The Journal of Rheumatology 2022;49:299–306
doi:10.3899/jrheum.201514
First Release December 15 2021

The Journal of Rheumatology

A Population-based Study of Grade 12 Academic Performance in Adolescents With Childhood-onset Chronic Rheumatic Diseases

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ABSTRACT. ***Objective.*** The aims of this study were (1) to compare grade 12 standardized test results of patients diagnosed with childhood-onset chronic rheumatic diseases (ChildCRD) and unaffected peers; and (2) to identify factors associated with test results of patients with ChildCRD and unaffected peers.

Methods. This was a population-based retrospective cohort study. All patients with ChildCRD (juvenile arthritis and systemic autoimmune rheumatic diseases) from the only pediatric rheumatology center in Manitoba for birth cohorts January 1979 to December 1998 were linked to the provincial administrative databases containing records of healthcare use and education outcomes. Patients were matched by age, sex, and postal codes to their peers who did not have ChildCRD. The primary outcomes were the grade 12 Language Arts Achievement Index (LAI) and the Math Achievement Index (MAI) scores. ChildCRD, sociodemographic, and mental health factors were tested for their associations with LAI and MAI scores using multivariable linear regression.

Results. Five hundred and forty-one patients with ChildCRD were matched to 2713 unaffected peers. Patients with ChildCRD had lower LAI and MAI scores compared to their peers. More patients with ChildCRD failed or did not take the language arts (51% vs 41%, $P < 0.001$) and math (61% vs 55%, $P = 0.02$) tests. On multivariable analysis, ChildCRD, lower socioeconomic status, younger maternal age at first childbirth, family income assistance, involvement with child welfare services, and mental health morbidities (between ChildCRD diagnosis and standardized testing), were associated with worse LAI and MAI results.

Conclusion. This population-based study showed that patients with ChildCRD performed less well than their peers on grade 12 standardized testing, independent of sociodemographic and mental health comorbidities.

Key Indexing Terms: arthritis, autoimmune diseases, child, cohort study, education, patient outcomes

The clinical outcomes of childhood-onset chronic rheumatic diseases (ChildCRD), juvenile arthritis (JA), and systemic autoimmune rheumatic diseases (SARD), have improved tremendously.[1,2,3] Although most affected children will now reach adulthood, they will continue to experience disease activity and accrue morbidities.[4] ChildCRDs directly affect children's physical function, limiting their abilities to participate fully or effectively in school.[5,6] Fatigue, mental health issues (as a result of ChildCRD, maladaptation, or preexisting), and adverse effects of medications can further affect the ability of children with ChildCRD to perform optimally in school.

Educational performance is a predictor of future employment and career attainment. Education and employment are important social determinants of health.[7] In adults with rheumatoid arthritis and systemic lupus erythematosus (SLE), those who were more highly educated had better disease outcomes and were more likely to continue working.[8,9,10,11,12,13] Continued employment provides access to healthcare benefits, which is important for adults with ChildCRD (if there is no universal healthcare coverage) as they require ongoing treatment.[1,2,3]

Two studies reported education outcomes of patients with childhood-onset SARD.[14,15] The first study found that among patients with SLE, the education outcomes of patients with childhood-onset and adulthood-onset SLE appeared to be similar.[14] However, since the patients with adult-onset SLE were much older and there has been a population-wide increase in the number of college-level graduates over time, patients with

This study is supported by funds from The Arthritis Society (Canada) Young Investigator Operating Grant.

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The authors declare no conflicts of interest relevant to this article.

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Accepted for publication October 13, 2021.

childhood-onset SLE might actually have lower education success compared to patients with adult-onset SLE of comparable age.[16] Further, no comparison was made with the healthy population.[14] In the second study among patients with juvenile dermatomyositis, education outcomes appeared to be similar to age- and sex-matched nondiseased peers.[15] More studies have been reported on education outcomes of patients with JA.[2,5,17,18,19] The results have been conflicting, with some finding better education outcomes in patients with JA compared to their peers, some with worse outcomes, and others with no difference from their peers.

