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Offspring Education and Parental Mortality: Evidence from South Asia

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Abstract

Decades of research shows that education not only confers individual health benefits, but it also spills over to advantage subsequent generations. More recently, research has confirmed that the intergenerational health benefits of education can also flow upward: aging adults with more highly educated children enjoy better health and survival. Research has documented this finding in high-income settings, and also in select low- and middle-income contexts, raising questions about the mechanisms through which having an adult child who attended relatively low levels of education in high-mortality contexts can benefit aging parents' well-being. In this study, we use multilevel, long-term panel data on a cohort of older adults from the Chitwan Valley Family Study in rural Nepal to establish whether the association between offspring education and parents' survival is observable in this extremely poor, agrarian context. Extending past studies, we then leverage additional data on older adults to examine the association between offspring education and two theorized mechanisms: older adults' better health behaviors and greater support in later life.

1. Introduction

Decades of social science research has confirmed that, across diverse regions of the world, educated individuals are healthier and live longer (Baker, Leon, Smith-Greenaway, Collins, & Movit, 2011; Molina, 2016), and they have healthier children who are more likely to survive to older ages (Smith-Greenaway, 2013). Recently, studies have begun to investigate if educational benefits also flow upward from adult children to improve their aging parents' health (De Neve & Kawachi, 2017).

Initially, studies documenting the health benefits associated with having more highly educated children focused on high-income settings, showing that older adults with a college-educated child experience substantially lower mortality rates relative to those whose child(ren) did not attend college (Friedman & Mare, 2014; Graham & Sabater, 2016; Torssander, 2013; Zimmer, Martin, Ofstedal, & Chuang, 2007). These studies emphasize the material, social, and informational support that college-educated children can provide their aging parents, offering little reason to assume that adult children's education will have any bearing on their parents' mortality in low- and middle-income countries, where children

commonly discontinue school at the primary or secondary level, healthcare is generally limited, and mortality risks are more pervasive. Nonetheless, growing evidence from lower income settings shows that older adults with more highly educated offspring also experience survival advantages (De Neve & Kawachi, 2017). These studies raise questions of the salience of the link between offspring education and parental survival to some of the world's poorest contexts, and the mechanisms that could drive it.

Our current study focuses on rural Nepal to offer the first analysis of the relationship between offspring education and women's and men's mortality in an extremely low-income context typical of the environments of many families residing in South Asia, the most populous world region, which is aging rapidly (Acharya, 2012; Gurung, Paudel, & Yadav, 2016; Poudel & Magar, 2016). Like older adults in many of South Asia's—and the world's—poorest, agrarian communities, the majority of older adults in rural Nepal enter late life after having endured years of poverty, physical labor, low nutrition, and minimal access to education or health services. Yet, due to the construction of schools during the 1970s (for more details regarding school construction and changing school quality, see Beutel and Axinn 2002; Brauner-Otto 2012), most older adults' children, particularly sons, have had the opportunity to attend primary and secondary school. Indeed, educational opportunities have historically favored boys over girls in rural Nepal (Stash & Hannum, 2001; Vogel & Korinek, 2012), due in part to parents' disproportionately investing in and supporting their sons' education in light of the cultural expectation that sons will provide for them in old age (Brunson, 2010; Chalise, Kai, & Saito, 2010; Niraula, 1995; Rajan, 2003). That is, unlike western countries where daughters typically care for their parents, in Nepal, filial responsibilities fall to sons—signaling the potential salience of sons' educational attainment for their parents' health and wellbeing in this context.

Thus, our first study goal is to establish if adult sons' educational attainment influences women's and men's mortality in rural Nepal, as has been shown of offspring educational attainment and older adults' mortality in other, select low- and middle-income settings. To do so, we analyze multilevel panel data from the Chitwan Valley Family Study (CVFS), which features 16 years of monthly mortality data following the baseline survey in 1996. We model women's and men's mortality separately in order to assess whether gender differences in older adults' health-related experiences, and/or differences in the parent-child relationship, lead adult sons' educational attainment to distinctly impact women's versus men's risk of mortality. After establishing whether there is an association between adult sons' education and women's and men's risk of mortality in this extremely poor, agrarian context, our second study goal is to identify the possible relevance of two previously theorized mechanisms. Specifically, we leverage additional data on CVFS respondents collected in 2006 to analyze whether adult sons' educational attainment is associated with women's and men's health behaviors and/or old-age support, as past studies hypothesize, however have not confirmed empirically.

2. Background

2.1 Intergenerational Health Benefits of Education

Researchers have long recognized that education not only benefits those who acquire it but can spill over to produce intergenerational health benefits for their children, including improving their nutritional status (Glewwe, 1999), lowering the risk of respiratory illness (Khandke, Pollitt, & Gorman, 1999), and increasing their likelihood of survival (Smith-Greenaway, 2013).

Of course, intergenerational influence is not a one-way process: children powerfully influence their parents (Axinn & Thornton, 1993; Bell & Harper, 1977; Gecas & Seff, 1990; Glass, Bengtson, & Dunham, 1986; Hagestad, 1984; Lerner & Spanier, 1978; Peterson & Rollins, 1987). Indeed, just as educational benefits flow downward from parent to child, a growing number of studies show they can flow upward from adult children to their aging parents (De Neve & Harling, 2017; Friedman & Mare, 2014; Torssander, 2013; Yahirun et al., 2016, 2017; Yang et al., 2016; Zimmer et al., 2007). These studies have been concentrated predominately in high-income contexts. Highlighting the complex web of healthcare in high-income countries, and the need to navigate different treatment options and specialists, researchers contend that college-educated adult children are more effective advocates for their aging parents (Torssander, 2013). Given that the Internet is an increasingly important way to obtain health-related information, researchers further contend that college-educated children's greater access to and familiarity with securing medical information from the web may further advantage their parents (Friedman & Mare, 2014).

