THE GERONTOLOGICAL SOCIETY OF AMERICA®

Journals of Gerontology: Social Sciences
cite as: *J Gerontol B Psychol Sci Soc Sci*, 2020, Vol. XX, No. XX, 1–12
doi:10.1093/geronb/gbaa107
Advance Access publication July 29, 2020

OXFORD

Research Article

A New Look at Cohort Trend and Underlying Mechanisms in Cognitive Functioning

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Received: May 29, 2020; Editorial Decision Date: July 16, 2020

Decision Editor: J. Scott Brown, PhD, FGSA

Abstract

Objectives: The prevalence of dementia in the United States seems to have declined over the last few decades. We investigate trends and their underlying mechanisms in cognitive functioning (CF) across 7 decades of birth cohorts from the Greatest Generation to Baby Boomers.

Methods: Data come from 30,191 participants of the 1996–2014 Health and Retirement Study. CF is measured as a summary score on a 35-point cognitive battery of items. We use generalized linear models to examine the trends in CF and explanatory variables across birth cohorts. Then, Karlson–Holm–Breen decomposition method is used to evaluate the contribution of each explanatory variable to the trend of CF.

Results: CF has been improving from the Greatest Generation to Late Children of Depression and War Babies, but then significantly declines since the Early-Baby Boomers and continues into Mid-Baby Boomers. This pattern is observed universally across genders, race/ethnicities, education groups, occupations, income, and wealth quartiles. The worsening CF among Baby Boomers does not originate from childhood conditions, adult education, or occupation. It can be attributed to lower household wealth, lower likelihood of marriage, higher levels of loneliness, depression and psychiatric problems, and more cardiovascular risk factors (e.g., obesity, physical inactivity, hypertension, stroke, diabetes, and heart disease).

Discussion: The worsening CF among Baby Boomers may potentially reverse past favorable trends in dementia as they reach older ages and cognitive impairment becomes more common if no effective interventions and policy responses are in place.

Keywords: Cognition, Cohort analysis, Dementia, Demography, Population aging

Several national level and subnational level studies have reported declines in the prevalence of dementia in the United States over the last few decades (Freedman et al., 2018; Hudomiet et al., 2018; Langa et al., 2008, 2017; Sheffield and Peek, 2011). Similar trends are observed in other developed countries, for example, United Kingdom (Matthews et al., 2013), Germany (Doblhammer et al., 2015), and Spain (Lobo et al., 2007). Some studies also corroborate the incidence rate of dementia may have been declining in these countries (Derby et al., 2017; Dufouil et al., 2018; Kosteniuk et al., 2016; Matthews et al., 2016; Noble et al., 2017; Satizabal et al., 2016; Wu et al., 2017). The decrease in dementia rates has been attributed to higher education (Meng and D'Arcy, 2012), and better treatment for cardiovascular diseases and diabetes (Matthews et al., 2013; Satizabal et al., 2016).

Some recent studies, however, imply that the incidence and prevalence rate of dementia may stabilize in the United States at either the community level (Hall et al., 2009; Rocca et al., 2011) or the national level (Choi et al., 2018; Crimmins et al., 2018). For example, Crimmins and colleagues (2018) found that the prevalence of dementia in each 5-year age group above age 65 remained stable from 2000 to 2010. Choi and colleagues (2018) found no significant

change in the prevalence of cognitive limitation among Americans ages 55–69 between 1998 and 2014. Some studies even report a worsening of cognition for blacks and whites ages 67 and older in Chicago (Weuve et al., 2018) or a decline in cognitive functioning (CF) among individuals 55–69 after 1998 (Choi et al., 2018). Choi and colleagues' (2018) findings are especially alarming because that study is at the national scale and implies that younger cohorts, including Baby Boomers, might begin to perform worse than preceding cohorts when they reach ages at which rates of dementia accelerate.

Most of aforementioned studies investigate the period trend in dementia, which is a by-product of changes in cognitive function later in life across birth cohorts (Dodge et al., 2017; Gerstorf et al., 2011; Sacuiu et al., 2010). Previous studies examining cohort effects in cognition tend to focus on older ages (above age 65 or 70) and earlier birth cohorts because these studies focus on cognitive predictors of dementia, the onset of which tends to occur in older ages (Lambert et al., 2014; WHO, 2012). Cohorts examined in these studies are born before the mid-1940s in the United States (Dodge et al., 2017; Gerstorf et al., 2011; Hendrie et al., 2018), Sweden (Sacuiu et al., 2010), and Denmark (Christensen et al., 2013). These studies found that the incidence and prevalence of dementia have declined and CF has improved across cohorts. For example, Dodge and colleagues (2017) found cohort effects favored the more recently born cohorts on immediate and delayed word recall. The trend for cohorts born after the mid-1940s, however, is not examined in these studies.

There are reasons to suspect that the cohort trend in CF since Baby Boomers may not be as favorable as previous generations in the United States. In recent decades, functional limitations and disability have increased in newer cohorts of people approaching middle and old age: ages 60–69 from 1988 to 2004 (Seeman et al., 2010), ages 55–64 from 2000 to 2008 (Freedman et al., 2013), ages 50–64 from 1997 to 2007 (Martin et al., 2010), and ages 40–59 from 1997 to 2006 (Martin et al., 2009). Studies also find a worsening mortality and morbidity profile among the young and middle-aged since the 2000s (Case and Deaton, 2017). One study reports elevated mortality in Baby Boomers for all races and genders, and in more recent cohorts for non-Hispanic whites (Zang et al., 2019). These increasing functional limitations, disability, morbidity, or mortality in the middle-aged (40–59) and "young old" (60–69) since the 2000s, and in cohorts born after mid-1940s, may be a result of changes in cardiovascular risk factors (e.g., diabetes, obesity, and physical inactivity) and depression (Martin et al., 2009, 2010), which are also important risk factors for cognitive decline and dementia (Beydoun et al., 2014; Deckers et al., 2015; NIA, 2013).

