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Ripple effects of developmental disabilities and mental illness on nondisabled adult siblings

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Abstract

Developmental disabilities and severe mental illness are costly to the affected individual and frequently to their family as well. Little studied are their nondisabled siblings. Here we examine major life course outcomes (education, employment, and marriage) of these siblings in adulthood using data from the Wisconsin Longitudinal Study. Our sample comprises 113 individuals with developmental disabilities and 337 of their nondisabled siblings; 97 individuals with mental illness and 235 of their nondisabled siblings; and 17,126 unaffected comparison group members. We find that siblings of individuals with mental illness have less education and less employment than the unaffected comparison group, whereas those who have a sibling with developmental disabilities had normative patterns of education and employment, but less marriage and more divorce. Robustness tests incorporating genetic data do not change the conclusions based on the nongenetic analyses.

Keywords

U.S.A; Siblings; Developmental disabilities; Severe mental illness; Education; Life course

Introduction

Developmental disabilities and serious mental illness are prevalent in American society, placing individuals with such conditions at heightened risk for divergent life course outcomes. Approximately 1.5% of the U.S. population has a developmental disability (DD)

such as Down syndrome, autism, or hundreds of other genetic and nongenetic causes of intellectual disability (formerly referred to as mental retardation; Larson et al., 2001). Individuals with DD are at high risk for unemployment and psychological distress and low likelihood of marriage (Fujura, 2003); they continue to rely upon their families in adulthood because most do not establish their own households or have children (Shattuck et al., 2012; Wells, Sandefur, & Hogan, 2003). Serious mental illness (MI) is more common, with a prevalence of 4.6% of the adult population in the United States (SAMHSA, 2012). Few studies have examined whether major life course outcomes (i.e., education, marriage, and employment) are divergent among nondisabled siblings who have a brother or sister with these disabilities.

For the present study, we compared siblings who have brothers or sisters with DD or MI with brothers and sisters who have no known disabilities using population-level data drawn from the Wisconsin Longitudinal Study, a cohort study based on a randomly selected sample, with data spanning a period of 50 years in the lives of participants. Virtually all past research on the lifelong effects of having a brother or sister with DD or MI was based on volunteer samples, thus the present study represents an opportunity to examine sibling effects in a population-based sample.

The emphasis of available research on sibling effects has been on the cognitive functioning and psychological well-being of nondisabled siblings. For example, Fletcher, Hair, and Wolfe (2012) recently found that having a sibling with a DD was associated with reductions in high school math and language achievement. However, there is a large body of research suggesting that most siblings of individuals with DD are indistinguishable from their age peers with respect to psychological functioning (for review, see Stoneman, 2005). Indeed, many siblings of individuals with DD experience positive reactions to having a sibling with disabilities (Hodapp, Urbano, & Burke, 2010; Taunt & Hastings, 2002), and develop positive personality characteristics (Cuskelly & Gunn, 2003; Stoneman, Brody, Davis, & Crapps, 1989), possibly because of early socialization. These personality traits developed during childhood may become psychological resources that siblings can draw on to succeed in major adult roles. In contrast, siblings of individuals with MI have been shown to have elevated rates of depression and neuroticism, poorer overall psychological well-being, and lower levels of cooperativeness and extraversion than controls (Farmer et al., 2003; Masi et al., 2003; Taylor, Greenberg, Seltzer, & Floyd, 2008). Recent longitudinal findings suggest that these effects persist across the life course (Taylor et al., 2008). However, no previous research using representative population-based samples have examined whether nondisabled siblings are at risk of altered life course outcomes in the realms of education, employment, and marriage by midlife.

We focus on the experience of siblings of persons with DD or MI separately because the timing of these over the life course suggests that their lives may be differentially affected. Whereas the great majority of children with DD are diagnosed at birth or in the first few years of life, MI is typically diagnosed during adolescence or young adulthood, although prodromal symptoms may be present in childhood. As a result of the difference in timing of the onset of the disability, siblings of persons with MI may not experience this family disruption until their adolescent and young adult years, when education and career goals are

in the process of being shaped. In contrast, most siblings of individuals with DD have many years before adulthood to acclimate to their sibling's difficulties and therefore, may experience fewer disruptions in their life course. Yet siblings of persons with DD are often asked at an early age to take on a caregiving role. Using a national volunteer survey, Hodapp et al. (2010) found that relative to the U.S. population, female siblings of persons with DD married later but had lower rates of divorce. This suggests that siblings of adults with DD may delay marriage to help care for their sibling with DD, but once married they may be less likely to be divorced, possibly due to their psychological resources (i.e., conscientiousness, agreeableness) and greater maturity due to later age of marriage, which are both related to marital stability (Shaver & Brennan, 1992).

Furthermore, the course of DD is distinctly different from the course of MI. Whereas DD tends to be characterized by relative stability in day-to-day functioning, the symptoms of MI are more episodic and have a less predictable course. The unpredictable nature of the symptoms may increase the day-to-day uncertainty of the well-sibling's life, even for siblings who live apart from their brother or sister with MI. The unpredictable course of MI is also known to affect the marriage of their parents (Cook, Hoffschmidt, Coher, & Pickett, 1992) and the available research suggests that this pattern spills over and may also negatively affect the marriage of their nondisabled siblings (Seltzer, Greenberg, Krauss, Gordon, & Judge, 1997). For different reasons (i.e., the unpredictable nature of MI, the long-term caregiving needs of adults with DD), having a sibling with DD or MI may increase the siblings' risk of off-time transitions (e.g., delayed or interrupted marriage or labor force participation). Yet these sibling effects have not yet been studied using population-based samples.

