DEMOGRAPHIC RESEARCH
A peer-reviewed, open-access journal of population sciences

DEMOGRAPHIC RESEARCH

VOLUME 54, ARTICLE 8, PAGES 215–262
PUBLISHED 10 FEBRUARY 2026
https://www.demographic-research.org/Volumes/Vol54/8/
DOI: 10.4054/DemRes.2026.54.8

Research Article

Brothers, sisters, and the legacy of sibship: Childhood coresiding siblings and late-life cognitive decline in the United States

Yiang Li

Contents

1	Introduction	216
2	Conceptual framework	218
2.1	Sibling resource dilution or confluence in childhood	218
2.2	Gendered differences in sibling attachment over the life course	219
2.3	Linking childhood sibship to later-life cognitive functioning	222
2.4	Research hypothesis	223
3	Research design	223
3.1	Data	223
3.2	Measures	224
3.3	Analytic approach	226
4	Findings	228
4.1	Presence of coresiding siblings and cognitive decline	230
4.2	Sibling compositions and cognitive decline	232
4.3	Sibling and cognitive functioning: Education as the mechanism	236
4.4	Sensitivity analysis	238
5	Discussion and conclusions	238
6	Acknowledgments	241
	References	243
	Appendices	253

Demographic Research: Volume 54, Article 8
Research Article

Brothers, sisters, and the legacy of sibship: Childhood coresiding siblings and late-life cognitive decline in the United States

Yiang Li[1]

Abstract

BACKGROUND
Siblings are the most common household companions in childhood, yet demographers know little about how sibship configurations reverberate across the life course to shape population-level cognitive health at older ages.

OBJECTIVE
The author assesses whether coresiding siblings in childhood are linked to late-life cognitive trajectories and asks how associations differ by sibship size, age spacing, and sex composition.

METHODS
This study uses 12 biennial waves of the Health and Retirement Study (1998–2020; 42,530 person-wave observations) linked to respondents' records in the 1940 full-count US census (N = 6,187). The author estimates late-life cognitive decline trajectories by childhood coresiding sibship structure, adjusting for childhood socioeconomic, demographic, geographic, and household attributes alongside time-varying adulthood health covariates.

RESULTS
Compared with only children, individuals who coreside with more than one sibling experience faster annual declines in cognition, net of covariates. Decline steepens monotonically with each additional sibling and is faster when at least one sibling is closely spaced. Men raised with only brothers display the lowest baseline scores, whereas women, especially those with brothers, show the most rapid deterioration. Findings are robust to birth order controls and alternative model specifications.

CONCLUSIONS
Resource dilution in large or closely spaced sibships erodes cognitive reserve over the life course, consistent with gendered sibling caregiving norms that magnify women's later-life risks.

[1] University of Chicago, Chicago, IL, USA. Email: yiangli@uchicago.edu.

CONTRIBUTION

By merging historical census data with longitudinal survey data, this study provides evidence that childhood sibship structures have enduring, gender-contingent associations with cognitive aging, highlighting siblings as an overlooked demographic determinant of population health.

1. Introduction

Over the past two decades, demographic research has highlighted the role of early childhood experiences in shaping and perpetuating health disparities over the life course (Ferraro, Schafer, and Wilkinson 2016; Luo and Waite 2005; Schafer, Ferraro, and Mustillo 2011; Umberson, Crosnoe, and Reczek 2010). Early life factors can shape key etiological processes initiated before disparities in health become apparent. Specifically, studies consider childhood to be a critical and sensitive period, during which family and contextual characteristics affect one's health and well-being and then have cumulative effects on health throughout the life course (Ferraro, Schafer, and Wilkinson 2016).

Among many childhood factors, family structure, defined as the composition of family members in a household, is an important characteristic in shaping health outcomes. Family structure affects the provision of time from parents, financial resources, and emotional companionship (Conley 2004; Hughes and Waite 2002). Past sociological literature has extensively demonstrated that different dimensions of family structure, including multigenerational coresidence and large household size, influence health outcomes across the life course (Umberson, Crosnoe, and Reczek 2010). Most of this literature has focused exclusively on the effects of childhood background on physical health (Ferraro, Schafer, and Wilkinson 2016; Lei 2019); other work has examined mental health consequences, primarily focusing on depression (Chen and Harris 2019; Chopik and Edelstein 2019). Relatively few studies have aimed to understand how childhood family structure over the life course may shape and perpetuate cognitive health disparities in later life. With the aging of the US population, Alzheimer's disease and related dementias (AD/ADRD) increasingly pose significant health challenges to the population, affecting millions of older adults and impairing their cognitive ability to perform everyday activities, manage chronic diseases, and maintain independence and well-being (Alzheimer's Association 2016; Li, Li, and Engelman 2026; Stokes et al. 2020).

Relatively few studies on childhood family background focus on the enduring influence of family structure as characterized by coresiding siblings. Yet siblings are ubiquitous among modern US families, despite the recent decline in family size. In the

1940 full-count census, when the adults in this sample were under 18 years old, 84.48% lived with at least one sibling (Ruggles et al. 2024). The figure remains relatively stable over time. For comparison, according to the 2024 US Current Population Survey, 77% of Americans aged 18 or below coresided with at least one sibling in the household, a share comparable to the proportion of families with a resident father (76.4%) (Flood et al. 2024).

While siblings share biological inheritance and family environments, social processes underpinning inter-sibling influences may perpetuate disparities over the life course (Black et al. 2021; Daysal et al. 2022). Studies on younger adults suggest that sibling interaction may be linked to cognitive development and education, which explains up to half of economic inequality as measured by earnings, wealth, and working hours in the United States (Conley 2004; Grätz et al. 2021; Mazumder 2008). Parents often adjust their time, attention, and material resources based on the needs and abilities of each child (Black et al. 2021). These adjustments, along with unequal access to time and other resources in the first place, can create *resource dilution*, defined as competition between siblings for family resources and opportunities, with some parents providing more resources to a particular child with greater needs or more potential (Downey 2001; Downey, Condron, and Yucel 2015). Such differences might lead to sibling rivalry and conflicts that could affect childhood educational attainment (Yu and Yan 2023). One hypothesis is that this compounding effect extends through the life course, with inequalities in early cognitive development due to sibship acting as a foundation upon which future educational achievements, family processes, career opportunities, wealth accumulation, and cognitive health are built (Blake 1985; Downey, Condron, and Yucel 2015; Workman 2017).

A countervailing hypothesis, *sibling confluence*, highlights the role of age spacing, with older siblings acting as role models so that younger siblings, especially of the same gender, can learn from their older siblings and exchange family support that promotes mutual growth (Altmejd et al. 2021; Zajonc 1976; Zang, Tan, and Cook 2023). The extent of sibling confluence or resource dilution might also differ by sex composition, with sisters sharing more emotional and instrumental support than brothers, who might vie for dominance (Buist, Deković, and Prinzie 2013; Feinberg, Solmeyer, and McHale 2012). While women with siblings may have higher baseline cognitive functioning, they could also face faster decline, as the gendered differences in supportive sibling relationships may reverse to the advantage of brothers in adulthood for at least two reasons. Sisters, compared to their male siblings, not only face gendered expectations in caregiving roles for family and parents (Grigoryeva 2017) but also tend to retire relatively early from work (Warner, Hayward, and Hardy 2010), both of which might reduce the availability of cognitively stimulating activities in later life (Bonsang, Adam, and Perelman 2012; Mallya and Fiocco 2018).

Using the Health and Retirement Study (HRS), a nationally representative survey linked to the 1940 census, I examine how sibling coresidence in childhood is related to cognitive functioning and cognitive decline at older ages and the extent to which it differs by sibling age spacing and gender composition. The findings are relevant to demographers and health policymakers by advancing our understanding of sibship from the life course perspective.

2. Conceptual framework

2.1 Sibling resource dilution or confluence in childhood

The size of sibships appears to be a key characteristic related to late-life outcomes (Downey 2001; Downey, Condron, and Yucel 2015; Jæger 2009; Steelman et al. 2002). Resource dilution theory suggests that each additional sibling, regardless of the birth order or gender, dilutes the quantity and quality of resources available from parents (Blake 1985; Conley 2004; Downey 2001). Studies show that the presence of multiple siblings is associated with fewer years of schooling and worse academic performance (Park 2008; Workman 2017; Yu and Yan 2023). Education provides knowledge and enhances cognitive reserve, a protective factor against cognitive decline in later life, suggesting that the educational disadvantages imposed by larger sibling groups translate into heightened vulnerability in old age (Wilson et al. 2019). Indirectly, lower educational attainment and reduced cognitive stimulation in early life, driven by sibling competition for resources, are linked to socioeconomic status, health behaviors, and residential environment in adulthood, which then cumulatively affect cognitive functioning and decline across the aging process (Lee et al. 2022; Luo and Waite 2005; Peng and Perry 2025). Beyond financial and material resources, parental time and emotional support are critical for cognitive and emotional development. The lack of one-on-one time with parents in large families may thereby reduce cognitive stimulation, which is necessary for optimal brain development and the maturity of logical reasoning (Jæger 2009). While siblings can offer emotional companionship independent of parents, these relationships often lack the complexity and nurturing quality of parent–child interactions conducive to developing advanced cognitive and emotional skills, which serve as important foundations for cognitive functioning in later life (Cruise and O’Reilly 2014). The impact of sibling-induced resource dilution is not uniform across all socioeconomic strata and is conditional on the contexts in which one grows up (Gibbs, Workman, and Downey 2016), with family resources playing a pivotal role (Quadlin 2019; Zang, Tan, and Cook 2023). That is, not all sibships are the same, with more resourced families being able to support the development of each child. Resource availability from parents, influenced by factors such as income, education, and social capital, shapes the quality of care and the opportunities each child receives (Datar, Kilburn, and Loughran 2010). In families with limited parental resources, there may be a stronger dilution effect, where resources such as time, attention, and educational support are spread thin among siblings, with males being favored over female siblings (Quadlin 2019).

The countervailing confluence theory suggests that resources may also be enriched by the presence of siblings, with older siblings acting as mentors to younger siblings (Zajonc 1976; Zajonc and Markus 1975). Age spacing between siblings is fundamental to confluence theory. When an older sibling excels in a particular subject at school, that sibling can provide direct help on homework, class choice, or school resources to siblings who are much younger (Black et al. 2021; Zang, Tan, and Cook 2023). Beyond academic pursuits, the exchange of experiences and knowledge among siblings, whether through direct sharing or observing each other's life events, can encompass a wide range of topics, such as life skills and social interactions (Howe and Recchia 2014; Mazumder 2008). Specifically, several studies report strong positive correlations among siblings on physical health outcomes that reflect more than just exposure to similar biological or socio-environmental influences and can be attributed to social learning between siblings (Black et al. 2021; Daysal et al. 2022). For example, Lei (2019), using the China Family Panel Studies, found that having an older brother has positive spillover effects on health behaviors, including smoking and physical exercise, and on health outcomes related to BMI, depression, life satisfaction, and cognitive ability.

The resource dilution theory and the confluence theory have diverging implications for how sibship might affect childhood cognitive development, which have subsequent influences on cognitive functioning and decline in later life. Resource dilution theory suggests that the birth spacing and birth order of a sibling have little to no effect on outcomes in later life beyond the size of the sibship, which the confluence theory "offers no explanation for" (Downey 2001: 497; Jæger 2009). Instead, the confluence theory focuses on the age spacing and birth order of siblings and argues that the unidirectional transfer of knowledge and mentorship from older to younger siblings could benefit younger siblings in development over the life course (Zajonc 1976; Zajonc and Markus 1975; Zang, Tan, and Cook 2023).

2.2 Gendered differences in sibling attachment over the life course

The consequences of a sibship may depend on the following sex compositions: male with only brothers, female with only sisters, male with at least one sister, and female with at least one brother (Gamble, Card, and Yu 2010; Steelman et al. 2002). Forming secure emotional attachments in the childhood family plays a key role in shaping an individual's emotional and cognitive development, yet gender shapes expectations around relationship formation and quality (Berkman et al. 2000; Bowlby 1969; Li and Waite 2025). Previous studies have found that brothers tend to have the least close and supportive sibling relationships, followed by mixed-sex siblings (a male with at least one sister or a female with at least one brother) and then sisters. Relationships between brothers may involve more competition for parents' limited time, particularly in activities such as play, sports, or other areas where brothers vie for dominance or recognition (Buist 2010), with the advantage going to the older brother. The competition for resources extends beyond parental time to material concerns, emotional support, and educational opportunities (Downey 2001). As parental time and energy are spent on the older brother, especially in families and communities with fewer resources, the younger children receive no parental attention and, worse, might have to stand around doing nothing – for example while their brother plays soccer (Lareau 2018). In this case, the younger children do not learn to play soccer and cannot work on math homework, while the older brother faces pressure to handle parental expectations and competition from younger siblings. Competition may reduce the child's opportunities for learning and social interactions in childhood, which influences brain and cognitive development and later-life cognitive health (Tenenbaum et al. 2020).

