

Family Matters: Siblings and High School Graduation

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Abstract

Introduction

Educational attainment is known to be related to family size, birth order, and the educational achievement of an older sibling.

Objective

This study examines younger siblings in large families, exploring the extent to which each older sibling's educational attainment is associated with attainment of the younger sibling.

Methods

Linkable administrative data were used to create a population-based cohort of third children in three child families born in Manitoba, Canada between April 1, 1984 and March 31, 1994, who stayed in the province until at least age 20 ($n = 5,771$). Logistic regression models were used to examine the relationship between the youngest siblings' educational achievement and that of their older two siblings, adjusting for a series of confounders.

Results

Youngest siblings have the greatest odds of graduating from high school if both older siblings graduated. Females also had greater odds of graduating if only one of those older siblings had graduated; this did not increase the odds for males. Associations in educational attainment were stronger when siblings were born close together. For siblings born further apart, these associations were stronger if those siblings were of the same sex as the youngest sibling.

Conclusions

In large families, the educational attainment of each older sibling is associated with the educational attainment of the younger sibling; associations differ depending on the birth order and sex of the older siblings. Families in which older siblings do not graduate from high school may be experiencing numerous challenges. Children with older siblings who fail to graduate may benefit from additional supports to increase their likelihood of graduation.

Introduction

The benefits associated with graduating from high school (and the risks associated with not) have been examined over the past few decades. Individuals who finish high school have better job prospects, better health outcomes, and generally live longer (1-5). Many risk factors for failing to graduate from high school have been identified; these include being born to a family with low socioeconomic status (teen mother, single mother, low income, low educational attainment, etc.), family instability, being diagnosed with mental health problems, and sex (6-13). Several surveys have examined the influence of family size, birth order, and siblings on the likelihood of graduation. If older siblings graduated from high school, younger siblings were also more likely to, and children having fewer siblings and born earlier were more likely to finish high school (14-19).

Much of the relationship between siblings' education attainment has been attributed to intrafamily resource allocation; lower attainment due to higher birth order and larger family size was linked to receiving fewer family resources (14-18). Although these surveys had a relatively large sample size, the limited number of variables permitted adjustment for only a small number of covariates. The large population-based administrative database available in Manitoba allows consideration of many important variables at the neighborhood, family, and individual level. Two neighborhood characteristics linked to academic achievement - socioeconomic status and location - were adjusted for. These characteristics were measured both for the neighborhood at birth and the neighborhood at age 18 (20,21). We were also able to adjust for mother's marital status at birth and mother's age at first birth (22,23). Events during the child's life can also strongly influence edu-

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cational achievement. We considered three of these events - having a mental illness diagnosis, experiencing a family structure change, and changing residences (24-26). Finally, we adjusted for prior educational achievement - achievement in grade 9 (27).

When examining relationships between siblings and high school graduation, previous studies have focused on family size, birth order, or the correlation of high school graduation between two siblings. Children who have multiple older siblings are likely influenced not only by the size of their family and their birth order, but also by the educational attainment of all older siblings. This study addresses this gap by exploring the extent to which each older sibling's educational attainment is associated with attainment seen in younger siblings, adjusting for a large number of important confounders. We also examine whether younger siblings' educational attainment has stronger associations with their older siblings' attainment if the younger sibling is male or female, and whether the birth order and sex of the older sibling matters.

Methods

Setting

Manitoba, the setting of this study, ranks in the middle on a series of Canadian health indicators, and slightly below average on educational achievement (28,29). At the time of the 2011 Census, approximately 1.2 million people resided in the province, with just over half living in two urban areas (30). Among Manitobans between 25 and 64 years old in 2012, 86.4% had finished high school; this is slightly lower than the Canada rate (89.1% in 2012) (31). This Canadian figure was lower than the graduation rate in USA (89.3% in 2011) and higher than that of the United Kingdom (73.8% in 2011) (31).