In this study, we investigate the cohort trend in CF using the 1996–2014 Health and Retirement Study (HRS). CF is measured as a summary score on a 35-point cognitive battery of items. We group all the single birth-year cohorts into nine generations: Greatest Generation (born 1890–1923), Early Children of Depression (born 1924–1930), Late Children of Depression (born 1931–1941), War Babies (born 1942–1947), Early-Baby Boomers (born 1948–1953), and Mid-Baby Boomers (born 1954–1959). We further take a comprehensive approach to investigate the causes for the trend, which is highlighted as an important direction of research in this area (Schoeni et al., 2018). The examined causes range from early-life health, nutrition, and family background, to adulthood socioeconomic status (SES), psychosocial factors, biobehaviors, and diseases. We also use a decomposition technique to evaluate the relative contribution of each factor.

Method

Data

We use data from the 1996–2014 HRS (Wave 3–12), which is a nationally representative, biennial, longitudinal survey of persons aged 51 or older since 1992. Refreshment cohorts of age 51–56 enter the survey every 6 years. The first two waves are not used because they employ different cognition measurements. We make use of imputed cognitive measures provided by HRS. Procedures for the imputation methodology are available on the HRS website (Fisher et al., 2017). Raw data are not used because they miss a large fraction of respondents with dementia. Sample includes 30,236 individuals aged 51 or older and 114,381 observations with valid cognition information (6% of interviews completed by proxy respondents were excluded because they did not take a cognitive test). Dropping individuals with missing data on sex, race, and ethnicity, we reach a final sample of 30,191 individuals with 114,323 observations. It includes 5,889 individuals in the Greatest Generation cohort, 3,888 Early Children of Depression, 9,144 Late Children of Depression, 3,329 War Babies, 3,876 Early-Baby Boomers, and 4,065 Mid-Baby Boomers. The HRS collects a variety of measures of childhood environments and adulthood factors that can be used to examine the trend in CF across birth cohorts.

Measures

Supplementary Information 1 shows the detailed descriptive statistics of the sample. Our indicator of CF is based on a summary cognition score, which is a summarized score of immediate and delayed word recall scores (0–20 points), a serial sevens subtraction test score (0–5 points), backwards counting from 20 (0–2 points), object naming (0–2 points), date naming (0–4 points), and President/Vice-President naming tasks (0–2 points). The summary cognition score ranges from 0 to 35. A greater number of points reflect better CF.

We test a range of childhood and adulthood factors to explain the cohort trend in CF. Childhood health is the

respondent's self-rated health while s/he was growing up, which is reported on a 5-point scale: 1 (*poor*), 2 (*fair*), 3 (*above average*), 4 (*very good*), or 5 (*excellent*). We use adult height as a marker of a child's early environment. The association between height at age 3 and height in adulthood is strong, so adult height provides a good marker of one's early-life nutrition and health environment (Case and Paxson, 2008). Respondents reported their heights in Waves 1 and 2. Respondents who were not surveyed in Waves 1 and 2 reported their heights when they were first interviewed. Even though height may shrink in older ages, the respondents were still relatively young when they were first interviewed and self-reports of height may be less likely to reflect age-related shrinkage than measured height (Case and Paxson, 2008). Childhood financial situation is assessed on a 3-point scale: 1 (*poor*), 2 (*about average*), or 3 (*pretty well off*). Parental education is the mother's or father's number of years of education, whichever are larger. Respondents also reported whether they were physically abused by either of their parents before age 18.

Adulthood education is measured as either years of education or the highest degree attained. Occupation is the job with longest reported tenure, which is further categorized as white collar or blue collar. Household wealth is the sum of both financial and nonfinancial assets (e.g., homes, vehicles, stocks) minus sum of all debts (e.g., mortgages). Household income is the sum of respondent and spouse earnings, pensions, annuities, Social Security retirement benefits, and any other incomes in the calendar year prior to interview. Both household wealth and income are adjusted for household size by dividing by the square root of the number of people in the household. For missing values of wealth and income, we use the imputed values provided by Rand (Hurd et al., 2016). We create three categories based on quartiles of household wealth or income in each wave to reflect one's relative rank within the population: 1 (below 25%), 2 (25%–75%), and 3 (above 75%). Wealth is a particularly important indicator of financial situation in the population we examine because they are beginning to transition to retirement, when they depend much more on accumulated assets than income. Therefore, even though CF trend is assessed by both wealth and income quartiles, wealth quartiles are used to explain the trend.

