Multilevel social determinants of individual and family well-being: National and international perspectives
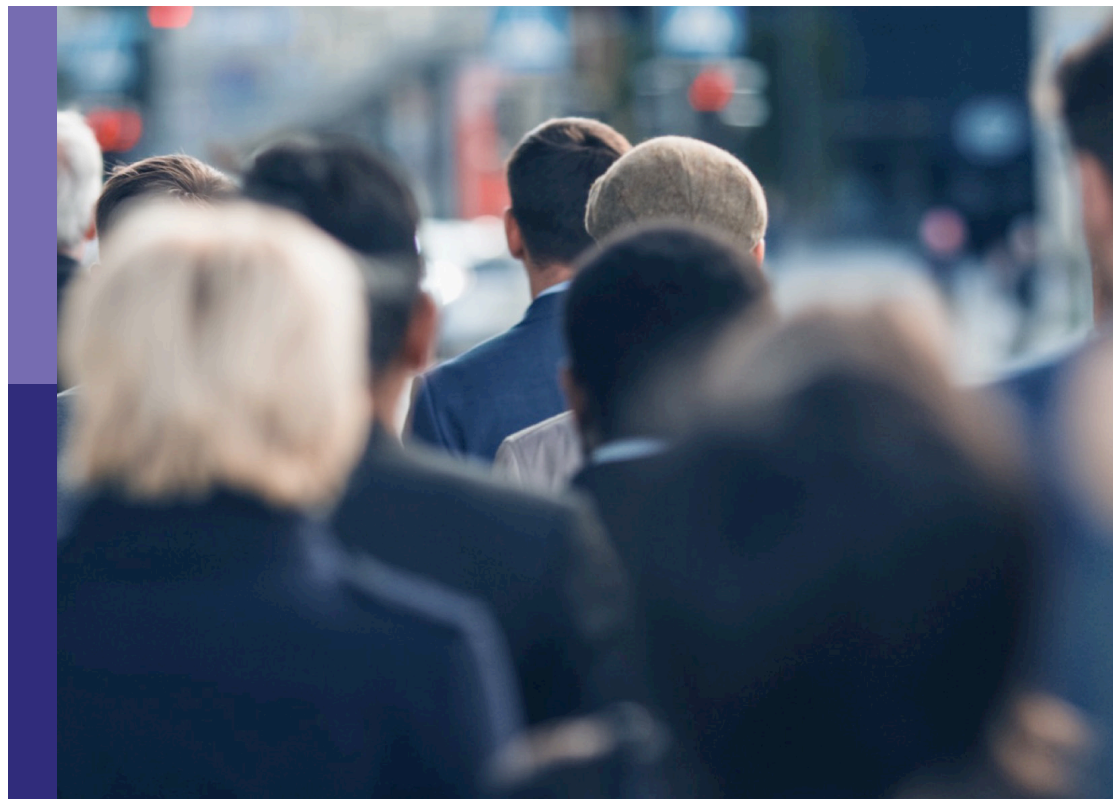
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Multilevel social determinants of individual and family well-being: National and international perspectives

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Editorial: Multilevel social determinants of individual and family well-being: national and international perspectives

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Editorial on the Research Topic
Multilevel social determinants of individual and family well-being: national and international perspectives

For decades, the "social determinants of health perspective" has provided a framework around how the health of individuals is linked to social contexts, including family, school, community, neighborhood, peer, economic, political, and cultural phenomena. Increasingly, the family, itself, is being considered as a critical unit-of-analysis in understanding how social determinants shape life, health, and well-being. As this special issue attests, public health scholars have expanded upon individual health metrics to consider substantive processes within the family that have been historically prioritized by family therapists and psychologists (1). This exciting development is in the spirit of "multiple levels of analysis" (2, 3), championed in developmental psychopathology, whereby a unique and interdisciplinary mode of understanding emerges only when considering constructs that have historically resided in disciplinary silos. The nine papers in this special issue follow this theoretical spirit. Below, we have highlighted our key learnings.

1. *Incorporation of historical epochs into theoretical paradigms, including the pandemic, remains essential in understanding the impact of social determinants on individuals and families.*

Much of the present research utilized data sets that were mobilized during the pandemic. For example, using an impressive nation-wide survey quickly mobilized by Statistics Canada in the wake of the COVID-19 pandemic, Colucci et al. demonstrated that parents who had lower levels of education, experienced unemployment, or were essential workers had greater fears about child and family welfare during the pandemic. Using the same dataset, Zhang et al. demonstrated that families with higher socioeconomic status (SES) tended to have children with less media-saturated experiences during the shutdown and were more likely to plan on utilizing out-of-home childcare upon the pandemic's recession. Outside the pandemic, both Toombs et al. and Hicks et al. positioned their important contributions in the Truth and Reconciliation conversation in Canada, as outlined below. As ongoing global events continue to shape health and well-being for individuals and families, it is essential to incorporate these perspectives into research and policy.

2. *Health disparities must be articulated, while promoting non-pathologizing strengths-based perspectives that identify the undeniable resilience of people and their kin.*

Toombs et al. and Hicks et al. offer exemplary, empirical perspectives from the Aboriginal Peoples Survey in Canada (2017), demonstrating how racist, genocidal national policies (i.e., the Canadian Residential School System) have informed health for generations. Yet, they acknowledge these historical injustices while offering a strengths-based understanding, articulating the dignity of persons, and make policy recommendations that are culturally sensitive, informed, and consider the complexity of social determinants among First Nations Canadians. In a completely different context, Jia et al. similarly demonstrate the health consequences of historical harms perpetuated by the state (i.e., the Hukuo System in China), which are presently being addressed through policies aimed at reparation and healing. Furthermore, Toombs et al., Hicks et al. and Jia et al. demonstrate the power of articulating these historical health events, and their sequelae, from an empirical perspective using sophisticated epidemiological paradigms.

3. *Social determinants are not only important to consider for individual health, but also in relation to general family well-being.*

Social determinants in relation to family health and well-being is a recurring theme across most studies in this special issue. This is evident in contributions even when a traditional "family" outcome is not, necessarily, at the forefront of the research question. For example, Herrin et al. consider childhood wheezing and asthma from the lens of prenatal programming within families. While their initial hypotheses were not directly supported, the paradigm speaks to the importance of considering intergenerational exposure to health pathogens, which may further interact with biological sex and social contexts, demonstrating complexity in mechanisms of transmission. Similarly, Sivashankar and Chen consider the highly familial problem of substance use disorder during the pandemic, which importantly interacted with shame, social relations, and socioeconomic related variables (e.g., employment), identifying important differences across male and female respondents. This work is an extremely important direction, especially considering the massive rise in substance use problems globally, particularly for males (4).

4. *Public attitudes, including stigma and racism, continue to be barriers that challenge efforts to promote the health of individuals and families, while redressing historical harms.*

The relationship between public attitudes and stigma related to mental illness is noted in several abstracts. Pybus et al. investigated the relationship between national socioeconomic conditions and public attitudes regarding individuals with mental illness, underscoring the importance of reducing stigma at national levels. Furthermore, this impressive contribution denotes the multiple levels of analysis perspective underscoring the entire special issue. That is, both macro (i.e., gross domestic product and income inequality) and micro (i.e., difficulty paying bills) processes corresponded to stigma among the Eurobarometer sample (over 20 countries). From stigma to racism, Toombs et al. and Hicks et al. contextualize their important findings within the institutional racism that has plagued Canada for generations and is epitomized by the Residential School System. While acknowledging the complex, multilevel, and historical challenges inherent in reconciliation, they provide specific recommendations for grassroots, community interventions that can support mental health challenges in Indigenous families.

5. *Policy and intervention implications must continue to incorporate perspectives of family well-being, given the clustering of social determinants amongst related and co-residing persons and, consequently, health outcomes.*

While the papers in this issue are distinct, each highlighting specific issues related to social determinants of health in different health domains, geographies, and historical contexts, they overlap in the call for health policy and interventions that address the complex ecology of family life. Interventions cannot be uncoupled from social determinants of health and must simultaneously consider the cultural realities of families they are intended to reach. Anti-racist practices that acknowledge the historical harms of states and political institutions are indispensable in this effort. Moreover, the uptake and sustainability of health-promotion initiatives depends, in part, on broader socio-political conversations. This is, perhaps, an upsetting truism considering suggestions of a rise in global populism and extremism (5). Nevertheless, based on this collection of papers, the development, implementation, and evaluation of culturally sensitive, specific, and measurable intervention practices and policies—ones that acknowledge social determinants of health for individuals and families, within historical and current political contexts—is undoubtedly on the pathway forward.

Author contributions

DB: Conceptualization, Writing – original draft. BM: Conceptualization, Writing – review & editing. NR: Conceptualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Inverted U-shaped relationship between education and family health: The urban-rural gap in Chinese dual society

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Introduction: The Healthy China Initiative emphasizes family health. Education is an upstream determinant of health, which can both achieve upward mobility and cause class solidification.

Methods: Using nationwide large-scale data collected in 2021, the present study explored the relationship between education and family health in the urban-rural dual society via Oaxaca-Blinder decomposition and propensity score matching.

Results: Our data revealed disparities in family health, educational attainment, household income, healthcare coverage, and job type between urban and rural China. An inverted U-shaped relationship existed between increasing years of education and family health. The upper limit was 17.1 years for urban residents and 13.7 years for rural residents, with limited health benefits from higher education obtained by rural residents. Mediated by work-family conflict, highly-educated people received gradually diminishing health returns. The results of the Oaxaca-Blinder decomposition showed that 25.8% of the urban-rural gap in family health could be explained by the disparity in education. Urban residents could translate cultural capital and economic capital into health capital to a greater extent. After propensity score matching, a robust, inverted U-shaped relationship was found between education and family health. The inverted U-shaped relationship was found to replace family health with self-rated health and quality of life.

Discussion: Family-centered public health and education programs, policies, and goals should be developed to break urban-rural dual structure barriers and advance social equity in China.

1. Introduction

The Health China Initiative aims at narrowing the gap in basic healthcare services between urban and rural areas, regions, and communities, to achieve universal health coverage and social equity. The awareness of healthy life and family health (FH) management has been enhanced in recent years. The family lays the foundation for individual growth and sustainable development (1, 2), which exerts an unparalleled influence and resource for health maintenance and disease prevention (3, 4), especially during the post-coronavirus disease 2019 (COVID-19) era.

The hukou system was first devised in 1955 and propagated in 1958 as a measure of social control to restrict rural populations from access to state-allocated products, welfare, and rights. Based on the place of birth and lineage (i.e., mother's hukou type), each person is assigned a hukou type [either agricultural (rural) hukou or non-agricultural (urban) hukou] (5). Because the hukou system strictly confined people to the land they were born for a few decades, a de jure rural-urban division has been created (6). Due to the hukou system, there are distinct differences in geographical environment, welfare resources, behavioral habits, and cultural values between urban and rural China (7–10), which may translate into inequalities in the economic status, educational opportunities, employment and health outcomes (11–13). Education—perhaps the most salient modifiable social determinant and an upstream cause of health, is a powerful means of reducing socioeconomic and political disadvantages, to achieve upward mobility (14). However, the dual social structure causes disparities in the acquisition and utilization of educational resources between urban and rural residents (15–17). For the post-90s generation, the probability of urban students attaining higher education is 90% higher than that of rural students (65.12 vs. 34.41%) (18). Thus, education can also reproduce social class and health inequality. Poor education in rural areas can directly reduce the happiness perception of rural residents and negatively impact their happiness perception through income and social class perception gap (19). In this case, clarifying the nexus and mechanism between education and health is critical to avoid the unintended consequence of aggravating class solidification, which is beneficial to urban-rural integrated development.

Previous research has demonstrated a significant relationship between educational achievement and multiple health consequences, including mortality, self-rated health status, morbidity using objective health measures such as blood pressure, body mass index, hypertension, and chronic disease, and health-related behaviors such as smoking and drinking (20–22). However, so far, there is no consensus on the relationship between education and health. Some studies have reported a positive effect (23, 24), while others have reported no or even negative effects (25–27). The health benefits of education may vary among people with different socioeconomic statuses in different stages of education (28, 29), and a non-linear association should exist between education and health. Whilst numerous studies have explored individuals' health—focusing on physiological and behavioral factors—family, as a systematical unit to develop multifaceted material, psychological, emotional, social, and cultural capital for health, has attracted less attention (30). Moreover, the social context in which education and health processes are embedded has been ignored, which may have a limited impact on addressing disparities (31). From the lens of structuralism (32), the economic position and living conditions determined by the social structure can cause health inequalities (33). Nowadays, topics such as "small-town swot," "impoverished families can hardly nurture rich sons," and "schooling is useless" are heatedly debated. Therefore, it is necessary to explore the health benefits of education in China's unique dual social context. The present study examines the impact of education on FH for urban and rural residents, which may provide a panoramic view for policymakers, educators, and health practitioners to conduct interventions aimed at specific populations to reduce social inequality and promote common prosperity.

2. Literature review and hypothesis

The family forms a the basic foundation for the individual and community health, as well as the basic unit of health care, disease prevention, and health promotion in the twenty-first century (34). Families are biologically, legally, or emotionally linked groupings, and health can "spread" through familial bonds. According to the family system theory, family members are interrelated, and individuals' health outcomes are determined by their family members (35).

Education can generate health externalities for individuals and their families through economic, health-behavior, and social-psychological paths (36) to preserve family wellbeing inter- and trans-generationally. Highly-educated people usually have life partners with similar educational backgrounds and professions, which can promote family harmony. Meanwhile, better-educated parents are more likely to live in a safe neighborhood and have stable family lives, providing sufficient material and spiritual support and developing healthy habits for their offspring (37, 38). In turn, better-educated adults can obtain decent jobs with higher salaries, relieving their parents' budget constraints, and making good use of health resources for physical examination and chronic disease management (39).

However, the long-term existence of uneven distribution of educational resources due to the Hukou system causes the segmentation of the labor market, the fragmentation of economic status, lifestyle, and social interaction, and the reproduction of health inequality (40). In the stage of compulsory education, rural schools are left behind in basic equipment, quality of instruction, attracting highly

qualified teachers, peer influence, parental expectations, and extracurricular training (41, 42). As a result, the opportunity to attend high school is biased toward urban residents. Moreover, schools in rural areas lack a physical exercise curriculum, sports facilities, and health concepts, leading to low health literacy among rural students from an early age (43, 44). Although access to higher education has increased with the college enrollment expansion policy, there is still uneven distribution of higher education due to the impact of family background and magnified regional differences (45). According to the maximum maintenance inequality hypothesis and the effective maintenance inequality hypothesis (46, 47), the superior class will crowd out the educational opportunities of the inferior class, preventing the elimination of inequality until the educational opportunities are saturated for the superior class. Moreover, the type of inequality transforms from the simple quantity to the differences in quality of enrollment and level of the university. Constrained by economic conditions and cultural horizon, it is more difficult for rural residents to succeed in the college entrance examination (48), and they are even more likely to make a "rational" decision to give up their education. Therefore, hypothesis 1 is proposed based on the disparities between urban and rural China.