Data

The Manitoba Population Health Research Data Repository contains province-wide, routinely collected individual data over time (going back to 1970 in some files), across space (with residential location documented using six-digit postal codes), for each family (with changes in family structure recorded every six months), and for each resident. Health variables are measured continuously from physician claims and hospital abstracts (as long as an individual remains in Manitoba) (32). A research registry identifies every provincial resident, with information on births, arrival and departure dates, and deaths created from the provincial health registry and coordinated with Vital Statistics files. Given approximately 16,000 births annually, follow-up (about 74% over 20 years) is comparable to that in the largest cohort studies based on primary data (33). Previous Manitoba work using similar information shows the results are not biased by individuals leaving the province or dying (28). Information on data linkage, confidentiality/privacy, and validity of the datasets used has been provided elsewhere (34-36). Children are linked to mothers using hospital birth record information (37). Being born to the same biological mother defines siblings.

Ethics approval

This study was approved by the Health Research Ethics Board at the University of Manitoba and reviewed by the Health Information Privacy Commission at Manitoba Health, Seniors and Active Living (#2013/2014-04). Using de-identified administrative data files did not require informed consent from participants.

Cohort Selection

The cohort consists of individuals in three child families where all siblings were born in Manitoba between April 1, 1984 and March 31, 1994, stayed in the province until at least their 20th birthday, and had no missing values on key variables. Only children from three child families are included to 1) examine the influence of multiple older siblings, 2) to avoid increasing complexity by including families with more than three children, and 3) to have an adequate number of cases to control for many confounding variables. Figure 1 diagrams the trajectory for the 5,771 individuals selected.

Variables

Outcome

Graduation within six years of entering grade 9 defines high school graduation.

Independent Variables

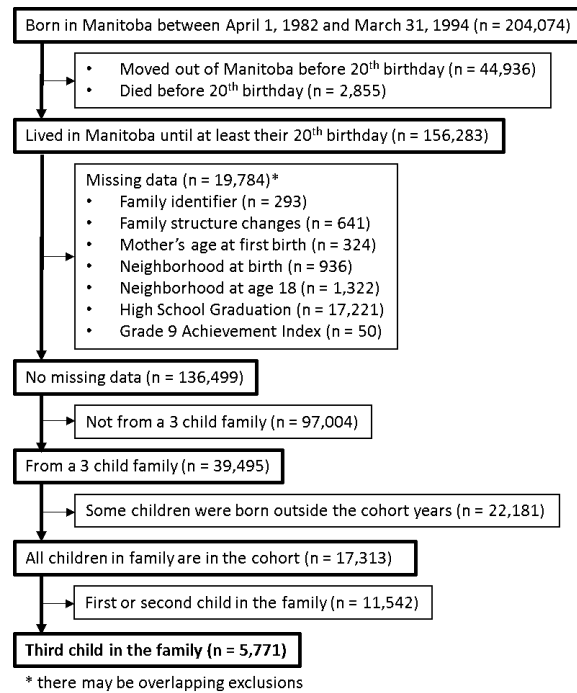
The variables of interest were high school graduation status, birth order, and sex of the older siblings, and sex of the youngest sibling.

Covariates

Based on an extensive literature review and the availability of information, several key variables describing neighborhood, maternal, and individual characteristics are included. Covariates measure characteristics in the younger sibling's life before age 18. The Socioeconomic Factor Index (SEFI) measures neighborhood socioeconomic status at birth and on each youth's 18th birthday; a higher SEFI score corresponds with lower socioeconomic status. Generated using Manitoba (Statistics Canada) dissemination areas, this index combines neighborhood information on income, education, employment, and family structure (38). These neighborhoods typically include between 400 and 700 urban individuals and are somewhat larger in rural areas. Neighborhoods fall into one of four locations: urban, rural south, rural mid, and rural north. Maternal characteristics include a mother's marital status at birth of the child studied (married or unmarried), and whether her first child was born before her 20th birthday.

Three measures of the younger siblings' life between birth and their 18th birthday were included - mental health conditions, residential mobility, and family structure change. These variables can occur at specific points in time and the timing of their occurrence varies across individuals. Mental health conditions are defined using diagnoses from hospital abstracts (ICD-9 codes before April 1, 2004, ICD-10 codes after April 1,

Figure 1: Cohort Selection



2004) and physician claims (ICD-9 codes). At least one mental health diagnosis indicates the relevant condition (ICD-9 codes 290 - 319, ICD-10 codes F01-F99). Residential mobility is indicated by a change in six-digit postal code between birth and age 18. Any child experiencing at least one parental divorce, death, marriage, or remarriage between birth and age 18 is noted as having a 'family structure change'. This study also controls for previous educational achievement. The earliest measure of educational achievement available is the Grade 9 Achievement Index. This index was built on a technique developed by Mosteller and Tukey using enrollment files, course grades, credits earned, and the provincial population registry (27,39). A scaled logit score was generated from the rank categories each individual was assigned to.

