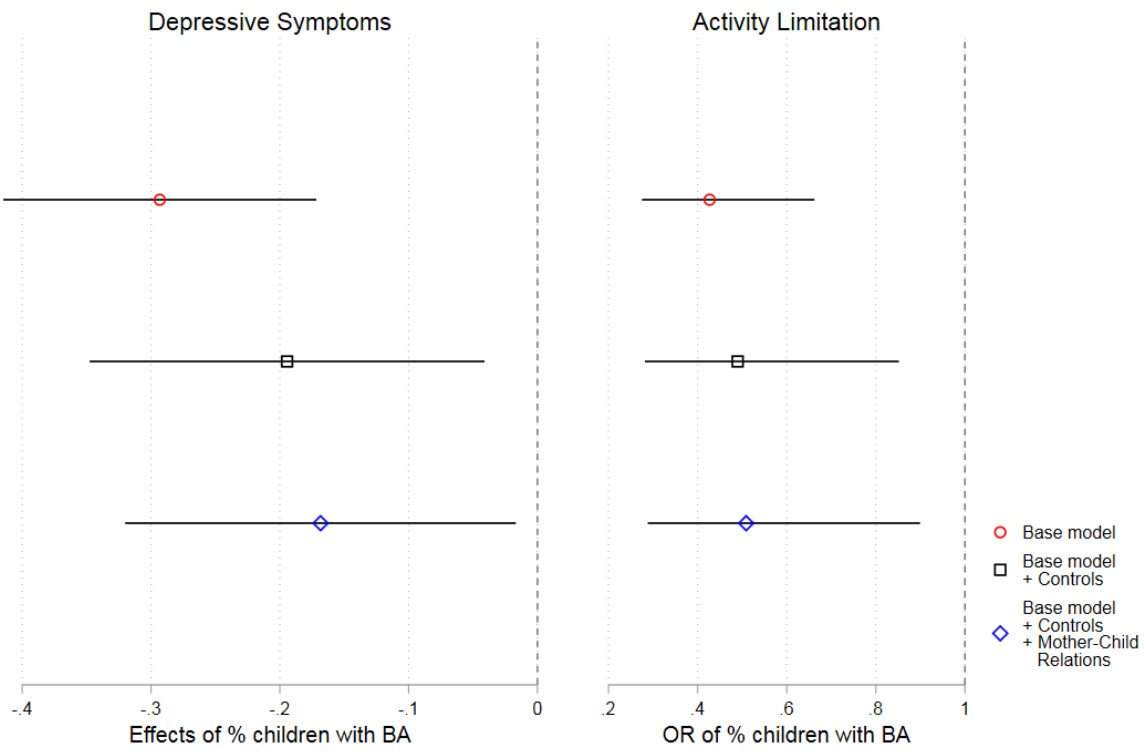
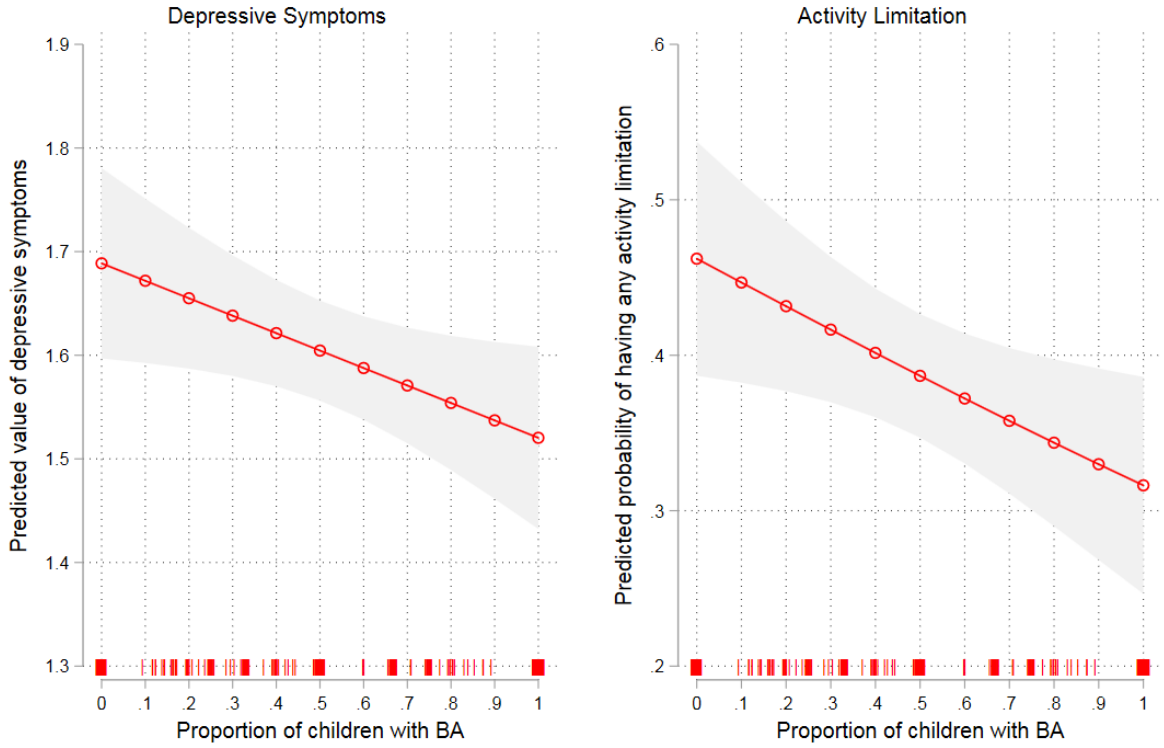


Figure 3. Predicted depressive symptoms and activity limitation using proportion of children with BA



Appendix

Table A1. Unstandardized estimates from regression models predicting depressive symptoms and activity limitation

	Depressive Symptoms						Activity Limitation					
	Model 1a		Model 2a		Model 3a		Model 1b		Model 2b		Model 3b	
	B	SE	B	SE	B	SE	OR	SE	OR	SE	OR	SE
% children with BA	-.29***	.06	-.19*	.08	-.17*	.08	.43***	.10	.49*	.14	.51*	.15
Mothers' Characteristics												
Age			.01	.01	.02	.01			1.07*	.03	1.08*	.03
White			-.06	.07	-.07	.07			.51**	.12	.49**	.12
Marital status (ref.=married)												
divorced			.04	.08	-.01	.08			2.11*	.64	2.01*	.61
widowed			.09	.06	.08	.06			1.32	.29	1.26	.28
Education (ref.=below high school)												
high school degree			-.16	.08	-.15	.08			.80	.21	.81	.22
some college			-.21*	.09	-.21*	.08			1.04	.31	1.07	.32
college degree or higher			-.12	.10	-.14	.10			1.64	.55	1.80	.66
Children's Characteristics												
Number of children			-.01	.01	-.01	.01			.97	.05	.98	.05
% female children			-.03	.09	-.01	.09			.66	.22	.67	.23
% married children			.02	.09	.04	.09			.84	.28	.99	.34
Mother-child Relations												
% children live within 2 hours					.10	.11					.98	.47
Avg. freq. of visits					-.02	.04					1.14	.14
Avg. freq. of talk on phone					-.01	.05					1.00	.11
Avg. strain with mother					.12**	.04					1.36*	.21
Avg. closeness with mother					.01	.05					1.00	.17
N	543		543		543		543		543		543	
BIC	967.50		1012.75		1029.39		725.33		751.85		775.05	

* p<.05, ** p<.01, *** p<.001