Additionally, from a life course perspective, the concept of linked lives, positing that "individual lives are intimately connected to the lives of others, and individual development is bound to and shaped by these ties" (Settersten, 2003, p. 38), suggests that DD and MI not only will result in life course disruptions for the individual with the condition but also for the members of their family. For this reason we study alterations in patterns of education, marriage, and employment both in nondisabled siblings of adults with DD or MI and in their brothers and sisters with disabilities.

Finally, we recognize that early adverse childhood experiences that are independent of having a sibling with a disability will likely have long-term effects on life course outcomes on nondisabled siblings, and these need to be controlled in the analysis of sibling effects. For example, parental divorce or separation (Huurre, Junkkari, & Aro, 2006; McLanahan & Sandefur, 1997), parental death (Lansford et al., 2006; Schmiede, Khoo, Sandler, Ayers, & Wolchik, 2006), and low socioeconomic status (Haveman & Wolfe, 1995) have all been shown to affect long-term life course outcomes, and in the present research, we take these into account.

The present study

Our major research question is whether nondisabled siblings of individuals with DD and MI have divergent life course outcomes in the domains of education, employment, and marriage

compared to their nondisabled age-peers who do not have a sibling with a disability or chronic condition. We conducted three sets of analyses.

First, for the major analysis of this study, we focused on the nondisabled siblings of individuals with DD and MI. On the basis of theory and prior research, we hypothesized that siblings of adults with severe MI would have lower levels of educational attainment and employment, decreased likelihood of ever having been married, and higher rates of divorce. The existing literature on siblings of individuals with DD shows few differences between these siblings of individuals and their age peers except in the realm of marriage (Hodapp et al., 2010; Stoneman, 2005); hence, we hypothesized that siblings of individuals with DD would be similar to their age-peers with respect to educational attainment and employment, but would show divergent marital patterns.

Second, we conducted an analysis to benchmark the extent to which individuals with DD and MI *themselves* have divergent patterns of life course outcomes during the transition to adulthood and into the adult years. Although much past research has shown such patterns of poorer life course outcomes for adults with MI (Breslau et al., 2011; Ettner, Frank, & Kessler, 1997; Forthofer, Kessler, Story, & Gotlib, 1996; Jayakody, Danzinger, & Kessler, 1998; Kessler, Foster, Saunders, & Stang, 1995; Kessler, Walters, & Forthofer, 1998; Kessler et al. 1997), almost no population-based studies have been conducted in the United States focused on life course outcomes of adults with DD. Thus, our second analysis was conducted to quantify the magnitude of the divergence of individuals with disabilities in educational, marital, and employment outcomes.

Finally, in an exploratory analysis, we conducted robustness tests by incorporating genetic data available on a large subgroup of respondents in order to reduce the likelihood that the hypothesized sibling effects were due to shared genetic vulnerabilities of the nondisabled siblings of adults with MI, in particular. We hypothesized that the differences between siblings of individuals with MI and the comparison group would be reduced in magnitude once genes known to be associated with mental health problems are brought into the analysis. To the extent that the estimates are unchanged from models without genetic controls, we interpret our results as preliminary suggestive evidence that we are measuring the influence of having a disabled sibling rather than simply shared genetics. We did not expect a reduction in effect to be evident in siblings of individuals with DD since the genetic control we used was risk for depression.

Method

Data and sample

The Wisconsin Longitudinal Study (WLS) is a one-third random sample of 10,317 women and men who graduated from Wisconsin high schools in 1957 (Hauser, Sheridan, & Warren, 1998). Follow-up surveys were conducted in 1975 with 9138 (90.1%) surviving members of the original sample when they were, on average, 36 years old; in 1992 with 8493 (87.2%) of the surviving original respondents when they were in their early 50s; and again in 2004 with 7265 (80.0%) of the surviving respondents when they were in their mid-60s. Family background data in 1957 and high school IQ scores were also available for the respondents.

Nearly all of the respondents were White (99.7%), reflective of Wisconsin's population in the mid-twentieth century.

For the present analyses, we used data pertaining to three generations: WLS respondents, their parents, and their children. The dependent measures were based on the patterns of life course attainment of the children. The research was declared exempt by the University of Wisconsin–Madison's IRB (Wolfe SE-2009-0786).

We drew on data from all four of the available WLS surveys (1957, 1975, 1992, and 2004). The 1957 and 1975 surveys provided data about the WLS respondent's background (e.g., socioeconomic status of their parents and circumstances surrounding the respondent's transition to adulthood, marriage, and childbearing); at the time of these surveys, the WLS respondents were age 18 and 36, respectively. The 1992 data measured challenging family circumstances that the children of WLS respondents might have encountered apart from having a sibling with a disability (e.g., parental divorce, unemployment, drinking, health problems, and early death); in 1992, the WLS respondents averaged 53 years of age and their children averaged 25 years. The 2004 data were used for the major dependent variables of the present study, reflecting the patterns of attainment of the children of the WLS respondents at around age 37; by this age, education is mainly completed, and patterns of marriage and employment are well established.