Adulthood psychosocial factors include current marital status, number of marriages, number of living children, religious preference, loneliness score, lack of social support, and the Center for Epidemiological Studies-Depression (CESD). Loneliness score is only available from Wave 6 to 12. It is a mean score of four different loneliness questions (how often the respondent feels they lack companionship, left out, isolated from others, not in tune with the people around them). Response to each question is coded on a 3-point scale. Loneliness score ranges from 1 to 3. Higher score indicates more loneliness. Lack of social support is only available from Wave 8 to 12. It is a mean score of lack of support from four domains: spouse, kids, friends, and other family members. Each domain is a mean score of seven different questions (e.g., can the respondent rely on them for a serious problem). Response to each question is coded on a 4-point scale. Lack of support in each domain is the mean of these scales across seven questions, ranging from 1 to 4. Mean score lack of social support across all the domains ranges from 1 to 4 as well. CESD is a summary score of eight measures: felt depressed, everything was an effort, sleep was restless, was happy, felt lonely, sad, could not get going, and enjoyed life. Each measure is a yes/no indicator of the respondent's feelings much of the time over the week prior to the interview. CESD score ranges from 0 to 8.

Adult biobehaviors include body mass index (BMI), smoking status, and vigorous activity. BMI consists of five categories: underweight (BMI < 18.5), normal weight (18.5 ≤ BMI < 25), overweight (25 ≤ BMI < 30), obese I (30 ≤ BMI < 35), and obese II/III (BMI ≥ 35). Smoking status includes current smoker and ever smoker with never smoker as the reference group. Vigorous activity is a binary indicator for whether the respondent had vigorous physical activities or sport at least once per week. Number of chronic diseases is a summary score of ever having the following chronic diseases: psychiatric problems (including emotional, nervous, or psychiatric problem), stroke, heart disease, high blood pressure, diabetes, lung disease, cancer, and arthritis. We examine the contributions of both the number of chronic diseases and each individual disease to the cohort trend in CF.

Analytic Methods

We examine the trend in CF across birth cohorts using ordinary least squares (OLS) regression, adjusting for within-subject correlation due to repeated measurements. Age, sex, and race/ethnicity are controlled in the regression to account for basic population compositional changes across birth cohorts. Age is grand-mean-centered. Late Children of Depression is used as the reference group. Trend analysis is conducted for both the whole sample and sex, race/ethnicity, and SES (education, occupation, income, and wealth) subgroups. Then, we examine the trends in explanatory variables across birth cohorts using a variety of generalized linear regression models, adjusting for within-subject correlation, age, sex, and race/ethnicity. OLS is used for a continuous outcome (e.g., height). Binary logistic regression is used for a binary dependent variable (e.g., parental abuse). Ordered logistic regression is used for an ordinal dependent variable (e.g., childhood financial background). Multinomial logistic regression is used for a nominal dependent variable (e.g., BMI categories). Negative binomial regression is used for a count outcome (e.g., CESD). We also use generalized linear mixed effects models with random intercept to examine the cohort trend in CF and explanatory variables. Overall cohort patterns are very similar.

Next, we undertake Karlson–Holm–Breen (KHB) decomposition method (Karlson et al., 2012) to evaluate the contribution of each explanatory variable to the difference in age/sex/race/ethnicity-adjusted cognition between Late Children of Depression and Baby Boomers. We focus on these cohorts because, as our analyses show mean cognition score peaks at Late Children of Depression and significantly declines in Baby Boomers, so our goal is to investigate the causes that may contribute to the declines. As in the trend analysis, age, sex, and race/ethnicity are preadjusted to account for basic population compositional changes across cohorts and to obtain the net contribution of explanatory variables. KHB is a method for comparing the estimated coefficients of two nested generalized linear models. It decomposes total effects into direct and indirect effects. This method can be used as a decomposition technique as well. Like other decomposition techniques (e.g., Blinder–Oaxaca decomposition method), KHB decomposes the difference in the outcome (cognition score in this study) between groups (Late Children of Depression vs Early-Baby Boomers or Mid-Baby Boomers in this study) to the difference in population composition with regard to the explanatory variables (indirect effect) and unexplained components (direct effect). The ratio of indirect effect over total difference in the outcome is the proportion explained by the explanatory variables. Like the trend analysis, decomposition analysis is adjusted for within-subject correlation due to repeated measurements.

Results

Cohort Trend in CF

Table 1 presents the means and standard deviations of cognition scores by cohort and 5-year age group. The mean cognition scores tend to decrease with age within cohorts. Pooled across all cohorts, the mean cognition scores decrease from 23.83 in age group 50–54 to 17.25 in age group 85+. Pooled across all ages, the mean cognition scores increase from 19.08 among the Greatest Generation (1890–1923), peak at 23.51 among War Babies (1942–1947), and decline to 22.69 among Mid-Baby Boomers (1954–1959). Because the age distributions across cohorts are not balanced, the cohort trend in cognition score can be potentially distorted by the age compositions. One way to account for these imbalances is to compare the cognition score across cohorts within each age group. This refined analysis overall confirms the gross cohort comparison, that is the mean cognition scores peak at Late Children of Depression (age 60–64) or War Babies (age 65–74) and decline in the Baby Boomers cohort.