Most of these studies used patient populations from tertiary referral centers, which are likely biased toward those with more severe disease. Also, most have focused on high school graduation rates, which do not reflect school performance. School performance reflects an individual's abilities and predicts higher education and potentially employment outcomes.[20] Previous studies have not accounted for sociodemographic factors that influence education outcomes such as family socioeconomic status (SES), parental (especially maternal) educational attainment, maternal age at first childbirth, and the patients' mental health conditions.[21] Thus, our understanding of the influence of ChildCRD on individuals' academic performance is incomplete.

Therefore, we conducted a population-based study of all patients with ChildCRD from 1 Canadian province, and compared their education performance—the grade 12 standardized test results—with matched population controls. We also tested the association of ChildCRD with education performance, in the context of sociodemographic and mental health factors.

METHODS

Study design and data sources. This was a retrospective longitudinal cohort based in Manitoba, a central province in Canada with a population of 1.2 million (2018).[22] We used data from a clinical registry, and provincial administrative databases housed within the Manitoba Population Research Data Repository (PRDR) at the Manitoba Centre for Health Policy (MCHP), a research unit within the University of Manitoba.[23] This study was approved by the University of Manitoba health research ethics board (HS20191 and H2016:389). Individual patient consent was waived due to the retrospective, long-term, and nonidentifying nature of this study.

All pediatric rheumatology services in Manitoba are provided in Winnipeg, the largest urban center (population > 600,000). One pediatric rheumatologist provided all the pediatric rheumatology care for this catchment area from 1984 until 2014. From 1984 to 2015, all patients with rheumatologist-confirmed ChildCRD were entered into a clinical registry, which captured names, health insurance numbers, rheumatic disease diagnosis, dates of birth, dates of diagnosis, and first clinic visit.

MCHP houses healthcare data from the provincial department of health. Almost all Manitobans are covered for health care (ambulatory and hospital) by Manitoba Health. MCHP provides access to multiple health administrative databases through the Manitoba PRDR, including the health insurance registry, hospital discharge abstracts database, medical services, and provider registry.[23] The population registry is updated every 6 months and captures information about dates of coverage initiation and termination, birth date, sex, postal codes of residence, healthcare region, and family codes (each child is linked to their biological mother).[24] The hospital Discharge Abstracts Database (DAD) contains information about admissions to and discharges from acute care hospitals. Until March 31, 2004, the DAD recorded up to 16 diagnoses using International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) codes and then up to 25 diagnoses using the ICD-10, Canadian enhancement codes, thereafter. Outpatient services are recorded in the medical services database and contain 1 ICD-9-CM diagnosis code per physician encounter. We also accessed the Drug Program Information Network (1996–2015) for information about outpatient prescription drug use for drugs dispensed and durations of use.

The Manitoba PRDR also houses nonhealth-related datasets collected by various government departments. We accessed the Enrollment, Marks, and Assessment (1996–2015) for the grade 12 standardized test results and enrollment information. We accessed the Employment and Income Assistance (EIA; 1995–2015) dataset for information on families who received support from the Manitoba EIA program. From the Child and Family Services Information Services (1993–2015) dataset, we obtained information on families who had been involved with the child welfare service.

Study population. We focused on 2 ChildCRD populations within the clinical registry: JA and SARD. JA referred to patients with onset of chronic arthritis at age < 16 years, satisfying terminology/definitions for juvenile rheumatoid arthritis, juvenile idiopathic arthritis, juvenile ankylosing spondylitis, or seronegative enthesopathy and arthropathy (SEA) syndrome. Categories of JA included oligoarticular, polyarticular (rheumatoid factor–positive or –negative), enthesitis-related arthritis (also including those with juvenile ankylosing spondylitis and SEA syndrome) and others. SARD included patients with childhood-onset SLE, idiopathic inflammatory myositis, systemic sclerosis, and Sjögren syndrome.[25,26] Childhood onset referred to patients with onset of disease prior to 17 years of age as Manitoba youths are transferred to adult services at this age.