Studies on early childhood also document that sister–sister pairs tend to be the most intimate, which may contribute to better baseline cognitive function before the decline in cognition at older ages becomes apparent (Feinberg, Solmeyer, and McHale 2012). While sisters also have to compete with sisters for parental attention (Salmon and Hehman 2015), they are slightly less sensitive to differential treatment and respond to this inequality with less anxiety and depression than brother–brother siblings (Buist, Deković, and Prinzie 2013). Sisters often share emotional support, confidence, empathy, and the like, which may foster positive social and cognitive skills (Tibbetts and Scharfe 2015). Siblings of the opposite sex may receive more balanced attention and support from their parents, who tend to favor children of their own gender (Buist, Deković, and Prinzie 2013; Butcher and Case 1994). Having siblings of the opposite sex may also lead to different personal traits, interests, expectations, and gender-specific activities in the household, which may reduce the level of competition and conflict (Salmon and Hehman 2015). Compared to men, women with opposite-sex siblings can also better compensate in adulthood for unequal treatment in childhood in families with lower resources as they may "marry up." There was a historical tendency in the mid-twentieth century for women to marry men with more education than themselves, which may have protected their cognitive health with improved family socioeconomic status (Hirschl, Schwartz, and Boschetti 2024).

Despite the documented benefits of intimate and supportive relationships between female siblings in childhood and adulthood, research indicates that women, especially those with brothers, may face significant stressors in midlife, potentially due to the disproportionate caregiving roles they assume. Studies have extensively documented the unequal division of caregiving labor within marital dyads to the detriment of women (Li, Li, and Engelman 2026; Raley, Bianchi, and Wang 2012). The direct effect of caregiving on health remains mixed and inconclusive. The healthy caregiver hypothesis suggests the protective benefits of caregiving from being more physically active, whereas the stress process theory highlights how chronic stress from caregiving adversely affects health (Bauer and Sousa-Poza 2015; Fredman et al. 2008; Pearlin et al. 1990). Indirectly, societal expectations that implicitly assign the bulk of family caregiving responsibilities to women also have adverse consequences for their employment and socializing opportunities throughout the life course (Perry-Jenkins and Gerstel 2020). Therefore, compared to men, older women retire earlier, are less likely to work as full-time employees, have fewer social engagements, tend to prefer occupations with more flexibility, and are more likely to exit the labor market overall (Moen 2016; Warner, Hayward, and Hardy 2010). Yet studies show that working and later retirement are cognitively challenging and therefore protective for cognitive decline at older ages (Bonsang, Adam, and Perelman 2012). Hence, while women enjoy better cognitive stimulation with siblings in childhood compared to brothers, they may suffer from faster cognitive decline as they age, partly because they are less likely to have activities that challenge them cognitively.

Women face additional stressors from siblings in later life as they share the responsibilities to provide care to their parents and in-laws (Grigoryeva 2017; Guberman 1999; Pillemer and Suitor 2014). Studies show that brothers typically perceive their caregiving role as supervisory, focusing on maintaining the independence of their parents, often delegating day-to-day care tasks to others, particularly their sisters (Hequembourg and Brallier 2005; Matthews 2003). The presence of women usually results in reduced caregiving hours for each male sibling when caring for parents and for their husbands when caring for in-laws (Guberman 1999; Kokorelias et al. 2022). Qualitative studies indicate that, among siblings, while daughters expect to share caregiving responsibilities with their sisters, they do not generally expect the same level of involvement from brothers, who are presumed to take a less active role (Gerstel and Gallagher 2001; Ingersoll-Dayton et al. 2003). Consequently, women with male siblings often end up assuming even greater responsibilities, exacerbating stress and cognitive decline due to the increased burden (Gerstel and Gallagher 2001; Leopold, Raab, and Engelhardt 2014). While the supportive roles sisters undertake from childhood offer significant emotional and social benefits, the unequal expectations placed on them in later life can undermine these benefits and adversely affect cognitive health (Mallya and Fiocco 2018).

2.3 Linking childhood sibship to later-life cognitive functioning

Building upon the resource dilution, confluence, and gendered attachment literature on the consequences of sibship in childhood, this section integrates them with the concept of cognitive reserve and theorizes that sibship specifically affects cognitive functioning and cognitive decline in later life through opportunities for individuals to engage in cognitively stimulating social interactions and life experiences.

Cognitive reserve represents a form of brain resilience that is hypothesized to explain why some individuals exhibit clinical manifestations of cognitive impairment sooner or more dramatically than others, despite similar levels of brain aging or pathology (Stern 2009; Wahl et al. 2019). Resource dilution among siblings, especially those close in age, can lead to a scarcity of cognitively stimulating activities in childhood as siblings navigate social realms in schools and communities (Howe and Recchia 2014; Jensen et al. 2016). This may negatively affect academic achievements, educational opportunities, and credential attainment (Jæger 2009; Yu and Yan 2023), which are considered important indicators for cognitive stimulation in childhood and build cognitive reserve that slows cognitive decline in later life (Peng and Perry 2025). Sibship can also influence cognitive health through unequal access to cognitively stimulating events throughout the life course processes of social stratification. That is, early life disparities by sibship not only affect educational attainment but also exert cascading influences on subsequent access to cognitively stimulating occupations, wealth accumulation, strong interpersonal networks, and adulthood health behaviors (Basu 2013; Steelman et al. 2002). Only two papers, to the author's knowledge, directly examine the influence of siblings on older adults' cognitive functioning, both using retrospective or subjective evaluations of sibship. Using the Mexican Health and Aging Study, Saenz, Quashie, and Zhang (2025) found that having no or only one sibling, measured by a retrospective question asking the number of siblings ever born, is linked to better cognitive functioning in later life compared to having more siblings. Kong et al. (2025) studied a cohort of high school graduates in the Wisconsin Longitudinal Study who had at least one sibling surviving until later life and showed that sibling relationship quality is a key mediator in how adverse childhood experiences exert a negative influence on later-life cognitive functioning.

Yet the existing literature has paid limited attention to how resource dilution may operate differently depending on the sex configuration of childhood coresiding siblings. Brothers of similar ages within the same household might vie for identical resources and recognition, potentially fostering rivalry in access to cognitively stimulating opportunities, such as education, from limited parental resources in early childhood, whereas brother–sister pairs might pursue divergent paths, benefiting from individualized parental engagement (Buist, Deković, and Prinzie 2013; Cicierelli 1985; McHale, Updegraff, and Whiteman 2012; White and Riedmann 1992). While women benefit from close sisterly bonds in childhood, they face the risk of significant cognitive decline later in life with a disproportionate reduction in exposure to cognitively stimulating activities due to caregiving responsibilities, exacerbated when they have brothers, who typically contribute less to caregiving (Grigoryeva 2017; Leopold, Raab, and Engelhardt 2014).

2.4 Research hypothesis

Based on the previous literature and conceptual models described above, this study hypothesizes the following: Children with more coresiding siblings may face resource dilution that impedes early cognitive development. Thus sibling companionship along the life course leads to differences in the rate of cognitive decline in later life compared to not having siblings (Hypothesis 1); the association will attenuate when adjusting for family and contextual characteristics (Hypothesis 2); there is a dose–response relationship by sibship size, and associations are stronger when at least one sibling is closely spaced (Hypothesis 3); among those with siblings, men with only brothers face stronger resource dilution and hence worse baseline levels of cognition than men with sisters or women with siblings of any gender, who face faster rates of decline (Hypothesis 4).

3. Research design

3.1 Data

The dataset I use combines 12 waves of HRS (1998 to 2020) and the 1940 US census. In 1992 HRS started by collecting a national sample of Americans born between 1931 and 1941 (the original HRS cohort). In 1998 HRS data included the original HRS cohort alongside two cohorts of Asset and Health Dynamics among the Oldest Old (AHEAD) (born before 1924) and Children of the Depression (CODA) (born between 1924 and 1930). This was the first time (wave 4, 1998) HRS became the nationally representative sample of the US population aged 51 and older, which will be considered the baseline in the analysis. Since then, HRS has periodically enrolled new cohorts that reached 51 years old (seven subsample cohorts to date) and interviewed cohorts biannually since enrollment. A detailed description of the HRS cohort and sampling strategies can be found elsewhere (e.g., Heeringa and Connor 1995; Sonnega et al. 2014). All descriptive results and analyses presented below use survey weights that account for both the inverse probability of selection and the likelihood of non-response (Heeringa and Connor 1995; Warren et al. 2020).

This study uses HRS data linked to the 1940 census. While the HRS core also reports sibling information, it does not include information related to characteristics of siblings (e.g., gender, age difference, and birth order) beyond the number and current marital status of siblings. Further, sibship information from the HRS is restricted to those siblings who were alive at the time of the HRS interview, which may not accurately reflect coresiding siblings in childhood. All age-eligible respondents from the HRS were matched to their individual and household records in the 1940 US census. Among the HRS respondents, 20,065 were born before March 1940 (so they are age-eligible) and are from three cohorts: the original HRS cohort, AHEAD, and CODA. The census enumerators were instructed to visit households and collect information for every American household member alive at 12:01 a.m. on April 1, 1940, including infants and children. HRS respondents were matched to their 1940 census records through a machine learning algorithm that minimizes false positive rates and maximizes the overall match rate based on name, sex, state of birth, and birth year (inferred from the age). A detailed description of the linkage process can be found elsewhere (Warren et al. 2020; Warren, Lee, and Osypuk 2022).

The combined processes of algorithm and human linkage produced 9,654 successful matches of HRS and the 1940 census, and 7,926 of them have been present in at least one of the HRS core surveys since 1998. Since this study is interested in the influence of coresiding siblings in childhood, I exclude individuals aged over 18 in 1940 whose childhood family structure is unknown from the 1940 census, as some moved out of their parents' home, with 6,187 respondents remaining in the sample frame (i.e., the birth years between 1922 and 1940). Preliminary analysis shows that the results remain robust when including those over 18 in the analysis. Between 1998 and 2020, these participants contributed 42,530 person-wave observations with an average follow-up of around seven waves. To account for unequal rates of linkage and selection into the sample across demographic and socioeconomic strata, the analysis applies inverse probability weighting. This reweighting approach up-weights the groups disproportionately more likely to suffer attrition in entering the analytic sample (e.g., due to name change after marriage or geographic mobility that limits 1940 census linkage success rates) and down-weights the overrepresented groups to correct for any systematic differences between linked respondents and non-linked respondents over time and for more accurate analyses and conclusions (Morgan and Todd 2008).

3.2 Measures

Cognitive functioning. In the HRS core survey, the original telephone interview for cognitive status (TICS), which is extensively used in demographic and population health research, was abbreviated to TICS-m. While HRS has other cognitive tests, they were administered only to respondents who are 65 or older, and TICS-m was the only one available for every HRS non-proxy respondent. HRS-TICS-m has been widely proven to have good discrimination between normal and cognitively impaired older populations (Desmond, Tatemichi, and Hanzawa 1994). Specifically, HRS TICS-m has three cognitive test components – ten-word immediate and delayed word recall tests, the counting backward test, and the serial 7s subtraction test – and a total score of 27. (See Crimmins et al. 2011 for details.) To avoid omitting respondents with dementia, the missing values in the cognitive functioning measure were imputed using a multivariate, regression-based multiple imputation procedure based on relevant demographic, health, and economic variables (see McCammon et al. 2022 for details).

Childhood coresiding siblings. For every household in the United States, the 1940 census collected information from every resident in the form of the household roster, which is used to derive the number of siblings residing with each respondent.[2] I begin by analyzing a binary measure of whether the respondent had one or more siblings in 1940 (yes = 1, no = 0). Then I use the number of siblings to estimate family size. I capped the number of siblings at five to avoid the influence of outliers raised in very large families, following the prior studies (Downey, Condron, and Yucel 2015; Workman 2017). Hence the number of siblings is coded as an ordinal variable of the following categories: one or two siblings, three or four siblings, and five or more siblings. The results remain substantively the same when using a continuous scale of number of siblings. In estimating the age spacing between siblings, I use the ages of the siblings coresiding in the household to distinguish respondents as having at least one coresiding sibling within a two-year age difference versus not having such a sibling. The results remain substantively similar when using the continuous measure of sibling age difference. The dichotomization is preferred given the non-linear associations of age difference and interpretability. Lastly, I distinguish four categories of siblings by their sex composition: males with only same-sex siblings (brothers), females with only same-sex siblings (sisters), males with at least one sister, and females with at least one brother.

Covariates. The model controls for standard demographic covariates, including baseline age, race (White = 1, other = 0), gender (male = 1, female = 0), and ethnicity (Hispanic = 1, other = 0), which are all assumed to be time-invariant for every individual. Due to the non-linear influence of age on the outcome health variable indicated by the prior studies (Lee et al. 2022), I also include a quadratic term of age in the covariates. Additionally, I adjusted for time-invariant characteristics of the respondent's childhood family socioeconomic condition, including parents' highest level of education, financial well-being (better or about average = 1, below average = 0), and father's occupation

[2] The census data collection on the siblings does not allow for distinguishing between biological and non-biological siblings to assess their differential impact on the findings.