Another way to account for the imbalanced age composition is to adjust for age in the regression analysis. Figure 1 shows the cohort trend in cognition score after adjusting for age, sex, and race/ethnicity compositions. The cognition score peaks at Late Children of Depression and declines afterwards. This pattern is observed almost universally for all sex and racial groups. Females have better CF compared to males, but experience a steeper decline in the Baby Boomer cohort, which reduces the sex gap. Whites have better CF compared to blacks and Hispanics, but the gap narrows in Mid-Baby Boomers compared to the Greatest Generation. The declining CF among the Baby Boomers is also observed across all the levels of SES, including education, occupation, household income, and wealth. Due to the differential rates of decrease, the cognition gap widens across educational categories and income quartiles, but slightly narrows between occupational groups and across wealth quartiles. Since the declining CF among the Baby Boomers cohort is observed in all the subgroups, we focus on explaining

Table 1. Means and Standard Deviations of Cognition Scores by Cohort and Age

	Cohort						
Age	Greatest Generation (1890–1923)	Early Children of Depression (1924–1930)	Late Children of Depression (1931–1941)	War Babies (1942–1947)	Early-Baby Boomers (1948–1953)	Mid-Baby Boomers (1954–1959)	All
50			24.84 (4.54)	24.89 (4.37)	23.94 (4.32)	22.85 (4.40)	23.83 (4.46)
55			24.19 (4.70)	24.31 (4.53)	22.64 (4.71)	22.38 (4.43)	23.56 (4.71)
60			23.62 (4.96)	21.85 (4.64)	21.33 (4.68)	21.11 (5.04)	23.29 (4.98)
65		23.04 (4.80)	23.13 (4.80)	23.18 (4.60)	23.03 (5.12)		23.13 (4.77)
70	21.77 (5.24)	22.27 (4.84)	22.16 (4.87)	22.60 (4.84)			22.19 (4.89)
75	20.93 (5.24)	21.32 (4.95)	21.08 (5.06)				21.11 (5.08)
80	19.43 (5.44)	19.84 (5.18)	19.82 (5.26)				19.62 (5.33)
85	17.09 (5.71)	18.02 (5.52)					17.25 (5.69)
Total	19.08 (5.74)	21.21 (5.19)	22.53 (4.99)	23.51 (4.65)	23.08 (4.71)	22.69 (4.41)	21.66 (5.35)
Number of respondents	5,889	3,888	9,144	3,329	3,876	4,065	30,191
Number of observations	23,946	22,420	49,508	9,769	4,504	4,176	114,323

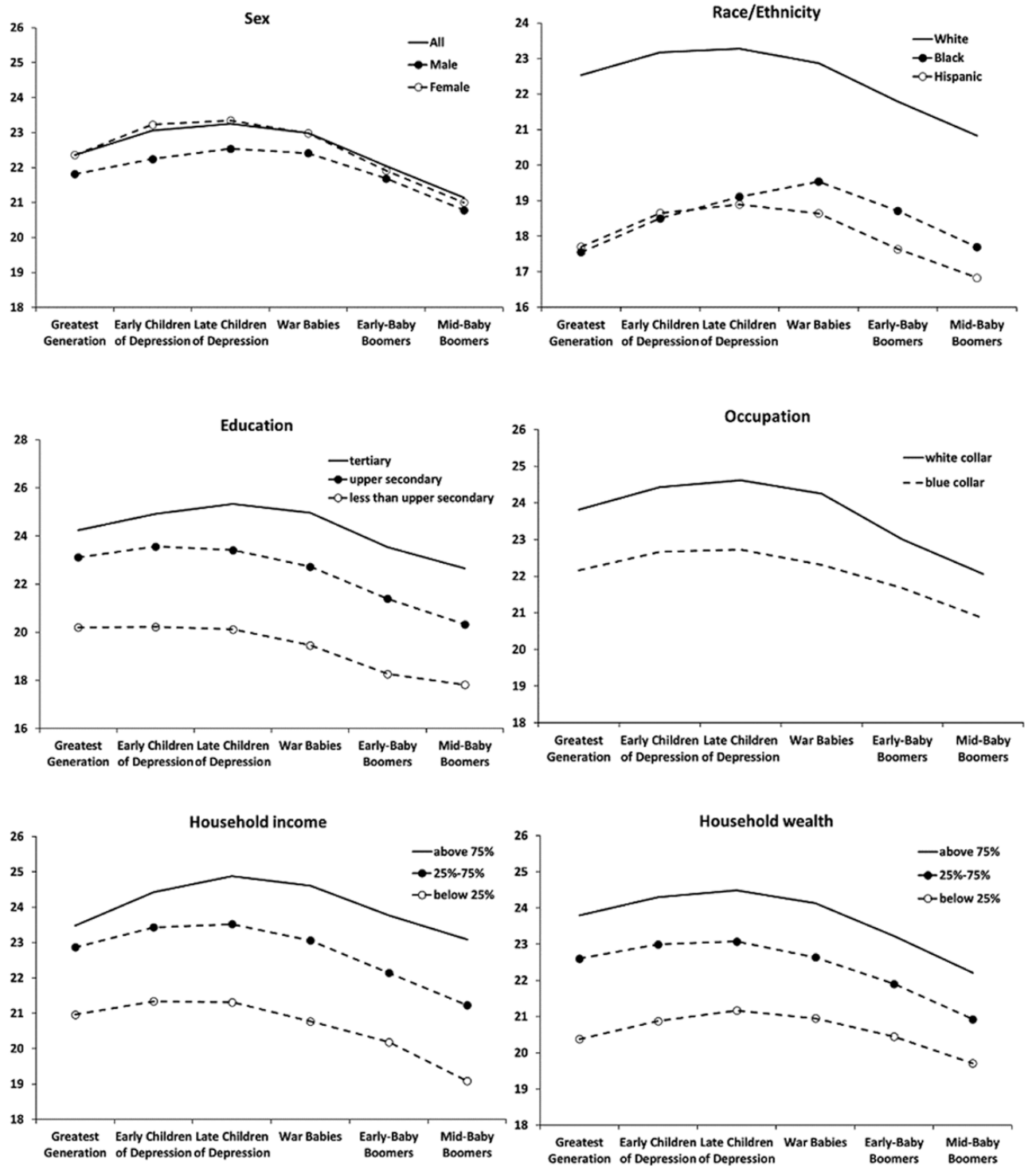

Figure 1. Age/sex/race/ethnicity-adjusted cohort trend in cognition score. All the trends are adjusted for age, sex, race, and ethnicity except that sex trend is adjusted for age and race/ethnicity and race/ethnicity trend is adjusted for age and sex.