We identified WLS respondents who had a biological or adopted child with DD or MI and who had one or more other children. In 2004, screener questions were asked to identify whether any of the children of the WLS respondents had developmental disabilities or mental illness. The screener consisted of a maximum of 31 questions that began by asking parents if any of their children (living or deceased) had a developmental disability or serious long-term mental health problems, and if so, the specific diagnosis. If the parent indicated that the son or daughter had a specific developmental disability (e.g., Down syndrome, cerebral palsy, fragile X syndrome, autism spectrum disorder), or used terms such as "developmental disability," "mental retardation," or "cognitive disability," then that child was included in the developmental disabilities sample. In a few cases, the parent did not know the specific diagnosis given to his or her child, but indicated that the child had difficulties in school. In such cases, branching follow-up questions asked if the child was below-average in intelligence, attended special education classes, and/or had difficulty performing activities of daily living. If so, he or she was included in the developmental disabilities sample. In addition, when a parent indicated that the child had epilepsy or seizures, the question about intelligence was asked, and only if the epilepsy was accompanied by below-average intelligence was the child included in the developmental disabilities group. Of 20,305 children of WLS respondents, 152 (.75%) were identified as having a developmental disability. Among them, 124 (81.6%) were still alive in 2004 and had at least one sibling. However, 11 were dropped from the analytic sample because (a) their siblings did not qualify for the study sample (e.g., the sibling was deceased or had his or her own disability, mental health condition, or other chronic health problems); (b) there were missing data on key variables (e.g., age); or (c) the sibling was younger than age 25 in 2004. As a result, 113 children of WLS respondents with developmental disabilities who had at least one living nondisabled sibling were included in the present analyses (52 mental

retardation, 14 autism spectrum disorder, 17 cerebral palsy, 15 Down syndrome, 3 brain injury before age 22, and 12 other developmental disabilities). Additional inclusion criteria are described below.

If the respondent answered affirmatively that a child had serious long-term mental health problems and indicated that a professional diagnosed the child as having bipolar disorder (also known as manic depression) or schizophrenia, he or she was included in the mental illness sample. If the child had ever been diagnosed as having depression, follow-up questions were asked if the child was ever a patient in a hospital overnight or longer because of his/her depression, or was unable to go to work or school, take care of his/her home and family, or take care of himself/herself during the depressive episode. Of 20,305 children of WLS respondents, 225 (1.1%) were identified as having long-term mental health problems and 208 of them (92.4%) were living in 2004. We focused on those whose symptoms began prior to age 21 and who had at least one nondisabled living sibling. Of 208 living children with mental health problems, 183 (88.0%) had valid information regarding the age of onset of the mental illness, and 118 of them experienced the onset of the condition before age 21 (64.5%). Of these 118 adult children, 114 had at least one sibling. However, 17 adult children with mental health problems were dropped from the analytic sample because (a) their siblings did not qualify for the study sample (e.g., the sibling was deceased or had his or her own disability, mental health condition, or other chronic health problem); (b) there were missing data on key variables (e.g., age); or (c) the sibling was younger than age 25 in 2004 or older than age 21 at the onset of the sibling's mental illness. As a result, 97 adult children with mental health problems who had at least one unaffected sibling were included in the analytic sample (48 bipolar disorder, 25 schizophrenia, 24 major depression).

The primary sample members were the *siblings of these children with DD or MI*. A total of 337 nondisabled siblings of individuals with DD and 235 nondisabled siblings of individuals with MI met all of these inclusion criteria.

We also identified a comparison group sample ($n = 17,126$), which consisted of WLS respondents' adult children in families where none of the children had DD, MI, or any chronic disease or physical conditions. All adult children who fulfilled the above condition and were 25 years and older in 2004 were included in the comparison sample. Multi-level models were used to account for potential dependency in the data emanating from including multiple children from the same family in the analysis (see below).

Measures

We used eight dependent variables measuring education, marital status, and employment status of the children of WLS respondents. Education was measured by parent-reported number of years of schooling. We also constructed three dichotomous variables indicating whether the adult child had achieved 12, 14, and 16 years of education or more (1 = yes, 0 = no). Three other dependent variables were used to assess the marital domain: marital history (1 = never been married, 0 = ever married [currently married, divorced, widowed]); current (2004) marital status (1 = married, 0 = not married); and current divorce status (1 = divorced, 0 = currently married or widowed). The final dependent variable was current employment status (1 = employed, 0 = not employed).

The key independent variable was sibling status, defined as whether the child had a sibling with a DD or MI or was a member of the comparison group. A number of other independent variables were included in the analysis. In Model 1, we entered a set of exogenous variables shown in past research to be associated with educational attainment, marital status, and employment in the general population. These included characteristics of the WLS respondents in 1957 (prior to becoming parents), family income, religious affiliation, whether they grew up in a rural or urban area, high school IQ, and whether they planned to marry right after high school. The income of the parents of WLS respondents (grandparents of the generation of interest) in 1957 was obtained from federal tax data for the years 1957 through 1960, averaged, and log transformed. Family religion was coded as a dichotomous variable (1 = Catholic, 0 = others). IQ was coded as a dichotomous variable (1 = IQ $\geq$ 100, 0 = IQ < 100) as measured by the Henmon–Nelson Test of Mental Ability (Henmon & Nelson, 1942). The population in 1957 of the community in which the WLS respondent attended high school was coded as rural (population $\leq$ 2500), urbanized area (population 25,000), or urbanized cluster (population is between 2500 and 25,000). The WLS respondent's plans regarding marriage in 1957 were coded as a dichotomous variable (1 = planned to get married during the next year, 0 = did not have such a plan). Finally, we controlled for sex (1 = female) of the sibling whose brother or sister had a DD or serious MI.

We also included a set of exogenous variables measured in 1975 that characterized the family structure and environment in which the children of WLS respondents grew up. These include the educational attainment of the WLS respondent and his or her spouse, as well as family income (log transformed). In addition, we included the birth order of each child (counting deceased children); the age of the mother at the birth of each child (less than or equal to age 19, age 20 to 34, and age 35 or greater); and the number of children in the family as of 1975.