(managerial or professional occupation = 1, other = 0). These parental characteristics were used in prior studies on the topic as key confounders (De La Rochebrochard and Joshi 2013; Saenz, Quashie, and Zhang 2025; Steelman et al. 2002). I also control for time-varying health outcomes such as adulthood self-rated health, depression, and whether the respondent ever had a stroke, which is highly correlated with dementia (Lee et al. 2022). Since the study focuses on the overall association of sibship and composition on the cognitive health trajectory, I avoid overcontrolling mediators that may lead to suppressor bias (Kim 2019). I show the mediation analysis estimators for the key mediators in the results section and Appendix A, including the respondent's years of education as an indicator for adolescent cognitive stimulation and their fertility history as an indicator for adulthood family processes (Saenz, Quashie, and Zhang 2025).

3.3 Analytic approach

First, I show the descriptive statistics of adults in the sample by the number of siblings. While the descriptive statistics indicate possible resource dilution linked to the family structure of siblings, the subsequent analysis minimizes the influence of these childhood contextual confounders in the association between having siblings and later-life cognition to account for the possibility that more resourced families can support more children (Gibbs, Workman, and Downey 2016; Steelman et al. 2002; Zang, Tan, and Cook 2023). Specifically, the analysis below employs entropy balancing weights in addition to the basic model that controls for the extensive time-varying and time-invariant covariates. Entropy balancing is a data preprocessing method designed to achieve covariate balance in the presence of binary (Hainmueller 2012) and continuous/multidimensional treatments (Zhou and Wodtke 2020). To apply this method, I recalibrate sampling weights in HRS alongside weights that adjust for selection into the analytical sample using a maximum entropy reweighting scheme. This process ensures that the reweighted treatment and control groups satisfy a comprehensive set of prespecified balance conditions, which in this case are childhood family resources and contextual attributes. Specifically, I match households residing in the same regions defined by the 1940 census, accounting for regional differences in family practices within the United States. Additionally, I match respondents with and without coresiding siblings by similar parental socioeconomic status by considering participation in farming, dwelling ownership, and urban/rural status. Lastly, I match the family structure to address extra resources brought by coresiding grandparents (Chen, Li, and Yang 2022; Lee et al. 2021) and the critical role of the presence of father figures for childrearing (Raley, Bianchi, and Wang 2012).[3] This multivariate reweighting method not only enhances balance across

[3] An alternative specification used the presence of single-parenthood results in consistent estimates.

covariates but also mitigates model dependence in the subsequent estimation of treatment effects. Importantly, entropy balancing ensures balance improvements across all included covariate moments, eliminating the need for continual balance checking and iterative searches over propensity score matching models (Hainmueller 2012).

Next, I use growth curve models (with the *lavaan* package in R) to exploit the longitudinal sample of 12-wave HRS person-wave observations, following prior studies (Lee et al. 2022; Lee and Schafer 2021). Specifically, I examine how early life coresiding siblings affect both the slope and the intercept of the trajectory of cognitive decline over the years. Intercept differences imply differences in late-life cognitive functioning at baseline in 1998 by sibship structure. Differences in slopes imply the differences in rates of cognitive health deterioration per year associated with the variation in sibship structure during childhood, with the slope factor loading set consistent with the biannual data collection. This analytical framework uses the maximum likelihood estimator, with robust standard errors accounting for the partially missing and possibly unbalanced person-wave observations, which produces equally or more unbiased estimates than multiple imputation methods (Curran, Obeidat, and Losardo 2010; Savalei 2014). Preliminary analyses using multiple imputation report substantively consistent conclusions.

The growth curve model is preferred over alternative analytic approaches for several reasons. It identifies not only changes in the level of cognitive health but also the rate of changes throughout later life, even with granular variation in cognitive functioning over time, without necessarily involving changes in cognitive functioning classifications. That is, it allows for examining changes within cognitive health categories rather than changes between categories based on cutoffs, which omits meaningful information about the variation within each category. It also avoids treating cognition at different ages as repeated measurements but instead captures the decline trajectory of cognitive functioning for an individual in later life. In Appendix C, I report and interpret results from survival analysis as an alternative analytic approach.

I fit a series of nested models, shown in Tables 2 and 3. Model 1 estimates the long-term impact of coresiding with siblings in childhood on cognitive decline trajectories in later life, controlling for time-invariant adulthood demographic characteristics to test Hypothesis 1. Two additional nested models were estimated to test Hypothesis 2, whether childhood confounders attenuate the association. In Model 2, I repeat the analysis using entropy weights that balance individuals with and without siblings on similar family and contextual-level covariates. I include time-varying covariates in Model 3. To examine the heterogeneities in the association between sibling composition and cognitive function and decline for Hypotheses 3 and 4, I repeat the analysis among the respondents with siblings and estimate the possible dose–response relationship by using the number, age differences, and sex composition of siblings as the independent variables of interest in Models 4, 5, and 6, respectively.

All regression analyses presented below are weighted by the combination of cross-sectional HRS survey weights and inverse probability weights, adjusting for selection into the sample with linkage between HRS and the 1940 census (Morgan and Todd 2008). From Model 2, I additionally weighted the analysis by combining the entropy balancing weights (Hainmueller 2012). All analytical results were estimated in R statistical software 4.2.1 (R Core Team 2022).

4. Findings

Weighted descriptive statistics of the demographic and social covariates of the analytic sample are presented in Table 1. The mean cognition score (range: 0–27) for the full sample across all years was 15.0, which varies from 15.7 among respondents without any coresiding siblings to 13.7 among those with five or more siblings. The average baseline age of the respondents in 1998 was 66.3 (i.e., 8.3 years old in 1940), with respondents with more siblings having a marginally higher age on average (65.2, 66.0, 67.0, and 67.3 for individuals with zero, one or two, three or four, and five-plus siblings, respectively). Limited variation in age by number of siblings possibly indicates that few of the siblings born later were missed, with limited underestimation of the association. Most respondents were White (93%) and non-Hispanic (98%). On average, respondents completed 12.5 years of education (i.e., graduated from high school) and were raised by parents who completed 10 years of education (some high school). Thirty-three percent of respondents report their childhood family finances as below average, and 25.6% of their fathers worked in professional or managerial jobs when they were growing up. Respondents having more siblings came from more disadvantaged socio-demographic groups (non-Whites and Hispanics with low education levels, low parental education levels, poor childhood family finances, and fathers not working in professional or managerial jobs). They resided across four regions of the United States in 1940, with the Midwest being the most common (35.8%) and the West being the least common (11.3%). Respondents having multiple siblings were more likely to live in the Midwest and the South of the United States in 1940. Half of the respondents lived in rural areas and half in urban areas in 1940, with 28% of respondents living in farming households. Respondents with more siblings were more likely to be from rural and farming households in 1940. Regarding living arrangements, most respondents lived in two-generation or fewer households (88%) in 1940, even more so among those with more siblings. Around half of respondents lived in rented residences in 1940 (58%), but individuals with more siblings were more likely to live in a residence owned by the family. In later life, most respondents reported good or better self-rated health (2.8 on a scale from 1 = excellent to 5 = poor), only 8% had had a stroke, and the average eight-item CES-D depression score was 1.2 (with ≥ 3 typically considered the cutoff of depressive symptoms [Soh et al. 2022]). Late-life health outcomes were worse among those with more siblings in childhood.

Table 1: Weighted descriptive statistics of analytic sample, Health and Retirement Study, 1998–2020, linked to 1940 US census (N = 6,187)

	Full sample (N = 6,187)	No sibling (N = 1,093)	1 or 2 siblings (N = 2,718)	3 or 4 siblings (N = 1,419)	5 or more siblings (N = 957)
Cognition score, TICS-m (range: 0–-27, mean)	15.0 (4.4)	15.7 (4.3)	15.3 (4.3)	14.5 (4.4)	13.7 (4.6)
Age in 1998, years, mean (SD)	66.3 (5.4)	65.2 (6.0)	66.0 (5.3)	67.0 (5.1)	67.3 (5.0)
Sex, n (%)					
Female	53%	56.2%	52.5%	51.9%	53.1%
Male	47%	43.8%	47.5%	48.1%	46.9%
Race, n (%)					
White	93.3%	94.0%	95.7%	92.8%	85.8%
Other	6.7%	6.0%	4.3%	7.2%	14.2%
Ethnicity, n (%)					
Non-Hispanic	97.8%	98.4%	98.5%	97.6%	95.2%
Hispanic	2.2%	1.6%	1.5%	2.4%	4.8%
Years of education	12.5 (2.8)	13.1 (2.5)	12.9 (2.6)	12.0 (2.9)	11.1 (3.2)
Parental years of education	10.0 (3.3)	10.8 (3.1)	10.5 (3.2)	9.4 (3.2)	8.6 (3.2)
Childhood family finances					
About average or above	67.5%	77.0%	71.1%	62.1%	53.2%
Below average	32.5%	23.0%	28.9%	37.9%	46.8%
Father's occupation in childhood					
Professional or managerial job	25.6%	34.3%	31.1%	17.2%	11.3%
Others	74.4%	65.7%	68.9%	82.8%	88.7%
Region of residence of household in 1940					
Northeast	23.6%	24.4%	25.8%	20.8%	20.2%
Midwest	35.8%	33.8%	36.6%	37.2%	33.5%
South	29.3%	30.3%	25.3%	31.2%	37.6%
West	11.3%	11.5%	12.3%	10.8%	8.7%
Urban/rural status of household in 1940					
Rural	51.6%	41.8%	45.4%	60.9%	68.1%
Urban	48.4%	58.2%	54.6%	39.1%	31.9%
Farming status of household in 1940					
Non-farm	71.9%	82.4%	77.6%	62.9%	55.7%
Farm	28.1%	17.6%	22.4%	37.1%	44.3%
Multigenerational coresidence in 1940					
No (two generations or less)	87.9%	80.4%	88.6%	89.9%	91.6%
Yes (three generations or more)	12.1%	19.6%	11.4%	10.1%	8.4%

Table 1: (Continued)

	Full sample (N = 6,187)	No sibling (N = 1,093)	1 or 2 siblings (N = 2,718)	3 or 4 siblings (N = 1,419)	5 or more siblings (N = 957)
Ownership of residence in 1940					
Owned or being bought (loan)	42.3%	39.4%	40.5%	46.3%	45.3%
Rented	57.7%	60.6%	59.5%	53.7%	54.7%
Presence of father					
Yes	93.5%	87.2%	95.4%	93.8%	94.7%
No father in coresiding household	6.5%	12.8%	4.6%	6.2%	5.3%
Late-life self-rated health (1 = excellent, 5 = poor)	2.8 (1.1)	2.7 (1.0)	2.7 (1.1)	2.9 (1.1)	3.0 (1.1)
Late-life depression score (eight-item CES-D)	1.2 (1.7)	1.2 (1.8)	1.2 (1.7)	1.3 (1.8)	1.4 (1.8)
Late-life ever had stroke					
No	92.0%	93.5%	91.5%	92.2%	91.1%
Yes	8.0%	6.5%	8.5%	7.8%	8.9%

The analysis begins by fitting a null specification of the growth curve model that captures the raw variation of cognitive functioning over the years since baseline. The intercept, which is the sample average baseline cognitive function in 1998, is 18.69 with a variance of 6.47. The slope capturing the rate of decline over the years in the sample is –0.175 with a variance of 0.008, indicating that older adults' cognitive function shows a downward trend during the 22-year observation period. While there are large individual differences in baseline cognitive function, the rate of change in cognition has less variation.

4.1 Presence of coresiding siblings and cognitive decline

Table 2 shows estimates of latent growth curve modeling (LGCM) predicting cognitive functioning and decline by childhood coresiding sibship and adulthood covariates. The table compares three models by incrementally adding controls. The table reports the fixed effects and the variance components of the models as well as some goodness-of-fit indicators. Model 1 controls for standard time-invariant demographic covariates, including age, sex, race, and ethnicity, alongside childhood socioeconomic background, including parental education, family finances, and father's occupation. The results suggest that having any coresiding siblings in childhood is strongly associated with, on average, 0.025 points per year faster of cognitive decline relative to those growing up as an only child over the 22 years of the longitudinal sample (b = –0.025, SE = 0.010, 95% CI = [–0.045, –0.005]). This result speaks to the cumulative disadvantages of childhood resource dilution among siblings that accumulate over the life course and are associated with steeper cognitive decline (supporting Hypothesis 1). However, the results show minimal association between any coresiding siblings in childhood and the level of cognition at baseline. That is, the number of siblings is not associated with cognitive function at the age of the baseline when entering the HRS, which is nationally representative of adults aged 51 and above. This finding suggests that sibling resource dilution is a life course cumulative process rather than an environmental shock such as lead exposure, which diminishes over the life course and results only in a shift in the level of cognitive function (Lee et al. 2022; Wodtke, Ramaj, and Schachner 2022).