All patients were from birth cohorts starting from January 1, 1979, until December 31, 1998 (coinciding with available grade 12 tests results). Clinical registry data were linked to provincial administrative data using scrambled unique identifiers.

Non-ChildCRD controls were ascertained from the Manitoba PRDR. For each patient with ChildCRD, we matched 5 individuals by age (± 1 yr), sex, and postal code of residence. We started with 6-digit postal codes, progressing to 5, 4, or 3-digit postal codes to find matches; all were matched using at least 3 digits. Controls could not have any rheumatic disease but could have other childhood chronic diseases. They were required to have continuous health insurance coverage from birth to age 21 years.

Study outcomes. We assessed education performance of patients with ChildCRD using grade 12 standardized test results. Beginning in 1993, all grade 12 students in Manitoba must take 2 standardized tests: math and language arts. Students pass by scoring at least 50% on each test. The math test could be any of precalculus, applied math, or consumer math, depending on students' capabilities. The language arts tests could be any the 3 options: English, French as a secondary language (French immersion program), or French as a primary language. The test results account for 30% of the students' final course mark.[27,28]

The primary outcomes were the Math Achievement Index (MAI) and the Language Arts Achievement Index (LAI) scores.[27,28] The MAI and LAI were developed using grade 12 standardized test results, information about graduation, grade repetition, or withdrawal.[27] There are 19 categories within the MAI and LAI; 14 categories represent scores on an underlying logit distribution divided according to the percentage of students included.[27] The last 5 categories are absent/dropped class, grade 12 not tested, ≤ grade 11 at age 17–18 years, not enrolled, and withdrawn. The indices correlate with the probability of age-appropriate graduation.[27] After a logit transformation, the highest scorers had an index score of +2.96 and the lowest scorers (school withdrawal) had a score of –1.84. Overall means were close to 0 and SDs were close to 1. The scoring was derived for each birth cohort taking the tests. This approach accounts for nontest takers, providing a more realistic assessment of population-level achievement.[28,29] The secondary outcome in this study was enrollment in grade 12 by 17 years of age.

Prognostic factors and confounders. SES was measured using a validated area-based measure, the Socioeconomic Factor Index version 2 (SEFI-2), which is based on average household incomes, unemployment rates, proportion of single parent families, and proportion of high school graduates; lower scores (i.e., more negative scores) indicate higher SES.[30,31] We calculated the SEFI-2 at diagnosis or index date.[32] SEFI-2 was evaluated as a categorical variable in quartiles, for easier interpretation (< −1, −1 to 0, > 0 to 1, ≥ 1).

We ascertained maternal age at first childbirth, family ever on income assistance, and child in care. These social factors had been found to account for as much of or even more of the variance in the LAI than other standard social factors, such as household income and parental education.[33] Maternal age at first childbirth was evaluated as a categorical variable (age ≤ 17, 18–19, 20–24, ≥ 25 yrs).

Mental health morbidity was defined based on diagnosis codes or prescription medication use for at least 1 of 5 psychiatric illnesses (from previously published definitions): attention deficit hyperactivity disorder, conduct disorder, substance use disorder, mood and anxiety disorders, and psychotic disorders (including schizophrenia).[34] We identified psychiatric morbidities in 3 time periods: (1) premorbid: time from birth until the date of diagnosis/index date; (2) intercurrent: 12-month period preceding the first of the standardized testing dates; and (3) disease course: from date of diagnosis or index date until the first of the standardized testing dates (overlaps with intercurrent). These measures were defined to distinguish the preexisting psychiatric morbidities from those after diagnosis, which could arise because of the chronic disease experience. Psychiatric morbidities could also recur over time, which is why we identified intercurrent psychiatric morbidities.