More recently, however, growing evidence from low- and middle-income settings in countries as diverse as South Africa (De Neve & Harling, 2017), Mexico (Yahirun, Sheehan, & Hayward, 2016, 2017), and China (Yang, Martikainen, & Silventoinen, 2016) similarly shows that older adults with more highly educated offspring experience lower risk of mortality in these distinct economic, educational, and health contexts. That is, even in settings where adult children have attended minimal school, healthcare is limited, and mortality risks are pervasive, older adults with more highly educated children experience lower mortality relative to parents whose children have attended less school (for a review, see De Neve and Kawachi 2017). Evidence that children's education is a key correlate of older adults' survival across a range of economic contexts raises questions of the salience of this finding to some of the world's poorest communities, like those in rural Nepal.

Indeed, the expansion of education is occurring particularly rapidly in some of the poorest countries in the world (Hannum & Buchmann, 2005), raising questions of the broader demographic benefits of this transition—even in the absence of widespread economic development. In the context of rural Nepal, of particular interest is the potential role of sons' education, given that Nepalese parents have historically invested disproportionately in their sons' education as they simultaneously view sons as responsible for providing them with old-age care (Stash & Hannum, 2001). Thus, in the following sections, we highlight the potential ways in which having a more highly educated son may pattern women's and men's mortality in rural Nepal. Drawing on past hypotheses that adult children encourage their parents to adopt healthier behaviors and offering their parents more, and higher-quality,

support in late life to “repay” them for having invested in them as young children (De Neve & Kawachi, 2017), we discuss how sons’ educational attainment may pattern women’s and men’s (1) health behaviors and (2) support in late life.

2.2 Mechanisms Driving the Link between Offspring Education and Women’s and Men’s Survival

2.2.1 Health Behaviors—Despite mounting evidence that offspring education patterns women’s and men’s mortality in diverse contexts across the globe, we have little knowledge of why this is the case. Prior work posits that a principal way having more highly educated children benefits older adults’ survival is through their health-related behaviors (Berkman, Glass, Brissette, & Seeman, 2000; Cutler & Lleras-Muney, 2010; Field & de la Roca, 2005). From a social influence perspective, more highly educated individuals can indirectly influence family members’ health behaviors simply by their modeling a healthier lifestyle (Cohen, 2004). Alternatively, from a social learning perspective, children may explicitly encourage their aging parents to adopt healthier behaviors (Montgomery, 1998).

Women and men with more highly educated sons may be especially apt to pursue healthier behaviors in rural Nepal, where evidence suggests that younger adults—especially more highly educated ones—are less likely to engage in unhealthy behaviors, such as tobacco use, relative to their less educated seniors (Bhatta, 2010; Sreeramareddy, Ramakrishnareddy, Kumar, Sathian, & Arokiasamy, 2011). Furthermore, because education shifts the dynamics of the parent-child relationship in agrarian communities in Nepal (Compernelle, 2015), it may heighten sons’ authority over health issues as parents increasingly view their sons as knowledgeable. As a result, parents may be more likely to model their sons’ healthier behaviors—such as not using tobacco—and may be more receptive if their sons provide health-related advice.

Although research has given little direct attention to empirical evidence that having more highly educated children is associated with healthier behaviors, past studies have examined cause-of-death data to indirectly explore whether this is a plausible pathway linking offspring education to parents’ mortality risk in diverse settings. For instance, Friedman and Mare’s (2014) study of U.S. families found that adult children’s education has the most pronounced influence on their parents’ likelihood of dying from causes linked to behavioral factors (e.g., chronic lower respiratory disease and lung cancer, which are more common among tobacco users), leading them to conclude that children may be influencing their parents’ behaviors. Similarly, De Neve and Harling’s (2017) study of South African families found that adult children’s education strongly reduces their parents’ likelihood of dying due to AIDS and tuberculosis, which they also hypothesize is a result of adult children encouraging their parents to adopt healthier behaviors. However, Yang and colleagues’ (2016) study in China demonstrates a significant association between offspring education and older adults’ survival net of their health behaviors, implying that if offspring education does influence older adults’ health behaviors—which remains unclear—it may not be the only mechanism leading to their lower mortality.

2.2.2 Support in Late Life—In line with the reciprocal exchange model, more highly educated offspring might also benefit their aging parents by explicitly behaving in ways to “repay” their parents for their earlier investments—namely educational investments (Goldscheider, Thornton, & Yang, 2001). Around the world, older parents rely heavily on their adult children for support (Agree & Glaser, 2009), and this is especially true in Asian settings (Cai, Giles, & Meng, 2006; Frankenberg, Lillard, & Willis, 2002; Giles, Wang, & Zhao, 2010; Knodel, Friedman, & Cuong, 2000). Scholars contend that, across various social settings, children whose parents have invested more heavily in their education may strive to recompense their parents (i.e., parental repayment) (De Neve & Harling, 2017; Frankenberg et al., 2002; Lillard & Willis, 1997). Although Nepalese public school attendance is free, there are many direct (e.g., uniforms, books, supplies, private school fees, or public schools that provide additional academic services beyond the core government curriculum, such as science labs and sports, for a fee) and even indirect (e.g., loss of child labor), costs.

One way that researchers contend adult children may strive to repay their parents is by their providing direct, financial transfers. Yahirun and colleagues (2017) show that accounting for financial transfers attenuates a marginally significant link between offspring education and parents’ health in Mexico, making it the only study that investigates a possible pathway linking offspring education to older adults’ health. Research suggests this mechanism may also have relevance in Nepal: more highly educated Nepalese men are more likely to have given financial or in-kind support to their parents relative to their less educated peers (Brauner-Otto, 2009). In Nepal, where the Asian Development Bank (2002) estimates that approximately 40% of the population lives below the national poverty line, even small income gains can dramatically improve older adults’ household environments and, in turn, their exposure to health threats. For example, families with more resources typically cook with gas or kerosene, rather than open fire, which substantially reduces indoor air pollutants and exposure to a host of respiratory risks (Bruce, Perez-Padilla, & Albalak, 2000). Approximately one-in-five Nepalese suffer from chronic bronchitis (Bumgarner & Speizer, 1989), putting them at risk of chronic obstructive pulmonary disease (Elo & Preston, 1992) and lung cancer (Raspanti et al., 2016), which remain common causes of adult morbidity and mortality in Nepal.