Analysis

The following logistic regression examines the association between siblings' high school graduation:

$$\text{logit}(P(Y = 1)) = \beta_0 + \beta_1 x_1$$

Where Y is the younger sibling's graduation status (1 = graduated from high school, 0 = did not graduate from high school), x_1 indicates which older siblings finished high school (neither, oldest only, middle only, both). Next, the cohort was divided into two groups to examine whether males or females were differently affected by their older siblings' educational attainment; the same model as above is used for both sub-cohorts. Models were adjusted for all covariates in Table 1. Next, the importance of older siblings' sex and educational status on the third child's educational attainment is examined using this model:

$$\text{logit}(P(Y = 1)) =$$

$$\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_1 x_3 + \beta_6 x_2 x_4$$

Where Y is the younger sibling's graduation status (1 = graduated high school, 0 = did not graduate from high school), x_1 indicates whether the oldest sibling graduated from high school (1 = yes, 0 = no), x_2 indicates whether the middle sibling graduated from high school, x_3 as an indicator as to whether the oldest sibling was of the same sex as the youngest (1 = yes, 0 = no), and x_4 as an indicator as to whether the second oldest sibling was the same sex as the youngest (1 = yes, 0 = no). Again, this cohort is divided into males and females to examine differences by sex of the youngest sibling. Adjusted odds ratios include all covariates listed in Table 1. The C-Statistic, which ranges from 0.5 to 1 and measures discrimination, assessed model fit. Reasonable models have a c of at least 0.7, while strong models have a c exceeding 0.8 (40).

Results

Just over 90 percent of third children in three child families graduated from high school. Table 1 presents characteristics of the individuals, families, and neighborhoods of these individuals. Differences between those who did and did not graduate are identified by χ^2 (for binary variables) and t (for continuous variables) statistics. Individuals not graduating from high school differed significantly from those who did on all covariates.

Table 1: Descriptive statistics of covariates for third siblings in three child families (n = 5,771)

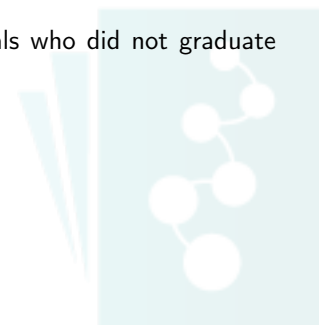
Independent Variables	Did not Graduate	Graduated from	Difference
	from High School (n = 561)	High School (n = 5,210)	
	n (%) / Mean (SD)	n (%) / Mean (SD)	χ^2/t^a
<i>Older siblings' graduation status</i>			
Both siblings graduated from high school	220 (39.22)	4,561 (87.54)	969.05 ^b
Only oldest sibling graduated	115 (20.50)	251 (4.82)	
Only middle sibling graduated	94 (16.76)	290 (5.37)	
Neither sibling graduated	132 (23.53)	118 (2.26)	
<i>Oldest siblings' sex</i>			
Male	275 (49.02)	2,724 (52.28)	2.16
Female	286 (40.98)	2,486 (47.72)	
<i>Middle siblings' sex</i>			
Male	284 (50.62)	2,740 (52.59)	0.79
Female	277 (49.38)	2,470 (47.41)	
<i>Youngest siblings sex</i>			
Male	360 (64.17)	2,626 (50.40)	38.45 ^b
Female	201 (35.83)	2,584 (49.60)	
Covariates			
Socioeconomic Status ^c of Neighborhood at Birth*	0.43 (1.03)	-0.30 (0.92)	16.00 ^b
<i>Location of Neighborhood at Age Birth</i>			
Urban	326 (58.11)	2,897 (55.60)	55.31 ^b
Rural South	100 (17.83)	1,445 (27.74)	
Rural Mid	86 (15.33)	684 (13.15)	
Rural North	49 (8.73)	183 (3.51)	
Socioeconomic Status ^c of Neighborhood at 18*	0.35 (0.99)	-0.30 (0.84)	15.07 ^b
<i>Location of Neighborhood on 18th Birthday</i>			
Urban	321 (57.22)	2,847 (54.64)	72.99 ^b
Rural South	99 (17.65)	1,470 (28.21)	
Rural Mid	95 (16.93)	756 (14.51)	
Rural North	46 (8.20)	137 (2.63)	
Mother Unmarried at Time of Birth	200 (35.65)	499 (9.58)	323.43 ^b
Mother had first child before age 20	151 (26.92)	311 (5.97)	301.74 ^b
Mental Health Diagnosis, 0 - 17	284 (50.62)	1,624 (31.17)	86.60 ^b
Residential Mobility, 0 - 17	418 (74.51)	2,847 (54.64)	81.35 ^b
Family Structure Change, 0 - 17	173 (30.84)	861 (16.53)	70.54 ^b
Grade 9 Achievement Index ^d *	-0.68 (0.47)	0.36 (0.80)	-45.95 ^b