Hypothesis 1 (H1): Disparities in education cause FH inequality between urban and rural China.

Since the access to higher education is limited, highly competitive, and selective, rural students have to make greater efforts and overcome more barriers to secure college admission. The opportunity for urban residents to attend university was 3.4 times that of rural residents among those born between 1975 and 1979, which increased to 5.5 times among those born between 1980 and 1985 (50). Higher education attainment may not make rural students and their families happier because of the high cost, low rates of return, and a prolonged period of investment (51). Wang et al. demonstrated that the positive spillover effect of higher education is significant only in urban families (52). Moreover, after the expansion policy, the job market is flooded with college graduates (over 10 million), leading to the devaluation of diplomas and the mismatch with the employers' demand. Worse still, the labor market segmentation occasioned by the hukou system exposes graduates from rural areas to a higher risk of unemployment and low-wage employment.

Additionally, Grossman proposed that everyone obtains the initial health stock at birth through heredity, which is maintained or improved through later individual or public investment (53). There are disparities in health stock between urban and rural residents caused by endowments and social determinants. According to the "resource multiplication" or "add protection" theory (54, 55), education has multiplicative health benefits for an advantaged subpopulation. Urban residents have a preference for a healthy lifestyle, which can be solidified and reinforced through the process of education.

However, it is more difficult for rural residents to obtain and translate educational gains into health benefits for the whole family due to the lack of a health concept and health resources (56). Moreover, accessing higher education is a crucial ladder for career development and social status for rural residents. While for urban residents with superior congenital conditions, higher education is more about cultural expectations and spiritual pursuit than just making a living. Thus, rural residents may suffer greater psychological deprivation and family-raising pressure when encountering negative events such as economic slumps and unemployment, which reduce their perception of happiness and family wellbeing (57). As a result, hypothesis 2 is proposed.

Hypothesis 2 (H2): Rural residents receive fewer FH benefits of higher education than urban residents.

According to the life course theory (49), the health benefits of education differ depending on the stage of education. When the educational level is relatively low, increasing years of schooling (YS) can greatly improve the health status; however, beyond a certain threshold, continued increase can hardly have a health premium. In western studies, although individuals with a secondary education diploma have the highest perception of happiness, the "marginal" health promotion "increment" is reduced after individuals obtain a college degree (58, 59). Highly-educated people tend to have higher expectations and are usually in a state of tension, anxiety, and disappointment, which may in turn offset the potential mental health benefits (60). For example, Avendano et al. found that increasing YS could incur psychological stress and emotional burdens (61). Even worse, these negative emotions are usually ignored or even suppressed, which increases the risk of unhappiness. In 2019, Nature investigated more than 6,300 doctoral students around the world and 36% of respondents had sought help because of anxiety or depression (62). Besides, the rate of sleep problems and suicide attempts has increased among Chinese college students from 2010 to 2020 (63). Hypothesis 3 is proposed that a non-linear relationship exists between education and health.

Hypothesis 3 (H3): There is an inverted U-shaped relationship between YS and FH.

The work-family conflict (WFC) occurs when demands and negative moods experienced in the work domain spill over into the family domain, which potentially undermines wellbeing, family functioning, and social relationships (64–69). WFC is significantly related to affective disorders including anxiety, depression, and suicidal ideation (70, 71). Frone et al. posited that mediates the relationship between work and family microsystems (65). Aryee et al. found that WFC mediates the effects of paid work and family systems on individual and family outcomes (72), including job and family satisfaction, psychological health (73), marital tension (74), and

parenting (75). Highly-educated people are more engaged in administrative management, and professional or technical work under a greater cognitive load, leading to extensive exposure to electronic products, irregular diet and rest schedules, lack of exercise, depression, and chronic diseases (76). The work stressors and negative affect can cross over within families and ultimately lead to family dysfunction (77, 78). Therefore, hypothesis 4 is proposed.

Hypothesis 4 (H4): WFC can negatively mediate the relationship between education and FH.

3. Methods

3.1. Setting, sample, and data collection

We carried out a cross-sectional nationwide survey from July to September 2021 to collect data on trends in China's wellbeing for people, families, communities, and cities. A total of 120 cities were randomly chosen from 23 provinces, capitals of five autonomous regions, and four province-level municipalities using a multistage cluster sampling technique. In each city, at least one surveyor or survey team was hired. Each surveyor was tasked with gathering 30–90 questions, and each team was tasked with gathering 100–200 questionnaires. The enumerators collected a sample with gender, age, and urban/rural distribution that generally matched the demographics based on the results of the "7th National Census, 2021". After removing respondents aged <18 years, the final sample included 9,964 responses [urban, $n = 5,796$ (58.2%); rural, $n = 4,168$ (41.8%)].

3.2. Measurement of key variables

3.2.1. Dependent variable

Family health (FH), which served as the primary explanatory variable, composed of family social and emotional health process, family health lifestyle, family health resources, and family external social supports (Supplementary Table 1), and was measured by a 10-item abbreviated version of the Family Health Scale (FHS-SF) (30). FHS-SF with Cronbach's α of 0.849 demonstrates good validity and reliability. Five response levels from strongly disagree (1) to strongly agree (5) were used to calculate the score. Negatively worded items were reverse scored so that higher scores indicated better FH.

Self-reported health and health score—measured by the EQ-5D-5L questionnaire—were used for robustness tests. EQ-5D-5L was used to define and assess health in various illness categories (79). The EQ-5D-5L descriptive system is composed of five dimensions, mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. Five response levels ranging from 1 to 5 for no problems, slight problems, moderate

problems, severe problems, and unable to/extreme problems, respectively, were used to calculate the score.

3.2.2. Independent variable

The primary explanatory variable was years of schooling (YS), with 0 denoting illiteracy, six denoting primary school, nine denoting junior high, 12 denoting high school, 15 denoting an associate's degree, 16 denoting a bachelor's degree, 19 denoting a master's degree, and 22 denoting a Ph.D. degree (80).

3.2.3. Control variables

Age, gender, marital status, religion, household income, healthcare, siblings, number of children, homestyle, ethnicity, and job type were all considered as control variables for individuals and family factors. Marital status was classified as married or others (single/divorced/widowed). Religion was classified as religious or not. Household income represents monthly household income per capita. Healthcare was classified as either out-of-pocket or purchased. Traditional homestyle was defined as couple family, nuclear family, main family, and united family, while others were defined as non-traditional homestyle. Ethnicity was classified as Han or other ethnic groups. Ethnicity was classified as Han or other ethnic groups. Workers were classified into three types: first-type, including government workers, enterprise managers, and professionals; second-type, including clerks, businessmen, producers, operators, and military personnel; and third-type, including agricultural, forestry, animal husbandry, fishery, water conservancy production personnel.

3.2.4. Mediating variable

WFC was measured through an index of five items (Supplementary Table 2). The items were answered on a five-point rating scale that ranged from strongly dissatisfied to strongly satisfied. The descriptive statistics for each of these variables are shown in Table 1.

3.3. Data processing and statistical analysis

All data were analyzed using R statistical software version 4.1.2 (81). The eq5d package was used to calculate the health score (82). Oaxaca-Blinder decomposition for linear regression models was performed using the Oaxaca package (83). Propensity score matching (PSM) was conducted using the MatchIt package (84). Mediating effect was performed using the mediation package (85).

Stage 1. Univariate analysis and descriptive statistics were used. To determine whether there was a statistically significant

TABLE 1 Descriptive statistics and univariate analysis.

Variables	All	Urban	Rural	p
Total	9,966	5,798 (58.2)	4,168 (41.8)	
Family health				0.000
Mean (SD)	3.81 (0.67)	3.86 (0.68)	3.75 (0.65)	
Self-reported health				0.000
Mean (SD)	81.49 (17.89)	82.34 (17.31)	80.30 (18.61)	
Health score				0.000
Mean (SD)	0.95 (0.12)	0.95 (0.11)	0.94 (0.13)	
Years of schooling				0.000
Mean (SD)	13.24 (4.45)	14.38 (3.70)	11.64 (4.88)	
Educational attainment n (%)				0.000
Pre-higher education	3,837 (38.5)	1,583 (27.3)	2,254 (54.1)	
Higher education	6,129 (61.5)	4,215 (72.7)	1,914 (45.9)	
Age				0.395
Mean (SD)	39.67 (15.49)	39.56 (14.45)	39.82 (16.83)	
Gender n (%)				0.172
Male	4,591 (46.1)	2,705 (46.7)	1,886 (45.2)	
Female	5,375 (53.9)	3,093 (53.3)	2,284 (54.8)	
Marital status n (%)				0.000
Single/divorced/widowed	3,740 (37.5)	1,982 (34.2)	1,758 (42.2)	
Married	6,226 (62.5)	3,816 (65.8)	2,410 (57.8)	
Ethnicity n (%)				0.000
Han	9,401 (94.3)	5,516 (95.1)	3,885 (93.2)	
Minority	565 (5.7)	282 (4.9)	283 (6.8)	
Religion n (%)				0.000
Infidelity	9,661 (96.9)	5,650 (97.4)	4,011 (96.2)	
Others	305 (3.1)	148 (2.6)	157 (3.8)	
Household income				0.000
Mean (SD)	4,642.69 (3,727.52)	5,515.62 (3,823.54)	3,428.38 (3,217.76)	
Healthcare n (%)				0.000
Self-paid	1,931 (19.4)	869 (15.0)	1,062 (25.5)	
Others	8,035 (80.6)	4,929 (85.0)	3,106 (74.5)	
Siblings n (%)				0.000
0	2,230 (22.4)	1,681 (29.0)	549 (13.2)	
≥1	7,736 (77.6)	4,117 (71.0)	3,619 (86.8)	
Number of children n (%)				0.000
0	4,002 (40.2)	2,247 (38.8)	1,755 (42.1)	
1	3,058 (30.7)	2,266 (39.1)	792 (19.0)	
2	2,231 (22.4)	1,076 (18.6)	1,155 (27.7)	
≥3	675 (6.8)	209 (3.6)	466 (11.2)	

(Continued)

TABLE 1 (Continued)

Variables	All	Urban	Rural	p
Homestyle n (%)				0.786
Traditional	9,063 (90.9)	5,277 (91.0)	3,786 (90.8)	
Non-traditional	903 (9.1)	521 (9.0)	382 (9.2)	
Job type n (%)				0.000
First-type	1,551 (33.3)	1,246 (38.9)	305 (21.0)	
Second-type	1,750 (37.6)	1,133 (35.4)	617 (42.4)	
Third-type	1,358 (29.1)	825 (25.7)	533 (36.6)	
Work-family conflict				0.522
Mean (SD)	12.88 (4.53)	12.85 (4.49)	12.92 (4.59)	

χ^2 tests for categorical variables and analysis of variance for continuous variables. Source: Own survey result, 2021. SD, standard deviation.

difference in the variables between China's urban and rural areas, the *P*-value was provided. Categorical variables were compared using chi-square analysis. Continuous variables were compared using an independent *t*-test.

Stage 2. To estimate the impact of YS on FH in the urban and rural areas, the following regression model was built:

$$FH_i = \alpha_0 + \alpha_1 YS + \beta X + \mu_m + \varepsilon_i \quad (1)$$

FH represents family health. YS represents years of schooling. X represents a set of control variables. μ represents fixed effect. ε represents a random perturbed variable. In all subscripts, i represents the individual and m represents the province.

Blinder-Oaxaca decomposition was developed and is commonly utilized in labor market discrimination research [86]. Economists and sociologists, for example, have used it to break down income and earnings disparities depending on gender [87] and ethnicity [88]. Although Blinder-Oaxaca decompositions have long been used in empirical studies on discrimination, they can be used to explain variations in any continuous outcome between any two groups. The decomposition divides the difference in mean outcomes into a portion that can be explained by cross-group differences in the explanatory factors and a portion that cannot. Discrimination has frequently been blamed for the unexplained fraction of the mean outcome gap.

A thorough comparison was conducted between urban and rural areas to test Hypothesis 1. The Oaxaca-Blinder (OB) model was used to determine how much of the variance in mean results between urban and rural areas was caused by group differences in the levels of explanatory variables and how much was caused by variations in the size of the regression coefficients [89]. The urban-rural FH gap can be broken down into two main components, according to the (OB) model, which is a counterfactual approach based on the supposition that "rural individuals had the same attributes as their urban counterparts".

$$\overline{H}_u - \overline{H}_r = \left(\overline{X}'_u - \overline{X}'_r\right)\hat{\beta}_u + \overline{X}'_u(\hat{\beta}_u - \hat{\beta}_r) \quad (2)$$

$\overline{H}_u$ and $\overline{H}_r$ are the FH status for the urban and rural areas; X is the explanatory variable; $\hat{\beta}_u$ and $\hat{\beta}_r$ indicate the coefficients of explanatory variables for the urban and rural areas, respectively. The endowment effect (explained effect) and the coefficient effect (unexplained effect) can be used to explain the urban-rural FH divide. The former shows the proportion that may be attributed to the various degrees of explanatory factors in urban and rural locations. The latter refers to the proportion that can be attributed to explanatory variables that affect FH differently in urban and rural settings. Bootstrap sampling was computed based on 1,000 iterations.

Stage 3. To evaluate the inverted U-shaped link between YS and FH (hypothesis 3), the following regression model was constructed:

$$FH_i = \alpha_0 + \alpha_1 YS + \alpha_2 YS^2 + \beta X + \mu_m + \varepsilon_i \quad (3)$$

YS^2 represents the square of years of schooling. The model's other definitions are identical to those in Equation (1).

Stage 4. Robustness was tested using two approaches. PSM [90] was applied in the first approach. Dummy variables were created for YS. YS was separated into five groups, ranging in size from small to large. The first group received a value of 0, the fifth group received a value of 1, and the middle three groups were not utilized. The above-mentioned variables were used to build the model. Then, using the nearest neighbor matching technique (ratio = 1, caliper size = 0.05), the people in the two groups were matched according to their propensity score values. A balanced distribution of each covariate between the two groups after matching is necessary for the PSM conclusion to be considered reliable. Therefore, the difference in FH may be attributable to YS rather than potentially confounding factors.

A substitute dependent variable was used in the second approach. To ascertain if the patterns were consistent, health metrics such as self-reported health and health score as dependent variables were added.

TABLE 2 Effects of YS on FH between urban and rural area.