The management of rheumatic diseases has changed substantially over the study period, resulting in improved disease control and physical function, which might in turn affect the observed education outcomes. Therefore, we created categories for the time periods of diagnosis (1980–1989, 1990–1999, 2000–2009, and 2010–2015).

Analysis. Categorical measures were described using frequencies and percentages. Continuous measures were described using means and SDs or medians and IQRs (25th–75th percentiles) as appropriate. Comparisons between ChildCRD and non-ChildCRD were conducted using chi-square test for categorical measures and *t* test for continuous measures.

We used simple linear regression to test the associations of each of the sociodemographic factors and mental health morbidity measures with each of the LAI and MAI scores. We performed testing in univariable logistic regression models to test the association between these same demographic and morbidity measures and age-appropriate enrollment in grade 12 by 17 years of age (yes/no).

Using multivariable linear models (PROC GENMOD), we tested the association between LAI and MAI scores and the key prognostic factor (ChildCRD vs non-ChildCRD), after controlling for time periods of disease onset, sociodemographic variables (SEFI-2, maternal age at first childbirth, family ever on income assistance, and child in care), and mental health morbidities. We assessed the 3 mental health morbidity covariates for multicollinearity using the variance inflation factor (VIF). Based on the VIF values, all 3 covariates could be retained in our final model. Scaled Pearson × 2 statistics was used to assess model goodness of fit. Values close to 1.0 indicate a good-fitting model.

Using a multivariable logistic regression model (PROC GENMOD), we tested the associations between the secondary outcome of enrollment in grade 12 by 17 years of age and the same covariates as defined for the multivariable LAI and MAI models. Estimated ORs and 95% CIs were reported. The C statistic, a measure of discriminative performance, was estimated for this model. All analyses were conducted in SAS 9.4 (SAS Institute).

RESULTS

Study population. Of the 571 patients within the clinical registry seen during the study period, 541 were linked successfully to the Manitoba PRDR and matched to 2713 non-ChildCRD. Table 1 contains the baseline demographic information of the study population and shows that the distribution of known prognostic factors was similar between the ChildCRD and non-ChildCRD groups.

Grade 12 standardized test results and enrollment in grade 12. Compared to the non-ChildCRD group, the ChildCRD group had lower unadjusted LAI scores (−0.22, $P < 0.0001$) and MAI scores (−0.21, $P < 0.0001$; Table 2). Also, a greater percentage of the ChildCRD group failed or did not participate in language arts (51% vs 41%, $P < 0.001$) and math (61% vs 55%, $P = 0.02$) testing (Figure 1). Of the ChildCRD group, 33% were not enrolled in grade 12 by 17 years of age, compared to 25% in the non-ChildCRD group ($P < 0.001$). Among all those not enrolled (ChildCRD and non-ChildCRD), 66% were females, which is lower than the proportion of females in this study population.

Association of ChildCRD with grade 12 standardized test results. In unadjusted (univariable) analysis, the ChildCRD group had lower unadjusted LAI and MAI scores than the non-ChildCRD group by about one-fifth of an SD (Table 2). Adverse social factors were also associated with poorer LAI and MAI performance, including lower SES, younger maternal age at first childbirth (< 25 yrs old), being a member of a family requiring income assistance, or ever being a child in care. The effects of these social factors on the LAI and MAI were greater in magnitude than the effect of having ChildCRD. Psychiatric morbidities (premorbid, disease course, and intercurrent) were associated with poorer LAI and MAI results. Given that premorbid and disease course psychiatric morbidities had similar associations with LAI and MAI and that these associations were stronger than intercurrent psychiatric morbidity, we excluded intercurrent psychiatric morbidity from the final multivariable model.