Table 2: Latent growth curve modeling estimates predicting cognition by childhood coresiding sibship and adulthood covariates, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 42,530 person-wave observations)

	Model 1		Model 2		Model 3	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
Fixed effects						
Had coresiding siblings in childhood						
No siblings	—	—	—	—	—	—
Any siblings	0.086	–0.025	0.107	–0.038	0.063	–0.037
	(0.189)	(0.010)	(0.223)	(0.010)	(0.233)	(0.011)
Age	0.111		0.079		0.183	
	(0.653)		(0.696)		(1.014)	
Age squared	–0.002		–0.000		–0.002	
	(0.005)		(0.005)		(0.008)	
Covariates						
Time-invariant controls	Y		Y		Y	
Weighted by 1940 social contexts	N		Y		Y	
Time-varying controls	N		N		Y	
Variance components						
Variance of random intercept	5.537		6.033		5.966	
	(0.368)		(0.386)		(0.384)	
Variance of random slope	0.009		0.008		0.007	
	(0.001)		(0.001)		(0.001)	
Goodness of fit						
AIC	59212		51152		43280	
BIC	59388		51367		43653	
RMSEA	0.034		0.034		0.025	
TLI	0.989		0.992		0.989	

Notes: Standard errors associated with the estimates are provided in parentheses. Time-invariant controls include sex, age, race, ethnicity, parental years of education, childhood family socioeconomic status, and childhood father's occupation. Time-varying covariates include self-rated health, depression, and stroke. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure.

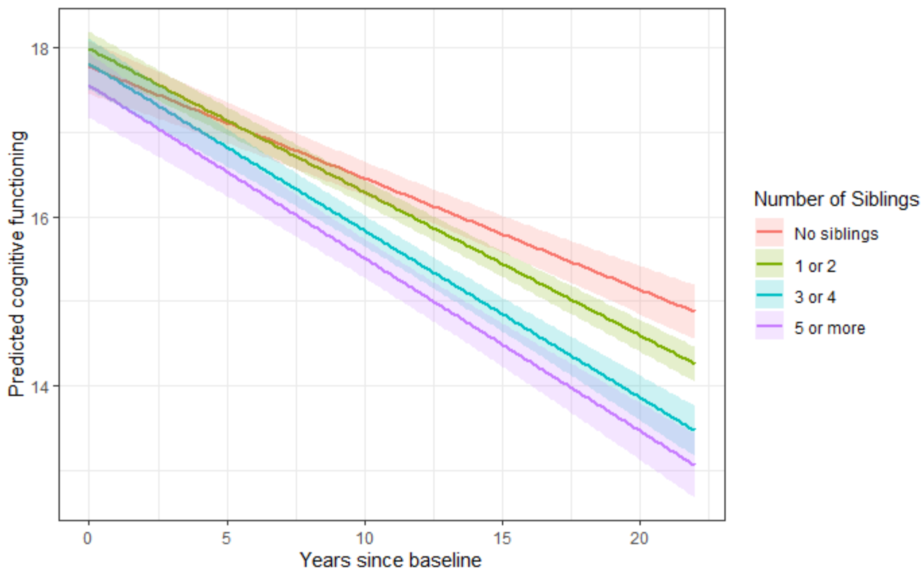
Model 2 further shows that these associations were partly underestimated without accounting for childhood characteristics, such as contextual factors and family socioeconomic status. After adjusting for these factors, having any number of siblings in childhood is associated with a much steeper decline in cognitive function at older ages (b = –0.038, SE = 0.010, 95% CI = [–0.058, –0.019]). These results suggest that childhood coresiding siblings may have long-term consequences for cognitive aging net of childhood family resources alongside adulthood demographic and health factors.

Lastly, with the inclusion of time-varying measures of health in Model 3, the estimated rate of cognitive decline was attenuated slightly, to –0.037 (SE = 0.011, 95% CI = [–0.059, –0.015]), but the precision of the estimate remains strong. The variation of the estimates from Models 1, 2, and 3 shows that demographic and adulthood factors partially account for the association of coresiding siblings with rates of cognitive decline in later life (supporting Hypothesis 2). The null model presented earlier suggests that cognitive decline falls by 0.175 points per year on average in the sample across the 22-year follow-up (≈ 3.85 points total: 0.175 × 22) and that having siblings is linked to an additional 0.037 points-per-year decline. That's about 21.1% faster per year relative to the sample average annual rate of cognitive decline. Over 22 years, that extra 0.037 point decline per year accumulates to 0.814 points more decline, over the study period from 1998 to 2020, associated with having siblings.

4.2 Sibling compositions and cognitive decline

The results from Table 3 show estimates of latent growth curve models predicting cognitive functioning by the number of siblings and, among those with siblings, sibling composition. In the first column (Table 3, Model 4), the results show that the number of siblings in childhood is negatively associated with the slope of decline in cognitive functioning in late adulthood (i.e., faster rates of decline) but not with the baseline level of cognitive functioning. Compared to not having siblings, having one or two siblings, three or four siblings, or five or more siblings is associated with a change in the slope of cognitive decline trajectories of –0.031 (SE = 0.011, 95% CI = [–0.053, –0.009]), –0.053 (SE = 0.016, 95% CI = [–0.084, –0.022]), or –0.059 (SE = 0.022, 95% CI = [–0.102, –0.016]), respectively, with incremental increases in decline steepness by the number of siblings. To put the estimates in comparison with the annual average cognitive functioning declines, having five or more siblings is linked to a 33.7% faster cognitive decline per year relative to the sample average annual rate of cognitive decline and accumulates to 1.30 points over the period of observation (i.e., 30% of the standard deviation of the average cognitive functioning score). In Figure 1, I plot out the cognitive trajectories with years since baseline for individuals with different numbers of childhood coresiding siblings.

Figure 1: Predicted cognitive functioning trajectory with years since baseline by sibship size, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 42,530 person-wave observations)



In Model 5, I show that those with closely spaced siblings have faster rates of cognitive decline (*b* = –0.038, SE = 0.014, 95% CI = [–0.065, –0.011]) compared to those with siblings of age differences of at least two years or greater. Preliminary analysis suggests that the result remains robust when controlling for the birth order of the focal respondent. These results test Hypothesis 3 and provide further support to the resource dilution theory, which suggests that siblings with small age differences compete for similar resources and emotional support from the family (Downey 2001; Downey, Condron, and Yucel 2015).

Model 6 compares differences in the baseline cognitive function and the rate of cognitive decline by the gender composition of the siblings. Specifically, compared to the male respondents with only brothers, women with only sisters show a higher level of cognitive functioning (*b* = 1.715, SE = 0.390, 95% CI = [0.951, 2.479]), and the association is similarly pronounced for those women with at least one brother (*b* = 1.125, SE = 0.336, 95% CI = [0.466, 1.784]). There is also suggestive evidence that among sibling pairs, sister–sister groups experience a faster decline in cognitive trajectories compared to brother–brother pairs (*b* = –0.032, SE = 0.020, 95% CI = [–0.071, 0.007]). Furthermore, when comparing individuals with mixed-gender siblings, women with at least one brother (*b* = –0.039, SE = 0.016, 95% CI = [–0.070, –0.008]) exhibit greater rates of cognitive decline compared to men with at least one sister (*b* = –0.014, SE = 0.017, 95% CI = [–0.047, 0.019]). In Figure 2, I visualize the cognitive trajectories with years since baseline for individuals with different sibling sex compositions. In Appendix D, I show estimates that compare the sex configuration using an alternative reference category of women with only sisters, with consistent substantive conclusions.

The findings of the differences by sibling sex composition corroborate the established literature around the disproportionately intense caregiving done by sisters compared to their brothers, who primarily focus on maintaining the independence of their parents rather than providing day-to-day caregiving (Hequembourg and Brallier 2005; Matthews 2003). Men with a brother would not be overwhelmed by caregiving, and women with sisters would share the burden (Grigoryeva 2017). An alternative explanation could also be that since the intercepts and slopes are often negatively correlated, a higher intercept would mathematically lead one to expect a more negative slope.

Figure 2: Predicted cognitive functioning trajectory with years since baseline by sibling sex composition, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 34,914 person-wave observations for sample with siblings)

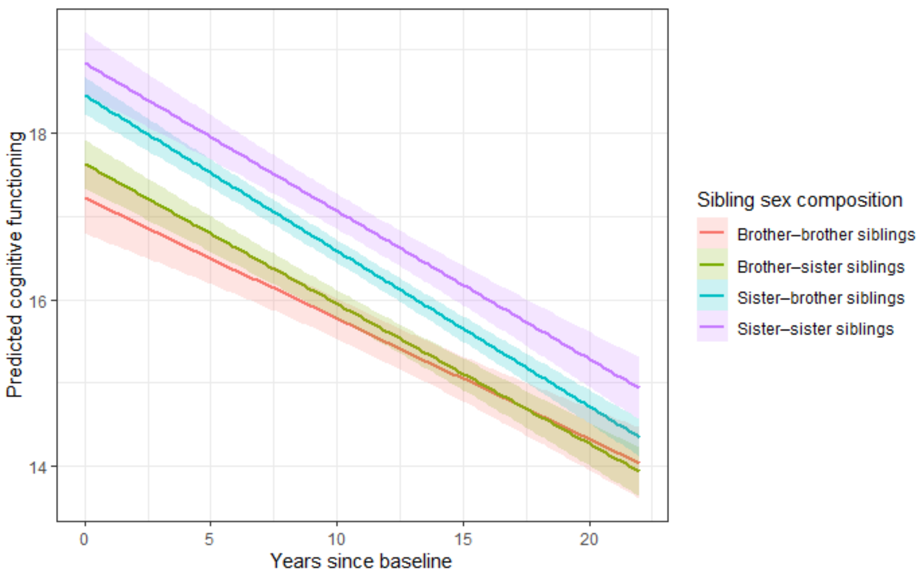


Table 3: Latent growth curve modeling estimates predicting cognition by number and sex composition of the siblings and adulthood covariates, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 42,530 person-wave observations for full sample and N = 34,914 person-wave observations for sample with siblings)

	Full sample		Sample with siblings			
	Model 4		Model 5		Model 6	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
Fixed Effects						
Number of siblings						
No sibling (ref)	—	—				
1–2 siblings	0.130	–0.031				
	(0.240)	(0.011)				
3–4 siblings	–0.098	–0.053				
	(0.322)	(0.016)				
5 or more siblings	–0.340	–0.059				
	(0.433)	(0.022)				
Sibling age difference						
Widely spaced siblings (ref)			—	—		
Closely spaced siblings			0.338	–0.038		
			(0.280)	(0.014)		
Opposite-sex siblings vs. same-sex siblings						
Male with only brothers (ref)					—	—
Female with only sisters					1.715	–0.032
					(0.390)	(0.020)
Female with at least one brother					1.125	–0.039
					(0.331)	(0.016)
Male with at least one sister					0.364	–0.014
					(0.348)	(0.017)
Age	–0.485		–0.043		–0.081	
	(1.049)		(1.070)		(1.094)	
Age squared	0.003		0.000		0.001	
	(0.008)		(0.008)		(0.009)	
Covariates						
Time-invariant controls	Y		Y		Y	
Weighted by 1940 social contexts	Y		Y		Y	
Time-varying controls	Y		Y		Y	
Variance components						
Variance of random intercept	5.698		6.307		6.237	
	(0.384)		(0.474)		(0.471)	
Variance of random slope	0.007		0.010		0.011	
	(0.001)		(0.002)		(0.002)	
Goodness of fit						
AIC	43311		34771		34952	
BIC	43702		35126		35299	
RMSEA	0.025		0.028		0.028	
TLI	0.989		0.988		0.987	

Note: Standard errors associated with the estimates are provided in parentheses. Time-invariant controls include sex, age, race, ethnicity, parental years of education, childhood family socioeconomic status, and childhood father's occupation. Time-varying covariates include self-rated health, depression, and stroke. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure.

4.3 Sibling and cognitive functioning: Education as the mechanism

One of the key consequences of sibling resource dilution during adolescence is differences in access to education, a cognitively stimulating experience during adolescence that builds the foundation for cognitive reserve and slows cognitive decline in later life. In Table 4, I show the latent growth curve model estimates with years of education as the mediator. (See Appendix A for methodological details.)

Consistent with resource dilution, having any sibling is associated with fewer years of schooling (*b* = –0.474, SE = 0.194, 95% CI = [–0.854, –0.094]). Yet higher schooling in turn is strongly related to a higher cognitive intercept (*b* = 0.479, SE = 0.040, 95% CI = [0.400, 0.558]) and a moderate change in the slope of cognitive decline (*b* = –0.004, SE = 0.002, 95% CI = [–0.008, –0.000]). The indirect effect via education on the baseline cognitive level is sizable and negative (*b* = –0.227, SE = 0.096, 95% CI = [–0.413, –0.039]), offsetting a positive direct path and yielding a near-zero total intercept effect (*b* = 0.059, SE = 0.233), which aligns with the idea that schooling builds a reserve that elevates baseline performance. Education also shows the central role in translating sibship into differences in initial cognitive reserve, but it is not directly linked to the subsequent rate of decline. For the rate of decline, the indirect effect is small and positive (*b* = 0.002, SE = 0.001, 95% CI = [0.000, 0.004]) relative to the total association (b = –0.037, SE = 0.011, 95% CI = [–0.059, –0.015]), implying that education modestly tempers rather than directly explains the faster decline among those with siblings. The results remain robust when using educational attainment instead.