the overall cohort pattern instead of subgroup difference in this paper.

Cohort Trend in Childhood and Adulthood Conditions

What may have caused the declining CF among Baby Boomers? We take a comprehensive and life-course approach and investigate a wide range of factors from childhood health, nutrition, and family background, to adulthood SES, psychosocial factors, biobehaviors, and diseases. Table 2 presents the results from various regression analyses. Depending on the nature of outcomes, we use different generalized linear regression methods. Since our focus is to investigate the causes for the declining CF in

Baby Boomers, we use Late Children of Depression, the cohort where cognition score peaks, as the reference group. Compared to Late Children of Depression, Baby Boomers overall have better childhood conditions. They have better health in childhood and come from more advantaged family backgrounds (i.e., better educated parents, more financially secured families) even though their nutrition statuses (measured by adult height) are not significantly different from preceding cohorts. One disadvantage they have is that they are more likely to report being abused by their parents in childhood.

With regard to adulthood SES, Baby Boomers have a mix of advantages and disadvantages compared to Late Children of Depression. They have more years of education and are more likely to have a white-collar occupation, but at the same time they are less likely to be located in higher household wealth quartile. They are generally disadvantaged in the psychosocial domain. They are less likely to be currently married, and more likely to have had multiple marriages. They also have fewer children, are more likely to have no religious affiliation, and report substantially higher levels of loneliness and CESD, even though they do not lack social support any more or less than other cohorts. With regard to adult biobehaviors, even though Baby Boomers are less likely to ever smoke or currently smoke, they are less likely to have weekly vigorous activities and more likely to be obese. They also report higher number of chronic diseases. Breaking down chronic diseases, we find Baby Boomers are more likely to have psychiatric problems, hypertension, diabetes, and stroke, but less likely to have lung disease and arthritis, and report no significant difference in cancer and heart diseases than Late Children of Depression (tables available upon request).

Overall, compared to Late Children of Depression, Baby Boomers have better childhood health and come from families with higher SES. They also have higher levels of education and better occupations even though they have less wealth. They are less likely to be married and have a religious affiliation, and more likely to feel lonely, depressed, and have psychiatric problems. Besides these, they are also more likely to have cardiovascular risk factors (e.g., obesity, physical inactivity, hypertension, diabetes, and stroke).

Factors Shaping Worsening CF Among Baby Boomers

Next, we examine how these childhood and adulthood conditions may contribute to the declining CF among Baby Boomers. Table 3 presents KHB decomposition of contribution of explanatory variables to the difference in age/sex/race/ethnicity-adjusted cognition between Late Children of Depression and Baby Boomers. Because Baby Boomers have better childhood health and come from families with better financial and educational backgrounds as shown in Table 2, these factors negatively contribute to their cognitive decline. Negative contribution can be interpreted as, if not for these factors, Baby Boomers would have performed even worse in CF. They are not significantly different from Late Children of Depression in height; therefore, this factor makes no significant contribution to their cognition difference. Even though Baby Boomers are more likely to report parental abuse in childhood, this factor makes no significant contribution to the cognition difference either. In sum, these observed childhood factors are not the reasons why Baby Boomers perform worse in CF.

Compared to Late Children of Depression, Baby Boomers also have higher education and are more likely to have white-collar jobs, both of which negatively contribute to their lowered CF. In contrast, household wealth explains about 10%–15% of their cognitive decline. Baby Boomers perform significantly worse in psychosocial factors. They are less likely to be currently married and have only one marriage, which explain about 8%–11% and 2%–3% of their cognitive decline, respectively. Their higher level of loneliness and CESD explain about 11%–17% and 10%–12% of cognitive decline, respectively. Baby Boomers also have fewer number of children and are more likely to have no religious affiliation, both of which, however, are negatively related to CF and therefore make negative contributions to their cognitive decline.

Their unhealthy biobehaviors (obesity and physical inactivity) explain about 2%–3% and 6%–11% of their worsening CF. Compared to physical inactivity, obesity plays a substantially smaller role. Number of chronic diseases explains about 4%–5%. Breaking down the number of chronic diseases as shown in Table 4, major contributions come from psychiatric problems (7%–10%), stroke (3%–5%), hypertension (1%–2%), diabetes (about 1%), and heart disease (about 1%). Cancer and arthritis make negative contributions. Overall, Baby Boomers' worsening CF compared to Late Children of Depression can be attributed to their disadvantage in household wealth, marriage, depression, psychiatric problems, and cardiovascular risk factors (e.g., obesity, physical inactivity, hypertension, stroke, diabetes, and heart disease).