In addition to improving older adults’ household conditions, more highly educated sons may also ensure their parents have the means to access higher-quality healthcare. In low-income settings like rural Nepal, public welfare systems are commonly limited. As a result, in low-income country contexts, children often function as a substitute for market institutions—including health insurance (Psacharopoulos, 1994; Schultz, 2004). Healthcare is limited in rural Nepal, but in addition to traditional healers (Sharma Bhattarai, 2013), it is increasingly available at pharmacies, health centers, and hospitals (Paudel, Upadhyaya, & Pahari, 2012). The quality of care varies tremendously, however, between lower-cost government health institutions and more costly, yet higher quality, private hospitals (Sharma Bhattarai, 2013). Moreover, most healthcare facilities in rural Nepal provide only primary care. Specialty care facilities are concentrated in urban areas (Nielsen, 2004; Wagstaff, 2002), requiring older adults to have the financial ability to travel to access such care. In Nepal, more educated

sons are also more likely to have traveled or migrated to urban areas (Williams, 2009) and therefore may be more likely to know of these medical and health resources and more successful at navigating them. Moreover, adult sons who have attended more school, and who are better off financially, may be better positioned to ensure their parents access the highest quality care, regardless of cost.

Beyond providing them with critical financial support, more highly educated adult sons may further repay their parents by providing them with functional support. Similar to other Asian countries, institutional care for the elderly is not widely available in rural Nepal (Chalise & Brightman, 2006). The family is thus the predominant social institution that provides care (Rajan, 2003). Moreover, the majority of older adults in Nepal report at least one functional limitation—suggesting that they are commonly in need of direct support not only in daily life, but also to access healthcare (Bista & Joshi, 2015; Chalise, Saito, & Kai, 2007). In a context where education influences young men's attitudes (Compernelle, 2015) and life course (Williams, 2009) in ways that could disrupt—not necessarily foster—intergenerational transfers, the salience of this pathway is unclear. Nonetheless, although young men's education is known to reduce their general sense of filial obligation in this setting (Compernelle, 2015), when their own parents become ill and are in need of care, more highly educated sons may be more likely to fulfill cultural expectations than their attitudes in the abstract suggest. Thus, more highly educated and better resourced adult sons may provide their aging parents with the functional support they need to complete such tasks like seek medical care.

3. Distinctions in Links between Sons' Educational Attainment and Women's and Men's Mortality

It is possible that having a more highly educated son differentially impacts Nepalese women's versus men's mortality. Past studies often model the survival consequences of having more highly educated offspring for women and men jointly (e.g., Friedman & Mare 2014). However, select studies have confirmed that offspring education can distinctly impact women versus men (Yahirun et al., 2016, 2017; Yang et al., 2016). Although there are gender differences in aging and health across all contexts, these differences may be particularly pronounced in rural Nepal where gender is a powerful stratifying force across all aspects of one's family relationships and health (Cameron, 1998).

On the one hand, the local gender system in rural Nepal may result in adult sons' educational attainment having a particularly pronounced influence on their fathers' health behaviors, access to support, and ultimately mortality. Like in other contexts, Nepalese men are more likely to engage in unhealthy behaviors, like tobacco use and excessive alcohol use, relative to women (Sreeramareddy et al., 2011). Thus, it is possible that their sons have more opportunities to positively influence their health. Additionally, in the absence of reliable economic prospects outside the home, parental inheritance, which men oversee, remains the primary source of livelihood and wealth for young people, especially sons (Gertler & Lillard, 1994). Thus, as a result of the gendered nature of intergenerational transfers, and the

father-son relationship it fosters, sons may be particularly attune to their fathers' needs as they age.

On the other hand, in a gender-stratified context like rural Nepal (Cameron, 1998), adult sons may be particularly apt to oversee their mothers' health-related experiences, and older women may be more responsive to their sons' health guidance and advice relative to their husbands. Thus, although older Nepalese women may already pursue healthier behaviors relative to men, their sons may be more readily willing to advise their mothers regarding her health-related experiences, and women may be more receptive to adopting their advice.

Additionally, because of the gendered nature of family life in rural Nepal, women provide considerable care for their children throughout their early life. Arguably the mother-child relationship tends to be a more intimate one than the father-child relationship in Nepal (Jennings, Axinn, & Ghimire, 2012), which could encourage adult sons to be particularly mindful of their mothers' needs in old-age. Indeed, this may be especially true given that older women are more likely to experience widowhood in Nepal relative to men. During the second half of 20th century, life expectancy in Nepal increased dramatically to 60 years (Chalise & Brightman, 2006). Although life expectancy at birth is comparable for women and men, when looking more closely at average life expectancy of 45 year olds, it is clear that women tend to have a slight survival advantage over men in late life (Global Health Workforce Statistics, 2017). Thus, given this epidemiological difference and women's likelihood of outliving their spouse, women's adult sons may have greater influence on their health-related experiences, and ultimately survival, in later life.

4. Current Study

In summary, a growing number of studies have demonstrated that women and men with more highly educated offspring experience lower risk of mortality in later life. The first goal of this study is to expand this literature by examining the upward flow of educational benefits in a context representative of some of the world's poorest, agrarian communities where educational attainment is rapidly increasing, even in the absence of the widespread economic development that is a primary correlate of improvements in older adults' health. We do this by assessing whether adult children's education benefits older women's and men's mortality in rural Nepal. We focus specifically on adult sons' educational attainment given that Nepalese parents historically invested disproportionately in their sons' education. Moreover, given the gendered nature of family life and health in rural Nepal, we pay close attention to any possible gender differences in the links between adult sons' educational attainment and older adults' mortality.

Our study's second goal is to further expand the literature by analyzing the possible salience of two widely theorized, yet empirically under-analyzed, mechanisms. Drawing on current hypotheses that highly educated children may benefit aging adults' health, and ultimately their survival, by encouraging them to adopt (1) healthier behaviors and/or by providing them with (2) support in late life, we use additional data to analyze whether there is evidence to support these two mechanisms, as past studies contend.