	(m1) All	(m2) Interaction	(m3) Urban	(m4) Rural
YS	0.010***	0.005#	0.015***	0.007*
	(0.002)	(0.002)	(0.003)	(0.003)
Hukou (ref: rural)	0.050***	−0.097*		
	(0.015)	(0.043)		
YS* Hukou (ref: rural)		0.011***		
		(0.003)		
Age	−0.004	−0.004	−0.005	−0.002
	(0.003)	(0.003)	(0.004)	(0.004)
Age^2	0.000*	0.000*	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Gender (ref: female)	−0.103***	−0.102***	−0.104***	−0.097***
	(0.013)	(0.013)	(0.017)	(0.020)
Marital status (ref: single/divorced/widowed)	0.074***	0.073***	0.075**	0.064*
	(0.021)	(0.021)	(0.027)	(0.031)
Ethnicity (ref: rural)	0.049	0.052	0.061	0.058
	(0.031)	(0.031)	(0.043)	(0.044)
Religion(ref: others)	−0.049	−0.051	−0.040	−0.062
	(0.039)	(0.039)	(0.056)	(0.055)
Household income	0.000***	0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Healthcare(ref: self-paid)	0.187***	0.187***	0.196***	0.176***
	(0.017)	(0.017)	(0.025)	(0.023)
Siblings	0.028	0.034	0.019	0.069*
	(0.017)	(0.017)	(0.022)	(0.031)
Number of children	0.011	0.007	−0.011	0.026
	(0.011)	(0.011)	(0.015)	(0.016)
Homestyle (ref: non-traditional)	0.095***	0.099***	0.093**	0.106**
	(0.024)	(0.024)	(0.032)	(0.036)
Fixed effect	Yes	Yes	Yes	Yes
N	9,966	9,966	5,798	4,168

Standardized regression coefficient, with standard errors in parentheses; #$p < 0.1$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. YS, years of schooling; FH, family health. Fixed effect is the province fixed effect.

Stage 5. To test hypothesis 4 that WFC is a significant mechanism by which YS affects FH, a mediating effect analysis method (91) was applied.

$$WFC_i = \alpha_0 + \alpha_1 YS + \beta X + \mu_m + \varepsilon_i \quad (4)$$

$$FH_i = \alpha_0 + \alpha_1 YS + \alpha_2 WFC_i + \beta X + \mu_m + \varepsilon_i \quad (5)$$

WFC represents work-family conflict. The model's other definitions are identical to those in Equation (1). For regression coefficients, Sobel Goodman mediation tests were performed. Bootstrap sampling was computed based on 500 iterations.

4. Results

4.1. Descriptive results

Demographic characteristics of the total sample as well as the rural and urban subsamples are displayed in Table 1. The proportion of respondents from urban and rural areas in the whole sample was 58.2 and 41.8%, respectively. At a 1% level, a statistically significant difference was found between the urban and rural subsamples in FH, self-reported health, health score, YS, educational attainment, marital status, religion, household
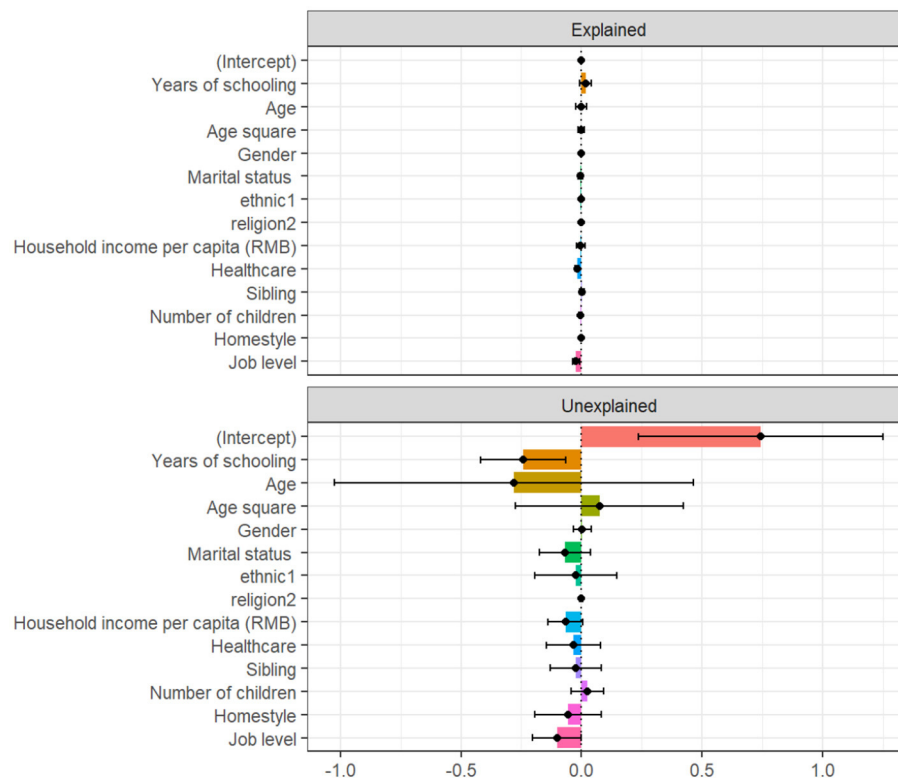
FIGURE 1
Oaxaca-Blinder decomposition of years of schooling between urban and rural subsamples.

income, healthcare, siblings, number of children, ethnicity, and job type. The mean FH score was 3.86 and 3.75 in the urban and rural subsamples, respectively. The mean number of YS was 14.38 and 11.64 in the urban and rural subsamples, respectively, a difference of almost 3 years. There was a significant difference in the acquisition of higher education between the urban and rural subsets (72.7 vs. 45.9%). The disparity in the urban-rural monthly household income per capita was more than 2,000 RMB. Regarding healthcare, the proportion of self-paid residents in the urban subsample was much lower than that in the rural subsample (15.0 vs. 25.5%). The proportion of the first-type job in the urban subsample was nearly twice that in the rural subsample (38.9 vs. 21.0%). The proportion of the second-type job was 35.4 and 42.4% in the urban and rural subsamples, respectively. The proportion of the third-type job was higher in the rural subsample than in the urban subsample (36.6 vs. 25.7%).

4.2. Average FH benefits from YS in urban and rural China

The regression analysis of YS and FH is shown in Table 2. The interaction between YS and hukou was significant (β = 0.011, p < 0.001). Residents with urban hukou had a greater regression coefficient (β = 0.015 vs. β = 0.007) and significance

level (p < 0.001 vs. p < 0.5) than residents with rural hukou, which were both significant in YS. Moreover, residents with urban hukou had better FH than their rural counterparts (β = 0.050, p < 0.001).

Figure 1 and Table 3 displays the Oaxaca-Blinder results. Bootstrap sampling was performed with 1,000 iterations. For FH by hukou, the upper half was divided into endowment differences, and the lower half was separated into coefficient differences of variables. As shown in Supplementary Table 4, the total gap in FH between urban and rural residents was 0.089 (p < 0.001). The endowment effect was significant (Coef = 0.101, p < 0.001). YS accounted for 25.8% of the total FH gap. Specifically, if residents with rural hukou have the same YS as residents with urban hukou, then the FH gap would reduce by 0.023. It was evident from the coefficient section that there was a substantial difference in FH benefits of YS by hukou (Coef = 0.202, p < 0.05). This implies that the FH benefits of YS for residents with urban hukou are larger than those for residents with rural hukou, which is consistent with the previous regression results.

4.3. Inverted U-shaped link between YS and FH

The inverted U-shaped relationship between YS and FH is shown in Table 4. Both urban and rural residents had substantial

TABLE 3 Oaxaca-Blinder decomposition between urban and rural subsamples.

	Overall	Explained Coef. (SE)	Unexplained Coef. (SE)
FH			
Urban	3.894*** (0.012)		
Rural	3.805*** (0.017)		
Difference	0.089*** (0.021)	0.101*** (0.012)	−0.012 (0.023)
YS		0.023** (0.009)	0.202*** (0.074)
Age		0.011 (0.009)	0.270 (0.367)
Age^2		−0.002 (0.004)	−0.072 (0.171)
Gender		−0.000 (0.001)	−0.004 (0.020)
Marital status		0.012*** (0.004)	0.060 (0.046)
Ethnicity		0.002 (0.001)	0.023 (0.091)
Religion		−0.000 (0.001)	0.002 (0.004)
Household income		0.022*** (0.005)	0.048* (0.026)
Healthcare		0.022*** (0.005)	0.031 (0.056)
Siblings		−0.005 (0.003)	0.026 (0.056)
Number of children		0.007** (0.003)	−0.027 (0.039)
Homestyle		0.001 (0.001)	0.056 (0.069)
Job type		0.007* (0.004)	0.117* (0.060)
Constant			−0.745*** (0.260)
Observations	4,659	4,659	4,659

Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. FH, family health; YS, years of schooling; SE, standard error. The percentage of explained contribution: The Coef. of YS (0.023)/The overall urban-rural FH difference(0.089) = 25.84%.

TABLE 4 The inverted U-shaped link between educational levels and FH.

	(m5) All	(m6) Urban	(m7) Rural
YS	0.119***	0.193***	0.109**
	(0.025)	(0.035)	(0.038)
YS^2	−0.077**	−0.144***	−0.083*
	(0.025)	(0.035)	(0.039)
Control variables	Yes	Yes	Yes
Fixed effect	Yes	Yes	Yes
N	9,966	5,798	4,168

Standardized regression coefficient, with standard errors in parentheses; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. The control variables are the same as the regressions in Table 2. Fixed effect is the province fixed effect. YS, years of schooling; FH, family health.

YS and YS^2 values; the coefficient of YS was positive while that of YS^2 is negative. The apogee of YS was about 17.8 (m5), whereas that in urban and rural areas was 17.1 (m6), and 13.7 (m7), respectively.

Dummy variables were established for YS as follows: the middle three groups were not used, the first group earned a value of 0, and the fifth group received a value of 1. The matching effect was confirmed by comparing the kernel density distributions of the first group and the fifth group before and after matching (Figure 2).

Reliability test results are shown in Table 5. According to the outcomes of regression analysis with the model (m8), the inverted U-shaped association between YS and FH remained significant after matching. Regression analysis with models (m9) and (m10) demonstrates that the results were still significant after changing the dependent variable.

4.4. Mediating effect of WFC

As shown in Table 6, YS significantly exacerbated WFC in (m11) (β = 0.208, $p < 0.01$). WFC negatively affected FH in (m12) (β = −0.113, $p < 0.001$). Further, Table 7 illustrates the mediating effect of WFC by Bootstrapping. Mediating analysis (m13) revealed a negative partial mediating effect (β = −0.094, $p < 0.05$).

FIGURE 2
Kdensity distribution of propensity score. **(A)** Before PSM; **(B)** after PSM.

TABLE 5 Effects of YS on HF, self-reported health, and health score.

	(m8) PSM	(m9) Self-reported health	(m10) Health score
YS	0.038***	0.752***	0.009***
	(0.009)	(0.156)	(0.001)
YS^2	−0.001**	−0.019**	−0.000***
	(0.000)	(0.007)	(0.000)
Control variables	Yes	Yes	Yes
Fixed effect	Yes	Yes	Yes
N	2,104	9,966	9,966

Standardized regression coefficient, with standard errors in parentheses; ** $p < 0.01$; *** $p < 0.001$. The control variables are the same as the regressions in Table 2. Fixed effect is the province fixed effect. YS, years of schooling; FH, family health; PSM, propensity score matching.

TABLE 6 The link between YS, WFH, and FH.

	(m11) WFC	(m12) FH
YS	0.208**	0.060***
	(0.074)	(0.011)
WFC		−0.113***
		(0.008)
Control variables	Yes	Yes
Fixed effect	Yes	Yes
N	6,810	6,810

Standardized regression coefficient, with standard errors in parentheses; ** $p < 0.01$; *** $p < 0.001$. The control variables are the same as the regressions in Table 2. YS, years of schooling; FH, family health; WFC, work-family conflict.

5. Discussion

To the best of our knowledge, this is the first study to examine the relationship between YS and FH using national representative data. Although several previous studies have explored the material returns of education, health benefits—as significant non-material returns of education—need more attention (92). Health is shaped by interaction with the family, community, and society. Instead of the individual-focused approach, the current study analyzed the family-centered health benefits of education, which can help release the positive externalities of education. Family is the basic "cell" of society in China, and FH forms the cornerstone of national health, which is a significant indicator for the implementation of health policy and allocation of social resources. Chinese people have strong family consciousness, and health-related knowledge and skills can be disseminated through kinship links, benefiting family members (93). Sharing information related to health care and disease prevention among families, especially during the COVID-19 pandemic, can build a culture of health, and foster family resilience and wellbeing (94–96).

TABLE 7 Mediating effect analysis by Bootstrap.

	Coef.	95% CI lower	95% CI upper	Control variables
ACME	−0.001**	−0.002	−0.000	Yes
ADE	0.013***	0.008	0.017	Yes
Total effect	0.012***	0.007	0.016	Yes
Prop. mediated	−0.094**	−0.222	−0.024	Yes

This table reports the results of the mediating effect analysis by Bootstrap. We resampled the sample 500 times. The control variables are the same as regressions in Table 2. ** $p < 0.01$; *** $p < 0.001$. ACME, average causal mediation effects; ADE, average direct effects; total effect, stands for the total effect (direct + indirect); prop. mediated, the proportion of the effect of the independent variable on the dependent variable.

In the process of building a moderately prosperous society, the principal contradiction between people's needs for a better life and unbalanced and inadequate development should be overcome. Besides medical factors, health status can be affected by social determinants to a certain extent, hence, health promotion should be extended to cultural, psychological, and social perspectives. By expanding from micro, middle, to macro levels, the study clarifies the internal relations among individuals' education, family health, and social structure, which is of great value to address systemic vulnerabilities, improve practices, and ensure more equitable education and health outcomes.

First, we found disparities in FH, educational attainment, household income, healthcare coverage, and job type between urban and rural China, and education inequality can translate into health inequality. There is uneven distribution and utilization of public resources, with low health awareness and inadequate medical security in rural China (80). Second, in general, education may have a positive effect on FH both for urban and rural residents. However, there is no simple linear relationship between education and health. Our study found an inverted-U relationship between YS and FH, which illustrates an upper limit of the "health dividend" of education. Increasing education beyond a certain threshold may not have health benefits (97). Higher education may negatively affect health. Previous studies demonstrated that people with higher education are more likely to be diagnosed with hypertension and psychological distress (98), and to drink more and exercise less (99). In the present study, health benefits declined at the turning point of 17.1 YS in the urban subsample, which occurred earlier in the rural subsample at 13.7. This suggested that rural residents, obtain limited FH benefits from higher education (52). One study suggested that minoritized racial groups generally experience poorer health and obtain fewer health benefits from education (100). Besides, the proportion of higher education is significantly lower among residents of rural hukou (101). It takes more effort for individuals and their families to attain higher education (102). However, they have more material expectations for higher education because of the long-term investment (103). Moreover, they have to overcome more risks to withstand the screening of the labor market

(57). Through mechanism analysis, we discovered that highly-educated people face stronger WFC, which undermines the FH benefits of education. One compelling explanation may be that highly-educated people usually migrate to first-tier cities with rapid economic development and higher living standard, where the work intensity and competitiveness encroach on their time and energy devoted to their families (104, 105), thus, they are faced with difficulties such as family regulation and family health management. It is more challenging for rural residents to settle in first-tier cities due to the inherited disadvantage in endowments and resources (42).