Discussion

In this study, we take a direct investigation on the cohort trend up to Baby Boomers in CF over age 50. We find CF has been improving from the Greatest Generation to Late Children of Depression and War Babies, but then significantly declines since the Early-Baby Boomers and continues into Mid-Baby Boomers. This cognitive decline pattern is observed universally across genders, race/ethnicities, education groups, occupations, and income and wealth quartiles, even though the rate of decline may be slightly different across subgroups. The improving CF from the Greatest Generation to cohorts born before the mid-1940s is consistent with the favorable trends in dementia and cognition reported in the literature. Studies have reported declining prevalence and incidence of dementia in the United States

Table 2. Cohort Trend in Childhood Conditions, Adulthood Socioeconomic Status, Psychosocial Factors, Biobehaviors, and Diseases

	Dependent variable: childhood conditions				
Cohort	Better childhood health (ologit)	Height in inches (OLS)	Better childhood finance (ologit)	Parental education (OLS)	Parental abuse (logit)
Greatest Generation	−0.210*** (0.041)	−0.732*** (0.058)	−0.097* (0.046)	−2.069*** (0.059)	−0.760*** (0.190)
Early Children of Depression	0.024 (0.042)	−0.389*** (0.059)	−0.236*** (0.045)	−0.615*** (0.080)	−0.271* (0.131)
Late Children of Depression (reference group)					
War Babies	0.255*** (0.044)	0.004 (0.059)	0.189*** (0.047)	0.647*** (0.079)	0.503*** (0.097)
Early-Baby Boomers	0.277*** (0.042)	−0.114 (0.061)	0.319*** (0.046)	1.221*** (0.078)	0.654*** (0.094)
Mid-Baby Boomers	0.257*** (0.042)	−0.011 (0.060)	0.457*** (0.046)	1.693*** (0.077)	0.752*** (0.098)
N	112,952	114,199	111,563	102,626	83,604

	Dependent variable: adulthood socioeconomic status			Dependent variable: adulthood psychosocial factors	
Cohort	Education (OLS)	White-collar occupation (logit)	Household wealth quartile (ologit)	Currently married (logit)	Married once (logit)
Greatest Generation	−1.036*** (0.066)	−0.293*** (0.053)	−0.466*** (0.037)	−0.192*** (0.042)	0.301*** (0.048)
Early Children of Depression	−0.397*** (0.065)	−0.090 (0.052)	−0.075* (0.036)	0.344*** (0.042)	0.216*** (0.048)
Late Children of Depression (reference group)					
War Babies	0.605*** (0.063)	0.326*** (0.050)	0.175*** (0.038)	0.035 (0.048)	−0.234*** (0.047)
Early-Baby Boomers	1.330*** (0.067)	0.464*** (0.050)	−0.306*** (0.040)	−0.897*** (0.048)	-0.468*** (0.045)
Mid-Baby Boomers	1.365*** (0.066)	0.250*** (0.050)	−0.355*** (0.041)	−1.180*** (0.049)	−0.432*** (0.045)
N	114,212	97,540	114,323	114,224	114,035

	Dependent variable: adulthood psychosocial factors				
Cohort	Number of children (OLS)	No religion (logit)	Loneliness (OLS)	Lack of social support (OLS)	CESD (nbreg)
Greatest Generation	−0.612*** (0.048)	−0.065 (0.106)	−0.014 (0.019)	0.044** (0.016)	0.195*** (0.021)
Early Children of Depression	0.016 (0.049)	−0.109 (0.107)	−0.014 (0.013)	−0.000 (0.011)	0.096*** (0.022)
Late Children of Depression (reference group)					
War Babies	−0.299*** (0.044)	0.552*** (0.090)	0.032* (0.013)	0.014 (0.011)	−0.025 (0.025)
Early-Baby Boomers	−0.917*** (0.043)	1.016*** (0.080)	0.146*** (0.022)	0.022 (0.019)	0.197*** (0.025)
Mid-Baby Boomers	−1.016*** (0.044)	1.326*** (0.078)	0.224*** (0.024)	−0.009 (0.020)	0.282*** (0.025)
N	112,653	114,047	25,712	23,350	114,271

	Dependent variable: adulthood biobehaviors and diseases				
Cohort	Obesity (mlogit)	Ever smoker (logit)	Current smoker (logit)	Vigorous activity (logit)	Number of chronic diseases (OLS)
Greatest Generation	−0.765*** (0.055)	−0.095* (0.045)	0.005 (0.074)	0.185*** (0.034)	−0.774*** (0.028)
Early Children of Depression	−0.387*** (0.048)	−0.028 (0.047)	0.030 (0.064)	0.190*** (0.031)	−0.353*** (0.027)
Late Children of Depression (reference group)					
War Babies	0.219*** (0.045)	−0.075 (0.049)	−0.065 (0.056)	−0.202*** (0.034)	0.229*** (0.029)
Early-Baby Boomers	0.256*** (0.047)	−0.445*** (0.046)	−0.263*** (0.052)	−0.594*** (0.040)	0.132*** (0.028)
Mid-Baby Boomers	0.352*** (0.048)	−0.411*** (0.046)	−0.238*** (0.050)	−0.610*** (0.040)	0.199*** (0.028)
N	112,824	113,561	113,516	114,143	114,316