The unadjusted analyses also revealed that having ChildCRD reduced the odds of enrollment in grade 12 by 17 years of age by 32% (Table 3). Social factors also reduced the odds of any individual being enrolled in grade 12 by 17 years of age by 51, to 93% (Table 3). Psychiatric morbidities, whether premorbid or disease course morbidities, including those in the last 12 months before the standardized testing, were all associated with lower odds of enrollment in grade 12 by 17 years of age.

In multivariable models, adjusted for all the sociodemographic and psychiatric morbidity variables, ChildCRD remained a statistically significant predictor of poorer LAI and MAI performance (Table 2). ChildCRD also remained a statistically significant predictor of enrollment in grade 12 by 17 years of age, even when adjusting for all the other covariates (Table 3).

DISCUSSION

In this population-based study of education performance, we showed that patients with ChildCRD performed worse than their age-, sex-, and postal code–matched non-childCRD peers on their grade 12 standardized test results and were less likely to be enrolled in grade 12 by the appropriate age (17 yrs). ChildCRD was associated with worse education performance, independent of sociodemographic and mental health factors known to affect education outcomes.

Table 1. Baseline demographic characteristics of the ChildCRD and matched non-ChildCRD cohorts.

	ChildCRD Cohort, n = 541	Non-ChildCRD Cohort, n = 2713
Age at diagnosis/index date, yrs, median (IQR)	10.0 (4.0–13.0)	11.0 (8.5–14.0)
Females, n (%)	379 (70)	1912 (70)
JA	497 (91)	NA
Oligoarticular	199 (40)	NA
Polyoligoarticular	149 (30)	NA
Enthesitis-related arthritis	65 (13)	NA
Other	84 (17)	NA
SARD[a]	44 (9)	NA
Systemic lupus erythematosus	23 (52)	NA
Juvenile dermatomyositis	16 (36)	NA
Systemic sclerosis	5 (12)	NA
Disease duration at tests, yrs, median (IQR)		
JA	7.5 (4.3–13.6)	NA
SARD	6.9 (2.6–8.8)	NA
Time period of diagnosis/index date		
1980–1989	69 (13)	349 (13)
1990–1999	250 (46)	1256 (46)
2000–2009	189 (35)	943 (35)
2010–2013	33 (6)	165 (6)
SEFI-2[b]		
< −1	110 (20)	567 (21)
−1 ≤ SEFI-2 < 0	212 (39)	1027 (38)
0 ≤ SEFI-2 < 1	140 (26)	701 (26)
≥ 1	79 (15)	418 (15)
Maternal age at first childbirth, yrs, (%)		
≤ 17	47 (9)	270 (10)
18–19	70 (13)	331 (12)
20–24	167 (31)	903 (33)
≥ 25	253 (47)	1201 (44)
Families ever on income assistance	99 (18)	519 (19)
Child ever in care	26 (5)	176 (6)
Premorbid mental health morbidity	43 (8)	203 (7)
Intercurrent psychiatric morbidity	30 (6)	152 (6)
Disease course psychiatric morbidity	67 (12)	282 (10)

Values are n (%) unless otherwise indicated. [a] None had Sjögren syndrome. [b] For SEFI-2, the more negative the value, the higher the socioeconomic status. ChildCRD: childhood-onset chronic rheumatic diseases; JA: juvenile arthritis; NA: not applicable; SARD: systemic autoimmune rheumatic diseases; SEFI-2: Socioeconomic Factor Index version 2.

Our study included all confirmed cases of ChildCRD in a single Canadian province during the study period, allowing us to generalize across multiple diseases and patients with the full spectrum of disease severity. This is unique compared to most previous studies, which were mostly referral center–based,[2,15,35,36] potentially suffering from selection bias. Suboptimal participation rates and cohort attrition over a long period of time could further contribute to bias if those who were particularly well or unwell did not participate or were not evaluated.[36] In our population-based study, if an adolescent moved away, it would be unlikely because of their disease or their grade 12 standardized test results. Further, the LAI and MAI indices we used accounted not only for those who took the standardized tests (who might already perform better), but also those who did not, avoiding bias.