Model 2 added the key independent variables that were the focus of this study. The core variables were *having a sibling with DD and having a sibling with MI vs. the comparison group*. Two other dichotomous variables were also included in Model 2, one each for the child who had the condition (either DD or MI) vs. being a member of the comparison group; the coefficients associated with these latter two variables indicated the effects of *having DD or MI*. Three other dichotomous control variables were included in Model 2 signifying whether the sibling was adopted, whether there was another child who was adopted in the family, and whether the sibling had a brother or sister who was deceased.

Model 3 adds on several measures of stressful family circumstances that might be a consequence of having a child with a disability in the family or related to other life challenges faced by the family during the child's formative years. These were measures of the WLS respondents' unemployment status in 1975, binge drinking and the number of diagnosed illnesses (obtained in 1992), and whether a parent divorced or died before the child was age 18. Parents' unemployment status was coded as a dichotomous variable (1 = head of the household was unemployed, 0 = head of the household was employed). Parents' binge drinking was measured by the question asking whether the parent had five or more drinks on at least one occasion during the past month and was coded as a dichotomous variable (1 = binge drinking, 0 = no binge drinking). Parents also indicated if a medical

professional had ever diagnosed them with one of 16 illnesses (e.g., asthma, bronchitis, cancer, diabetes); affirmative answers were counted (0–16). A parent's divorce status and death before the child was age 18 were coded as dichotomous variables (1 = parent divorced [died] before the child reached age 18, 0 = parent was not divorced [had not died] before the child reached age 18).

In Model 4, we added genetic data. Genetic data were available for a subset of WLS participants who provided saliva samples from which DNA was extracted. In 2006, Oragene DNA sample collection kits (DNA Genotek, Kanata, Canada) were sent to WLS respondents, with a response from 4569 participants (Roetker et al., 2012). DNA was available for one parent of 50 individuals with DD, 70 individuals with MI, 160 nondisabled siblings of individuals with DD, 175 nondisabled siblings of individuals with MI, and 9963 nondisabled individuals in the comparison group. An indicator of genetic risk for depression of the WLS respondent was included in the analyses with the subsample of genetic data (see below for details regarding how this indicator variable was constructed). Model 4.1 used the smaller genetic sample replicating Model 3 while 4.2 added the genetic risk variable.

Data analysis

As a first step, we examined whether in 1957, WLS respondents who later had a child with DD or MI differed systematically in other ways from WLS respondents who later had only nondisabled children. For this analysis, we estimated logistic regressions including measures of the family background of the WLS respondent, circumstances regarding the WLS respondent's transition to adulthood, and circumstances of the birth of the child (results available from the first author). We found that having a child with either DD or MI was more likely when the child came later in the birth order and when the child was adopted. Additionally, parents who grew up in rural areas were less likely to have a child with DD, whereas having a child who later developed MI was more likely among parents who had higher IQs and among fathers who had had more education. We controlled these variables in all subsequent analyses. No other variables were statistically significant in this estimation.

For our primary analysis to examine the effects of having a sibling with DD or MI on adult outcomes, we estimated multilevel models using Stata to control the potential dependency in the data due to inclusion of multiple children from a family. For missing cases on grandparent's income in 1957, mother's education, father's education, family income in 1975, and the number of diagnosed illnesses in 1992, dichotomous flag variables (1/0) indicating missing values on these variables were included in the analysis and –1 was assigned for the missing values.

To test the robustness of the results, we also estimated models including a genetic risk variable for the subgroup of the sample for whom the genetic data were available ($n = 4,569$, 56.1% of the 2004 participants). DNA was extracted from the saliva samples and genotyped for 78 single-nucleotide polymorphisms (SNPs). We built our analysis on a previous WLS study that used the genetic data to predict lifetime history of depression (Roetker et al., 2012). Based on the findings of the Roetker et al. study, we classified WLS respondents as at genetic risk if they tested positive for risk allele(s) identified as increasing the lifetime risk of depression. Specifically, among WLS men, one gene was identified by Roetker et al. to

raise the probability of having a lifetime history of depression 2.13 times higher than baseline incidence, from 9.9% to 21.1% (those who had the T/T allele of *ANKK1*, rs1800497, which historically was referred to as *DRD2* Taq1A). In this same analysis, four genes were found to significantly raise the probability of having a lifetime history of depression in women, which in the overall WLS was 19.5%. Women who had the T/T allele of *DRD2* rs2242592 and the T/T allele of *APOC3* rs45537037 and either the C/C or the T/T allele of *ACVR2B* rs3749386 had a 27.7% risk of having a lifetime history of depression, which was approximately 1.42-fold higher than the baseline incidence. Women who had either the C/C or the T/C allele of *DRD2* rs2242592 and who had either the C/C or T/T allele of *FTO* rs1421085 also had 25.8% risk of having a lifetime history of depression, which was 1.32-fold higher than baseline incidence.

Based on the Roetker et al. (2012) analyses, we created a genetic risk variable for our test of robustness whereby if a male WLS respondent had the T/T allele of *ANKK1*, he was coded as 1; otherwise 0. If a female WLS respondent had one of the specified allele combinations noted above, she was coded as 1; otherwise 0. We were thus able to designate nondisabled siblings as the child of a parent (either the father or the mother based on which parent was the WLS respondent) who had a genetically increased risk of depression. After first re-running Models 1, 2, and 3 to confirm that this smaller subsample had results consistent with those for the entire sample, we then added this genetic indicator as an independent variable to test the robustness of our findings.