Notes: All models include age, gender, race, and ethnicity. CESD = Center for Epidemiological Studies-Depression; logit = binary logistic regression; mlogit = multinomial logistic regression; nbreg = negative binomial regression; ologit = ordered logistic regression; OLS = ordinary least squares regression.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Karlson–Holm–Breen Decomposition of Contribution of Mediators to the Difference in Age/Sex/Race/Ethnicity-Adjusted Cognition Score Between Late Children of Depression and Baby Boomers

	Mediator: childhood conditions				
Cohort	Better childhood health	Height in inches	Better childhood finance	Parental education	Parental abuse
Late Children of Depression (reference group)					
Early-Baby Boomers	−6.21%**	1.33%	−4.18%***	−26.73%***	0.77%
Mid-Baby Boomers	−3.64%**	0.07%	−3.38%***	−20.94%***	0.57%
N	112,952	114,199	111,563	102,626	83,604
	Mediator: adulthood socioeconomic status			Mediator: adulthood psychosocial factors	
Cohort	Education	White-collar occupation	Household wealth	Currently married	Married once
Late Children of Depression (reference group)					
Early-Baby Boomers	−67.39%***	−20.38%***	**15.23%***	**10.65%***	**3.16%***
Mid-Baby Boomers	−39.09%***	−5.64%***	**10.14%***	**7.97%***	**2.29%***
N	114,212	97,540	114,323	114,224	114,035
	Mediator: adulthood psychosocial factors				
Cohort	Number of children	No religion	Loneliness	Lack of social support	CESD
Late Children of Depression (reference group)					
Early-Baby Boomers	−8.24%***	−3.13%**	**17.40%***	2.74%	**11.89%***
Mid-Baby Boomers	−5.19%***	−2.82%**	**11.01%***	−0.33%	**9.81%***
N	112,653	114,047	25,712	23,350	114,271
	Mediator: adulthood biobehaviors and diseases				
Cohort	Obesity	Smoking	Vigorous activity	Number of chronic diseases	
Late Children of Depression (reference group)					
Early-Baby Boomers	**2.79%***	−0.93%	**10.83%***	**4.69%****	
Mid-Baby Boomers	**2.10%***	0.36%	**6.33%***	**4.03%***	
N	112,824	113,207	114,143	114,316	

Note: The bold number indicates the corresponding factor makes a significant contribution to the cognitive decline among Baby Boomers. CESD = Center for Epidemiological Studies-Depression.
**$p < .01$. ***$p < .001$.

over the last few decades (Freedman et al., 2018; Langa et al., 2008; Satizabal et al., 2016; Wu et al., 2017), for example, significant decreases in the proportion of individuals with severe cognitive impairment between 1993 and 1998 (Freedman et al., 2002) and between 2000 and 2012 (Langa et al., 2017). Similarly, the trends in CF have also been improving across birth cohorts (Dodge et al., 2017; Gerstorf et al., 2011; Hendrie et al., 2018), for example, improving verbal memory spanning four decades of birth cohorts from 1902 to 1943 (Dodge et al., 2017). Most of the aforementioned studies tend to focus on population roughly 70 and older and cover the cohorts born before the mid-1940s.

The declining CF results among Baby Boomers stand in sharp contrast to those found elsewhere for the population aged 70 and older or earlier birth cohorts. But this finding is in line with some recent studies, which find stabilizing prevalence of dementia, increasing prevalence of disability and functional limitations, and elevated mortality for those approaching middle age and young old since the late 1990s (Case and Deaton, 2017; Choi et al., 2018; Freedman et al., 2013; Fuller-Thomson et al., 2009; Martin et al., 2009, 2010; Zang et al., 2019). For example, Choi and colleagues (2018) found the prevalence of cognitive limitation stabilized while CF worsened among Americans ages 55–69 between 1998 and 2014. Martin and colleagues (2009) reported stabilizing functional limitations while increasing cardiovascular disease, obesity, diabetes, and the need for help with personal care for the 40–59 population between 1997 and 2006. Case and Deaton (2017) found morbidity and mortality rates have elevated in the middle-aged since the late 1990s.

We further investigate the reasons for this declining CF among Baby Boomers compared to Late Children of Depression. We find this cognitive decline does not originate from childhood conditions, adult education, or occupation. In fact, if not for their better childhood health, more favorable family background, more years of education, and higher likelihood in white-collar occupation, Baby Boomers would have had even worse CF. In spite of higher levels of education and white-collar occupation, Baby Boomers have lower household wealth compared to previous cohorts, which explains 10%–15% of their cognitive decline. Lower household wealth reflects not only a

Table 4. Karlson–Holm–Breen Decomposition of Contribution of Chronic Diseases to the Difference in Age/Sex/Race/Ethnicity-Adjusted Cognition Score Between Late Children of Depression and Baby Boomers

	Mediator: chronic disease							
Cohort	Psychiatric problem	Stroke	High blood pressure	Diabetes	Heart disease	Lung disease	Cancer	Arthritis
Late Children of Depression (reference group)								
Early-Baby Boomers	**10.08%*** **	**4.77%*** **	**1.52%** **	**1.13%** **	**0.87%**	−0.42%	−0.47%	−1.92%**
Mid-Baby Boomers	**6.58%*** **	**2.97%*** **	**1.36%*** **	**0.52%**	**0.88%** **	0.47%	−0.52%**	−1.39%***

Note: The bold number indicates the corresponding factor makes a significant contribution to the cognitive decline among Baby Boomers.
$^{**}p < .01$. $^{***}p < .001$.