The study indicates the health benefits of different educational stages and heterogeneity of the impacts of Hukou. Education can exert substantial, lasting, and wide-ranging health benefits by modifying health behaviors, enhancing healthy psychology, and strengthening social interactions (106). Therefore, policymakers, healthcare practitioners, and educators, should develop joint strategies to suppress the health disadvantages caused by social factors. Besides, the gradient upgrading of human capital should be encouraged in rural areas through the consolidation of compulsory education, the popularization of high school education, and the extension of higher education. Meanwhile, the social inequalities caused by education should also be negated. Our study supports the "resource multiplication" theory, the advantages of urban residents in cultural resource stock and the utilization efficiency further widens the urban-rural health inequality. This suggests that strategies to prevent vulnerable groups from falling into the happiness "trap" of education, that is, to pursue education and self-development at the cost of individual health and family happiness should be developed.

In this study, we only measured the YS by an individual rather than the whole family. Notably, educational attainment can be influenced by the family to some extent. Thus, although the robustness of the results was high based on PSM and the substitution of the dependent variable, the causal relationship between education and health cannot be concluded given the cross-sectional nature of the data analyzed in this study. Future studies should explore and compare the health benefits of different educational stages, such as compulsory education, high education, and associate, bachelor, and postgraduate education.

It should be on that the data used in this study was collected during the pandemic, and thus whether the findings can be generalized to other contexts before or after the pandemic should be further explored. Moreover, the extent of work-family conflict faced by people of different genders and occupational types, and how it mediates the relationship between education and health need to be analyzed in future.

6. Conclusions

In summary, health development and promotion are embedded in the family unit and social structure. The present study contributes to family-centered health promotion and targeted interventions for urban and rural populations, respectively. Contrary to the intuition that education can promote social equity, this study reveals that uneven distribution and utilization of educational resources exacerbate health inequalities between urban and rural China. In addition, health dividend decreases after higher education. WFC is believed to be the negative mechanism of the education-FH nexus, which warns highly-educated people to avoid falling into the happiness "trap" of education and maintain a balance between work and family. However, this requires the joint efforts of the government, educational and health institutions, and the labor market to broaden externalities in education.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Jinan University. The patients/participants provided their written informed consent to participate in this study.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1071245/full#supplementary-material

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Neighbourhood characteristics, lifestyle factors, and child development: Secondary analysis of the All our families cohort study

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Background: Neighbourhood characteristics have been found to influence child development, but little is known about lifestyle factors that may moderate this relationship, which can provide modifiable targets for policies and programing. This study investigated the association between neighbourhood characteristics (e.g., deprivation, disorder) during pregnancy and child development at age 5 in relation to various lifestyle factors (e.g., physical activity, parent-child reading, community resource use) during early childhood.

Methods: A secondary analysis was conducted using multilevel modeling of data from the All Our Families cohort, recruited in Canada from 2008 to 2010. Participants self-reported on demographics during pregnancy, lifestyle factors at 3 years, and child development at 5 years using the Ages and Stages Questionnaire (ASQ-3). Neighbourhood deprivation was evaluated using the Vancouver Area Deprivation Index (VANDIX), while disorder was measured using police services' community crime reports.

Results: Geocoded information was available for 2,444 participants. After adjusting for covariates, multilevel modeling indicated a significant negative association between neighbourhood deprivation and overall child development (b = −.726, 95% CI: −1.344, −.120). Parent-child reading was found to be a significant moderator of the effect of neighbourhood disorder (b = .005, 95% CI: .001, .009). There were no statistically significant moderation effects for physical activity or community resource use.

Conclusion: Neighbourhood deprivation during pregnancy is associated with early child development. Parent-child reading may function as a protective factor in the presence of higher neighbourhood disorder. Overall, neighbourhood-level effects should be considered in policies and community programs that promote family and child well-being.

KEYWORDS

neighbourhood, lifestyle, child development, parents, community

1. Introduction

Despite the importance of early childhood development for well-being (1, 2) and the provision of federally funded early childhood education and care (ECEC), many Canadian children remain vulnerable to developmental delays. In Canada, approximately one in four children (26%) are reported to be vulnerable to delays in one or more developmental areas at time of entry into grade one (3). Notably, children in low-income neighbourhoods displayed a higher rate of developmental vulnerability (34.9%) compared to children in high-income neighbourhoods (19.5%) (3). Similarly, living in higher poverty index neighbourhoods in Canada has been associated with significant declines in young children's physical health and well-being (4, 5). Less is known about the impact of neighbourhoods during pregnancy, a critical period for child development, and potential protective factors in the first few years postpartum.

A variety of neighbourhood characteristics have been linked with well-being, and these generally include both physical and social characteristics. Physical characteristics refer to neighbourhood attributes such as degree of urbanization (e.g., density) (6, 7), public and open spaces (e.g., walkability, transportation, cleanliness) (8), available resources and facilities (9), green space (10), environmental noise (e.g., traffic) (11), and air pollution (12, 13). Social characteristics refer to factors such as neighbourhood deprivation (i.e., low socioeconomic status (SES) (14), disorder (i.e., incivility, deterioration, crime) (15), social capital (16), and ethnic composition (12, 17). Extant research has found strong associations between neighbourhood characteristics, particularly deprivation, with physical, behavioural, and mental health outcomes in children (18–21). Children in disadvantaged neighbourhoods (i.e., lower SES and poor physical conditions) on average were at higher odds of experiencing obesity (22), having poor peer relations (23), lower cognitive development (24, 25) and more mental health concerns (26). By contrast, children living in neighbourhoods that are perceived as having higher collective efficacy (i.e., belief in the capability of the community to maintain social order) were more likely to play outside, watch less television, and engage in more activities that promote socialization and physical stimulation (27).

The impact of neighbourhood characteristics during pregnancy is particularly pertinent to explore in light of the Developmental Origins of Health and Disease (DOHaD) hypothesis, which postulates that exposure to certain environmental influences *in utero* may have both short and long-term consequences (28). According to this theory, if a pregnant person is exposed to poor environmental conditions (i.e., neighbourhood deprivation), the fetus may develop adaptations to help immediate survival and future response if a similar environment is encountered again (i.e., down-regulation of metabolic and organ function). However, these adaptations can lead to long-term changes in child development (29). Previous findings from the All our Families cohort study have linked prenatal exposure to neighbourhood deprivation and disorder with child outcomes, including lower language scores at 5 years of age, even after controlling for family history of language delay, infant sex, and early vocabulary (20). Furthermore, greater neighbourhood deprivation has been indirectly associated with poor infant sleep consolidation through perceptions of poor neighbourhood safety and maternal anxiety (30).

It is also important to consider resilience and plasticity of child development despite exposure to prenatal adversity. Social interactive processes and lifestyle at the individual and family level have been proposed as protective factors for the influence of neighbourhood characteristics on child development (31), however, few studies have examined these as moderators. For example, involvement in community programs or activities has been found to mitigate the impact of neighbourhood problems, including violence, on academic performance and depression (32, 33). Potential protective lifestyle factors warranting investigation include physical activity, parent-child reading, and community resource use as they have been previously associated with positive developmental outcomes such as motor skills, vocabulary, and behaviour (34–36). Identifying such lifestyle factors as moderators could provide modifiable targets that help buffer against the impact of adversity during pregnancy and minimize the possibility of long-lasting adverse effects of neighbourhoods.

The current study aimed to investigate: (1) to what extent neighbourhood characteristics (e.g., deprivation and disorder) during pregnancy are associated with developmental outcomes in children at age 5; and (2) how various lifestyle factors (e.g., physical activity, parent-child reading, and community resource use) may moderate the association between neighbourhood characteristics and child development. In terms of hypotheses, children whose birthing parents were living in neighbourhoods with more deprivation and disorder during pregnancy were expected to have poorer development at age 5, whereas positive lifestyle factors (i.e., physical activity, community resource use, parent-child reading) during early childhood were hypothesized to be associated with better development and buffer the impact of neighbourhood characteristics.

2. Materials and methods

2.1. Study design & procedure

The current investigation utilized data from the larger, ongoing All Our Families (AoF) cohort study (37, 38) in

Alberta, Canada. From 2008 to 2010, a total of 4,011 individuals responded to community advertisements or researchers at primary health care offices and laboratory services recruiting "pregnant women" (referred to as birthing parents or participants throughout since gender identity information was not collected), of which 3,387 met eligibility criteria (understand English, >18 years old, <25 weeks' gestation, receiving prenatal care near Calgary, Canada) and were enrolled in the study. All participants provided informed written consent and ethical approval was obtained from the Conjoint Health Research Ethics Board (CHREB) at the University of Calgary for both the original study (REB13-0868) and secondary analysis (REB19-1417). Participants were asked to complete questionnaires twice during pregnancy (<25 and 34–36 weeks' gestation) and were followed up at 4 months and 1, 2, 3, and 5 years postpartum.

2.2. Measures

2.2.1. Sociodemographic variables

Participants reported on relevant sociodemographic variables during pregnancy (at <25 weeks of gestation) including their ethnicity, age (years), education (1 = *some elementary to high school*, 2 = *graduated high school*, 3 = *some college/trade/university*, 4 = *graduated college/trade/university*, 5 = *some graduate school*, and 6 = *completed graduate school*), postal code, annual household income (1 = *less than $10,000*, 2 = *$10,000 to $19,999*, 3 = *$20,000 to $29,999*, 4 = *$30,000 to $39,999*, 5 = *$40,000 to $49,999*, 6 = *$50,000 to $59,999*, 7 = *$60,000 to $69,999*, 8 = *$70,000 to $79,999*, 9 = *$80,000 to $89,999*, 10 = *$90,000 to $99,999*, and 11 = *$100,000 or more*), and marital status (1 = *single*, 2 = *single with partner*, 3 = *married*, 4 = *common-law*, 5 = *divorced*, 6 = *separated*, and 7 = *widowed*). Information on child sex and preterm birth status (gestational age of 36 weeks or less at birth) were collected at 4 months postpartum, while number of moves since birth was reported at 3 years postpartum (1 = *haven't moved*, 2 = *moved once*, 3 = *moved twice*, and 4 = *moved three or more times*).

2.2.2. Neighbourhood characteristics
2.2.2.1. Neighbourhood deprivation
The Vancouver Area Neighbourhood Deprivation Index (VANDIX) is a census-based tool that includes both social and economic indicators (39). Participant postal codes from early pregnancy were transformed to geographic coordinates (i.e., latitude and longitude), which were then overlayed on the City of Calgary's neighbourhood boundaries using the spatial join tool in ArcGIS Desktop version 10.6.1 (ESRI, Redlands, CA, USA), and linked with the socioeconomic information from the 2011 National Household Survey census data (40). Following the established method for computing the VANDIX (41), seven indicators (high school completion,

university completion, unemployment rate, proportion of lone parent families, average income, home ownership, employment ratio) were weighted (0.250, 0.179, 0.214, 0.143, 0.089, 0.089, 0.036), standardized (z-score), and summed to create a score for each neighbourhood where higher scores represent greater deprivation.

2.2.2.2. Neighbourhood disorder
Neighbourhood disorder was measured objectively using publicly available statistics on disorder (e.g., noise, threats) and crime (e.g., robbery, non-domestic assault) collected from Calgary Police Services' 2010 and 2011 Community Crime Reports, following the Uniform Crime Reporting guidelines (42). The number of crime, physical and social disorder reports were standardized (z-score) and summed to generate a total number of disorder reports per neighbourhood (20, 30).

2.2.3. Lifestyle factors
2.2.3.1. Physical activity
Child physical activity at 3 years of age was assessed by asking participants how much time their child engages in physical activity, such as playing, walking, running, and jumping, on weekdays and weekends. Responses were rated on a six-point scale (where 1 = *none*, 2 = *less than 1 h per day*, 3 = *1 to less than 3 h per day*, 4 = *3 to less than 5 h per day*, 5 = *5 to less than 7 h per day*, and 6 = *7 or more hours per day*). Based on the Canadian Society for Exercise Physiology (CSEP)'s recommendation of at least 180 min of daily physical activity for children aged 3–4 years (43), the variable was dichotomized for analysis, where 0 = less than 3 h of daily physical activity and 1 = 3 h or more of daily physical activity.

2.2.3.2. Parent-Child Reading
At 3 years postpartum, participants were asked "How many minutes each day do you spend sharing books with your child?". Responses were rated on a four-point scale (where 1 = *0–10 min*, 2 = *11–20 min*, 3 = *21–30 min*, and 6 = *>30 min*). Based on the recommendations for children's vocabulary and school readiness (44), responses were dichotomized for the analysis, where 1 = greater than 20 min per day and 0 = 20 min per day or less.

2.2.3.3. Community resource use
Participants' community resource use at 3 years postpartum was assessed by asking whether they had used or attended (0 = *no*, 1 = *yes*) various community resources or programs in the past year. Listed resources and programs included recreational facilities (e.g., YMCA, leisure centres), libraries, parenting groups, play groups, and childcare centres. Consistent with previous studies using AOF data (45), responses were dichotomized for analysis, where 0 = accessed less than three community resources in the past year and 1 = accessed three or more in the past year.

2.2.4. Child development

Child development at 5 years of age was assessed with the Ages and Stages Questionnaire, Third Edition (46), which is a commonly used, parent-reported and norm-referenced screening tool (47) of developmental progress across five domains: communication, gross motor, fine motor, problem-solving, and personal-social. Subscale scores were summed to determine a total score ranging from 0 to 300 (48), where higher scores were indicative of better developmental outcomes.

2.3. Statistical analysis

Descriptive statistics and correlation analyses were conducted using SPSS version 25.0 (IBM, USA). Pearson correlation coefficients were estimated between the neighbourhood characteristics (deprivation, disorder) during pregnancy, lifestyle factors (physical activity, parent-child reading, and community resource use) at 3 years postpartum, and child development (ASQ-3 total score) at age 5. Multilevel modelling, in Mplus version 8.1 (49), was used to test the relationship between neighbourhood characteristics and child development, as well as potential interactions between neighbourhood characteristics and lifestyle factors. As participants in our sample were nested within neighbourhoods, a two-level random model with Bayes estimation (50) was conducted to account for within neighbourhood (level 1) and between-neighbourhood (level 2) effects. Moderation was tested using cross-level interactions by estimating the slope of each lifestyle factor on the ASQ-3 total score at level 1, and then regressing the neighbourhood factors on these slopes at level 2. Any non-significant moderators were removed from the final model. Additionally, several sociodemographic characteristics were considered as control variables including ethnicity, education, household income, preterm status, child sex, and moving (25, 26, 51), and included as level 1 covariates in the final model if they were significantly correlated with the ASQ-3 total score. Missing data were handled using Full Information Maximum Likelihood (FIML), which produces unbiased model parameters (52). Significant effects were determined by a 95% Bayesian credibility interval (BCI) that did not cross zero (53).

3. Results

3.1. Sample description

After removing those who gave birth to twins ($n = 36$) and those who could not be geocoded ($n = 907$) because they did not provide postal codes or lived outside the city of Calgary boundaries, the final sample consisted of 2,444 participants.