Yet an emerging body of literature points to how education, an early cognitively stimulating event, can provide foundations for or limit access to later cognitively stimulating experiences (e.g., interpersonal network diversity and caregiving demands) that may exert strong effects on the rate of cognitive decline (Grigoryeva 2017; Peng and Perry 2025). High-quality measurements of these education-induced mediators are not available in the HRS data prior to the measurement of cognitive functioning, which precludes establishing the temporal order of the mediator and the outcome critical for mediation analysis. Additionally, mediation results are based on strong assumptions for causal identification, as data availability further limits the analysis from controlling for exposure-induced mediator-outcome confounders (e.g., educational opportunities in the neighborhood, quality of sibling interactions) that might confound the estimated mediation pathway.

Table 4: Latent growth curve modeling estimates predicting cognition by sibship and adulthood covariates, with mediation of years of education, Health and Retirement Study, 1998–2020, linked to the 1940 census with childhood coresiding siblings (N = 42,530 person-wave observations)

	Model 7	
	Mediation by education	
	Intercept	Slope
Total effects	0.059	–0.037
	(0.233)	(0.011)
Indirect effects	–0.227	0.002
	(0.096)	(0.001)
Fixed effects		
	Intercept	Slope
Has coresiding siblings in childhood	0.286	–0.039
	(0.212)	(0.011)
Age	0.373	
	(0.943)	
Age squared	–0.004	
	(0.007)	
	Years of education	
Has coresiding siblings in childhood	–0.474	
	(0.194)	
Age	–0.363	
	(1.071)	
Age squared	0.003	
	(0.008)	
	Intercept	Slope
Education	0.479	–0.004
	(0.040)	(0.002)
Time-invariant controls	Y	
Weighted by 1940 social contexts	Y	
Time-varying controls	Y	
Variance components		
Variance of random intercept	4.941	
	(0.339)	
Variance of random slope	0.007	
	(0.001)	
Goodness of fit		
AIC	46439	
BIC	46899	
RMSEA	0.025	
TLI	0.989	

Note: Standard errors associated with the estimates are provided in parentheses. Time-invariant controls include sex, age, race, ethnicity, parental years of education, childhood family socioeconomic status, and childhood father's occupation. Time-varying covariates include self-rated health, depression, and stroke. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure.

4.4 Sensitivity analysis

In Appendix A, I additionally tested for the mediating role of fertility history and whether education mediates the association between sibling sex composition and cognitive functioning. Results show limited explanatory power for the association.

In Appendix B, I test the idea that the sibship relationship might differ by the birth order of the focal respondent in the confluence theory, with the youngest siblings receiving more assistance from the older ones, who are more providers than recipients of care and mentorship throughout the life course (Zajonc 1976; Zajonc and Markus 1975; Zang, Tan, and Cook 2023). The results show that the estimates controlled for the birth order of the respondent as recorded by the 1940 census remain substantively similar to those reported above.

In Appendix C, I additionally estimate Cox proportional hazards models for time to first observed cognitive impairment based on established TICS-m cut points. This event history specification addresses a question related to but distinct from the growth curve models, as it evaluates whether sibship structure predicts the timing of crossing the clinical threshold of cognitive impairment rather than modeling continuous change in cognitive scores. The results indicate consistent findings that respondents with a higher number of siblings have elevated hazards of experiencing cognitive impairment or dementia – that is, they tend to develop impairment at earlier ages rather than later.

5. Discussion and conclusions

This study contributes to the present demographic literature by examining the long-term impact of childhood family structure on cognitive function and cognitive decline among older adults, with a specific focus on sibship. While common knowledge considers conflicts and resource dilution among siblings that may harm child and adult development (Downey 2001; Workman 2017; Yu and Yan 2023), an emerging literature in family demography suggests that sibship can facilitate social learning and be favorable for children's early development, especially for younger siblings (Zang, Tan, and Cook 2023). Yet little is known about whether the influence of coresiding siblings on health outcomes persists throughout the life course. Using a nationally representative sample of older Americans in HRS (1998–2020) linked to their 1940 census records, this study shows how childhood coresiding siblings can be linked to cognitive health in later life. Taking advantage of longitudinal survey data collected over the respondents' later life linked to administrative census records from childhood, I extend prior research by studying different characteristics of siblings after controlling for time-invariant measures on the childhood family and social background alongside time-varying health variables from the HRS. Additionally, the study employs entropy balancing to match the household socioeconomic resources and other aspects of contextual characteristics observable from the 1940 census.

Consistent with the present literature on childhood development and the hypotheses (Downey 2001; Downey, Condron, and Yucel 2015), the results suggest that having any siblings in childhood is associated with faster rates of cognitive decline in late adulthood for both men and women, but there is minimal difference in baseline cognition (supporting Hypothesis 1). That is, the number of siblings is not associated with baseline cognitive function at the individual's age in 1998, when HRS became nationally representative of adults aged 51 and above. This finding differs from those of earlier studies that showed the influence of an environmental shock in childhood (Lee et al. 2022; Wodtke, Ramaj, and Schachner 2022), such as lead exposure, on the level of cognitive function. Such a difference might reflect that sibling resource dilution is a life course cumulative process rather than an exogenous shock in childhood with diminishing exposure over the life course as individuals move residences and environmental regulations develop. The results also indicate that, in later life, rates of cognitive decline exhibit incremental increases in steepness by the number of siblings. This corroborates a recent paper showing a similar pattern of resource dilution by the number of siblings on cognitive functioning in the Mexican population (Saenz, Quashie, and Zhang 2025). This association was partly explained by childhood family and regional characteristics, such as socioeconomic status and urban/rural status (supporting Hypothesis 2), but the precision of the estimate remains small in the fully adjusted model. Moreover, the association was stronger for those with at least one closely spaced sibling than for those with widely spaced siblings (supporting Hypothesis 3). Together with the preliminary analysis that finds consistent results when controlling for the birth order of the siblings, the results of this paper provide empirical support for the resource dilution theory (Downey 2001; Jæger 2009).

Results also suggest that brother–brother pairs have the lowest level of cognitive function but that sisters experience steeper trajectories of cognitive decline compared to other sex configurations of siblings (supporting Hypothesis 4). That is, boys have worse cognitive functioning in later life if they were coresiding with only brothers than they do if they were coresiding with opposite-sex sibling, whereas older women with siblings face faster cognitive decline, especially if they have a brother. These results corroborate earlier literature suggesting how childhood conflicts among brothers may impede childhood cognitive development (Feinberg, Solmeyer, and McHale 2012), but sisters have greater caregiving responsibilities and earlier retirement as adults (Bonsang, Adam, and Perelman 2012; Grigoryeva 2017; Pillemer and Suitor 2014), which accelerates the cognitive decline trajectory. The results reported here show, from the life course perspective, the consequences of sibling sex composition on cognitive health measured in later life, and they contribute to prior literature with mixed results focusing on socioeconomic attainment during adolescence and early adulthood (Steelman et al. 2002). An alternative explanation is that the higher baseline intercept of cognitive function for women would mathematically lead one to expect a more negative slope. Since we cannot rule out the possibility that the higher one starts, the more room one has to fall, future research on data with the life course dynamics of caregiving responsibilities is needed.

The study has some limitations. First, using the entropy balancing approach to match parents' educational and economic resources and other aspects of social background leaves some uncertainty in the interpretation of the findings. There might be other unobserved confounders not measured in the 1940 census. Second, the data used in this study were collected from a cohort of HRS adults born between 1922 and 1940, which may limit the generalizability of the findings. The racial composition of the cohort, and especially of those whose 1940 census records were linked to the HRS survey, does not allow for investigation of racial heterogeneities in the influence of sibship. The results might also suffer from underestimations of the resource dilution since the respondents may have additional younger siblings. Yet the findings do strongly support the resource dilution hypothesis, and the descriptive statistics show limited differences in the birth year by number of siblings. Future studies should use more recent data sources, such as the multiple waves of subsequent historical censuses linked to the HRS, to test the robustness and validity of the findings.

Third, the interpretations remain speculative without direct measurement and causal identification of the mediating process of resource dilution versus confluence in the sibling relationship. Positive interactions among siblings would provide cognitive stimulation, emotional support, and social engagement, whereas conflict between siblings is common and may involve verbal and even physical aggression that may persistently damage the development of cognitive reserve and late-life cognitive functioning (Kong et al. 2025; McHale, Updegraff, and Whiteman 2012). This is an example of an exposure-induced confounder that the data do not include. Additionally, the mediation results indicate that education is a key channel for baseline cognitive reserve, but this explains comparatively few of the differences in rates of decline, suggesting the need for data that can track how early educational constraints interact with later-life circumstances that vary by sibling configuration, particularly for women with brothers. More broadly, if women's educational attainment is more sensitive to resource dilution in larger sibships, changing fertility patterns across 20th-century cohorts could have implications for cohort shifts in women's dementia risk and the evolution of gender disparities in cognitive aging (Garcia et al. 2021; Levine et al. 2021). Future studies should collect prospective data that include repeated measurements of family socioeconomic resources, sibling interactions, and cognitive reserve capacity to test the causal pathways and mediating effects.

The results of the study show that sibship size and composition are linked to differential rates of decline in the cognitive score trajectory. However, the cognitive score (TICS-m) data used in the study include only non-proxy respondents, and the HRS allows for proxy responses for individuals who are unable to complete the survey themselves. Studies show that the dementia prevalence is much higher among proxy respondents (Farina, Crimmins, and Hayward 2024; Stokes et al. 2020). If respondents with many coresiding siblings are disproportionately answered by proxy due to dementia, the association could be underestimated relative to what is presented here.

Nonetheless, the findings have implications for policy and practice. Cognitive functioning is a critical component of well-being and quality of life among older adults, and dementia affects millions of Americans and their families, with substantial economic and social costs (Alzheimer's Association 2016; Li, Li, and Engelman 2026). Given the critical role of education in linking childhood sibship to cognitive health, policies should aim at improving support within schools and educational institutions for siblings. School programs should target children with multiple siblings, who very likely attend the same school. For example, studies show that strategic investments in improving an oldest sibling's academic achievement allow for reduced resource dilution and, more importantly, contribute to the academic development of younger siblings (Zang, Tan, and Cook 2023). With the rate at which fertility outgrows the mortality experienced by later US cohorts compared to the 1922–1940 cohort analyzed in this study, the number and prevalence of coresiding siblings would be, on average, even higher in cohorts born between 1940 and 1960 (Coale 1972; Verdery 2015). Cohorts with even more siblings may have an even higher likelihood of being exposed to resource dilution. Policies that support families with multiple children, such as child care subsidies, parental leave, and education grants, may help mitigate the adverse effects of sibling resource dilution on cognitive and other population health disparities in more recent cohorts.

6. Acknowledgments

This paper benefited from the insightful discussions and comments of three anonymous reviewers. I am also grateful to Linda J. Waite, Geoffrey T. Wodtke, Jenny Trinitapoli, Emma X. Zang, Rebecca A. Schut, Stephen W. Raudenbush, Boyan Zheng, Melissa Howe, and participants in seminars at the University of Chicago, University College London, and the University of Minnesota, Twin Cities, for their helpful feedback. Earlier Versions of this article were presented at the annual meetings of the American Sociological Association in Montreal, Canada, in 2024, the Population Association of America in Columbus, OH, in 2024, and the PAA Applied Demography Conference, Virtual, in 2024. The data used in the study are available upon application to the Health and Retirement Study Restricted Data maintained by the Michigan Center for the Demography of Aging (MiCDA) at https://hrs.isr.umich.edu/data-products/restricted-data. This study was approved by the University of Chicago Institutional Review Board (IRB23-0029). This paper received funding support from the University of Michigan's Centers on the Demography and Economics of Aging Coordinating Center (R24AG066588). The author also acknowledges the support and facilities of the Center on Health Aging Behaviors and Longitudinal Investigations at the University of Chicago, funded by the National Institute on Aging (P30AG066619) and NORC at the University of Chicago. The content is solely the responsibility of the author and does not necessarily represent the official views of the National Institute on Aging, National Institutes of Health, or NORC.

References

Altmejd, A., Barrios-Fernández, A., Drlje, M., Goodman, J., Hurwitz, M., Kovac, D., Mulhern, C., Neilson, C., and Smith, J. (2021). O brother, where start thou? Sibling spillovers on college and major choice in four countries*. *The Quarterly Journal of Economics* 136(3): 1831–1886. doi:10.1093/qje/qjab006.

Alzheimer's Association (2016). 2016 Alzheimer's disease facts and figures. *Alzheimer's and Dementia* 12(4): 459–509. doi:10.1016/j.jalz.2016.03.001.

Basu, R. (2013). Education and dementia risk: Results from the Aging Demographics and Memory Study. *Research on Aging* 35(1): 7–31. doi:10.1177/0164027511434086.

Bauer, J.M. and Sousa-Poza, A. (2015). Impacts of informal caregiving on caregiver employment, health, and family. *Journal of Population Ageing* 8(3): 113–145. doi:10.1007/s12062-015-9116-0.

Berkman, L.F., Glass, T., Brissette, I., and Seeman, T.E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science and Medicine* 51(6): 843–857. doi:10.1016/S0277-9536(00)00065-4.