5. Analytic Approach

5.1 Data and Sample

We use data from the Chitwan Valley Family Study (CVFS). CVFS is a panel study in rural Nepal that includes detailed data on individuals' and their children's life experiences. In 1996, the CVFS conducted a baseline interview, which consists of a structured interview and a semi-structured life history calendar interview. The CVFS interviewed all household members age 15 to 59 years and their spouses in sampled neighborhoods (97 percent response rate). To achieve our first study goal of establishing whether offspring education is associated with older adults' survival in this especially low-income, agrarian setting, we use data from the baseline interviews, as well as vital status data from the CVFS monthly household registry system, to assess whether adult sons' educational attainment influences older women's and men's risk of mortality over a 16-year period. We focus specifically on the subsample of women and men who were 45 years or older at the time of the baseline survey. Research on older adults often focuses on individuals 60 years and older; however, because of the physical demands associated with living in this agrarian setting, many respondents experience physical aging symptoms at relatively young ages. For example, in line with past studies of older adults in Nepal (Bista & Joshi, 2015), CVFS data confirm that high proportions of adults 45 years and older report difficulties with basic physical activities (e.g., kneeling, walking for an hour).

Of the 930 adults 45 years or older at the time of the baseline survey in 1996, the mortality analysis focuses specifically on the subsample who had at least one son 18 years or older ($N=754$). The vast majority of young adults in 1996 had permanently left school by this age, thus this sample restriction enables us to ensure that we capture sons' complete educational attainment. Note that the vast majority (88.5%) of the 176 respondents whom we excluded had at least one son but did not have one over the age of 18 at the time of the baseline survey. Whereas we omitted only 2% of age-eligible women who did not have at least one child above age 18, this restriction omitted a higher percentage of 45 year old men. To ensure that this sample restriction is not biasing our results for men's mortality, we ran additional models wherein we altered the sample inclusion criteria. More specifically, we re-ran all models wherein we included adults age 45 years and older who have at least one son who is (1) any age, (2) at least 14 years old, (3) at least 15 years old, or (3) at least 16 years old. Results from each set of supplementary analyses produce estimates that are nearly identical in size and statistical significance to the ones we report here, reassuring us that the sample restriction is not biasing our results. We further excluded 22 respondents because they only had daughters—but not sons—above age 18 at the time of the baseline survey. Supplementary analyses confirm that the sociodemographic profiles of the unrestricted, full sample of older adults and the final analytic sample are highly comparable (results available upon request).

Our second set of analyses of older adults' health-related experiences focuses on participants age 45 years and older at the time CVFS collected health-related data in 2006 with at least one adult son in 1996 ($N=997$). Ideally, we would empirically examine mediators of the relationship between offspring education and older women's and men's mortality using this

same analytic sample, and we would conduct a formal mediation test. Unfortunately, however, aside from mortality data, we do not have health-related outcome measures for the entire sample of older adults. Instead, the CVFS did incorporate measures of older adults' health-related experiences a decade after the baseline interview (in 2006), thus some of the older adults in our sample died prior to the collection of data on their health-related experiences ($N=69$). Additionally, other adults not included in our mortality analysis (due to their being younger than 45 and/or having younger children) aged into the sample. Indeed, a higher percentage of women aged into this sample relative to men, given that many women were age ineligible in 1996 (i.e., younger than 45 years old), but had children 18 years or older in 1996, and thus were excluded from the mortality analysis. Although we have follow-up mortality data on this subsample of older adults, excessive censoring and concerns of power due to the small number of subsequently observed deaths ($N=62$) motivated us to focus our mortality analyses on the original sample of older adults at the time of the baseline interview, whom we observe for a full 16 years.

In 2006, if eligible respondents were not available at the time of the interview to answer health-related questions, another household member reported on their behalf. This was the case in approximately 40% of the cases that we study here. One way this could potentially influence our results is if older adults are more/less likely to answer "yes" to unhealthy behaviors relative to those who had another individual report on their behalf. In supplementary analyses, however, we find no evidence that this is the case: levels of tobacco and alcohol use were not significantly different between groups.

5.2 Measures

5.2.1 Dependent variables—We examine older adults' timing of death by leveraging 192 months of prospective mortality data. Using these data, we use a discrete-time event-history approach, wherein we restructured the data to a person-month format. We code survival as "0" for each month the mother/father remains alive and "1" in the month s/he dies, at which time the respondent no longer contributes observations. Over the study period, we observe 131 deaths (17% women ($N=65$); 18% men ($N=66$)).

We then analyze whether adult sons' educational attainment is associated with two commonly theorized mechanisms that correspond with older adults' better survival: improved health behaviors and greater support. In terms of health behaviors, we analyze whether older adults (1) currently smoke (1=yes, 0=no) and/or (2) consume alcohol (1=yes, 0=no). In terms of support, in a context where barriers to high-quality healthcare are pervasive among older adults, we assess whether older adults have experienced a lack of healthcare support. Interviewers asked older adults whether, in the past year, they did not obtain healthcare because of a lack of money, transportation, or a caregiver to accompany them. Using this information, we created a binary indicator for whether older adults lacked the financial or functional support to seek healthcare in the prior year.

5.2.2 Independent variables—CVFS interviewers asked respondents a series of questions about each child, including information on their educational histories and highest level of school completed. We created a continuous measure that captures the highest level

of educational attainment in 1996 of any son over age 18, regardless of birth order. Note that in supplementary hazard analyses we test for nonlinearity in the association; however, we found no significant non-linearity. In further supplementary analyses, we constructed additional measures of offspring education, including the average attainment among sons, to confirm the robustness of the results shown here to our construction of this measure. We also explored educational inequality between children as a predictor of older women's and men's health-related outcomes, but we found no significant results. The same is true of models exploring whether there is an association between daughters' educational attainment and their parents' survival. However, we anticipate that daughters' education may have growing salience in Nepal as gender inequalities in school have declined dramatically—a potential we discuss in greater detail below (7. Discussion).