Results

Patterns of attainment in siblings of individuals with disabilities

Do nondisabled siblings of individuals with DD and MI show divergent patterns of attainment? Descriptive data are shown in Table 1 and multivariate models in Tables 2–4. (See Table 2 for the full model specifications. The results reported in Tables 3 and 4 present only the estimates for the key independent variables of interest.) As shown in Model 2 of Table 2, consistent with our hypothesis, siblings of individuals with MI had significantly less education than the comparison group (tables from models predicting high school completion or two years or four years of postsecondary education available from the first author). The reduction in their years of schooling, slightly more than .4 of a year, is nearly 20 percent of one standard deviation in years of schooling. Regarding the marital domain (Table 3), counter to our hypotheses, there were no differences between siblings of adults with MI and the comparison group in current marital status, likelihood of ever having been married, or among those who ever married, of being divorced. But, as hypothesized, siblings of individuals with MI were significantly less likely to be currently employed. Specifically, siblings of individuals with MI were almost twice as likely to be unemployed than the comparison group.

Among siblings of individuals with DD, there were no significant differences from the comparison group in educational attainment or rates of employment. Instead, these siblings were significantly less likely to be currently married than the comparison group (see Table 3, Model 3). Siblings of individuals with DD were 1.3 times less likely to be currently married than the comparison group. There were no significant differences in the likelihood

of ever being married in siblings of individuals with DD, but there was a significantly higher likelihood of being divorced. The odds of divorce among sibling of individuals with DD were 1.5 times greater than in the comparison group.

All of these effects on education, employment, and marriage were net of other sources of family stress – parental divorce, unemployment, binge drinking, health problems, and early death (see Model 3, Tables 2–4).

To summarize the ripple effects of having a sibling with a disability, those who had a sibling with MI had less education and were less likely to be employed as they reach midlife than the comparison group who did not have any siblings with a disability. Those who had a sibling with DD had normative patterns of education and employment, but were less likely to be currently married and more likely to be divorced at this stage of life. Thus, the profile of sibling effects is dependent on the type of disability of the brother or sister, in part likely reflective of the severity of family stress but also possibly a result of shared genetic vulnerability. We return later to the possibility of genetic vulnerability of the nondisabled siblings, particularly among siblings of individuals with MI.

Patterns of attainment in individuals with disabilities

We also considered whether individuals with DD and MI themselves had divergent patterns of life course outcomes in contrast to age-peers who did not have disabilities. As shown in Table 2, both groups of individuals with disabilities had significantly lower levels of educational attainment, whether measured as years of education, completion of high school, or two or four years of postsecondary education. Descriptively (see Table 1), individuals with DD averaged 11.9 years of education, and 92.5% completed high school. This compared with an average of 13.5 years of education among individuals with MI, of whom 88.7% completed high school, and 14.4 years of education and 98% high school completion in the nondisabled comparison group. Not surprisingly, only 5% of individuals with DD had four or more years of postsecondary education, as compared with 25.8% and 42.7% of individuals with MI and the comparison group, respectively.

Individuals with DD and MI also had significantly poorer marital outcomes than those in the comparison group – more likely never to have been married, less likely to be currently married, and if ever married, more likely to be divorced than their age-peers without disabilities. The analysis finds far larger effects on individuals with DD than MI, especially for never having been married. As shown in Table 1, 90.1% of those with DD, 51.6% of those with MI, and only 17.3% of the comparison group never were married. In addition, among those who ever married, individuals with MI were 9 times more likely to divorce than those in the comparison group. The small number of individuals with developmental disabilities who were ever married prevents us from estimating their probability of divorce. Descriptively, 5.4% of individuals with developmental disabilities were married at the time of data collection (at a mean age of about 37), whereas 21.1% of those with MI were married. However, the norm among their age-peers was sharply higher – 70.6% married at this stage of life. Of those ever married, a much higher percentage of adults with disabilities had been divorced (36.4% and 56.5% among those with DD and MI, respectively) vs. only 13.8% in the comparison group.

Significant differences were also found among these groups with respect to the likelihood of being currently employed. Descriptively, whereas 90.4% of the comparison group was employed at this stage of life, only 57.7% of those with DD and 43.2% of those with MI had jobs. Finally, as shown in Table 1, a greater proportion of those with DD or MI continued to live with their parents as they neared their 40th birthday than the comparison group (30.4%, 14.4%, and 2.6%, respectively). Thus, the data confirm that individuals with DD and MI themselves had sharply divergent patterns of attainment in adulthood, and were therefore more likely to be dependent on family members—parents and siblings—throughout their adult years.

Additional analysis

As a follow-up analysis, we returned to the question of whether some of the sibling effects reported earlier, particularly among those who have a sibling with MI, were, in part, the result of genetic vulnerability to mental health problems rather than the direct effect of having a sibling with a disability. In an exploratory analysis, we examined the subset of nondisabled siblings for whom genetic data were available ($n = 4569$). We estimated models that extended the analyses in Table 2 through 4 above by including an additional step: in Model 4.1, we repeated the analyses reported above for the genetic sample, and in Model 4.2, we added the main effect of having a parent with a genetic risk of depression.

The findings that we reported in the full sample were confirmed in these additional analyses (Model 4.1) and the models with the genetic risk indicator (Model 4.2) remained fully consistent with the results reported above, although the reduction in sample size influenced statistical significance. (Note that there were too few married individuals with DD in the genetic sample to estimate the models for the three marital variables.) The main effect of genetic risk itself was never a significant predictor in any of the models. Thus, the genetic analysis supports the findings of the full sample analyses, at least with respect to the genetic risk of depression as defined by prior WLS analyses and present in one parent of the adults who are the focus of this study.

Discussion

This study's central question was whether growing up with a sibling who had a major disability, either DD or MI, would result in their nondisabled siblings having an altered pattern of life course development as they approached their 40th birthday. We asked this question in the context of both a comparison group of siblings who had only nondisabled brothers and sisters and were thus not exposed to disability in the sibship, and in direct comparison with their disabled brother or sister. The comparisons were made in well-controlled models that held constant both family factors that preceded the birth of all siblings in the family and subsequent risk factors that may have jeopardized their outcomes during their formative years. In general, the families of origin in which these different groups of siblings grew up were very similar and they also were similar in their likelihood of subsequently experiencing other sources of distress.