^a χ^2 test (for binary variables)/t-test (for continuous variables - marked by *) show whether individuals who did not graduate from high school differ from individuals who did graduate high school

^b $p < 0.05$

^c Higher Socioeconomic Factor Index (SEFI) corresponds with lower SES

^d Higher Grade 9 Achievement Index score corresponds with higher achievement



Number of older siblings graduating and their birth order

When both older siblings graduated from high school, the odds of the youngest sibling graduating were almost five times greater than if neither sibling had graduated (Table 2). If only one sibling graduated from high school, it was the middle sibling who significantly increased the odds of the younger sibling graduating.

For males, having only one sibling graduate (whether it was the oldest or the middle sibling) did not significantly increase the odds of the youngest sibling graduating compared to having no older sibling who had graduated (Table 2). Females were significantly more likely to finish high school even if only one older sibling had graduated, but most likely to graduate if both had.

Birth order and sex of older siblings graduating

Next, the sex of each older sibling was included. Oldest and middle siblings increased the odds of high school graduation more if those siblings were female (Table 3). Educational attainment in the youngest siblings was more strongly associated with that seen among middle siblings than oldest siblings. For both males and females, the oldest siblings' graduation status significantly increased their odds of graduation only when that sibling was of the same sex that they were (Table 3). The sex of the middle sibling did not seem to matter as much.

Discussion

This paper adds to the existing literature around sibling associations in relation to high school graduation. Previous studies have been limited to examining the influence of one older sibling on the younger sibling's achievement (14). In this study, we examined whether and how the educational attainment of all older siblings was associated with the attainment of the youngest child in three-child families. The educational attainment, birth order, and sex of each older sibling appear to matter when examining the attainment of younger siblings. These associations differed depending on the sex of the younger sibling. Having a large number of cases and variables has allowed development of models with a high degree of fit. Inclusion of the measure of Grade 9 achievement controls for performance earlier in adolescence.

For both males and females, their oldest sibling's educational attainment only increased their odds of graduating from high school if that sibling was of the same sex. Social learning theory, which states that siblings are more likely to model same-sex siblings, and that "siblings in same-gender dyads may be more sensitive to issues of rivalry and competition" is one possible explanation (41). However, this was not true for middle siblings. Having a middle sibling graduating from high school significantly increased the odds of graduation regardless of the sex of that sibling, more so if that sibling was female. Previous work suggests that "older siblings who are close in age may serve as examples for their younger siblings to emulate" (42). Children born close sequentially tend to spend more time together and have more similar social lives, with "closely spaced siblings . . . more likely to share the same

friends and peers" (43). Thus, associations tended to be larger when siblings were born close together. When siblings are born further apart, the sex of that sibling is important in predicting educational attainment in younger siblings.

Using linkable administrative data to examine this research question provides several benefits. First, access to the educational attainment of all siblings in a population cohort allowed the associations of multiple older siblings on the educational achievement of younger siblings to be examined. Previous work looking at the influence of an older sibling included unrepresentative families (mean number of children = 5), and in most cases, educational information was only available for two of those children (14). Where multiple siblings can influence the educational attainment of younger siblings, three child families are most common. Linking the education database with health and social data allowed controlling for a wide range of possible confounders. This study is unique in incorporating earlier individual educational achievement (in Grade 9) when examining the associations between siblings' educational attainment.