In all models, we control for a number of individual- and neighborhood-level factors at the time of the baseline survey that are likely to be associated with parents' subsequent health-related experiences and mortality. We use the standard categorization of ethnic groups into five categories: Brahmin/Chhetri (high caste Hindus), Dalit (low caste Hindus), Hill Janajati, Newar, and Terai Janajati (Fricke, 1986; Guneratne, 1994; Gurung, 1980; Macfarlane, 1976; Pradhan & Shrestha, 2005). High caste Hindus historically have the greatest engagement in education and are greatly advantaged in access to health care, thus, it is important that any association between education and mortality in Nepal accounts for ethnic differences in patterns of each.

We also account for respondents' own education using a binary variable of whether they ever attended school. We consider ever school attendance, rather than highest level of school, because of minimal variation in educational attainment among this cohort (Chaudhury, 2004)—especially among older women. Supplemental models in which we include the older adult's highest educational attainment produce results consistent with those shown here. All models account for respondents' age. We include a dummy variable for age at each year (enabling us to account for nonlinear effects of age on mortality) in our discrete-time hazard approach to estimation of the mortality models. Note that the results are consistent when accounting for age using wider age groups. In the analyses of older adults' health behaviors and support, we include a continuous measure for the respondents' age at the time of the health survey in 2006. Finally, we account for respondents' total number of children as of 1996.

We also account for a number of socioeconomic controls that correlate with older adults' risk of mortality. We include a household wealth index to differentiate respondents according to their socioeconomic resources. Because it is difficult to measure yearly income or net assets in our study site, due to the predominance of subsistence agriculture, we instead control for a measure of consumer goods and the quality of the family's home at the time of the baseline survey in 1996. The household wealth index considers the presence of nine household goods/dwelling characteristics, resulting in a scale ranging from zero to nine. The index increases by one point for each item owned/dwelling characteristic: radios, televisions, bicycles, motorcycles, electricity, toilet on the premises, permanent wall material (wood, stone, brick, or cement rather than mud or cane), permanent roof material (slate, tin, or concrete rather than thatch), permanent flooring (wood, concrete, or brick rather than mud)

(see Yabiku 2006). We also account for whether respondents have ever worked outside the home. To capture older adults' prior health, we include an indicator for whether they had sought formal healthcare by the time of the baseline survey. We also include a time-varying covariate (measured each month) of the older adults' marital status and living arrangement, differentiating between those that are (1) currently married and living with their spouse, (2) currently married but the spouse is living elsewhere, or (3) unmarried due to divorce or widowed.

With detailed CVFS data on respondents' adulthood community context, we measure whether the respondent lived in close proximity to a school and/or health facility. As noted, in the 50 years preceding the baseline survey, health services and schools became available in select neighborhoods in the Chitwan Valley (Axinn & Barber, 2001; Barber & Axinn, 2004; Yabiku, 2004); however, access remained unequal across neighborhoods, especially at the time of the baseline survey. Thus, we use data from the CVFS Neighborhood History Calendar data, which recorded the walking time (in minutes) to the nearest of each of these services (Axinn, Barber, & Ghimire, 1997). We created binary indicators for whether a respondent lived within a five-minute walk of a school or health service in 1996. Although previous research in this setting demonstrates that more sophisticated measures that account for the spatial distribution of all available resources perform better than simple distance measures, both approaches produce substantively comparable associations on health-related outcomes (Brauner-Otto, Axinn, and Ghimire 2007). Because these geographically weighted measures performed similarly in our models here we opted to present the simple, more intuitive measures.

5.3 Multivariable Models

In the first set of analyses, we estimate adults' monthly hazard of mortality for 192 months following the baseline interview (in 1996). We estimate a series of multilevel, discrete-time hazard models to analyze women's and men's mortality, with person-months of exposure the unit of analysis. To address censoring and the hierarchical nature of our data (Raudenbush & Bryk, 2002), we estimate a series of random-effects discrete-time logit models:

$$\text{logit}(h_{tij}) = \alpha_t + \beta_1 X_{ij} + \beta_2 Y_{ij} + u_j$$

where h_{tij} is the hazard that person i in neighborhood j dies at time t ; X_{ij} is a vector of individual-level covariates, including sons' educational attainment; Y_{ij} is a vector of neighborhood-level covariates; u_j is the neighborhood-level random effect; and the β s represent the corresponding coefficients. Note that the model treats time as a discrete factor with monthly precision, introducing one parameter, α_t , for each possible time of death. We estimate all models for men and women separately. Note that results are consistent when we use person-years versus person-months.

In the second set of analyses, in which we establish whether adult sons' educational attainment is associated with two widely theorized mechanisms (i.e., adults' health behaviors and measures of support in old age), we estimate standard logistic regression models that appropriately address the binary distribution of the outcome variables. Because

of the small sample size, and few number of oadult respondents per neighborhood, in these models, we account for clustering at the neighborhood-level.

6. Results

6.1 Sample Characteristics

Table 1 offers an overview of the older women and men in our two analytic samples. Beginning with the sample of older adults who are the focus of our mortality analyses, adults age 45 years or older at the time of the baseline survey in 1996 had sons who, on average, attained close to nine years of school, which is remarkable given the relatively recent nature of school access in Nepal. Indeed, fewer than 10 percent of older women, and less than one-half of older men, attended school themselves. One-half of older women, and three-fourths of older men, have worked outside the home. Most of the older respondents have visited a health center at some point in their lives. On average, respondents had more than five children. One-half of respondents resided in a neighborhood that had a school within a five-minute walk at the time of the baseline survey; just one-fourth were within a five-minute walk to a health center.

Turning to the older adults who participated in the 2006 survey and are the focus of our analysis of possible mediators, one-third of older women, and two-thirds of older men, reported that they currently use tobacco. Among older women, 10 percent consume alcohol regularly, compared to 30 percent of men. Approximately 6 percent of the samples of women and men reported that they could not access healthcare in the past year due to a lack of support (i.e., lacking money, transportation, or someone to accompany them).