Nevertheless, siblings who grew up with a brother or sister with DD or MI evidenced a divergent pattern of adult development. In families where a brother or sister had

schizophrenia, bipolar disorder, or major depression, the nondisabled siblings completed fewer years of education than their counterparts where no siblings had disabilities, and were less likely to be employed in the early years of midlife. These divergent patterns continued to be evident when we included a risk variable that was constructed based on prior WLS analyses of genetic risk for depression. Although this approach to measuring genetic risk has limitations (see below), it provides an initial indication of the robustness of the impact of sibling disability, net of familial vulnerability.

For siblings whose brother or sister had DD, the divergence in adult developmental outcomes was less pronounced, with normative patterns of education and employment, but considerably lower rates of marriage and elevated rates of marital disruption. The inclusion of a genetic risk variable did not alter our conclusions.

Virtually all past studies used data from individuals who volunteered for research that they understood would focus on the family impacts of DD or MI over the life course; these volunteers might not be representative of the full range of affected families. Indeed, past convenience samples may either have over- or under-estimated the ripple effects of having a brother or sister with DD or MI, possibly reflecting the level of distress experienced by their parents who were the volunteers for the research. In contrast, the WLS respondents were a random sample of their birth cohort, selected prior to the time when they had any children. Since the WLS enjoys remarkably high rates of retention, the estimates yielded by the present study are unlikely to reflect self-selection bias. This is one unique contribution of the current study.

We use life course theory to interpret these divergent patterns of adult development. Most siblings of brothers and sisters with DD grew up always experiencing this difference in the family, whereas for those whose brother or sister had MI, the onset of mental illness symptoms was later and likely resulted in a change in the prior sibling relationship. This experience of disruption may be one reason why the transition to adulthood for those siblings whose brother or sister had MI was more negatively affected than in the case of sibling DD. Other tenets of life course theory line up with the findings of the present study, as well, including the unpredictable course of MI as contrasted with the stability of DD across the life course, which may have resulted in repeated family disruptions and consequent risk of off-time transitions.

Efforts to benchmark the toll of disability on society have focused both on the person with the disability (Wells et al., 2003) and on their parents' health, mental health, and engagement in the labor force (Seltzer, Floyd, Song, Greenberg, & Hong, 2011). The present population-based analysis shows that the toll extends to nondisabled siblings with respect to the major markers of adulthood – educational attainment, marriage, and employment. The long-term effects on health, mental health, and labor market success in later midlife and beyond remain to be studied, but prior research has shown that early disruptions tend to accumulate over the life course (Dannefer, 2003). Indeed, the life course tenet of linked lives (Elder, Johnson, & Crosnoe, 2003) suggests that there may also be disruptions in their likelihood of providing parent care when their parents reach old age, due to simultaneous

need for these siblings to be supportive to their parents and to their disabled siblings, but this speculation warrants direct examination in future research.

One additional contribution of the present study is that it gives population-based estimates of the degree to which individuals with disabilities themselves manifest atypical patterns of adult development. Our findings, while not surprising, quantify the magnitude of the disruptions in adult outcomes. For individuals with DD, postsecondary education and marriage are rare (only 5% have four years of schooling after high school and about the same proportion are married when they are in their late 30s). Of those who do marry, divorce is the outcome in one-third of the cases. Employment is more normative, with 58% employed, but many of these jobs were in agency-based settings (i.e., sheltered workshops). It is informative that fully 30% of those with developmental disabilities continued to co-reside with a parent as they approached their 40th birthday. A different pattern of disruption is evident for those with MI – 25% attained four years of postsecondary education and approximately 20% were married in their late 30s – but fewer were employed (43%) at this stage of life than those with DD, and 14% continued to live with their parents.

Given the magnitude of the life course disruptions that are characteristic of both those with DD and those with MI and the intertwined nature of sibships, it is not at all surprising that there are ripple effects on their nondisabled siblings. As people with significant disabilities are living longer into old age, the likely impact on the lives of nondisabled siblings will persist indefinitely. The sibling relationship is the longest-lasting family tie (Pollet & Hoben, 2011) and in this context our findings take on added significance even though our follow-up period ended in sibling's midlife. Whether the difficulties in the lives of both siblings eventually disrupt the sibling relationship cannot be determined from the available data, but estrangement among siblings should be studied in future research, especially given the vulnerability and potential isolation of adults with disabilities as their parents age and after parental death.

The findings of this study have implications for practitioners and educators who work directly with families of persons with DD and MI. Although the past decade brought increasing recognition of the needs of families with children with disabilities for information and support, these efforts have focused mainly on parents and young siblings. Few programs have targeted adult siblings of individuals with disabilities. Our study findings speak to the needs of adult siblings for education and support about the unique ways that having a brother or sister with a disability might affect their lives. They are also suggestive that these needs differ depending on the nature of the disability of their sibling and also the timing of the disability.

This study has a number of limitations. The WLS consists primarily of White families, and all of the parent respondents had completed high school. Thus, the extent to which the ripple effects we observed on siblings' adult development would also be evident in more racially and ethnically diverse families and among those whose parents did not finish high school is unknown. More research is needed to directly examine the mechanisms of the ripple effects, their impact over the full life course, and their effects on other areas of life. Another limitation is that the study refers to one generation; we do not know if the same patterns will

hold for children being raised today. An additional limitation is that genetic data were available for only a subset (56%) of WLS respondents. The sons and daughters of these respondents, who were the focus of our analysis, were identified as being at risk if they had one parent who carried the risk allele of a few selected genes that were found to be associated with depression in WLS respondents. The other parent's level of genetic risk was not available in the data, nor was the sibling's own genetic risk, so our robustness test was limited.