We demonstrated that ChildCRD had an independent adverse association with grade 12 standardized testing performance. Also, we were able to appreciate, for the first time, the relative magnitude of the prognostic effect of ChildCRD, compared to the other sociodemographic and mental health factors, on education performance of adolescents. Compared to ChildCRD, the sociodemographic factors had up to 3-fold greater adverse effect on their academic performance and up to a 2-fold greater effect in reducing the odds of being enrolled in grade 12 by 17 years of age. Further, those assessed in the 2010–2013 time period were more likely to be enrolled in grade 12 by 17 years of age compared to earlier years. This likely reflected the change in legal age when a student can legally leave school to 18 years (previously 16 yrs) from 2010 onward in Manitoba.

Our results suggest that the pediatric rheumatologist should be cognizant of the fact that sociodemographic and mental health factors can equally or even more adversely affect

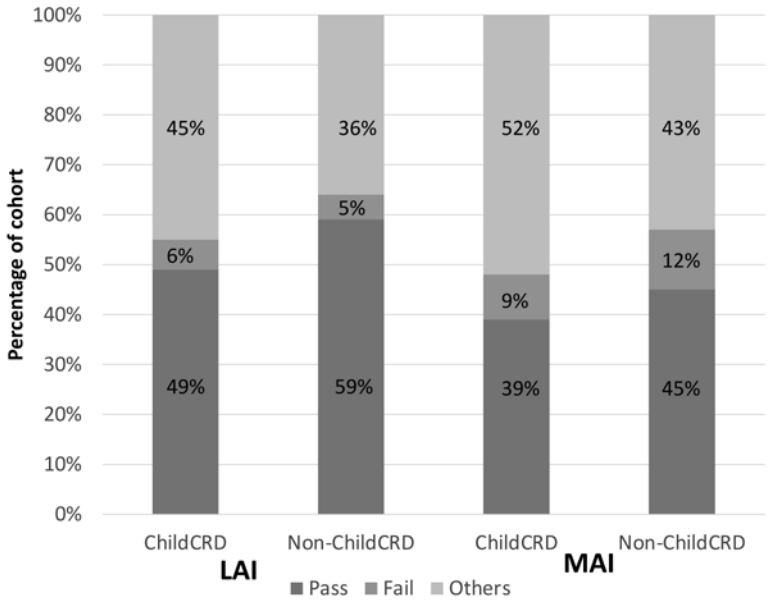

Figure 1. Results of grade 12 standardized testing in language arts and math in ChildCRD cohort and non-ChildCRD cohort. Patients either passed, failed or did not take the tests ("Others"). ChildCRD: childhood-onset chronic rheumatic disease; LAI: Language Arts Achievement Index; MAI: Math Achievement Index.

Table 2. Factors predictive of grade 12 education performance in youths with ChildCRD in Manitoba.