6.2 Adult Sons' Educational Attainment and Women's and Men's Mortality

Turning to the multivariable hazard models, Table 2 shows the results analyzing the association between women's and men's adult sons' educational attainment and their risk of mortality. Model 1 and 2 demonstrate that women's and men's mortality risk is lower with each additional year of school their sons attained. Beginning with women in Model 1, each year of a son's educational attainment corresponds with an approximately 10 percent reduction in women's odds of mortality. The results in Model 2 show that each year of a son's educational attainment corresponds with an approximately 8 percent reduction in the men's risk of mortality. These reductions in the odds of dying are very large. For example, the difference between an older adult with a son with four years of schooling and a son with ten years of schooling – a common difference across families in 1996 – cuts the rate of dying in half (0.90 raised to the sixth power = a 0.53 rate of dying). The cumulative consequence is a very large difference in old age survival associated with sons' educational attainment.

To further illustrate the differential risk of mortality for women and men by their sons' educational attainment, Figure 1 depicts Kaplan-Meier hazard estimates of women's and men's mortality. To display women's and men's inequalities in survival as a function of their sons' education, we present differences in survival among women and men whose sons' educational attainment places them within the 25th or lower percentile (6 years of education

or less) versus the 75th or higher percentile (11 years of education or more). As noted, log-rank tests confirm that women with more highly educated sons survive at higher rates across the study period ($p < .01$), whereas differences in men's survival according to their sons' educational attainment emerges over the course of the study ($p < .05$).

Returning to the hazard model results shown in Table 2, Model 3 results confirm that this association holds for women after including the full set of covariates: each year of school attained by a son corresponds with a 15 percent reduction in a women's risk of mortality—net of several covariates (estimated odds multiplier of 0.85 produces a 15% reduction: $1.0 - 0.85 = 0.15$). The size of this association is substantial: women with sons who completed four fewer years of schooling die at nearly twice the rate of women with sons who completed three more years of schooling.

Turning to the results for men in Model 4, once we account for the full set of individual-, household-, and neighborhood-level covariates, the association between adult sons' educational attainment and men's mortality becomes non-significant (at $p < .05$ level). Note that despite finding a significant relationship between son's education and mortality for women but not for men, an interaction term between son's education and respondent gender in pooled models was not statistically significant.

6.3 Adult Sons' Educational Attainment and Women's and Men's Health Behaviors and Receipt of Support

Why does adult sons' educational attainment correspond with adults', particularly women's, lower risk of mortality? The results in Table 3 show that adult sons' education is associated with both older adults' health behaviors and their receiving adequate healthcare support in old-age. As Models 1 and 2 of Table 3 show, each year of education attained by women's and men's sons corresponds with a respective 11 and 14 percent reduction in their odds of tobacco. As shown in Model 3 and Model 4, each year of adult sons' educational attainment is associated with a further 13 and 12 percent reduction in the odds of women's and men's alcohol use. Again, because differences across families are often characterized by 4, 5 or 6 years of difference in sons' educational attainments, these are very large and important family-level differences in older adults' exposure to health risks. An odds multiplier corresponding to a 12 percentage point reduction in the odds of a health risk implies a five year difference in sons' educational attainment cuts exposure to that risk in half (0.88 raised to the fifth power = 0.53).

The full model results (not shown but available upon request) further show that there are large ethnic differences in women's tobacco and alcohol use, and that women in wealthier households are significantly less likely to engage in these health risk behaviors. Moreover, women who have ever been to school are significantly less likely to use tobacco, whereas those who have engaged in non-family work are more likely to use tobacco. The same is true of men: men who live in households with higher wealth index scores are also substantially less likely to use tobacco or alcohol. Additionally, there are substantial ethnic differences in tobacco and alcohol use, as well as a higher likelihood of alcohol use among men whose spouse resides elsewhere relative to those who reside with their spouse.

The results in Table 3 further show that adult sons' educational attainment is not only associated with adults' healthier behaviors, but also men's reporting support in old-age. The results in Model 5 show no significant association between adult sons' educational attainment and women's odds of not receiving healthcare due to a lack of financial or functional support in the past year. However, the full model results show that women who reside in wealthier households are substantially less likely to experience healthcare barriers relative to their peers in less resourced households. However, the results in Model 6 confirm that men who have more highly educated sons experience a 22 percent reduction in the odds of reporting that they face financial or functional barriers to accessing healthcare in the prior year. The magnitude of this difference is even larger than the other differences observed in this prospective panel study of older age health and mortality. A mere three year difference in sons' educational attainment doubles the odds that a father receives the support he needs to access health care ($0.78^3 = 0.47$; $1/0.47 = 2.13$). The family level variation in sons' education has quite large consequences for their fathers' access to old age health care. The full model results (not shown but available upon request) further demonstrate ethnic differences in men's barriers to healthcare.

7. Discussion

In some of the world's poorest regions, older populations are growing more rapidly than they are in high-income regions (Shrestha, 2000), but we know far less about the factors that contribute to healthy aging and longevity in these settings. Recent studies on various low- and middle-income settings report that older adults, many of whom came of age when educational opportunities were unavailable, enjoy health and survival benefits from their adult children having gone further in school (De Neve & Harling, 2017; Yahirun et al., 2016, 2017; Yang et al., 2016). This nascent, rapidly expanding literature on this topic motivates our first goal of assessing whether the link between offspring education and adults' survival is also present in the context of rural Nepal, an extremely poor South Asian setting.

We find that offspring education is strongly associated with older adults', specifically women's, survival in rural Nepal. Leveraging 16 years of monthly mortality data, we find that each year of sons' educational attainment corresponds with an approximately 17 percent reduction in the odds of women's mortality; however, the association between adult sons' education and men's mortality is non-significant after accounting for key sociodemographic differences in men's mortality. Although the difference in the size of the respective associations between adult sons' educational attainment and women's and men's mortality is non-significant, the statistical significance of the association for women but not men corresponds with some emerging evidence of greater offspring educational health benefits for women in other contexts (Yahirun et al., 2016, 2017). Yet, it contrasts with evidence of a stronger link between offspring education and men's mortality in China (Yang et al., 2016)—the only other study of an Asian population that has investigated the health benefits of offspring education for women and men separately. Of course, the Chinese and Nepalese economic, cultural, and health contexts differ dramatically, which may drive these discrepant findings.