Black, S.E., Breining, S., Figlio, D.N., Guryan, J., Karbownik, K., Nielsen, H.S., Roth, J., and Simonsen, M. (2021). Sibling spillovers. *The Economic Journal* 131(633): 101–128. doi:10.1093/ej/ueaa074.

Blake, J. (1985). Number of siblings and educational mobility. *American Sociological Review* 50(1): 84–94. doi:10.2307/2095342.

Bonsang, E., Adam, S., and Perelman, S. (2012). Does retirement affect cognitive functioning? *Journal of Health Economics* 31(3): 490–501. doi:10.1016/j.jhealeco.2012.03.005.

Bowlby, J. (1969). *Attachment and loss: Attachment*. New York: Basic Books.

Buist, K.L. (2010). Sibling relationship quality and adolescent delinquency: A latent growth curve approach. *Journal of Family Psychology* 24(4): 400–410. doi:10.1037/a0020351.

Buist, K.L., Deković, M., and Prinzie, P. (2013). Sibling relationship quality and psychopathology of children and adolescents: A meta-analysis. *Clinical Psychology Review* 33(1): 97–106. doi:10.1016/j.cpr.2012.10.007.

Butcher, K.F. and Case, A. (1994). The effect of sibling sex composition on women's education and earnings. *The Quarterly Journal of Economics* 109(3): 531–563. doi:10.2307/2118413.

Chen, L., Li, Y., and Yang, Q. (2022). The effect of grandparenting on the depression and life satisfaction among middle-aged and older Chinese adults. *International Journal of Environmental Research and Public Health* 19(17): 10790. doi:10.3390/ijerph191710790.

Chen, P. and Harris, K.M. (2019). Association of positive family relationships with mental health trajectories from adolescence to midlife. *JAMA Pediatrics* 173(12). doi:10.1001/jamapediatrics.2019.3336.

Chopik, W.J. and Edelstein, R.S. (2019). Retrospective memories of parental care and health from mid- to late life. *Health Psychology* 38(1): 84–93. doi:10.1037/hea0000694.

Cicierelli, V.G. (1985). The role of siblings as family caregivers. In: Sauer, W.J. and Coward, R.T. (eds.). *Social support networks and the care of the elderly: Theory, research, and practice*. New York: Springer.

Coale, A.J. (1972). *The growth and structure of human populations*. Princeton, NJ: Princeton University Press

Conley, D. (2004). *The pecking order: Which siblings succeed and why*. New York: Pantheon Books.

Crimmins, E.M., Kim, J.K., Langa, K.M., and Weir, D.R. (2011). Assessment of cognition using surveys and neuropsychological assessment: The Health and Retirement Study and the Aging, Demographics, and Memory Study. *The Journals of Gerontology: Series B* 66B(suppl_1): i162–i171. doi:10.1093/geronb/gbr048.

Cruise, S. and O'Reilly, D. (2014). The influence of parents, older siblings, and non-parental care on infant development at nine months of age. *Infant Behavior and Development* 37(4): 546–555. doi:10.1016/j.infbeh.2014.06.005.

Curran, P.J., Obeidat, K., and Losardo, D. (2010). Twelve frequently asked questions about growth curve modeling. *Journal of Cognition and Development* 11(2): 121–136. doi:10.1080/15248371003699969.

Datar, A., Kilburn, M.R., and Loughran, D.S. (2010). Endowments and parental investments in infancy and early childhood. *Demography* 47(1): 145–162. doi:10.1353/dem.0.0092.

Daysal, N.M., Simonsen, M., Trandafir, M., and Breining, S. (2022). Spillover effects of early-life medical interventions. *The Review of Economics and Statistics* 104(1): 1–16. doi:10.1162/rest_a_00982.

De La Rochebrochard, E. and Joshi, H. (2013). Siblings and child development. *Longitudinal and Life Course Studies* 4(3): 276–287: doi:10.14301/llcs.v4i3.248.

Desmond, D.W., Tatemichi, T.K., and Hanzawa, L. (1994). The Telephone Interview for Cognitive Status (TICS): Reliability and validity in a stroke sample. *International Journal of Geriatric Psychiatry* 9(10): 803–807. doi:10.1002/gps.930091006.

Downey, D.B. (2001). Number of siblings and intellectual development: The resource dilution explanation. *American Psychologist* 56: 497–504. doi:10.1037/0003-066X.56.6-7.497.

Downey, D.B., Condron, D.J., and Yucel, D. (2015). Number of siblings and social skills revisited among American fifth graders. *Journal of Family Issues* 36(2): 273–296. doi:10.1177/0192513X13507569.

Farina, M.P., Crimmins, E.M., and Hayward, M.D. (2024). The role of Southern context in shaping life course exposures linked to dementia incidence for Black and White older adults in the United States. *BMC Geriatrics* 24(1): 927. doi:10.1186/s12877-024-05508-x.

Feinberg, M.E., Solmeyer, A.R., and McHale, S.M. (2012). The third rail of family systems: Sibling relationships, mental and behavioral health, and preventive intervention in childhood and adolescence. *Clinical Child and Family Psychology Review* 15(1): 43–57. doi:10.1007/s10567-011-0104-5.

Ferraro, K.F., Schafer, M.H., and Wilkinson, L.R. (2016). Childhood disadvantage and health problems in middle and later life: Early imprints on physical health? *American Sociological Review* 81(1). doi:10.1177/0003122415619617.

Flood, S., King, M., Rodgers, R., Ruggles, S., Warren, J.R., Backman, D., Chen, A., Cooper, G., Richards, S., Schouweiler, M., and Westberry, M. (2024). Integrated public use microdata series, current population survey: Version 3.0.[machine-readable database]. Minneapolis, MN: IPUMS. doi:10.18128/D030.V12.0.

Fredman, L., Cauley, J.A., Satterfield, S., Simonsick, E., Spencer, S.M., Ayonayon, H.N., Harris, T.B., and Health ABC Study Group (2008). Caregiving, mortality, and mobility decline: The health, aging, and body composition (health ABC) study. *Archives of Internal Medicine* 168(19): 2154–2162. doi:10.1001/archinte.168.19.2154.

Gamble, W.C., Card, N.A., and Yu, J.J. (2010). Self-representations in early adolescence: Variations in sibling similarity by sex composition and sibling relationship qualities. *Social Development* 19(1): 148–169. doi:10.1111/j.1467-9507.2008.00532.x.

Garcia, M.A., Downer, B., Chiu, C.-T., Saenz, J.L., Ortiz, K., and Wong, R. (2021). Educational benefits and cognitive health life expectancies: Racial/ethnic, nativity, and gender disparities. *The Gerontologist* 61(3): 330–340. doi:10.1093/geront/gnaa112.

Gerstel, N. and Gallagher, S.K. (2001). Men's caregiving: Gender and the contingent character of care. *Gender and Society* 15(2): 197–217. doi:10.1177/089124301015002003.

Gibbs, B.G., Workman, J., and Downey, D.B. (2016). The (conditional) resource dilution model: State- and community-level modifications. *Demography* 53(3): 723–748. doi:10.1007/s13524-016-0471-0.

Grätz, M., Barclay, K.J., Wiborg, Ø.N., Lyngstad, T.H., Karhula, A., Erola, J., Präg, P., Laidley, T., and Conley, D. (2021). Sibling similarity in education across and within societies. *Demography* 58(3): 1011–1037. doi:10.1215/00703370-9164021.

Grigoryeva, A. (2017). Own gender, sibling's gender, parent's gender: The division of elderly parent care among adult children. *American Sociological Review* 82(1): 116–146. doi:10.1177/0003122416686521.

Guberman, N. (1999). Daughters-in-law as caregivers: How and why do they come to care? *Journal of Women and Aging* 11(1): 85–102. doi:10.1300/J074v11n01_07.

Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis* 20(1): 25–46. doi:10.1093/pan/mpr025.

Heeringa, S.G. and Connor, J.H. (1995). *Technical description of the Health and Retirement Survey sample design*. Ann Arbor, MI: University of Michigan. doi:10.7826/ISR-UM.06.585031.001.05.0001.1995.

Hequembourg, A. and Brallier, S. (2005). Gendered stories of parental caregiving among siblings. *Journal of Aging Studies* 19(1): 53–71. doi:10.1016/j.jaging.2003.12.001.

Hirschl, N., Schwartz, C.R., and Boschetti, E. (2024). Eight decades of educational assortative mating: A research note. *Demography* 61(5): 1293–1307. doi:10.1215/00703370-11558914.

Howe, N. and Recchia, H. (2014). Sibling relationships as a context for learning and development. *Early Education and Development* 25(2): 155–159. doi:10.1080/10409289.2014.857562.

Hughes, M.E. and Waite, L.J. (2002). Health in household context: Living arrangements and health in late middle age. *Journal of Health and Social Behavior* 43(1): 1–21. doi:10.2307/3090242.

Ingersoll-Dayton, B., Neal, M.B., Ha, J., and Hammer, L.B. (2003). Redressing inequity in parent care among siblings. *Journal of Marriage and Family* 65(1): 201–212. doi:10.1111/j.1741-3737.2003.00201.x.

Jæger, M.M. (2009). Sibship size and educational attainment. A joint test of the Confluence Model and the Resource Dilution Hypothesis. *Research in Social Stratification and Mobility* 27(1): 1–12. doi:10.1016/j.rssm.2009.01.002.

Jensen, A.C., Whiteman, S.D., Loeser, M.K., and Bernard, J.M.B. (2016). Sibling influences. In: Levesque, R.J.R. (ed.). *Encyclopedia of adolescence*. Cham: Springer International Publishing: 1–7. doi:10.1007/978-3-319-32132-5_37-2.

Kim, Y. (2019). The causal structure of suppressor variables. *Journal of Educational and Behavioral Statistics* 44(4): 367–389. doi:10.3102/1076998619825679.

Kokorelias, K.M., Rittenberg, N., Law, A., Wan, N.T.C., Machon, J., Arfeen, Y., and Cameron, J.I. (2022). Brothers and sisters sharing in the care of a parent with dementia. *Dementia* 21(3): 765–780. doi:10.1177/14713012211053970.

Kong, J., Moorman, S.M., Lee, G., and Engelman, M. (2025). Life course associations of sibling relationships and cognitive functioning in late adulthood. *The Journals of Gerontology: Series B* 80(1): gbae191. doi:10.1093/geronb/gbae191.

Lareau, A. (2018). Unequal childhoods: Class, race, and family life. In: Grusky, D. and Hill, J. (eds.). *Inequality in the 21st century*. New York: Routledge. doi:10.4324/9780429499821-75.

Lee, H., Lee, M.W., Warren, J.R., and Ferrie, J. (2022). Childhood lead exposure is associated with lower cognitive functioning at older ages. *Science Advances* 8(45): eabn5164. doi:10.1126/sciadv.abn5164.

Lee, H., Ryan, L.H., Ofstedal, M.B., and Smith, J. (2021). Multigenerational households during childhood and trajectories of cognitive functioning among U.S. older adults. *The Journals of Gerontology: Series B* 76(6): 1161–1172. doi:10.1093/geronb/gbaa165.

Lee, H. and Schafer, M. (2021). Are positive childhood experiences linked to better cognitive functioning in later life? Examining the role of life course pathways. *Journal of Aging and Health* 33(3–4): 217–226. doi:10.1177/0898264320972547.

Lei, L. (2019). The spillover of sibling education on own education and health in China. *SSRN Electronic Journal*. doi:10.2139/ssrn.3439597.

Leopold, T., Raab, M., and Engelhardt, H. (2014). The transition to parent care: costs, commitments, and caregiver selection among children. *Journal of Marriage and Family* 76(2): 300–318. doi:10.1111/jomf.12099.

Levine, D.A., Gross, A.L., Briceño, E.M., Tilton, N., Giordani, B.J., Sussman, J.B., Hayward, R.A., Burke, J.F., Hingtgen, S., Elkind, M.S.V., Manly, J.J., Gottesman, R.F., Gaskin, D.J., Sidney, S., Sacco, R.L., Tom, S.E., Wright, C.B., Yaffe, K., and Galecki, A.T. (2021). Sex differences in cognitive decline among US adults. *JAMA Network Open* 4(2): e210169. doi:10.1001/jamanetworkopen.2021.0169.

Li, M., Li, Y., and Engelman, M. (2026). Gender differences in associations between spousal cognitive decline and marital strain: Evidence from the U.S. older couples. *Social Science and Medicine* 388: 118772. doi:10.1016/j.socscimed.2025.118772.

Li, Y. and Waite, L.J. (2025). It is not what you weigh, it is how you present it: Body size, attractiveness, physical functioning, and access to partnership and sexuality for older men and women. *Social Forces* 104(2): 776–802. doi:10.1093/sf/soaf046.

Luo, Y. and Waite, L.J. (2005). The impact of childhood and adult SES on physical, mental, and cognitive well-being in later life. *The Journals of Gerontology: Series B* 60(2): S93–S101. doi:10.1093/geronb/60.2.S93.

Mallya, S. and Fiocco, A.J. (2018). Impact of informal caregiving on cognitive function and well-being in Canada. *International Psychogeriatrics* 30(7): 1049–1055. doi:10.1017/S1041610217002605.