	Univariable		Multivariable	
	LAI Estimate (SE)[a]	MAI Estimate (SE)[a]	LAI Estimate (SE)[a]	MAI Estimate (SE)[a]
ChildCRD[b]	−0.22 (0.05)	−0.21 (0.05)	−0.23 (0.04)	−0.23 (0.04)
Time periods				
2010–2013	−0.03 (0.09)*	0.01 (0.09)*	0.06 (0.08)*	0.09 (0.08)*
2000–2009	−0.15 (0.06)	−0.16 (0.06)	0.02 (0.05)*	−0.02 (0.06)*
1990–1999	−0.10 (0.06)*	−0.14 (0.06)	−0.01 (0.05)*	−0.05 (0.06)*
1980–1989	Ref	Ref	Ref	Ref
SEFI-2[c]				
≥1	−1.20 (0.06)	−1.16 (0.06)	−0.70 (0.06)	−0.70 (0.06)
0 ≤ SEFI-2 < 1	−0.43 (0.05)	−0.36 (0.05)	−0.21 (0.05)	−0.15 (0.05)
−1 ≤ SEFI-2 < 0	−0.25 (0.05)	−0.21 (0.05)	−0.12 (0.04)	−0.09 (0.05)
< −1	Ref	Ref	Ref	Ref
Maternal age at first childbirth, yrs				
≤ 17	−1.12 (0.06)	−1.06 (0.06)	−0.59 (0.06)	−0.54 (0.06)
18–19	−0.86 (0.05)	−0.78 (0.05)	−0.50 (0.05)	−0.43 (0.06)
20–24	−0.44 (0.04)	−0.42 (0.04)	−0.30 (0.04)	−0.29 (0.04)
≥ 25	Ref	Ref	Ref	Ref
Families ever on income assistance[d]	−0.81 (0.04)	−0.74 (0.04)	−0.33 (0.05)	−0.26 (0.05)
Child ever in care[d]	−0.97 (0.07)	−0.96 (0.07)	−0.27 (0.07)	−0.32 (0.07)
Premorbid mental health morbidity[d]	−0.33 (0.07)	−0.32 (0.07)	−0.22 (0.06)	−0.23 (0.06)
Disease course mental health morbidity[d]	−0.37 (0.06)	−0.39 (0.06)	−0.19 (0.05)	−0.22 (0.05)

Univariable and multivariable linear regression models were fitted. Scaled Pearson × 2 (value/degree of freedom), a measure of model fit, was 1.00 for both (LAI, MAI) multivariable models. [a] All estimates are statistically significant at a < 0.05 except for time periods where * denotes results that were not significant. [b] ChildCRD compared to non-ChildCRD. [c] More negative SEFI-2 indicates better socioeconomic status. [d] Compared to not having the covariate of interest as the reference. ChildCRD: childhood-onset chronic rheumatic diseases; LAI: Language Arts Achievement Index; MAI: Math Achievement Index; SE: standard error; SEFI-2: Socioeconomic Factor Index version 2.

Table 3. Factors predictive of age-appropriate grade 12 enrollment in youths with ChildCRD in Manitoba.

	Univariable OR (95% CI)	Multivariable[a] OR (95% CI)
ChildCRD[b]	0.68 (0.56–0.83)*	0.58 (0.46–0.72)*
Time periods		
2010–2013	1.72 (1.09–2.69)*	2.73 (1.61–4.63)*
2000–2009	0.81 (0.63–1.06)	1.33 (0.99– 1.79)
1990–1999	0.83 (0.64–1.07)	1.08 (0.81– 1.43)
1980–1989	Ref	Ref
SEFI-2[c]		
≥ 1	0.07 (0.05–0.09)*	0.17 (0.12–0.24)*
0 ≤ SEFI-2 < 1	0.38 (0.29–0.50)*	0.62 (0.45–0.84)*
−1 ≤ SEFI-2 < 0	0.61 (0.46–0.80)*	0.82 (0.61–1.10)
< −1	Ref	Ref
Maternal age at first childbirth, yrs		
≤ 17	0.10 (0.07–0.13)*	0.29 (0.21–0.40)*
18–19	0.15 (0.12–0.19)*	0.32 (0.24–0.43)*
20–24	0.37 (0.30–0.46)*	0.51 (0.41–0.64)*
≥25	Ref	Ref
Families ever on income assistance[d]	0.20 (0.17–0.24)*	0.48 (0.38–0.60)*
Child ever in care[d]	0.14 (0.10–0.19)*	0.42 (0.29–0.61)*
Before diagnosis psychiatric morbidity[d]	0.71 (0.53–0.93)*	0.80 (0.57–1.12)*
Disease course psychiatric morbidity[d]	0.46 (0.36–0.58)*	0.59 (0.45–0.78)*