This observed, prospective association between son's schooling and their mothers' risk of dying is very large. In Nepal in 1996 secondary schooling was available, and growing common, but college or more was rare. Daughters were still much less likely to go to school or stay in school than sons (Beutel and Axinn 2002). Family-level differences in adult sons' educational attainment were frequently several, which we find corresponds with women's rate of death being cut in half. Careful investigation of the prospective association between sons' schooling and older women's health behaviors further demonstrates that these differences in sons' educational attainments also cut their mothers' odds of tobacco and alcohol use in half. These findings highlight that Nepalese women who came of age before the widespread expansion of schools, but whose sons benefitted from the rapid expansion of schools, experienced substantial health and survival benefits as a result.

Although we find no evidence that adult sons' educational attainment independently patterns men's mortality, we find clear evidence that it influences their health-related experiences. Our analysis of a more recent cohort of older adults reveals two key findings: adult sons' educational attainment corresponds with older men's healthier behaviors as well as greater support in old-age—in terms of a lower likelihood of reporting barriers to healthcare. In terms of the former, offspring education is associated with a substantially lower likelihood that older men, as well as women, currently engage in two unhealthy behaviors: tobacco and alcohol use. These findings imply that public health campaigns aimed at improving the health behaviors of young adults in Nepal may also improve the health behaviors of older generations, either by the younger generation simply modeling healthier behaviors or by their explicitly encouraging their parents to adopt them.

Corresponding with evidence from other settings that parents' investments in their children yield greater support from them in later life (Cunningham, Yount, Engelman, & Agree, 2013; Zimmer & Kwong, 2003), we also find that men whose sons have continued further in school are less likely to report recently experiencing financial or logistical barriers to healthcare. That is, in line with evidence that children's education has the strongest impact on adults' well-being after they have already developed health problems (Zimmer, Hermalin, & Lin, 2002), sons' educational attainment is valuable to ensuring men do not experience barriers to healthcare. Interestingly, despite adult sons' educational attainment having a significant association with women's mortality, we find no evidence that adult sons' educational attainment is tied to their lower likelihood of experiencing healthcare barriers, suggesting that the association works through distinct mechanisms.

It is important to note, however, that these data are limited by their asking specific questions regarding older adults' receipt of healthcare. In other analyses, we made use of data on the small subsample of women and men—representing approximately 14 percent of the sample—who report that they have recently received support from a relative and women are significantly more likely to report that their son and/or daughter-in-law helped them relative to men. Moreover, women with more highly educated sons are significantly more likely to report that they received help from sons relative to their peers whose sons have less education. Thus, these findings highlight the need for a wide array of support measures on older women and men in Nepal to fully understand who is experiencing what support from their sons, and under what conditions.

Nonetheless, the non-significance of these findings for women, corresponding with the significant impact of adult sons' educational attainment on women's mortality, suggest that adult sons' educational attainment is likely working through distinct mechanisms to positively influence women's survival. Other research suggests women's mental health could be another possible mechanism. That is, research suggests that older Nepalese adults whose sons are more supportive in old age experience a higher life satisfaction (Gautami, Saito, & Kai, 2008), which may further promote their overall well-being and ultimately their survival.

Together, our findings challenge long-standing concerns that social change, including education, will disrupt traditions of filial responsibility. We find compelling evidence that adult sons' educational attainment is associated with men's healthier behaviors and greater support, as well as women's health behaviors and lower mortality. Going to school can dramatically shift individuals' attitudes and expectations regarding caregiving roles (Caldwell, 1982; Compernelle, 2015; Lesthaeghe & Surkyn, 1988), so researchers have posited that the education of younger generations could disrupt traditional care arrangements. Our results offer no evidence that more highly educated sons balk at historical cultural expectations to provide for their parents once they are in need. Even though young men's education is known to reduce their general sense of filial obligation in the rural Nepalese community where our study is situated (Compernelle, 2015), their aging parents ultimately benefit from their sons' greater access to knowledge, resources, and opportunities that education affords.

Although our study advances the current literature in important way, it comes with notable limitations. Our models control for older adults' individual, household, and neighborhood conditions in an attempt to isolate the association between adult sons' educational attainment and older adults' health-related outcomes and mortality. We find that inclusion of these factors explains the observed association between adult sons' educational attainment and men's lower risk of mortality, but not women's. Nonetheless, we recognize that selection could still drive the association between adult sons' educational attainment and women's lower mortality risk—a possibility that complicates the broader literature on education and health. Moreover, although our identification of possible mediators advances current knowledge, we focus on two distinct samples to demonstrate the respective links between adult sons' educational attainment and older adults' survival and possible mechanisms; this prevents us from conducting a formal mediation test. Thus, although we demonstrate that adult sons' educational attainment is associated with older adults' healthier behaviors and men's access to greater support in old-age, our study does not confirm whether—or to what extent—these factors explain the link between offspring education and older adults'—specifically women's—survival. Instead, our study takes the first step in this direction by demonstrating that—at least in the context of rural Nepal—adult sons' educational attainment is associated with these hypothesized mechanisms.

A related limitation is that our analysis of older adults' health behaviors does not confirm whether or how their adult sons influence their behaviors. The same is true of our analysis of older adults' barriers to healthcare: we cannot confirm that sons are themselves the reason why men face fewer barriers to receiving healthcare. In Nepal, out-migration of young men

is common, thus these sons may be delegating their parents' care to other relatives. At the same time, young men's migration is typically motivated by employment opportunities so these men may be sending substantial remittances home to be used in the care of their parents. It could then be the additional income that is improving the parents' mortality and health behaviors.

Another limitation is that our study focuses on an older cohort of Nepalese adults, and thus cannot speak to the population health relevance of some recent shifts in Nepal's educational context. One dramatic shift in recent years has been the rapid increase in girls' school participation. Future studies on the upward flow of educational benefits should explore the broader health salience of daughters' educational attainment. Additionally, with the recent proliferation of private schools in Nepal, as well as rising participation in post-secondary education, there is a need for additional work to explore whether the magnitude of these associations varies as a function of adult children's educational experience.