Matthews, S.H. (2003). *Sisters and brothers/daughters and sons: Meeting the needs of old parents*. Unlimited Publishing LLC.

Mazumder, B. (2008). Sibling similarities and economic inequality in the US. *Journal of Population Economics* 21(3): 685–701. doi:10.1007/s00148-006-0127-2.

McCammon, P.R.J., Fisher, G.G., Hassan, H., Faul, J.D., Rodgers, W.L., and Weir, D.R. (2022). *Health and Retirement Study imputation of cognitive functioning measures: 1992–2018*. Ann Arbor, MI: Survey Research Center, University of Michigan.

McHale, S.M., Updegraff, K.A., and Whiteman, S.D. (2012). Sibling relationships and influences in childhood and adolescence. *Journal of Marriage and the Family* 74(5): 913–930. doi:10.1111/j.1741-3737.2012.01011.x.

Moen, P. (2016). Work over the gendered life course. In: Shanahan, M.J., Mortimer, J.T., and Kirkpatrick Johnson, M. (eds.). *Handbook of the life course: Volume II*. Cham: Springer International Publishing: 249–275. doi:10.1007/978-3-319-20880-0_11.

Morgan, S.L. and Todd, J.J. (2008). A diagnostic routine for the detection of consequential heterogeneity of causal effects. *Sociological Methodology* 38(1): 231–281. doi:10.1111/j.1467-9531.2008.00204.x.

Park, H. (2008). Public policy and the effect of sibship size on educational achievement: A comparative study of 20 countries. *Social Science Research* 37(3): 874–887. doi:10.1016/j.ssresearch.2008.03.002.

Pearlin, L.I., Mullan, J.T., Semple, S.J., and Skaff, M.M. (1990). Caregiving and the stress process: An overview of concepts and their measures. *The Gerontologist* 30(5): 583–594. doi:10.1093/geront/30.5.583.

Peng, S. and Perry, B. (2025). A life course perspective on cognitive aging: The interplay between early and later life stimulating environments. *Journal of Health and Social Behavior* online first. doi:10.1177/00221465251356611.

Perry-Jenkins, M. and Gerstel, N. (2020). Work and family in the second decade of the 21st century. *Journal of Marriage and Family* 82(1): 420–453. doi:10.1111/jomf.12636.

Pillemer, K. and Suitor, J.J. (2014). Who provides care? A prospective study of caregiving among adult siblings. *The Gerontologist* 54(4): 589–598. doi:10.1093/geront/gnt066.

Quadlin, N. (2019). Sibling achievement, sibling gender, and beliefs about parental investment: Evidence from a National Survey Experiment. *Social Forces* 97(4): 1603–1630. doi:10.1093/sf/soy095.

R Core Team (2022). *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing. https://www.R-project.org/.

Raley, S., Bianchi, S.M., and Wang, W. (2012). When do fathers care? Mothers' economic contribute and fathers' involvement in child care. *American Journal of Sociology* 117(5): 1422–1459. doi:10.1086/663354.

Ruggles, S., Nelson, M.A., Sobek, M., Fitch, C.A., Goeken, R., Hacker, J.D. et al. (2024). IPUMS ancestry full count data: Version 4.0. Minneapolis, MN: IPUMS. doi:10.18128/D014.V4.0.

Saenz, J., Quashie, N.T., and Zhang, X. (2025). Family size across the life course and cognitive decline in older Mexican adults. *The Journals of Gerontology: Series B* 80(5): gbaf010. doi:10.1093/geronb/gbaf010.

Salmon, C. and Hehman, J. (2015). Evolutionary perspectives on the nature of sibling conflict: The impact of sex, relatedness, and co-residence. *Evolutionary Psychological Science* 1(2): 123–129. doi:10.1007/s40806-015-0013-9.

Savalei, V. (2014). Understanding robust corrections in structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal* 21(1): 149–160. doi:10.1080/10705511.2013.824793.

Schafer, M.H., Ferraro, K.F., and Mustillo, S.A. (2011). Children of misfortune: Early adversity and cumulative inequality in perceived life trajectories. *American Journal of Sociology* 116(4): 1053–1091. doi:10.1086/655760.

Soh, Y., Tiemeier, H., Kawachi, I., Berkman, L.F., and Kubzansky, L.D. (2022). Eight-year depressive symptom trajectories and incident stroke: A 10-year follow-up of the HRS (Health and Retirement Study). *Stroke* 53(8): 2569–2576. doi:10.1161/STROKEAHA.121.037768.

Sonnega, A., Faul, J.D., Ofstedal, M.B., Langa, K.M., Phillips, J.W., and Weir, D.R. (2014). Cohort profile: The Health and Retirement Study (HRS). *International Journal of Epidemiology* 43(2): 576–585. doi:10.1093/ije/dyu067.

Steelman, L.C., Powell, B., Werum, R., and Carter, S. (2002). Reconsidering the effects of sibling configuration: Recent advances and challenges. *Annual Review of Sociology* 28(1): 243–269. doi:10.1146/annurev.soc.28.111301.093304.

Stern, Y. (2009). Cognitive reserve. *Neuropsychologia* 47(10): 2015–2028. doi:10.1016/j.neuropsychologia.2009.03.004.

Stokes, A.C., Weiss, J., Lundberg, D.J., Xie, W., Kim, J.K., Preston, S.H., and Crimmins, E.M. (2020). Estimates of the association of dementia with US mortality levels using linked survey and mortality records. *JAMA Neurology* 77(12): 1543–1550. doi:10.1001/jamaneurol.2020.2831.

Tenenbaum, H.R., Winstone, N.E., Leman, P.J., and Avery, R.E. (2020). How effective is peer interaction in facilitating learning? A meta-analysis. *Journal of Educational Psychology* 112(7): 1303–1319. doi:10.1037/edu0000436.

Tibbetts, G. and Scharfe, E. (2015). Oh, brother (or sister)! An examination of sibling attachment, conflict, and cooperation in emerging adulthood. *Journal of Relationships Research* 6: e8. doi:10.1017/jrr.2015.4.

Umberson, D., Crosnoe, R., and Reczek, C. (2010). Social relationships and health behavior across the life course. *Annual Review of Sociology* 36(1): 139–157. doi:10.1146/annurev-soc-070308-120011.

Verdery, A.M. (2015). Links between demographic and kinship transitions. *Population and Development Review* 41(3): 465–484. doi:10.1111/j.1728-4457.2015.00068.x.

Wahl, D., Solon-Biet, S.M., Cogger, V.C., Fontana, L., Simpson, S.J., Le Couteur, D.G., and Ribeiro, R.V. (2019). Aging, lifestyle and dementia. *Neurobiology of Disease* 130: 104481. doi:10.1016/j.nbd.2019.104481.

Warner, D.F., Hayward, M.D., and Hardy, M.A. (2010). The retirement life course in America at the dawn of the twenty-first century. *Population Research and Policy Review* 29(6): 893–919. doi:10.1007/s11113-009-9173-2.

Warren, J.R., Lee, M., and Osypuk, T.L. (2022). The validity and reliability of retrospective measures of childhood socioeconomic status in the Health and Retirement Study: Evidence from the 1940 U.S. Census. *The Journals of Gerontology: Series B* 77(9): 1661–1673. doi:10.1093/geronb/gbac045.

Warren, J.R., Pfeffer, F., Helgertz, J., and Xu, D. (2020). Linking 1940 U.S. census data to the Health and Retirement Survey: Technical documentation. (HRS documentation report). Ann Arbor, MI: Michigan Center of the Demography of Aging. https://hrs.isr.umich.edu/sites/default/files/restricted_data_docs/HRS-1940-Census-Data-Documentation-Report.11.20.2020.pdf.

White, L.K. and Riedmann, A. (1992). When the Brady Bunch grows up: Step/half- and fullsibling relationships in adulthood. *Journal of Marriage and Family* 54(1): 197–208. doi:10.2307/353287.

Wilson, R.S., Yu, L., Lamar, M., Schneider, J.A., Boyle, P.A., and Bennett, D.A. (2019). Education and cognitive reserve in old age. *Neurology* 92(10): e1041–e1050. doi:10.1212/WNL.0000000000007036.

Wodtke, G.T., Ramaj, S., and Schachner, J. (2022). Toxic neighborhoods: The effects of concentrated poverty and environmental lead contamination on early childhood development. *Demography* 59(4): 1275–1298. doi:10.1215/00703370-10047481.

Workman, J. (2017). Sibling additions, resource dilution, and cognitive development during early childhood. *Journal of Marriage and Family* 79(2): 462–474. doi:10.1111/jomf.12350.

Yu, W. and Yan, H.X. (2023). Effects of siblings on cognitive and sociobehavioral development: Ongoing debates and new theoretical insights. *American Sociological Review* 88(6): 1002–1030. doi:10.1177/00031224231210258.

Zajonc, R.B. (1976). Family configuration and intelligence: Variations in scholastic aptitude scores parallel trends in family size and the spacing of children. *Science* 192(4236): 227–236. doi:10.1126/science.192.4236.227.

Zajonc, R.B. and Markus, G.B. (1975). Birth order and intellectual development. *Psychological Review* 82(1): 74–88. doi:10.1037/h0076229.

Zang, E., Tan, P.L., and Cook, P.J. (2023). Sibling spillovers: Having an academically successful older sibling may be more important for children in disadvantaged families. *American Journal of Sociology* 128(5): 1529–1571. doi:10.1086/724723.

Zhou, X. and Wodtke, G.T. (2020). Residual balancing: A method of constructing weights for marginal structural models. *Political Analysis* 28(4): 487–506. doi:10.1017/pan.2020.2.

Appendix A

Latent growth curve modeling estimates predicting cognition by number and sex composition of siblings and adulthood covariates, with mediation of years of education and number of children ever born

Given the role of education as a potential channel in either confluence or resource dilution and as an important indicator for the stimulating events in building cognitive reserve in adolescence, I test it as a mediator in estimating the association between childhood coresiding siblings and cognitive health. I also test mediation by fertility history, as prior literature points to parity as an indicator of adulthood family processes through which childhood sibling structure might exert effects.

To estimate the mediation, the mediator (M_i) was regressed on sibship status S_i and the baseline covariates X_i. Both growth factors (ζ_{0i} for intercept and ζ_{1i} for the slope/rate of change) were regressed on M_i while including sibship S_i. The mediation was defined through the product of coefficients at the latent factor level. The indirect effect on the level of cognition is defined as the product of the coefficient of sibship on education and the coefficient of education on the level of cognition. The indirect effect on the rate of change of cognition is defined as the product of the coefficient of sibship on education and the coefficient of education on the rate of change of cognition. Direct effects of sibship on the growth factors were estimated simultaneously. The percent mediated is presented as the ratio of the indirect to the total effect at the latent level (separately for level and slope).

The results suggest that having coresiding siblings in childhood is associated with fewer years of education, which is a protective factor for the level of cognition in later life. However, due to the complexities of developmental processes, I do not have sufficient measures to control for all unobservables in both direct and indirect effects (e.g., educational opportunities in the neighborhood and the quality of sibling interactions) that might confound the estimated mediation pathway as exposure-induced mediator-outcome confounders. Hence the results are based on strong assumptions, and education or fertility cannot be interpreted as the exclusive pathway, with other potential roles for adulthood family, socioeconomic, and emotional resources remaining plausible mechanisms. Future studies could formally examine the causal pathways behind the relationship with new prospective data sources.

Table A-1: Latent growth curve modeling estimates predicting cognition by sibship, with mediation of number of children ever born, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 41,270 person-wave observations)

	Model 8	
	Mediation by fertility	
	Intercept	Slope
Total	0.028	–0.031
	(0.254)	(0.012)
Indirect effects	0.005	–0.001
	(0.016)	(0.001)
Fixed effects		
	Intercept	Slope
Had coresiding siblings in childhood	0.023	–0.031
	(0.254)	(0.012)
Age	0.572	
	(1.067)	
Age squared	–0.006	
	(0.008)	
	Children ever born	
Had coresiding siblings in childhood	0.136	
	(0.098)	
Age	0.068	
	(0.502)	
Age squared	–0.001	
	(0.004)	
	Intercept	Slope
Number of children	0.033	–0.006
	(0.118)	(0.006)
Time-invariant controls	Y	
Weighted by childhood characteristics	Y	
Time-varying controls	Y	
Variance components		
Variance of random intercept	5.567	
	(0.393)	
Variance of random slope	0.007	
	(0.001)	
Goodness of fit		
AIC	41458	
BIC	41490	
RMSEA	0.024	
TLI	0.989	

Note: Standard errors associated with the estimates are provided in parenthesis. Time-invariant controls include sex, age, race, ethnicity, parental years of education, childhood family socioeconomic status, and childhood father's occupation. Time-varying covariates include self-rated health, depression, and stroke. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure.