Participants were distributed across 192 neighbourhoods, with an average of 12.73 participants each. Overall, 15.17% of the data were missing and covariance coverage ranged from .507–1.00. The sample mostly consisted of pregnant individuals who were married or in common law[1] relationships (94.9%), identified as European Canadian (77.2%), had attained post-secondary education (76.0%), and an annual household income of greater than $60,000 (82.3%). At 3 years postpartum, most participants had not moved since their child's birth (62.2%). The mean age of participants at <25 weeks gestation was 30.8 years ($SD = 4.5$). Most participants' children were not born preterm (92.8%) and slightly above half were male (52.4%). **Table 1** displays detailed demographic information for the sample.

The sociodemographic characteristics of the current sample are consistent with the local Calgary population, where for example the median household income is approximately $97,000, 69.9% have attained post-secondary education, and 78% identify their ethnic origin as North American or European (55). Among participants who could not be geocoded, slightly more identified as European Canadian (80.6%), less were married or in common law[1] relationships (92.9%), less attained post-secondary education (29.1%), more used ≥3 community resources (75,2%), and were on average older ($M = 30.78$ years).

3.2. Descriptive statistics

The mean neighbourhood VANDIX score was −6.67, suggesting that, on average, most participants resided in socioeconomically advantaged neighbourhoods. The number of neighbourhood disorder reports varied considerably across neighbourhoods, ranging from 1 to 7000. At three years postpartum, slightly over half of participants read with their children for greater than 20 min per day (53%), most had accessed 3 or more community resources in the past year (66%), and most children met the CSEP daily physical activity recommendation of 3 h (63%). In terms of development at 5 years of age, children in the sample scored relatively high on the ASQ-3 ($M = 274.55$), given that the maximum possible total score is 300. Few children in the sample scored in either the "monitoring zone" (≤1 SD below the mean of the ASQ normative data) or the "referral zone" (≤2 SD below the mean of the ASQ normative data) on any of the individual ASQ-3 subscales: communication (7.9%), gross motor (7.7%), fine motor (7.1%), problem solving (2.1%), and personal-

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[1]Defined as living in a conjugal relationship with a person who is not a married spouse (54).

TABLE 1 Descriptive statistics for study variables ($n = 2444$).

	n (%)	M (SD)	Range
Demographics (pregnancy)			
Ethnicity			
European Canadian	1,878 (77.2)		
Asian	317 (13.0)		
Latin American	56 (2.3)		
Black	37 (1.5)		
Middle Eastern	36 (1.5)		
Indigenous	21 (0.9)		
Mixed/other	87 (3.6)		
Marital status			
Married/common law	2,310 (94.9)		
Single with partner	89 (3.7)		
Single	24 (1.0)		
Divorced/Separated	10 (0.4)		
Education			
Completed post-secondary	1,848 (76.0)		
Some post-secondary	338 (13.9)		
Graduated high school	173 (7.1)		
Some elementary or high school	73 (3.0)		
Annual household income			
<$10K	27 (1.1)		
$10K-$19K	48 (2.0)		
$20K-$29K	54 (2.3)		
$30K-$39K	77 (3.3)		
$40K-$49K	89 (3.8)		
$50K-$59K	123 (5.2)		
$60K-$69K	128 (5.4)		
$70K-$79K	162 (6.9)		
$80K-$89K	200 (8.5)		
$90K-$99K	197 (8.3)		
≥$100K	1,255 (53.2)		
Child sex (female)	1,164 (47.6)		
Preterm status (≤36 weeks GA at birth)	164 (7.2)		
Moves since birth (≥1 time)[a]	572 (37.8)		
Maternal age (years)		30.78 (4.49)	18–47
Neighbourhood characteristics (pregnancy)			
Neighbourhood deprivation		−6.67 (2.86)	−15.64–1.70
Neighbourhood disorder		591.67 (684.44)	1.00–7000.00

(continued)

TABLE 1 Continued

	n (%)	M (SD)	Range
Lifestyle factors (3 years postpartum)			
Parent-child reading (>20 min daily)	805 (53.1)		
Community resource use (≥ 3 in past year)	993 (65.5)		
Physical activity (≥3 h/day)	953 (62.9)		
Child development (5 years of age)			
ASQ-3 total score		274.55 (27.09)	25.00–300.00

Note: n, sample size; M, mean; SD, standard deviation; K, thousand; GA, gestational age; ASQ-3, Ages and Stages Questionnaire. Parent-child reading refers to daily minutes participants spent sharing books with their child.
[a]Measured at 3 years postpartum.

social (7.8%). See Table 1 for descriptive statistics for key study variables.

3.3. Bivariate correlations

Correlations between neighbourhood variables, lifestyle factors, and child development are reported in Table 2. Neighbourhood deprivation was significantly negatively associated with parent-child reading and community resource use, and positively associated with physical activity. Additionally, neighbourhood disorder was significantly positively associated with physical activity. There was a significant positive relationship between the ASQ-3 total score and parent-child reading. However, the associations between ASQ-3 total score and community resource use and physical activity were not significant.

Correlations between the ASQ-3 total score and potential covariates revealed significant associations with ethnicity ($r = .078$, $p < .01$), education ($r = .074$, $p < .01$), household income ($r = .091$, $p < .01$), child sex ($r = .175$, $p < .01$), and preterm status ($r = −.127$, $p < .01$). These variables were therefore included as covariates in the multilevel analyses. Whether participants had moved or not between birth and 3 years was not associated with ASQ total score ($r = −.016$, $p = .572$) and therefore was not included as a covariate in the multilevel analyses.

3.4. Multilevel modelling

The intraclass correlation (ICC) for child development was 0.024, indicating that 2.4% of the variance in total ASQ-3 score was due to variation between neighbourhoods, while 97.6% of the variance was attributable to variation across individuals within neighbourhoods. Parameter estimates from the final

TABLE 2 Pearson's correlation coefficients.

	1	2	3	4	5	6
Neighbourhood characteristics						
1. Deprivation	–					
2. Disorder	.197[b]	–				
Lifestyle factors						
3. Parent-child reading	−.111[b]	.008	–			
4. Community resource use	−.111[b]	−.032	.076[b]	–		
5. Physical activity	.085[b]	.052[a]	.090[b]	.010	–	
Child development						
6. ASQ-3 total score	−.094[b]	−.048	.077[b]	.018	.038	–

Note. ASQ-3, Ages and Stages Questionnaire.
[a]Correlation is significant at the 0.05 level (two-tailed).
[b]Correlation is significant at the 0.01 level (two-tailed).

TABLE 3 Final multilevel model of effects on child development at 5 years of age.

	Estimate, b	95% BCI	p-value
Intercept	229.847	166.661, 301.924[b]	<.001
Covariates (level 1)			
Child sex	9.726	6.948, 12.533[b]	<.001
Preterm status	−11.404	−17.046, −5.915[b]	<.001
Maternal ethnicity	2.445	−1.242, 6.212	.096
Maternal education	3.513	−.212, 7.269	.032
Household income	3.066	−1.417, 7.659	.091
Lifestyle factors (level 1)			
Parent-child reading[a]	–	–	–
Community resource use	−.519	−3.729, 2.625	.375
Physical activity	3.025	−.074, 6.194	.028
Neighbourhood characteristics (level 2)			
Deprivation	−.726	−1.344, −.120[b]	.011
Disorder	−.001	−.003,.001	.223
Moderation effects (level 2)			
Deprivation on reading slope	−.463	−1.751,.656	.225
Disorder on reading slope	.005	.001,.009[b]	.015

Note: BCI, Bayesian credibility interval.
[a]Parent-child reading cannot be entered as an independent variable fixed effect since it is turned into a dependent variable in order to define the random effect for the slope on ASQ-3 total score.
[b]95% BCI does not cross zero.

multilevel model considering neighbourhood deprivation and disorder during pregnancy as predictors of child development at age 5 are displayed in Table 3. After controlling for level 1 covariates, there was a statistically significant negative association between the VANDIX and ASQ-3 total score, such that higher levels of neighbourhood deprivation during pregnancy were associated with poorer overall child development at age 5. Neighbourhood disorder during pregnancy was not directly associated with total ASQ-3 score.

In terms of individual- and family- level factors, child sex was found to be significantly associated with child development, with girls having higher ASQ-3 total scores than boys. Preterm birth status was significantly associated with child development, where children who were born preterm had lower ASQ-3 scores than those who were born at <37 weeks gestational age. None of the other individual or family-level variables (ethnicity, education, household income, community resource use, physical activity) were significantly associated with the ASQ-3 total score.

In terms of moderation effects, there was a statistically significant cross-level interaction where neighbourhood disorder was found to predict a positive slope between parent-child reading and overall child development (see Figure 1). That is, as the amount of neighbourhood disorder increases (i.e., the number of crime and disorder reports), the slope between the ASQ-3 total score and parent-child reading increases. The cross-level interaction of neighborhood deprivation with parent-child reading on development slope was not significant. Additionally, no significant moderation effects were found for community resource use ($b_{deprivation}$ = .385, 95% CI: −.880, 1.716; $b_{disorder}$ = .003, 95% CI: −.002,.009) or physical activity ($b_{deprivation}$ = −.686, 95% CI: −1.970, 0.642; $b_{disorder}$ = −.003, 95% CI: −.009,.003), therefore these slopes were not included in the final model.

4. Discussion

4.1. Synthesis of results

The current investigation utilized data from a large Canadian cohort to elucidate the influence of neighbourhood characteristics (deprivation and disorder) during pregnancy on child development, as well as the potential moderation by lifestyle factors (physical activity, parent-child reading, and community resource use). Multilevel analyses indicated that neighbourhood deprivation during pregnancy was associated with poorer child development at age 5 and that parent-child reading may function as a protective factor for child development in the presence of higher neighbourhood disorder.
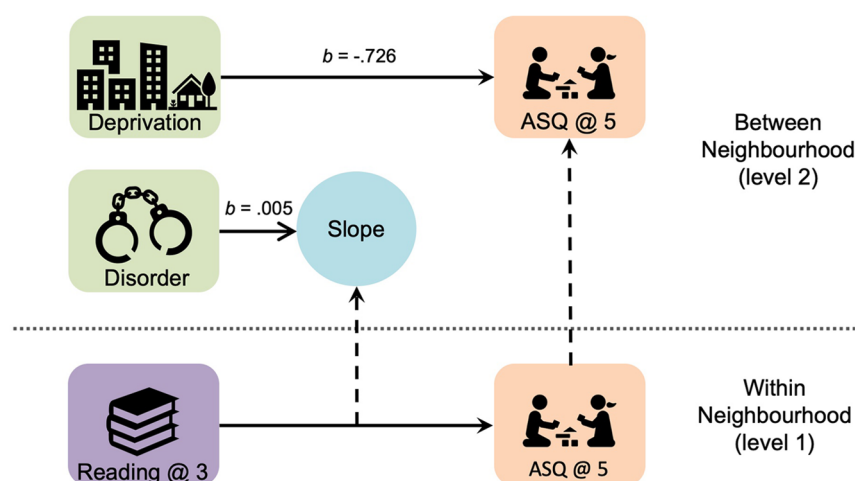
FIGURE 1
Main and moderation effects of neighbourhood characteristics on child development. Solid arrows represent regression paths, dashed arrows represent parameters brought from the within to the between neighbourhood level. Moderation is represented by the regression of neighbourhood disorder on the slope for Reading to ASQ. ASQ, ages and stages questionnaire.

The observed association between neighbourhood deprivation and child development, even after controlling for child sex, preterm status, maternal ethnicity, maternal education, and household income, is consistent with extant findings that neighbourhood deprivation is independently associated with developmental delays in preschool- and school-aged children. For example, preschool-aged children living in more deprived neighbourhoods were reported to be 3.15 times more likely to have a speech, language, or communication concern as measured by the ASQ-3 (56). Similarly, after accounting for family-level SES, children in deprived neighbourhoods were found to have concurrently higher levels of behavioural problems and lower cognitive test scores (57). Previous literature has proposed various potential mechanisms for this association, which include reduced access to programs and institutions that promote healthy childhood development, less exposure to highly educated role models in one's neighbourhood, and lower levels of social support and control (58). The current findings are the first to demonstrate associations between prenatal exposure to neighbourhood deprivation and child development, providing further support for the DOHaD hypothesis and pointing to the need for early intervention. Although intervening during pregnancy is proposed to have the largest returns on investments (59), the multilevel nature of social determinants needs to be taken into account. As such, socioeconomic inequalities between neighbourhoods should be addressed as part of policies and programs that promote child and family well-being.

The lack of direct effect of neighbourhood disorder on overall child development at 5 years may reflect a function of age and domain. Neighbourhood disorder has been more frequently linked with development in later childhood and adolescence for conduct problems and mental health outcomes (60–62). Since the ASQ-3 total score captures more motor and cognitive domains and to a lesser extent personal-social outcomes, future research could examine follow-up of specific conduct and mental health outcomes at later ages in the AoF cohort. Interestingly however, there was a moderation effect where as neighbourhood disorder increased during pregnancy, the association between parent-child reading and overall development got stronger. This finding suggests that parents reading with their children more often may buffer the negative impact of prenatal exposure to a neighbourhood with higher disorder. Parent-child reading is proposed to promote child development through various mechanisms such as improved linguistic, interactive, and parental functioning including reduced stress and increased sense of control (63). Parent-child reading interventions are also associated with improved relationship quality (64), which could create a safe space to learn. It is possible that parent-child reading and the related improvement in relationship quality may help to mitigate the impact of prenatal exposure to neighbourhood disorder, such as less safety and more stress (65). Together with previous evidence of the positive psychosocial effects of parent-child reading interventions (64), our results point to this as an important target for public health and community programming (e.g., awareness campaigns, access to books and inclusive reading spaces), particularly for young children living in neighbourhoods with higher levels of disorder.

At the within neighbourhood level two individual characteristics, child sex and preterm birth, were significantly associated with ASQ-3 total scores at five years of age.

Consistent with previous research, children reported as male or born before 37 weeks gestation had poorer overall development outcomes. For example, younger gestational age was uniquely associated with increased odds of speech, language, and communication concerns in a statistical model with neighbourhood deprivation (56). Male children have also been observed to have more behavioural problems in a statistical model with neighbourhood social conditions (51). Further research is needed to examine potential moderating effects of individual characteristics to identify who is more vulnerable or resilient to the impact of neighbourhood characteristics on early development (31).

Contrary to expectations, community resource use was not found to have a significant buffering effect against neighbourhood deprivation or disorder, nor was it directly associated with overall child development. These findings may be due to our measure of community resource use mainly capturing participants' own use of community resources rather than their children's direct participation (32, 33). Similarly, no significant moderation effects were observed for physical activity, nor was it significantly associated with overall child development. Although a systematic review indicated that physical activity was associated with improved motor skills and cognitive development in children aged 4–6 years (35), some of the included studies found mixed or no significant effects. Given that parent-report was used to measure children's physical activity and intensity was not distinguished (66), it is possible that we may not have captured the full extent of children's physical activity participation. Future studies in this area could consider using more objective measurements of physical activity, such as standardized questionnaires or accelerometers, as well as capturing variation in the intensity of physical activity that children participate in.