lower level of absolute wealth but also a lower rank in the population, which may be a more direct cause of distress. In addition, Baby Boomers are less likely to be married or have a stable marriage. They face significantly higher level of loneliness, depression, and psychiatric problems. They also have more cardiovascular risk factors (e.g., obesity, physical inactivity, hypertension, stroke, diabetes, and heart disease). Among the chronic diseases examined, psychiatric problems explain CF more than all other diseases combined (see Table 4). Prior studies have reported the increases in cardiovascular risk factors among newer cohorts of people approaching middle and old age (Martin et al., 2009, 2010), and increases in depression across successive birth cohorts in the United States (Twenge, 2015). Depression has a strong association with difficulties in managing work, disabilities, household responsibilities, relationship, and social roles (Kessler et al., 2003; Martin et al., 2010), all of which can have a long-lasting negative consequence on CF. "Death of despairs" also have been identified as the contributors to the elevated mortality rates among the Baby Boomers (Case and Deaton, 2017).

In order to test the robustness of these findings, we undertake several sensitivity analyses. First, we break down summary cognition score into two domains: (a) immediate and delayed word recall (20 points), and (b) a serial sevens subtraction test, backwards counting, object, date, and President/Vice-President naming tasks (15 points). Overall patterns are similar across these two domains, although the decline is more pronounced in the first domain. We also create a total score of CF based on immediate and delayed word recall, serial sevens, and backwards counting (27 points) (Crimmins et al., 2011) and find the overall cohort pattern is similar. Second, Baby Boomers are not included in the HRS until 2004. Cognitive test scores may improve through repeated testing across survey waves (Dodge et al., 2017; Rodgers et al., 2003). To address differential testing exposures across cohorts, we constrain the sample to the first observation for each respondent, conduct identical analyses, and find the pattern of declining CF among Baby Boomers is unchanged. Third, about 6% of interviews completed by proxy respondents were excluded because they did not take a cognitive test. We impute the missing value of cognition score for the proxy interviews with the last available cognition score. The overall cohort pattern is robust to inclusion of proxy interviews. Finally, related to the last issue, like all the longitudinal data, HRS may suffer from attrition bias, due either to mortality or nonmortality dropout. But attrition bias should not be the major cause here; otherwise, we should expect the oldest cohort Greatest Generation has the highest cognition score. In addition, attrition bias tends to occur in older ages and later waves. But Baby Boomers already start having lower cognition score than Late Children of Depression and War Babies at age 50–54 (Table 1). We further conduct two analyses to test the attrition bias. First, we test whether the attrition in the next wave is associated with cognition score in the previous wave conditional on the observed covariates and find the missing mechanism follows MAR (missing at random). Second, we apply the selection model of Diggle and Kenward (1994) and the shared parameter model of Follmann and Wu (1995) to account for the mortality selection and nonmortality dropout biases jointly, and coefficients are only slightly changed, which is because the attrition is MAR conditional on the observables.

There are limitations to our analysis. First, we use the HRS cognitive test score as a measurement of CF. It is important to replicate the analysis with clinical and neuropsychiatric assessments of cognitive function. Second, even though we do not find practice tests can change the overall cohort pattern, future work should utilize more waves of data when they become available to test the robustness of the results. Third, we have limited childhood condition indicators. Future work should utilize more childhood information, especially cognitive test scores and direct measures of nutrition and illness, to examine whether the worsening CF in old age among Baby Boomers may originate from other unobserved childhood conditions. Fourth, substance abuse has been identified as an important cause of elevated mortality among Baby Boomers. Future research should explore whether it also contributes to the worsening CF among this cohort. Fifth, the trend in CF has important implications for dementia as these recent "young olds" turn into older ages in the coming decade. Future research should monitor trends in dementia for these birth cohorts as they reach older ages and cognitive impairment becomes more common. Sixth, we have not examined disparities in CF trends by sex, race, ethnicity,

and SES because such analysis is beyond the scope of this paper and the overall cohort pattern is universal across these subgroups. But such analysis may be valuable in ascertaining explanations for the trends found here.

Despite these limitations, this paper portrays a clear and alarming cohort pattern in CF, which is different from the overall favorable pattern in dementia over time found in prior studies. Based on our analyses, the worsening CF among Baby Boomers can be attributed to lower household wealth, lower likelihood of marriage, higher levels of loneliness, depression and psychiatric problems, and more cardiovascular risk factors (e.g., obesity, physical inactivity, hypertension, stroke, diabetes, and heart disease). This decline may potentially reverse past favorable trends in dementia as Baby Boomers reach older ages and cognitive impairment becomes more common if no effective interventions and policy responses are in place. Measures, such as increasing financial support, promoting social relationships, encouraging physical activities, and treating psychiatric and cardiovascular diseases, may well pay off in slowing or even preventing the potential increase in dementia in the decades to come.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

Funding

This publication was supported by the grant P2CHD058484 funded by the Eunice Kennedy Shriver National Institute for Child Health and Human Development, R03AG053463 funded by National Institute on Aging, and R03SH000046 funded by Centers for Disease Control and Prevention. The content is solely the responsibility of the author and does not necessarily represent the official views of the National Institutes of Health, the Centers for Disease Control and Prevention, or the Department of Health and Human Services.

Author Contributions

H. Zheng is the sole author of this paper. He is responsible for designing the study, conducting the analyses, and writing the manuscript.

Conflict of Interest

None declared.

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