While this study has many strengths, several important limitations should be considered. This research examines the correlations among siblings' educational attainments but is unable to demonstrate a causal relationship. While the linkage of many databases allowed control for many confounders, we are limited by lack of certain covariates. Two such variables are parental education level and household income. To address this, we included the SEFI index (used at both birth and the 18th birthday), which includes both income and educational components at the neighborhood level (small areas of 400-700 individuals). Previous work has shown adding individual family income to analyses using SEFI improved models only slightly. The fit of the models using the rich Manitoba database compares favorably with the results of such well-known work as the Panel Study in Income Dynamics and the National Longitudinal Study of Youth (27). With provincial education information available starting in 1995, future research will be able to account for mother's high school graduation. Linkages to fathers are not complete, so paternal educational attainment will be more difficult to include. Social variables, such as family relationships and the level of parental involvement, may also affect the educational attainment of all siblings. Despite such issues, the covariates included resulted in excellent model fit. Additionally, this paper examines the associations seen among siblings of three child families; these results may not be generalizable to families of different sizes. This study examined the relationships between siblings' educational attainment - future research in this area could also examine the influence of siblings on graduation status and establish whether the relationships seen here are causal.

Conclusion

We have provided a better understanding of the relationships in educational attainment in larger families, examining the attainment of all older siblings on the educational attainment of younger siblings. The extensive adjustment of confounders lends empirical support to the judgement that older children do matter in affecting the educational attainment of their younger siblings. In larger families, the birth order and sex

Table 2: Odds Ratios for High School Graduation of Youngest Sibling, for the whole population, and for males and females separately

	All (n = 5,771)	Male (n = 2,986)	Female (n = 2,785)
Older Sibling High School Graduation Status (Reference = Neither Sibling Graduated)	Adjusted a Odds Ratio (95% CI)	Adjusted a Odds Ratio (95% CI)	Adjusted a Odds Ratio
Only Oldest Sibling Graduated	1.3 (0.9, 2.0)	0.8 (0.4, 1.3)	2.3 (1.2, 4.3)
Only Middle Sibling Graduated	2.1 (1.4, 3.2)	1.4 (0.3, 2.5)	3.2 (1.7, 6.1)
Both Siblings Graduated	4.9 (3.5, 7.0)	3.7 (2.3, 5.9)	6.6 (3.9, 11.0)
C-Statistic	0.912	0.9	0.923

^a Adjusted for all variables in Table 1

Table 3: Odds Ratios for High School Graduation of Youngest Sibling, by older siblings' sex and graduation status, for the whole population, and males and females separately

	All (n = 5,771)	Male (n = 2,986)	Female (n = 2,785)
Older Sibling Graduation Status and Sex	Adjusted a Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	Adjusted Odds Ratio
Oldest Sibling Graduated vs Oldest Sibling did not Graduate			
Oldest Sibling is Male	1.71 (1.22, 2.40)	1.97 (1.26, 3.08)	1.45 (0.84, 2.50)
Oldest sibling is Female	2.20 (1.50, 3.22)	1.57 (0.95, 2.59)	3.84 (2.07, 7.12)
Middle Sibling Graduated vs Middle Sibling did not Graduate			
Middle Sibling is Male	2.73 (1.97, 3.79)	2.87 (1.93, 4.59)	2.73 (1.61, 4.62)
Middle sibling is Female	3.27 (2.24, 4.78)	3.30 (1.98, 5.09)	3.62 (1.99, 6.55)
C-Statistic	0.911	0.901	0.924

^a Adjusted for all variables in Table 1

of each older sibling affect the degree of correlation in older and younger siblings' educational attainment. These relationships are stronger among female siblings. Additionally, families in which older siblings failed to graduate from high school may be experiencing numerous challenges. Younger siblings in such families may benefit from additional support to increase their likelihood of graduation.

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Statement on conflicts of Interest

The authors have no conflicts of interest to declare.

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Abbreviations

SEFI - Socioeconomic Factor Index
 ICD - International Classification of Disease