4.2. Strengths and limitations

The current investigation utilized a large Canadian cohort study and advanced multilevel analyses to identify early social determinants of individual well-being, and represents a novel examination of prenatal exposure to neighbourhood deprivation on child development. Moreover, potential modifiable protective factors were explored including community resource use, physical activity, and parent-child reading. However, the results of the current investigation should be interpreted within the context of several limitations. Although the use of parent reported measures of child development is common and feasible in population-based birth cohorts (67, 68), potential bias could be mitigated by using multiple informants as well as observational or experimental methods. While the ASQ-3 is a well-validated screening tool for developmental delays, further assessment would be required to examine clinical diagnoses. Given neighborhood deprivation and disorder data

were only available for pregnancy, it was not possible to isolate the impact of exposure during this period while accounting for the first five years postpartum. Future research examining cumulative effects of neighbourhood characteristics is warranted. Although several potential confounding variables were included as covariates, it is possible that there are others for which we did not have data such as physical health of children (35). Finally, there was a lack of variability in our sample in terms of sociodemographic and neighbourhood characteristics. In general, the socioeconomic deprivation of neighbourhoods in Calgary is relatively low and residents are more advantaged compared to the larger Canadian population (55). Thus, our findings may not be generalizable to more vulnerable families, or to areas where there are larger differences in socioeconomic deprivation between neighbourhoods.

5. Conclusion

Our findings expand previous work on social determinants of well-being by elucidating the association of exposure to neigbourhood deprivation as early as pregnancy, which goes beyond individual and family level factors, with child development. Moreover, the multilevel analysis also identified parent-child reading as a potentially modifiable protective factor in the presence of higher neighbourhood disorder. Neighbourhood-level effects should be considered in the development of policies and community programs that promote family and child well-being.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The datasets analyzed for this study can be accessed through the University of Calgary subsequent to proposal and ethics review by qualified applicants. Requests to access these datasets should be directed to https://allourfamiliesstudy.com/data-access/.

Ethics statement

The study involving humans participants were reviewed and approved by Conjoint Health Research Ethics Board (CHREB) at the University of Calgary. The participants provided their written informed consent to participate in this study.

Author contributions

Conceptualization, LTM and ALM; data curation, ALM and HS; formal analysis, ALM and HS; funding acquisition, ST and

LTM; project administration, ST and LTM; supervision, ST and LTM; writing—original draft, HS and ALM; writing—review & editing, ALM, HS, KS, EBX, JWJ, ST and LTM. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Intergenerational residential school attendance and increased substance use among First Nation adults living off-reserve: An analysis of the aboriginal peoples survey 2017

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Introduction: The Truth and Reconciliation Commission of Canada (TRCC) published 94 Calls to Action in 2015 to address long-term, intergenerational effects of the residential school system, highlighting the pervasive impact of colonialism on the wellbeing of Indigenous peoples in Canada. Indeed, research with Indigenous populations in Canada has captured that prior experiences of residential schools contributes to the intergenerational transmission of mental and physical health disparities. Despite these studies, further research is needed that contextualizes the influence of residential schools within broader frameworks that consider Indigenous social determinants of health in Canada. As such, the purpose of the present study was to examine patterns of substance use and mental and physical health among individuals with a history of residential school attendance (RSA) and individuals reporting parent or two-generation (parent and grandparent) RSA.

Method: Data from the Aboriginal Peoples Survey (2017), involving 10,030 First Nations individuals living off reserve, were analyzed.

Results: Self-reported mental and physical health scores were significantly lower among those had attended residential schools, whose parents attended residential schools, and whose grandparents attended residential schools, when compared to those who did not. Further, family RSA was associated with increased substance use among participants, though the findings were variable based on sex and specific substance analyzed. Meanwhile, individual and family RSA was not associated with increased likelihood of a mental health diagnosis.

Discussion: These findings provide additional support for how both parental and two-generation family histories of RSA are associated with individual physical and mental health outcomes. Further, these findings articulate

the need for the TRCC's Calls to Action to be actually implemented, including community-based approaches that harness the strength of Indigenous people and communities who aim to close the gap in these health disparities for their children and families.

1. Introduction

Indigenous peoples in Canada have experienced intergenerational transmission of many detrimental physical and mental health concerns, which have been partially attributed to ongoing experiences of systemic discrimination, colonization, and cultural genocide (1–4). These intergenerational experiences of trauma have disrupted parenting practices, exacerbated untreated mental and physical health difficulties of prior generations, and contributed to disparities in Indigenous health outcomes when compared to non-Indigenous people (3, 5). Canada continues to attempt to reconcile ongoing ramifications of inequalities perpetuated by these systems, including attempts to rectify legislative actions that have reduced wellness and autonomy of Indigenous communities for generations. The Truth and Reconciliation Commission of Canada (6) published 94 Calls to Action to address long-term, intergenerational effects of the residential school system by improving child welfare, health, justice, and education systems for Indigenous peoples. For example, the 19th Call to Action identifies relevant gaps and suggests methods to reduce long-term health disparities for Indigenous peoples. This includes gathering relevant data on factors that affect life expectancy within Indigenous communities, such as the presence of chronic disease, mental health, and addiction (6).

We cannot authentically understand the many health disparities experienced by Indigenous peoples without considering the ramifications of the extended history of residential schools. The residential school program in Canada, lasting from the early 1800's to 1996, removed children from their families and forced children to adopt non-Indigenous identities (6). By prohibiting the use of traditional language and cultural practices and removing children from their communities where cultural practices were often taught, many children grew up not knowing their cultural identity or how cultural practices were embedded in daily life (6). The effects of these experiences are long-lasting. Residential school attendance is associated with depressive symptoms, suicidal ideation, a history of abuse, sex work involvement, and problematic substance use (7–9).

1.1. Intergenerational transmission of trauma within indigenous populations

Research with Indigenous populations in Canada has described how prior experiences of residential schools has contributed to the intergenerational transmission of mental and physical health disparities (4, 10). Intergenerational trauma, first academically conceptualized by Rakoff (11) in relation to high levels of psychological distress among offspring of Holocaust survivors, describes the preliminary theories that later informed current understandings of genetic and epigenetic transmission of health outcomes between generations. This research has broadened an epigenetic understanding of how transmission of trauma can influence health across generations, including both through preconception, utero, and post-natal early child developmental effects on individual phenotypes (12). Research has since been extended globally to explain how genocides (13), famines (14), slavery (15), and refugee experiences (16) influence mental and physical health outcomes within large populations of people across generations. The relationship between residential school attendance and lower health outcomes for Indigenous people across generations remains clearly predicted. Bombay et al. (4, 10) found that family experiences of residential school attendance predict poorer health outcomes, including mental health and suicide ideation across generations. Similarly, parent residential school attendance predicts self-reported physical and health, psychological distress, suicide ideation, and suicide attempts among Indigenous individuals living off reserve (17). When childhood educational outcomes were examined, maternal residential school attendance was associated with increased school suspensions or expulsion, children being less likely to get along with teachers, and less likely to look forward to attending school (18).

Residential school attendance is associated with increased rates of mental health difficulties not only for those who have attended these institutions, but also for subsequent children and grandchildren of these survivors (4, 10). Although the last residential school closed in 1996, the effects of these practices and the continued trauma experienced within Indigenous communities are long-lasting and continue to affect the next generations of families. This type of intergenerational transmission of trauma, including how detrimental mental

health symptoms are experienced across generations, has been further exacerbated experiences of colonization and cultural assimilation, decreased the transfer of culturally-useful parenting practices, and affected outstanding parent-child relationships in present day (7). Disrupted transmission of culturally-relevant parenting practices has been associated with lower emotional warmth or expressiveness by parents, increased substance abuse, and experiences of abuse or neglect by parents resulting in challenging relationships with their children and influencing the way that they parented (19). Mechanisms of action postulated in current literature to potentially explain how parental or family RSA is affiliated with mental and physical health concerns among offspring have included environmental exposure among offspring to:

- Ineffective or harsh parenting practices.
- Attachment disruptions or separation from caregiver.
- Increased exposure to caregiver mental health concerns, stress, or adverse childhood experiences (including exposure to violence, isolation, or social disadvantages).
- Community-based stressors, aggression, and racism.
- Individual isolation.
- Disruption to cultural approaches of wellness, including resilience-building or protective strategies previously used among families (4, 17, 20, 21).

To date, there is a paucity of research that has examined genetic or epigenetic differences related to families with a history of RSA. Few studies have assessed potential mechanisms of action that moderate or mediate these relationships.

The influence of residential schools on Indigenous health in Canada must be contextualized within broader frameworks that describe how these experiences intersect with Indigenous social determinants of health (22). Specific outcomes of the residential school system have created continued disparities in health status among Indigenous peoples in Canada, including *via* a loss in socio-economic status through disrupted education and employment outcomes. Educational attainment has been used to colonize, abuse, and control Indigenous individuals through forced participation in the residential school system, and educational systems continue to be sources of assimilation and discrimination for Indigenous individuals. Bolstering Indigenous engagement and participation in education systems is warranted given that higher educational attainment is associated with increased employment outcomes and higher socio-economic status which then in turn, influence health outcomes. Additional social determinants of health many Indigenous communities face include food insecurity, housing insecurity, and disrupted childhood development. For example, suicide ideation and attempts across a lifespan were disproportionally higher among individuals with lower income and food security (23). Exposure to adverse childhood experiences has been higher within

Indigenous populations (24, 25) creating disruptions to typical childhood developmental processes. Such indicators, although not a proxy of intergenerational trauma, are relevant on their own accord, and therefore, may be a specific indicator of health. Given that the vast majority of residential schools in Canada were largely attended by Indigenous populations (6), residential school attendance may be a unique predictor of poor health for Indigenous populations in Canada.

Despite knowing that such experiences contribute to greater health disparities among Indigenous communities, understanding the mechanisms of actions for the transmission of such effects across generations remains limited. Epigenetic theories have focused on environmental mechanisms [including disrupted parenting/caregiving stress (26), attachment, and social learning] and biological mechanisms (including changes to typical neuroanatomical and neuroendocrine functioning and structures). For example, disruption of typical patterns of stress responses, including cortisol secretion, can create lasting influences on offspring of parents exposed to trauma (27). Multifaceted theories have incorporated such bio-psycho-social models of the influence of intergenerational stress and examined broader predictors of mental health functioning affiliated with substance use. Intergenerational transference of problematic substance use at a one to one ratio of disease transference is documented among parents and grandparents (28–30).

1.2. Mental health difficulties among Indigenous communities

Research on prevalence of mental health difficulties experienced within Indigenous communities is mixed. While some studies depict positive mental health outcomes [including broader life satisfaction, increased wellbeing, and absence of a mental health disorder; (31)] experienced among Indigenous individuals (67.9% of Indigenous people surveyed), when research shows disproportionally higher rates of mental health concerns within Indigenous communities. Although rates of depression, anxiety, and panic disorders can be similar among Indigenous and non-Indigenous populations (32, 33), rates of Post-Traumatic Stress Disorder (PTSD) are often reported to be higher (32–34). Indigenous youth have reported higher rates depression, anxiety, seriously considering suicide and attempting suicide (35). Suicide has been considered to be a leading cause of death for Indigenous individuals under the age of 44 [Kumar and Nahwegahbow (36) as cited in Ansloos (37)], particularly for those who identify as Inuit and among Indigenous youth.

Exposure and earlier onset of mental health concerns can be further exacerbated by barriers to accessing various health promoting social determinants, such as housing, liveable income, childcare, health care, in addition to educational and

employment opportunities. For example, a population-based analysis of predictors of health found Indigenous individuals with higher education, employment, and living off-reserve were associated with higher self-reported health (38). Indigenous individuals disproportionally experience homelessness (33), incarceration (39), child welfare intervention (40, 41), all of which can amplify detrimental effects of concurrent mental health difficulties experienced across a lifespan. Indigenous populations experience a higher prevalence of Fetal Alcohol Spectrum Disorder (FASD); a recent population-based prevalence study showed statistically significant differences among Indigenous and non-Indigenous populations in Canada (42). Among Indigenous child and youth populations, the prevalence of diagnosed FASD was ∼1.2%, while within non-Indigenous populations, the prevalence was 0.1% (42). In a smaller study of Indigenous children diagnosed with a FASD, the majority (80%) experienced behavioral concerns and comorbid learning disabilities (63%), and some reported involvement with the criminal justice system (12%) and alcohol use [10%; (43)]. Recent research shows that Indigenous families are also more likely to experience exposure to adverse childhood experiences (44). Such experiences can exacerbate mental health concerns experienced among communities by preventing access to timely identification, treatment, and broad-based prevention strategies.

Predictors of mental health difficulties can differ by community, and estimates that amalgamate rates of illness experienced across regions, Indigenous groups, or communities can fail to capture variation in predictors of wellness (45). Rigorous data collection protocols for Indigenous populations have been proposed to adequately track changes in suicide rates, and increase the utility of population-based data for Indigenous communities (37, 46), however to date, such approaches have yet to be implemented. As such, it remains difficult to accurately conceptualize population-based mental health trends for First Nations, or more broadly, Indigenous communities in Canada, as communities have unique strengths and challenges related to health promotion of their members. Contextualization of these experiences is required to accurately understand experiences of First Nations individuals, particularly with consideration of the underlying assumptions related to the conceptualization of mental illness, wellness, and health (37).

1.3. Substance use among Indigenous communities

For Indigenous populations, contextualizing high rates of problematic substance use in a way that better reflects the needs of these individuals can inform understanding of high rates of chronic physical and mental health concerns among those with substance use concerns. First Nations individuals have identified substance use as a serious concern within their communities, ranking issues from addiction and substance use as more important than both housing and employment (47). Although First Nations adults are more likely than non-Indigenous Canadians to abstain from alcohol use, those that do consume alcohol are more likely to binge drink [defined as consuming more than five drinks per occasion; FNIGC (47, 48)]. Research suggests increased substance use is also more prevalent within some First Nation populations (35, 49), particularly among Indigenous youth when rates of use were compared to non-Indigenous youth (50). A national study of youth substance use rates found that Indigenous youth were more likely to consume marijuana and alcohol, and begin use at an earlier age (50).

Substance use concerns and Substance Use Disorders (SUDs) experienced among Indigenous individuals can also be co-morbid with additional psychiatric diagnoses, including trauma and stressor, depressive, and anxiety disorders, which can complicate treatment by reducing initial treatment options and subsequent treatment outcomes (51). In one study of Indigenous adults in a residential substance use treatment, 61 percent of individuals attending treatment reported clinically significant post-traumatic stress symptoms (34). Within the same sample, 19% reported moderate or severe depressive symptoms (34), much higher than population-based samples which suggest ∼7% of individuals experience clinically-significant depression symptoms (52). Recent research has begun to explore commonly co-occurring disorders affiliated with problematic substance use among Indigenous communities, including mental health disorders and chronic diseases (53, 54). A large longitudinal study found that, among Indigenous youth, rates of meeting criteria for one or more SUD was 31%, and presence of an externalizing disorder predicted increased odds of SUD diagnosis for all substances examined (alcohol and cannabis), except for nicotine (53). When use of cannabis, alcohol, e-cigarettes, and tobacco among high school students was examined, Indigenous students were significantly more likely to report polysubstance use (55). Similar trends are noted within samples of Indigenous post-secondary students (35).