[a] The C statistic for the multivariable model was 0.80. [b] ChildCRD compared to non-ChildCRD. [c] The more positive the SEFI-2, the lower the socioeconomic status. [d] Compared to not having the covariate of interest as the reference. * Significant result. ChildCRD: childhood-onset chronic rheumatic diseases; SEFI-2: Socioeconomic Factor Index version 2.

the academic performance of their patients with ChildCRD. Therefore, pediatric rheumatologists or other healthcare providers should perform a more holistic assessment of each patient with ChildCRD for additional risk factors that could adversely affect their academic performance and elicit information about perceived barriers to the patient's school experience. If additional risk factors are identified or the patient or family expressed difficulties in their schoolwork, the pediatric rheumatologist should engage with student services personnel within the school or school district to advocate for additional assessments and/or supports for each patient. Discussions about the child's education experience (eg, progress, risk factors) are an essential topic during routine clinical assessments. In resource-poor practice settings, pediatric rheumatologists should familiarize themselves with local school personnel and resources to learn how to advocate effectively for their patients. It is important to work with school personnel to identify the supports available for children and youths with chronic illnesses and opportunities to personalize the supports to the needs of child or youth.[37] The pediatric oncology community has a long history of dealing with school disruptions and has developed many resources to help their patients cope with school disruptions.[38] Perhaps the pediatric rheumatology community can learn from their examples to develop, in parallel to the therapeutic plan for every newly diagnosed patient with ChildCRD, a school action plan to address anticipated illness-related issues and propose strategies to help patients cope.[38]

We could not examine the effect of ethnocultural factors and parental education attainments, which are known to influence education outcomes; these data are not available in the study database.[39,40,41] We did not have access to an individual-level measure of SES but we used an area-based socioeconomic measure, as well as other individual-level sociodemographic factors (eg, families on income assistance) to study their effects. At the same time, the sociodemographic and mental health factors included in this study are the most comprehensive to date, to our knowledge, for studying education outcomes in patients with ChildCRD. We could not report any outcomes for JA-specific categories, as the numbers in some categories were too small to be reported based on restrictions because of health information privacy requirements. We believe the school experiences of patients with ChildCRD are sufficiently homogenous that these reporting requirements do not detract from our comparisons involving patients with ChildCRD and non-ChildCRD peers.

In summary, ChildCRD was associated with worse education performance, as measured by lower grade 12 standardized test results and age-appropriate grade enrollment by 17 years of age. The negative association of ChildCRD was independent of other sociodemographic and mental health factors that influenced education performance. Whereas ChildCRD was adversely associated with education performance, the relative magnitude of effect was smaller than sociodemographic factors. Pediatric rheumatologists and other healthcare providers should take all these factors into consideration and seek to evaluate for potential problems in school performance in children with

ChildCRD who have a high-risk profile. These children should receive additional education assessments and support in school to improve their education outcomes. Pediatric rheumatologists should consider making routine assessments for risk factors of poor education outcomes and for school difficulties. As a community, we might consider actions such as proactively engaging with every patient/family with ChildCRD regarding the effects on schoolwork, connecting patients and their families to resources, or helping to advocate for these resources as part of our routine care from the time they are diagnosed. Detecting and supporting patients to address potential challenges early on may help set patients with ChildCRD up for improved education outcomes later.

ACKNOWLEDGMENT

We acknowledge the MCHP for the use of data contained in the PRDR under project #2017005 (HIPC# 2016/2017–37). The datasets we used were derived from Manitoba Health and Seniors Care, Manitoba Department of Families, and Manitoba Education and Training. Approvals for use of data were given by all 3 agencies. The results and conclusions from this study are those of the authors and no official endorsement by MCHP, Manitoba Health and Seniors Care, Manitoba Department of Families, and Manitoba Education and Training is intended or should be inferred. We also thank Dr. Kiem Oen, the pediatric rheumatologist who provided care to all children and youths with pediatric rheumatic diseases in our province for over 30 years. She created and maintained the clinical registry that we used to conduct this study.

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