How these challenges unfold in midlife and old age, and how they affect intergenerational relationships with their aging parents and their own children, remains to be studied in future research. Another important next step in this line of research involves investigating the mechanisms by which the ripple effects observed in the present study come about – be these direct effects of the severity of the child's disability, effects mediated by parental distress, or an interaction of both. The present research sets the stage for these next steps, as we provided evidence that the ripple effects of having a brother or sister with a disability are measurable and sustained. Individuals with less education and employment, and more marital disruption during the early years of adulthood, may suffer cumulative effects across the life course and across generations, with significant public health and public policy implications.

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Table 1

Descriptive statistics of analysis variables: individual level variables.

	Has sibling w/MI ^a N = 235		Has sibling w/DD ^b N = 337		Has MI ^c N = 97		Has DD ^d N = 113		Comparison Individuals ^e N = 17,126		Group difference
	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	
Age	38.3	(4.4)	37.3	(4.7)	37.0	(4.7)	36.8	(4.8)	37.8	(4.5)	** a > d
Birth order	2.4	(1.2)	2.9	(1.7)	2.5	(1.3)	2.6	(1.6)	2.4	(1.4)	*** b > a,c,e
Number of sibling	3.3	(1.5)	4.1	(2.5)	2.8	(1.4)	3.2	(2.1)	2.9	(1.6)	*** b > a,c,d,e
Mother's age at the individual's birth	25.3	(4.4)	26.4	(4.5)	26.7	(5.8)	30.6	(6.3)	25.3	(4.3)	*** d > a,b,c,e
Education (years)	14.4	(2.4)	14.4	(2.3)	13.5	(2.3)	11.9	(2.4)	14.4	(2.3)	*** a,b,e > c > d
% Education 12 years	96.2	(.19)	98.2	(.13)	88.7	(.32)	92.5	(.27)	98.0	(.14)	*** a,b,e > c,d
% Education 14 years	57.3	(.50)	57.3	(.50)	41.2	(.49)	11.3	(.32)	58.1	(.49)	*** e > a,c > d
% Education 16 years	42.3	(.50)	43.6	(.50)	25.8	(.44)	5.0	(.22)	42.7	(.49)	*** a,b,e > c > d
% Married 2004	70.9	(.46)	64.5	(.48)	21.1	(.41)	5.4	(.23)	70.6	(.46)	*** a,b,e > c > d
% Never been married 2004	18.8	(.39)	19.7	(.40)	51.6	(.50)	90.1	(.29)	17.3	(.38)	*** d > c > a,b,e
% Divorced 2004	11.1	(.32)	19.3	(.40)	56.5	(.50)	36.4	(.48)	13.8	(.35)	*** c,d > b > a,e
% Employed 2004	83.1	(.38)	90.0	(.31)	43.2	(.50)	57.7	(.50)	90.4	(.29)	*** a,b,e > d > c
% Living with parents 2004	.4	(.07)	2.1	(.14)	14.4	(.35)	30.4	(.46)	2.6	(.16)	*** d > c > a,b,e
% Women	49	(.50)	51	(.50)	52	(.50)	50	(.50)	50	(.50)	ns
% Adopted	5.1	(.22)	5.6	(.23)	7.2	(.26)	7.1	(.26)	3.3	(.18)	**
% Has deceased sibling	15.3	(.36)	19.0	(.39)	5.2	(.22)	12.4	(.33)	7.3	(.26)	*** a,b > c,e
% Has adopted sibling	12.8	(.33)	17.5	(.38)	11.3	(.32)	14.2	(.35)	5.1	(.22)	*** a,b,d > e

**
p .01.***
p .001.

Table 2

Summary of multilevel analysis for variables predicting education.

	Education (Years)									
	Full sample					Genetic sample				
	Model 1	Model 2		Model 3		Model 4.1	Model 4.2		Model 4.1	Model 4.2
	b	S.E.	b	S.E.	b	S.E.	b	S.E.	b	S.E.
<i>Fixed parts</i>										
Intercept	7.925***	.326	7.873***	.325	7.994***	.327	7.974***	.429	7.973***	.429
Grandparent's income (1957) (logged)	-.004	.033	-.006	.033	-.0001	.033	.023	.043	.024	.043
Family religion (1957)	.217***	.040	.217***	.040	.212***	.040	.223***	.052	.223***	.052
Parent grew up in rural	-.053	.046	-.052	.046	-.058	.046	-.049	.059	-.050	.059
Urban	.037	.051	.041	.050	.041	.050	.040	.066	.041	.066
Other (omitted)	—	—	—	—	—	—	—	—	—	—
Parent IQ (1957)	.376***	.041	.383***	.041	.378***	.041	.370***	.053	.370***	.053
Parent's marriage plan (1957)	-.277***	.060	-.266***	.060	-.246***	.060	-.332***	.079	-.331***	.079
Female	.174***	.028	.174***	.028	.173***	.028	.180***	.037	.180***	.037
Mother's education (1975)	.230***	.014	.235***	.014	.233***	.014	.217***	.017	.217***	.017
Father's education (1975)	.250***	.009	.252***	.009	.247***	.009	.241***	.012	.240***	.012
Family income (1975) (logged)	.031+	.017	.032+	.017	.032+	.017	.053*	.024	.052*	.024
Birth order	-.010	.012	-.008	.012	-.005	.012	-.010	.016	-.010	.016
Mothers' age at birth 19	-.127+	.074	-.120	.074	-.108	.074	-.108	.099	-.109	.099
Mothers' age at birth 35	.386***	.089	.428***	.089	.423***	.089	.392***	.117	.392***	.117
Mothers' age at birth 20–34 (omitted)	—	—	—	—	—	—	—	—	—	—
Number of siblings	-.114***	.014	-.116***	.014	-.113***	.014	-.105***	.019	-.105***	.019
Has sibling w/MI	—	—	-.366*	.156	-.349*	.156	-.472**	.181	-.471**	.181
Has sibling w/DD	—	—	.073	.139	.074	.139	.208	.202	.207	.202
Individuals w/MI	—	—	-.1430***	.205	-.1419***	.205	-.1253***	.241	-.1252***	.241
Individuals w/DD	—	—	-.2542***	.222	-.2544***	.222	-.2617***	.343	-.2618***	.343
Not having sibling w/DD or MI (omitted)	—	—	—	—	—	—	—	—	—	—