Despite the need for future work to study the population health salience of new educational developments in Nepal, this study advances the nascent literature on offspring education and older adults' health-related experiences and mortality. Evidence presented here demonstrates significant associations in yet another socially, culturally, and economically distinct population. Mounting evidence of a relationship between offspring education and adults' health-related outcomes in diverse settings suggests that, offspring education should perhaps be recognized as well. Moreover, the findings offer compelling evidence that, as low-income populations rapidly age, investing in youth may produce benefits that stretch across generations. Contrary to the notion that social realities that benefit one generation in a population typically do so at the expense of another (Preston, 1984), our study contributes to growing evidence that investments in educating youth will have positive spillover effects that flow upward to aging adults.

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Figure 1.

Kaplan-meier survival curves demonstrating inequality in men's and women's risk of mortality by sons' level of educational attainment*

*Log-rank test confirms statistical significance of elevation in mortality risk for adults whose sons are in the 25th percentile of educational distribution (6 or fewer years of school) versus 75th percentile (11 or more years of school) (men at $p < .05$; women at $p < .01$).

Table 1.

Characteristics of the analytic samples of older adults

	Mortality Analysis (1996)		Health Behavior and Support Analysis (2006)	
	Women	Men	Women	Men
	Mean/% (SD)	Mean/% (SD)	Mean/% (SD)	Mean/% (SD)
<i>Health behaviors</i>				
Tobacco use			38.41	66.76
Alcohol use			8.63	29.67
<i>Support in old age</i>				
Lack healthcare support			6.87	6.09
Sons' highest educational attainment	8.55 (3.66)	8.46 (3.44)	8.49 (3.26)	8.59 (3.06)
<i>Level-1 (Individual-level)</i>				
<i>Socioeconomic controls</i>				
Respondent attended school	9.45	41.62	14.79	50.92
Household wealth index	0.97 (3.01)	1.01 (2.94)	0.99 (2.84)	0.96 (3.05)
Ever worked	51.71	75.95	49.04	76.61
Ever visited health center	92.61	92.43	92.92	93.21
<i>Demographic controls</i>				
Total number of children	5.97 (2.35)	5.81 (2.23)	5.50 (2.19)	5.63 (2.24)
<i>Ethnicity</i>				
Brahmin/Chhetri	43.68	45.11	49.68	45.18
Hill Janajati (indigeneous)	17.63	16.85	14.63	14.45
Dalit	12.37	12.77	10.93	11.24
Newar	6.05	7.34	6.43	6.65
Terai Janajati (Indigeneous)	20.26	17.93	18.33	22.48
Age ⁺	50.74 (4.08)	51.41 (4.40)	55.64 (6.27)	58.76 (6.09)
<i>Marital and residential status⁺</i>				
Living with spouse	73.44	86.42	68.97	90.37
Spouse lives elsewhere	10.42	9.38	10.45	3.21
Widowed/divorced	16.15	4.28	20.58	6.19
<i>Level-2 (Neighborhood-level)</i>				
Health facility within five-minute walk	24.67	24.86	26.04	25.46
School within five-minute walk	48.82	49.19	49.51	49.77
N	376	378	622	375

Source: Chitwan Valley Family Study

⁺ time-varying covariates in mortality analyses; value shown at respective baseline

Table 2.

Multilevel Discrete-time Hazard Models Analyzing the Relationship between Adult Sons' Educational Attainment and Women's and Men's Risk of Mortality

	Model 1: Women		Model 2: Men		Model 3: Women		Model 4: Men	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Sons' highest educational attainment	0.902 *	0.016	0.915 *	0.028	0.847 **	0.005	0.922	0.109
<i>Level-1 (Individual-level)</i>								
<i>Socioeconomic controls</i>								
Respondent attended school					0.704	0.578	0.715	0.284
Household wealth index					1.111	0.121	0.973	0.636
Ever worked					0.911	0.798	0.739	0.356
Ever visited health center					1.365	0.585	1.040	0.933
<i>Demographic controls</i>								
Total number of children					1.000	0.997	0.987	0.835
<i>Ethnicity</i>								
Brahmin/Chhetri	--		--		--		--	
Hill Janajati (indigenous)	1.563	0.284	1.323	0.476	1.476	0.383	1.481	0.348
Dalit	1.537	0.353	1.829	0.144	1.530	0.413	2.258	0.064
Newar	0.876	0.865	2.171	0.101	0.748	0.716	2.782 *	0.044
Terai Janajati (Indigenous)	2.048	0.079	1.247	0.566	2.411 *	0.040	1.266	0.558
<i>Age dummies (not shown)</i>								
<i>Marital and residential status+</i>								
Living with spouse								
Spouse lives elsewhere					1.127	0.832	0.707	0.633
Unmarried					0.793	0.488	0.593	0.354
<i>Level-2 (Neighborhood-level)</i>								
Health facility within five-minute walk					1.574	0.268	0.716	0.370
School within five-minute walk					0.703	0.311	0.943	0.281
<i>Variance Components</i>								
Rho	0.131		0.015		0.101		0.014	
Person-months	59,030		59,764		59,030		59,764	

Source: Chitwan Valley Family Study

* p<.05;
** p<.025

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Table 3.

Logistic Regression Models Analyzing the Relationship between Adult Sons' Educational Attainment and Women's and Men's Health Behaviors and Care Support

	Tobacco use				Alcohol use				Lack of healthcare support			
	Model 1: Women		Model 2: Men		Model 3: Women		Model 4: Men		Model 5: Women		Model 6: Men	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Sons' highest educational attainment	0.893 ^{***}	0.003	0.864 ^{**}	0.008	0.870 [*]	0.025	0.881 [*]	0.016	0.928	0.280	0.783 ^{**}	0.005
<i>Model fit statistic</i>												
LR test	139.84 ^{***}		52.64 ^{***}		71.44 ^{***}		68.27 ^{***}		25.30 [*]		25.46 [*]	

● All models control for respondent school attendance, household wealth index, ever worked, ever visited health center, total number of children, ethnicity, age, marital status, neighborhood-level access to health facility, and neighborhood-level access to school.

two-tailed test;

* p<.05;

** p<.01;

*** p<.001

Source: Chitwan Valley Family Study

N=622 women; 375 men