These trends must be situated within culturally-relevant treatment and prevention options, including exploring predictive factors of higher use. The health burden of substance use across a lifespan can also be disproportionally impactful among Indigenous populations, given that Indigenous peoples have unique experiences that can contribute to broader health difficulties. For example, Indigenous peoples were five times more likely to die from opioid use in 2017 (56), which has likely been exacerbated during the COVID-19 pandemic (57). Among First Nations individuals who have reported opioid misuse, 91% reported attending a residential school, 73% had experienced a crisis or natural disaster, 67% reporting that a friend or family member had attempted suicide, and 61% reported trauma from the completed suicide deaths of family and friends (58). First Nations adults seeking treatment at an Indigenous-led health center have reported disproportionately higher rates of adverse

childhood experiences, including early exposure to abuse, neglect, and household dysfunction (44). As such, pathways of promoting Indigenous health and wellbeing across a lifespan are both multi-faceted and complex, particularly when intersecting social determinants of health and exposure to life stressors are considered.

2. The current study

2.1. Study purpose

Prevention strategies employed with Indigenous populations may address intergenerational aspects of substance use transmission by identifying shared predictors among these groups and integrating such findings with previous knowledge of harm resulting from the residential school system. Experiences of historical trauma have contributed to the intergenerational transmission of health outcomes that cannot be resolved without consideration of protective factors that foster resilience among Indigenous communities, culturally-relevant interventions, and understanding mechanisms of transmission across populations (59, 60). Given that previous intergenerational pathways to mental health among large samples of Indigenous individuals in Canada have been documented (4, 10), it is possible that such predictors across generations can be extended to improve an overall understanding of higher substance use among Indigenous communities.

The purpose of this study was to identify patterns of substance use among individuals with a history of residential school attendance as well as individuals reporting parent or two-generation (parent and grandparent) residential school history. Although previous literature has explored intergenerational patterns of mental health difficulties, no studies to date have explored whether attendance at a residential school is associated with increased substance use difficulties among offspring using a large, population-based sample. The current study aimed to assess if residential school attendance was associated with risky substance use, among First Nations individuals living off-reserve.

2.2. Study hypotheses

We hypothesized those with a history of individual, parent and grandparent residential school attendance would self-report lower physical and mental health ratings when compared to those who had not attended a residential school (Hypothesis 1). We also hypothesized that increased frequency of substance use would be associated with history of residential school attendance among First Nation individuals living off-reserve. Specifically, when each substance was entered as a dependent variable, we hypothesized that individual, parent-only, and two-generation

(parent and grandparent) residential school attendance would be associated with increased odds of daily tobaccos use, daily cannabis use, alcohol use, and illicit substance use.

Secondary analyses also explored related hypotheses predicting that individual, parent-only, and two-generation residential school attendance would be associated with increased odds of being diagnosed with an anxiety disorder, a mood disorder, or any mental health disorder, in addition to history of suicide contemplation, or attempts (in the past year or across a lifetime).

3. Method

3.1. Participants

For the purpose of this study, data from First Nations individuals living off reserve were analyzed (Table 1). In accordance with release of data in accordance with Statistics Canada policies, each individual case in the Aboriginal Peoples Survey (APS, 2017) was adjusted to represent a broader population using a seven-step weighting method. An adjusted weight was applied to each case and accounted for non-response, partial response, and a post-stratification that corresponded each unit with population estimates based strata of Aboriginal status, region, and age group (61). The final sample initially consisted of $n=$ 10,030 individuals who self-identified as First Nation and was weighted to represent 491,010 individuals in these analyses.

3.2. Measures

3.2.1. Data set

Data from the APS 2017 was accessed with permission from the Canadian Research Data Centre Network (CRDCN) and analyzed at the Research Data Center at McMaster University using Stata 17. The 2017 APS is a national survey of Indigenous peoples in Canada, specifically First Nations individuals living off-reserve, Métis, and Inuit populations. Across the five iterations of the APS, occurring approximately every 5 years, the survey has focused on social and economic conditions of Indigenous peoples in Canada. The Lakehead University Research Ethics Board (REB) provided an exemption to REB approval, as this study used de-identified secondary data. The data analytic plan was approved by representatives from the CRDCN, and was drafted to comply with Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada (62) and Ownership Control Assess Possession [OCAP^{TM}; (63)] principals when possible.

All data were aggregated, and no individual scores for any respondent were reported. Congruent with Statistics Canada data regulations for the APS (2017), if a sample size within

TABLE 1 Participant demographics.

Demographic		Frequency	%
Sex	Male	221,200	45.05
	Female	269,810	54.95
Age		M = 40.4 (sd = 17.07)	
Life stage	Youth (age 15–19)	62,570	12.74
	Adult	389,810	87.26
Marital status	Single	207,470	42.25
	Married	140,990	140,990
	Living common law	79,940	16.28
	Separated	16,220	3.3
	Divorced	31,210	6.36
	Widowed	15,130	3.08
Place of residence	Rural (under 1 000)	112,930	23.00
	Small population center (1,000–29,999)	107,750	21.95
	Medium population center (30,000–99,999)	72,860	14.84
	Large urban population center (100,000 or more)	197,410	40.21
Household type	Two-generation household	254,680	51.87
	Three or more-generation household	29,130	5.93
	Skip-generation household	10,810	2.2
	Other household type	195,790	39.88
Highest attained level of education	Grade 8 or lower	24,050	4.90
	Some secondary education	64,130	13.06
	Secondary school diploma	73,560	14.98
	Some post-secondary	85,540	17.42
	Post-secondary diploma	150,460	30.64
	Bachelor's degree	34,170	6.96
	Degree above bachelor level	14,730	3.00
Employment status	Employed	267,820	54.54
	Unemployed	43460	8.85
	Not in labor force	177,710	36.19
Estimated 2016 total personal income	<$, 000	71,210	14.5
	$5,000–9,999	34,470	7.02
	$10,000–19,999	52,630	10.72
	$20,000–29,999	45,850	9.34

(Continued)

TABLE 1 (Continued)

Demographic		Frequency	%
	$30,000–39,999	33,330	6.79
	$40,000–49,999	27,550	5.61
	$50,000–69,999	48,430	9.86
	$70,000 and over	35,200	7.17
Residential school attendance	Individual attendance	31,570	8.52
	Parent attendance	120,640	26.78
	Grandparent attendance	163,100	44.86

a particular sub-population of variables was below 10, results were not reported. Place of residence was calculated by using participant-reported description of population size, and was not described for any individual community, to preserve confidentiality and to adhere to OCAP™ (63) principles related to individual community sovereignty regarding research goals, approaches, and dissemination of results.

3.2.2. Variables

For the purposes of this study, variables depicting demographical characteristics (age, sex, socio-economic status, education level, and household members, among others), and self-report ratings of mental health, physical health, and employment status were used from relevant APS variables. Data was selected for those participants who identified as First Nation to the question, "Are you First Nations, Métis, or Inuk?". Binary dummy variables were derived from specific substance use questions in the APS 2017. Increased frequency of substance use was defined as daily tobacco or marijuana use, consuming 5 or more alcoholic drinks in one period (once a week or more), or off-label prescription drug use or street drug use (once a month or more).

3.2.2.1. Tobacco

Daily tobacco was entered as 1, while both other frequencies ("occasionally" or "not at all") were ranked as 0.

3.2.2.2. Marijuana

Similarly, daily or almost marijuana use was coded 1, while the remaining four categories ("at least once a week," "at least once a month," "less than once a month," or "not at all") were coded as 0.

3.2.2.3. Alcohol

With respect to alcohol use, self reported use of either "once a week" or "more than once a week" was coded as 1, while other frequencies ("2–3 times a month," "once a month," "less than once a month," or "never") were coded as 0.

TABLE 2 Independent *t*-tests of self-reported mental and physical health of individual, parent, and grandparent RSA.

			m	Bootstrapped *SE*	CI (lower)	CI (upper)	*t*	*p*
Self-reported mental health	Sex	Male	2.67	0.026	2.62	2.72	−7.67	0.000
		Female	2.41	0.024	2.40	2.45		
	Individual RSA	RSA	2.39	0.069	2.26	2.53	−2.77	0.006
		Non-RSA	2.58	0.021	2.54	2.62		
	Parent RSA	RSA	2.42	0.035	2.35	2.48	−4.06	0.000
		Non-RSA	2.58	0.020	2.54	2.62		
	Grandparent RSA	RSA	2.40	0.032	2.34	2.47	−5.84	0.000
		Non-RSA	2.64	0.023	2.60	2.67		
Self-reported physical health	Sex	Male	2.42	0.027	2.37	2.48	9.92	0.000
		Female	2.26	0.023	2.20	2.30		
	Individual RSA	RSA	2.17	0.037	2.09	2.24	−4.98	0.000
		Non-RSA	2.42	0.020	2.38	2.50		
	Parent RSA	RSA	2.30	0.035	2.23	2.37	−5.95	0.000
		Non-RSA	2.41	0.024	2.37	2.47		
	Grandparent RSA	RSA	2.30	0.035	2.23	2.37	−3.01	0.003
		Non-RSA	2.42	0024	2.37	2.47		

3.2.2.4. Illicit substance use

Due to lower responses for either prescription and street drug use frequency, these categories were collapsed together and responses of "at least once a month," "at least once a week, and "daily or almost daily" were coded as 1, while use of "less than a month" or "not at all" were coded as 0.

3.3. Analysis procedure

Independent *t*-tests were used to describe differences in mean self-reported mental and physical health among groups of individuals who had attended residential schools and those who had not (Hypothesis 1). We also aimed to completed exploratory analyses related to sex differences among physical and mental health ratings, however did not have a hypothesis predicting any anticipated differences.

Logistic regressions (Hypothesis 2) compared frequency of use for each substance among those with an individual history of RSA, those with single generation (parent) history of RSA, and those reporting both grandparent and parent (two-generation) RSA history. Within each of these regressions, both age and sex were entered as covariates, and for analyses with single or two-generation RSA, individual's own history of RSA was also entered as a covariate. Among these analyses, daily tobacco and cannabis use was associated with individual, parent, and two-generation RSA.

In an attempt to reduce the likelihood of a multiplicity error from non-adjusted analyses within the current study, the analyses of mental health disorders and suicide ideation were considered to be a secondary goal of this study. These comparisons should be considered as exploratory.

4. Results

Self-reported mental and physical health scores (Table 2) were significantly lower among those had attended residential schools, whose parents attended residential schools, and whose grandparents attended residential schools, when compared to those who did not. This was predicted in Hypothesis 1. When these self-reported health ratings were compared by sex in an exploratory analysis, male participants reported both better mental and physical health outcomes than female participants.

4.1. Hypothesis 2: Substance use frequency

Results of hypothesis 2 are found in Table 3.

4.1.1. Tobacco use

Respondents with an individual history of RSA were 1.6 times more likely to use tobacco daily and 2.6 times to use cannabis daily compared to those without a history. Among

TABLE 3 Predictors of substance use frequency including individual, parent, and two-generation RSA.

		Individual RSA				Single generation RSA (Parent)				Two generation RSA (Parent + Grandparent)			
		z*	OR	CI (-)	CI (+)	z*	OR	CI (-)	CI (+)	z*	OR	CI (-)	CI (+)
Daily tobacco use	Age	−4.35[a]	0.98	0.984	0.994	−4.2[a]	0.99	0.982	0.994	−2.91[a]	0.99	0.985	0.997
	Sex (female)	0.31	1.03	0.870	1.211	0.15	1.01	0.849	1.209	−0.44	0.96	0.783	1.167
	Constant	−3.41	0.63	0.478	0.819	−3.58	0.58	0.427	0.780	−4.00	0.50	0.351	0.699
	Individ. RSA	3.04[b]	1.58	1.175	2.112	1.81	1.38	0.973	1.960	2.08[c]	1.51	1.025	2.244
	Parent RSA					3.34[1]	1.43	1.159	1.765				
	Two gen RSA									2.91[a]	1.22	1.066	1.238
Alcohol consumption of 5 or more drinks, once a week or more	Age	0.08	1.00	0.993	1.008	−0.60	1.00	0.990	1.006	−1.58	0.99	0.983	1.001
	Sex (Female)	−3.49[a]	0.61	0.466	0.807	−3.00[a]	0.64	0.481	0.858	−2.58[b]	0.66	0.476	0.903
	Constant	−9.21	0.11	0.107	0.234	−8.05	0.17	0.109	0.260	−5.98	0.21	0.127	0.352
	Individ. RSA	0.05	0.63	0.626	1.636	−1.03	0.77	0.479	1.257	−0.62	0.84	0.490	1.447
	Parent RSA					1.34	1.22	0.911	1.642				
	Two gen RSA									0.46	1.05	0.862	1.272
Daily cannabis use	Age	−9.50[a]	0.95	0.941	0.961	−9.40[a]	0.95	0.937	0.958	−7.84[a]	0.95	0.938	0.962
	Sex (Female)	−4.57[a]	0.52	0.389	0.686	−4.19[a]	0.52	0.383	0.706	−3.79[a]	0.51	0.365	0.725
	Constant	0.14	1.03	0.644	1.659	0.12	1.03	0.611	1.746	−0.41	0.88	0.471	1.638
	Individ. RSA	2.62[a]	1.95	1.184	3.222	1.73	1.69	0.932	3.054	1.64	1.75	0.896	3.416
	Parent RSA					2.41[c]	1.52	1.081	2.149				
	Two gen RSA									2.38[c]	1.33	1.052	1.689
Monthly or greater prescription or illicit drug abuse	Age	−5.08[a]	0.96	0.938	0.972	−4.76[a]	0.95	0.932	0.971	−3.06[a]	0.96	0.943	0.987
	Sex (Female)	−1.95	0.61	0.374	1.003	−2.19[c]	0.56	0.336	0.941	−2.28[c]	0.51	0.290	0.912
	Constant	−3.09	0.25	0.101	0.598	−2.91	0.20	0.065	0.587	−3.51	0.11	0.032	0.378
	Individ. RSA	−0.19	0.93	0.437	1.979	−1.31	0.58	0.251	1.319	−0.88	0.68	0.285	1.615
	Parent RSA					4.22[a]	3.02	1.810	5.071				
	Two gen RSA									4.64[a]	1.85	1.426	2.392

[a] $p \geq 0.001$.
[b] $p \geq 0.01$.
[c] $p > 0.05$.
*Significance tests of constant values not reported.

those with parent and two-generation RSA history, respondents were 1.4x more likely to use cannabis daily if they had a parent who attended a residential school, and 2.9x more likely to use cannabis daily if both a parent and a grandparent attended.