	Education (Years)									
	Full sample					Genetic sample				
	Model 1		Model 2		Model 3		Model 4.1		Model 4.2	
	<i>b</i>	S.E.	<i>b</i>	S.E.	<i>b</i>	S.E.	<i>b</i>	S.E.	<i>b</i>	S.E.
Adopted			-.403***	.103	-.457***	.103	-.505***	.131	-.502***	.131
Had deceased sibling			-.070	.073	-.070	.073	-.043	.093	-.043	.093
Had adopted sibling			-.008	.083	-.006	.083	-.099	.105	-.099	.105
Parent divorced before individual's age 18					-.404***	.082	-.369***	.107	-.367***	.107
Parents' unemployed (1975)					-.399**	.138	-.432*	.181	-.433*	.181
Parent's binge drinking (1992)					-.155**	.061	-.228**	.077	-.230**	.077
Parent's diagnosed illness (1992)					-.043*	.018	-.005	.022	-.005	.022
Parent died before individual's age 18					-.019	.224	-.022	.314	-.022	.314
Parent had genetic risk of depression					-	-	-	-	-.028	.065
<i>N</i>	17,760		17,760		17,760		10,362		10,362	
<i>Random parts (SD)</i>										
Intercept	1.088***		1.082***		1.073***		1.031***		1.031***	
Level-1 residuals	1.710		1.700		1.699		1.728		1.728	

* $p < .05$;

** $p < .01$.

*** $p < .001$.

Table 3

Summary of multilevel analysis for variables predicting marital history and marital status.

	Full sample				Genetic sample			
	Model 2		Model 3		Model 4.1		Model 4.2	
	<i>b</i>	S.E.	<i>b</i>	S.E.	<i>b</i>	S.E.	<i>b</i>	S.E.
<i>Never been married vs. Ever married</i>								
Has sibling w/MI	.126	.202	.132	.202	.115	.240	.116	.240
Has sibling w/DD	.126	.174	.123	.174	.368	.250	.368	.250
Individuals w/MI	1.633***	.244	1.634***	.243	2.004***	.291	2.005***	.291
Individuals w/DD	4.108***	.364	4.101***	.364	—	—	—	—
<i>N</i>	17,743		17,743		10,352		10,352	
Random parts (SD): Intercept	.828***		.818***		.842***		.842***	
Log likelihood	-7802.49		-7793.50		-4538.30		-4538.26	
<i>Married vs. Unmarried in 2004</i>								
Has sibling w/MI	.036	.165	.045	.165	.008	.190	.007	.190
Has sibling w/DD	-.280*	.136	-.277*	.135	-.359+	.196	-.358+	.196
Individuals w/MI	-2.259***	.270	-2.246***	.270	-2.411***	.329	-2.412***	.329
Individuals w/DD	-3.627***	.433	-3.623***	.433	—	—	—	—
<i>N</i>	17,743		17,743		10,352		10,352	
Random parts (SD): Intercept	.583***		.572***		.549***		.550***	
Log likelihood	-10458.73		-10445.24		-6068.36		-6069.91	
<i>Divorced vs. Non-divorced in 2004</i>								
Has sibling w/MI	-.240	.252	-.270	.252	-.126	.273	-.125	.274
Has sibling w/DD	.414*	.174	.409*	.173	.278	.261	.278	.261
Individuals w/MI	2.279***	.326	2.224***	.324	2.198***	.403	2.198***	.403
Individuals w/DD	—	—	—	—	—	—	—	—
<i>N</i>	14,496		14,496		8443		8443	
Random parts (SD): Intercept	.528***		.506***		.418*		.418*	
Log likelihood	-5740.80		-5724.72		-3285.03		-3284.96	

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† p .10.
 * p .05.
 ** p .01.
 *** p .001.

Full specifications as shown in Table 2.

Table 4

Summary of multilevel analysis for variables predicting employment status.

	Employed vs. Non-employed in 2004					
	Full sample			Genetic sample		
	Model 2	Model 3		Model 4.1	Model 4.2	
	<i>b</i>	S.E.	<i>b</i>	S.E.	<i>b</i>	S.E.
Has sibling w/MI	-.674**	.215	-.660**	.216	-.757**	.240
Has sibling w/DD	-.136	.211	-.122	.211	.199	.331
Individuals w/MI	-2.856***	.257	-2.841***	.257	-2.689***	.301
Individuals w/DD	-1.993***	.246	-1.985***	.246	-1.401***	.380
<i>N</i>	17,695		17,695		10,327	
Random parts (SD): Intercept	.786***		.781***		.740***	
Log likelihood	-5209.42		-5203.08		-3098.33	

†
p .10.
*
p .05.
**
p .01.

p .001.

Full specification as shown in Table 2.