Table A-2: Latent growth curve modeling estimates predicting cognition by sibling sex composition, with mediation of number of children ever born and education, Health and Retirement Study, 1998–2020, linked to the 1940 census among those with childhood coresiding siblings (N = 34,914 person-wave observations)

	Model 9		Model 10	
	Mediation by education		Mediation by fertility	
	Intercept	Slope	Intercept	Slope
Total effects				
Male with only brothers (ref)	—	—	—	—
Female with only sisters	1.726	–0.033	1.847	–0.042
	(0.391)	(0.020)	(0.398)	(0.020)
Female with at least one brother	1.128	–0.040	1.172	–0.046
	(0.331)	(0.016)	(0.341)	(0.016)
Male with at least one sister	0.382	–0.017	0.369	–0.023
	(0.348)	(0.017)	(0.361)	(0.017)
Indirect effects				
Male with only brothers (ref)	—	—	—	—
Female with only sisters	–0.058	0.000	0.033	–0.003
	(0.141)	(0.001)	(0.066)	(0.003)
Female with at least one brother	–0.089	0.001	0.020	–0.002
	(0.121)	(0.001)	(0.040)	(0.002)
Male with at least one sister	0.091	–0.001	0.017	–0.002
	(0.136)	(0.001)	(0.036)	(0.002)
Fixed effects				
	Intercept	Slope	Intercept	Slope
Opposite-sex siblings vs. same-sex siblings				
Male with only brothers (ref)	—	—	—	—
Female with only sisters	1.785	–0.034	1.814	–0.039
	(0.377)	(0.020)	(0.405)	(0.020)
Female with at least one brother	1.217	–0.041	1.152	–0.044
	(0.317)	(0.016)	(0.345)	(0.016)
Male with at least one sister	0.292	–0.016	0.352	–0.022
	(0.326)	(0.017)	(0.364)	(0.017)
Age	0.339		–0.470	
	(1.089)		(1.158)	
Age squared	–0.003		0.003	
	(0.009)		(0.009)	
	Years of education		Children ever born	
Opposite-sex siblings vs. same-sex siblings				
Male with only brothers (ref)	—		—	
Female with only sisters	–0.123		0.478	
	(0.295)		(0.153)	
Female with at least one brother	–0.187		0.288	
	(0.251)		(0.125)	
Male with at least one sister	0.190		0.250	
	(0.287)		(0.132)	
Age	–1.214		–0.091	
	(1.209)		(0.533)	
Age squared	0.011		0.000	
	(0.010)		(0.004)	

Table A-2: (Continued)

	Model 9		Model 10	
	Mediation by education		Mediation by fertility	
	Intercept	Slope	Intercept	Slope
Mediator (education or fertility, respectively)	0.476	–0.003	0.069	–0.006
	(0.045)	(0.002)	(0.137)	(0.007)
Time-invariant controls	Y		Y	
Weighted by childhood characteristics	Y		Y	
Time-varying controls	Y		Y	
Variance components				
Variance of random intercept	5.357		5.934	
	(0.393)		(0.454)	
Variance of random slope	0.010		0.010	
	(0.001)		(0.001)	
Goodness of fit				
AIC	37515		33959	
BIC	37953		34390	
RMSEA	0.027		0.038	
TLI	0.984		0.986	

Note: Standard errors associated with the estimates are provided in parenthesis. Time-invariant controls include sex, age, race, ethnicity, parental years of education, childhood family socioeconomic status, and childhood father's occupation. Time-varying covariates include self-rated health, depression, and stroke. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure.

Appendix B

Latent growth curve modeling estimates predicting cognition by number and sex composition of the siblings and adulthood covariates, with additional controls for respondent’s own birth order

In Appendix B, I assess whether the association between childhood sibship and later-life cognition is adjusted for the respondent’s birth order, as confluence theory suggests that younger siblings may benefit from older siblings’ mentorship and support across the life course. The results indicate that adjusting for birth order as recorded in the 1940 census yields estimates that are substantively consistent with the main findings.

Table A-3: Latent growth curve modeling estimates predicting cognition by number and sex composition of siblings and adulthood covariates, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 42,530 person-wave observations for full sample and N = 34,914 person-wave observations for sample with siblings)

	Full sample				Sample with siblings			
	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope
Fixed effects								
Has coresiding siblings in childhood								
No siblings	—	—						
Any siblings	–0.85	–0.026						
	(0.253)	(0.012)						
Number of siblings (0, 1, 2, 3+)								
No siblings (ref)			—	—				
1–2 siblings			0.028	–0.014				
			(0.278)	(0.013)				
3–4 siblings			–0.149	–0.048				
			(0.364)	(0.018)				
5 or more siblings			–0.807	–0.029				
			(0.506)	(0.024)				
Sibling age difference								
Widely spaced sibling (ref)					–	–		
Closely spaced sibling					0.234	–0.029		
					(0.292)	(0.015)		
Opposite-sex siblings vs. same-sex siblings								
Male with only brothers (ref)							–	–
Female with only sisters							1.729	–0.032
							(0.375)	(0.020)
Female with at least one brother							1.114	–0.038
							(0.314)	(0.016)
Male with at least one sister							0.376	–0.016
							(0.325)	(0.017)
Age	–0.053		–0.109		–0.365		–0.270	
	(1.016)		(1.128)		(1.035)		(1.058)	
Age squared	–0.000		–0.002		0.003		0.002	
	(0.008)		(0.009)		(0.008)		(0.008)	
Covariates								
Time-invariant controls	Y		Y		Y		Y	
Weighted by 1940 social contexts	Y		Y		Y		Y	
Birth order of focal respondent	Y		Y		Y		Y	
Time-varying controls	Y		Y		Y		Y	

Table A-3: (Continued)

	Full sample				Sample with siblings			
	Intercept	Slope	Intercept	Slope	Intercept	Slope	Intercept	Slope
Variance components								
Variance of random intercept	5.931		5.278		6.444		6.340	
	(0.381)		(0.391)		(0.437)		(0.433)	
Variance of random slope	0.007		0.007		0.009		0.010	
	(0.001)		(0.001)		(0.001)		(0.001)	
Goodness of fit								
AIC	43282		39647		34770		34949	
BIC	43692		40086		35164		35344	
RMSEA	0.024		0.025		0.029		0.029	
TLI	0.989		0.989		0.985		0.985	

Note: Standard errors associated with the estimates are provided in parenthesis. Time-invariant controls include sex, age, race, ethnicity, parental years of education, childhood family socioeconomic status, and childhood father's occupation. Time-varying covariates include self-rated health, depression, and stroke. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure.

Appendix C

Alternative model specification: Cox proportional hazard model estimates

Appendix C re-estimates the association between childhood sibship structure and cognitive aging using a Cox proportional hazards model for time to first observed cognitive impairment based on TICS-m cut points. This approach is included as a robustness check to assess whether the central patterns from the latent growth curve models, estimated on continuous cognitive trajectories, are directionally consistent when cognition is operationalized as entry into the clinically meaningful state. However, the time-to-event models address the timing of threshold-crossing rather than the rate of continuous decline reported in the main results.

Results show the same substantive patterns expected under resource dilution and gender dynamics. First, risk rises monotonically with sibship size: Relative to only children, the hazard is similar for one or two siblings (HR = 1.034, 95% CI = [0.889, 1.202]), higher for three or four siblings (HR = 1.12, 95% CI = [0.983, 1.278]), and clearly elevated for five-plus siblings (HR = 1.200, 95% CI = [1.014, 1.420]), consistent with greater competition for parental time and schooling opportunities in larger families. There is also suggestive evidence that close age spacing is linked to a higher risk (HR = 1.071, 95% CI = [0.968, 1.186]), in line with resource dilution being most acute when siblings vie for the same stage-specific inputs. Second, the differences in cognitive functioning by sibling sex composition mirror the main text's evidence of gendered sibling dynamics. Women with only sisters (HR = 0.821, 95% CI = [0.687, 0.982]) and women with at least one brother (HR = 0.854, 95% CI = [0.744, 0.979]) face lower incident risk than brother–brother siblings, while men with at least one sister are indistinguishable (HR = 1.061, 95% CI = [0.923, 1.219]). These patterns align with the main findings from LGCM that sister-linked configurations are associated with more favorable baseline cognitive standings (consistent with supportive ties and less early rivalry), even as the main text shows that women may experience steeper later-life decline. Yet using cutoffs that require drastic changes in cognition within a relatively short period of time does not allow survival models to capture such differences in the rate of decline in LGCM. However, the time-to-event specification still confirms that larger sibships carry higher impairment risk while sister-inclusive configurations are comparatively protective, demonstrating that the central conclusions are robust to alternative modeling of the outcome.

Table A-4: Cox proportional hazard model estimates predicting cognitive impairments by number and sex composition of siblings and adulthood covariates, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 6,187 individuals for full sample and N = 5,094 individuals for sample with siblings)

	Full sample		Sample with siblings	
	Model 11	Model 12	Model 13	Model 14
	Hazard ratios	Hazard ratios	Hazard ratios	Hazard ratios
Has coresiding siblings in childhood				
No siblings	–			
Any siblings	1.083			
	[0.946, 1.240]			
Number of siblings (0, 1, 2, 3+)				
No sibling (ref)		–		
1–2 siblings		1.034		
		[0.889, 1.202]		
3–4 siblings		1.121		
		[0.983, 1.278]		
5 or more siblings		1.200		
		[1.014, 1.420]		
Sibling age difference				
Widely spaced siblings (ref)			—	
Closely spaced siblings			1.071	
			[0.968, 1.186]	
Opposite-sex siblings vs. same-sex siblings				
Male with only brothers (ref)				—
Female with only sisters				0.821
				[0.687, 0.982]
Female with at least one brother				0.854
				[0.744, 0.979]
Male with at least one sister				1.061
				[0.923, 1.219]

Table A-4: (Continued)

	Full sample		Sample with siblings	
	Model 11	Model 12	Model 13	Model 14
	Hazard ratios	Hazard ratios	Hazard ratios	Hazard ratios
Sex (ref = female)				
Male	1.214	1.212	1.240	
	[1.123, 1.313]	[1.114, 1.318]	[1.140, 1.349]	
Age	0.882	0.854	1.050	1.046
	[0.731, 1.065]	[0.703, 1.037]	[0.838, 1.316]	[0.837, 1.308]
Age squared	1.001	1.002	1.000	1.000
	[0.999, 1.003]	[1.000, 1.004]	[0.998, 1.002]	[0.998, 1.002]
Race (ref = non-White)				
White	0.464	0.464	0.457	0.456
	[0.407, 0.529]	[0.407, 0.529]	[0.398, 0.526]	[0.396, 0.525]
Ethnicity (ref = non-Hispanic)				
Hispanic	1.559	1.550	1.445	1.438
	[1.249, 1.945]	[1.230, 1.953]	[1.113, 1.875]	[1.119, 1.848]
Parental years of education	0.932	0.935	0.939	0.939
	[0.920, 0.945]	[0.922, 0.948]	[0.924, 0.954]	[0.924, 0.954]
Childhood family finances (ref = average or better)				
Below average	1.012	1.007	0.996	1.002
	[0.918, 1.116]	[0.913, 1.111]	[0.905, 1.096]	[0.910, 1.103]
Parental occupation (ref = others)				
Professional or managerial job	0.800	0.799	0.819	0.825
	[0.711, 0.900]	[0.70, 0.902]	[0.718, 0.934]	[0.721, 0.945]
Covariates				
Weighted by 1940 social contexts	Y	Y	Y	Y

Note: Consistent with literature applying the Cox proportional hazard model, 95% confidence intervals associated with the estimates are provided in brackets. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure. Sex was not adjusted for the model on the sex configuration of the siblings due to collinearity.

Appendix D

Latent growth curve modeling estimates predicting cognition by sex composition of the siblings (with alternative reference category)

The alternative parameterization sets females with only sisters as the reference category. Coefficients therefore represent differences relative to that group.

Table A-5: Latent growth curve modeling estimates predicting cognition by sex composition of the siblings (with alternative reference category) and adulthood covariates, Health and Retirement Study, 1998–2020, linked to the 1940 census (N = 34,914 person-wave observation for sample with siblings)

	Model 15	
	Intercept	Slope
Fixed effects		
Opposite-sex siblings vs. same-sex siblings		
Female with only sisters (ref)	—	—
Male with only brothers	–1.715	0.032
	(0.390)	(0.020)
Female with at least one brother	–0.590	-0.007
	(0.311)	(0.017)
Male with at least one sister	–1.351	0.018
	(0.331)	(0.019)
Age	–0.081	
	(1.094)	
Age squared	0.001	
	(0.009)	
Covariates		
Time-invariant controls	Y	
Weighted by childhood characteristics	Y	
Time-varying controls	Y	
Variance components		
Variance of random intercept	6.396	
	(0.449)	
Variance of random slope	0.010	
	(0.001)	
Goodness of fit		
AIC	34952	
BIC	35299	
RMSEA	0.028	
TLI	0.985	

Note: Standard errors associated with the estimates are provided in parentheses. Time-invariant controls include sex, age, race, ethnicity, parental years of education, childhood family socioeconomic status, and childhood father’s occupation. Time-varying covariates include self-rated health, depression, and stroke. Weights for 1940 social contexts include region of residence, urban/rural status, farming status, multigenerational coresidence, home ownership, and presence of a father figure.