4.1.2. Cannabis use

Similarly, with respect to cannabis use frequency, individuals with a personal history of RSA were 2.6 times more likely to use cannabis daily, however were 2.4 times more likely if a parent had attended a residential school, and 2.4x more likely if a parent and a grandparent had attended. In initial analyses of individual RSA, males were 1.9 times more likely to use cannabis daily compared to female participants, which was significant at a 0.001 level.

4.1.3. Alcohol use

When alcohol use frequency was analyzed using logistic regressions, frequency of use was not predicted by individual, parent, or two-generation residential school attendance, however similar to cannabis use frequency, males were more likely to consume 5 or more drinks a week compare to females. In initial analyses examining individual RSA, males were 1.6 times more likely to have higher alcohol consumption.

4.1.4. Illicit substance use

Illicit substance use frequency was not significantly predicted by an individual history of RSA, however was associated with both parent and two-generation RSA. Among those who reported a parent history of RSA, individuals were 3.0 times more likely to engage in monthly or greater illicit substance or prescription drug abuse. For individuals with two-generation RSA, they were 1.9 times more likely to fall in the higher illicit use category.

4.2. Mental health disorder and suicide-specific secondary analyses

Contrary to our hypotheses, logistic regression results (Table 4) did not show any statistically significant relationship among these diagnostic categories and any type of RSA when age and sex were entered as covariates. Within initial analyses, female participants were 2.5 times more likely to be diagnosed with an anxiety disorder and 2.1 times more likely to have a diagnosis of a mood disorder, however there were no sex differences found for the broader category of having any type of mental health disorder diagnosis.

A lifetime history and frequency in the past year of both suicide contemplation and attempts was also analyzed with

respect to individual, parent, and two-generation RSA. These hypotheses were tested using logistic regression, however results (Table 5) were inconsistent across these analyses. Only two statistically significant relationships emerged; parent RSA was associated with lifetime suicide contemplation (OR = 2.2) and two-generation RSA was associated with having a suicide attempt in the last year (OR = 2.8).

5. Discussion

This study explored how individual, parent, and two-generation (having both a parent and a grandparent) histories of RSA influence frequency of tobacco, cannabis, alcohol, and other illegal substances. We also used exploratory analyses to examine similar trends for prevalence of any type of mental health disorder, and more specifically, anxiety and mood disorders. Study analyses demonstrated that, overall, family RSA was associated with increased substance use among individuals, however results were somewhat inconsistent across substances and dependent on who in the family had attended a residential school (individual, parent, or both parent and grandparent). When age and sex were entered as covariates, having both a parent and a grandparent attend a residential school was associated with increased odds of individual daily tobacco use, daily cannabis use, or misusing prescriptions or street drugs monthly or more. Having both a parent and a grandparent attend a residential school was not associated with increased odds of alcohol use (consuming more than five standard drinks in one setting, once a week or more), which was a similar finding when both parent-only and individual RSA were examined. Individual RSA was associated with increased odds of daily tobacco and daily cannabis use, while parent-only RSA was associated with daily tobacco use, daily cannabis use, and monthly or greater street drug or prescription drug misuse.

The current study has supported previous literature that associated intergenerational RSA with individual health outcomes among offspring (1, 4, 10), with a focus on substance use frequency and mental health diagnoses. We examined one pathway, within a series of relatively complex relationships, that described how various types of family histories of RSA can influence present-day substance use among individuals. Results suggest that such experiences are associated with increased substance use across most substances examined in the current study. Further examination of these nuances may inform broader conceptualizations of the intergenerational transmission of mental health difficulties using a bio-psycho-social model (64) as a relevant framework. For example, when biological differences were examined in hair samples and compared with exposure to life stressors, Indigenous women had significantly higher cortisone levels when compared to

TABLE 4 Predictors of mental health disorder diagnoses including individual, parent, and two-generation RSA.

		Individual RSA				Single Generation RSA (Parent)				Two Generation RSA (Parent + Grandparent)			
		z^*	OR	CI (-)	CI (+)	z^*	OR	CI (-)	CI (+)	z^*	OR	CI (-)	CI (+)
Diagnosis of any mental health disorder	Age	−3.82[a]	0.97	0.953	0.985	−3.42[a]	0.97	0.959	0.989	−3.49[a]	0.97	0.950	0.986
	Sex (female)	−1.79	0.60	0.342	1.051	−1.91	0.57	0.319	1.014	−0.96	0.72	0.369	1.404
	Constant	−1.80	0.47	0.204	1.068	−2.59	0.36	0.167	0.781	−1.28	0.528	0.198	1.409
	Individ. RSA	1.15	1.72	0.683	4.350	1.20	1.87	0.673	5.209	1.53	2.50	0.778	8.035
	Parent RSA					−0.12	0.96	0.506	1.821				
	Two gen RSA									−1.29	0.72	0.441	1.185
Diagnosis of an anxiety disorder	Age	−5.99[a]	0.97	0.973	0.986	−6.07[a]	0.98	0.971	0.985	−6.43[a]	0.97	0.967	0.982
	Sex (female)	8.31[a]	2.54	2.041	3.170	8.03[a]	2.57	2.040	3.233	6.91[a]	2.48	1.919	3.213
	Constant	−5.80	0.34	0.239	−0.492	−5.36	0.35	0.241	0.517	−3.83	0.42	0.271	0.656
	Individ. RSA	0.43	1.09	0.740	1.600	0.22	1.05	0.697	1.571	0.13	1.03	0.644	1.657
	Parent RSA					1.15	1.15	0.908	1.448				
	Two gen RSA									1.24	1.10	0.944	1.292
Diagnosis of a mood disorder	Age	−3.62[a]	0.99	0.983	0.995	−3.67[a]	0.99	0.982	0.995	−2.98[b]	0.99	0.982	0.996
	Sex (female)	7.33[a]	2.11	1.729	2.579	7.40[a]	2.23	1.804	2.763	5.63[a]	2.07	1.606	2.667
	Constant	−8.51	0.24	0.176	0.338	−8.19	0.22	0.162	0.327	−7.08	0.21	0.139	0.327
	Individ. RSA	−0.73	0.88	0.624	1.240	−1.34	0.77	0.531	1.126	−1.25	0.75	0.483	1.174
	Parent RSA					1.03	1.12	0.899	1.404				
	Two gen RSA									1.54	1.12	0.968	1.304

[a]$p \geq 0.001$.
[b]$p \geq 0.01$.
[c]$p > 0.05$.
*Significance tests of constant values not reported.

TABLE 5 Predictors of suicide contemplation and attempts including individual, parent, and two-generation RSA.

		Individual RSA				Single generation RSA (Parent)				Two generation RSA (Parent + Grandparent)			
		z*	OR	CI (−)	CI (+)	z*	OR	CI (−)	CI (+)	z*	OR	CI (−)	CI (+)
Contemplated suicide in lifetime	Age	−4.49[a]	0.98	0.978	0.991	−4.18[a]	0.98	0.977	0.992	−4.30[a]	0.98	0.973	0.990
	Sex (female)	4.72[a]	1.62	1.328	1.986	4.78[a]	1.67	1.352	2.060	3.90[a]	1.64	1.28	2.09
	Constant	−6.22	−0.34	0.238	0.474	−5.95	0.30	0.204	0.448	−4.27	0.35	0.223	0.573
	Individ. RSA	1.11	1.23	0.852	1.783	0.54	1.12	0.734	1.719	0.65	1.18	0.722	1.914
	Parent RSA					2.21[c]	1.31	1.032	1.669				
	Two gen RSA									1.25	1.11	0.943	1.305
Contemplated suicide in past year	Age	−1.29	0.99	0.975	1.005	−1.16	0.99	0.975	1.007	−0.56	0.99	0.977	1.013
	Sex (female)	−0.01	1.00	0.665	1.500	0.28	1.06	0.691	1.638	0.54	1.15	0.702	1.869
	Constant	−1.83	0.48	0.219	1.052	−1.89	0.44	0.192	1.031	−2.35	0.32	0.121	0.826
	Individ. RSA	0.04	1.01	0.519	1.984	0.10	1.04	0.490	2.199	−0.02	0.99	0.428	2.288
	Parent RSA					−0.19	0.96	0.605	1.513				
	Two gen RSA									0.41	1.06	0.790	1.434
Suicide attempt in lifetime	Age	1.44	1.01	0.997	1.021	−0.19	1.00	0.972	1.024	0.61	1.00	0.990	1.020
	Sex (Female)	1.78	1.44	0.963	2.161	1.43	1.37	0.890	2.094	0.59	1.15	0.725	1.825
	Constant	−2.28	0.47	0.245	0.899	−2.01	0.495	0.249	0.982	−1.62	0.51	0.221	1.153
	Individ. RSA	1.74	1.92	0.922	4.006	1.31	1.73	0.762	3.944	1.45	1.98	0.785	5.015
	Parent RSA					1.40	1.35	0.888	2.037				
	Two gen RSA									1.54	1.25	0.941	1.663
Suicide attempt in last year	Age	−0.44	0.99	0.970	1.019	−0.19	1.00	0.972	1.024	1.29	1.02	0.991	1.044
	Sex (female)	−1.37	0.53	0.214	1.317	−0.65	0.71	0.249	2.001	−0.52	0.73	0.228	2.348
	Constant	1.13	0.14	0.032	0.644	−2.61	0.08	0.012	0.532	−4.23[a]	0.01	0.002	0.101
	Individ. RSA	1.13	1.84	0.638	5.316	0.52	1.35	0.435	4.208	0.08	1.05	0.318	3.486
	Parent RSA					1.22	1.84	0.693	4.868				
	Two gen RSA									2.76[a]	2.24	1.262	3.963

[a] $p \geq 0.001$.
[b] $p \geq 0.01$.
[c] $p > 0.05$.
*Significance tests of constant values not reported.

non-Indigenous women. These relationships trended in the opposite direction for Indigenous men, such that Indigenous men had significantly lower cortisone levels (65). It is likely that various predictors of the intergenerational transmission of trauma, substance use, and additional mental health difficulties vary within intersecting biological, social, and psychological determinants (66).

Current findings were generally consistent with previous trends describing sex differences among mental health, substance use, and suicide ideation within Indigenous populations (67). Although family or individual RSA was not associated with increased odds of frequent alcohol use when sex differences were examined, male participants were more likely to engage in higher frequency alcohol use and daily cannabis use. Female participants in our sample were more likely to have a diagnosis of an anxiety or mood disorder. With respect to a lifetime history of suicide contemplation, female participants were also more likely to have contemplated suicide in their lifetime, although male participants were more likely to have attempted suicide in the last year. These results suggest that there continue to be gendered experiences of mental health difficulties within Indigenous samples in Canada, which can trend similar to non-Indigenous population data.

Previous literature has explored how higher rates of childhood maltreatment and ACEs are associated with increased rates of specific psychiatric disorder (44) in a First Nation sample; However, in the current study, individual and family RSA was not associated with increased likelihood of a mental health diagnosis. Similar to previous data analyzed from the 2012 iteration of the APS (68), individual residential school attendance was not associated with increased likelihood of an anxiety disorder in our analyses. It is likely that barriers to receiving health care, including perceived stigma of and access to specialized care providers, including psychological assessment, may potentially bias these findings. Increased substance use may also mask mood or anxiety symptoms experienced by an individual, particularly when motives of use are considered. Given motives of use (social, coping, enhancement, and conformity) can differ among First Nations individuals (69), those who consume for coping reasons may not necessarily report higher anxiety and depression. Lastly, given that colonization has impacted the wellbeing and mental health of all Indigenous peoples (not solely those who have a history/family history of RSA), it may be difficult to clearly delineate RSA effects with the use of binary mental health diagnosis variables, whereas symptom severity measures may provide more information. Further research regarding pathways to increased prevalence rates of particular psychiatric disorders within Indigenous communities may be a better approach to addressing these questions, particularly when such experiences are examined across a lifespan.

5.1. Public health, clinical, and policy implications

Indigenous peoples in Canada have consistently reported the wide spread impact of residential schools on individual, family, and community wellbeing (6). The detrimental effects of RSA across generations of Indigenous families are well-documented, and the 94 Calls to Action aim to rectify the disproportionate social, health, and cultural influence of government mandated colonization, discrimination, and marginalization (6). Federal government leaders have even gone so far to relay that all TRCC Calls to Action will be implemented within current federal leadership terms, however limited steps to achieving this aspirational goal have been completed to date (45). Future efforts can explore potential mechanisms of authentically implementing the TRCC Calls to Action, including necessary public health interventions, policy adaption, and reconciliation efforts that can improve Indigenous health outcomes related to histories of RSA previously described in the final report. It is likely that culturally-relevant public health interventions that address housing instability, poverty, disproportionate criminal justice involvement, and exposure to ACEs can increase wellbeing among Indigenous families, particularly among individuals experiencing substance use and mental health difficulties (70).

Culturally-relevant clinical interventions that simultaneously address both co-morbid substance use and trauma are required, particularly those that embed mechanisms to address family-related trauma. The effect of intergenerational mental health difficulties on offspring may be exacerbated when one is consistently exposed to those with similar concerns. It can be challenging to treat individual mental health difficulties when their most proximal environment is in conducive to support individual change within treatment, no matter how motivated an individual may be. Given that First Nation individuals living on-reserve are more likely to live in crowded housing, and those households are most frequently multi-generational (71), there may be a clustering effect of increased mental health difficulties when older generations in the household have a history of residential school attendance. Family-based therapy or simultaneous implementation of multi-generational treatment within a household may facilitate meaningful change, however given the intensive nature of such treatment, access to such programs remains limited. Although embedding family supports and family-based approaches are more common in child or youth-focused programs, such models could be extended to adults as well to address broader family systems.

Future health policies can provide more resources to develop and assess efficacy for intergenerational treatment of mental health concerns within Indigenous families. Currently mental health funding and services available to Indigenous populations are primarily individually-focused. For example, non-insured

health benefits for mental health counseling, available to only registered "Status Indians" in Canada, is billed for each individual client and does not provide any type of family coverage (72). A focus on family-based benefits, that could comprehensively include an entire family structure, regardless of treaty status, may be one down-stream solution to address ongoing mental health concerns within family units. Such interventions could likely prevent ongoing exacerbation of concerns or reduce effects of caregiving stress on offspring in such households.

5.2. Limitations and future directions

General limitations of the APS include generalizability of the survey respondents to broader the population and response bias given the method of survey administration. The APS is only completed with First Nations individuals living off-reserve and therefore, cannot be generalized to all First Nations individuals in Canada, particularly those living on-reserve (61). Given that the APS is completed predominately by telephone, in-person, or a combination of these methods from individuals who had completed the long-form of 2016 Canadian census, the sample does not include individuals who are incarcerated, living with no fixed address, or who could not be contacted using computer-assisted questionnaires completed in-person or by telephone. Another limitation is that there may be a response bias within some questions of the APS. In accordance with RDC guidelines, any cross-section of the data resulting in <10 individual cases cannot be analyzed or reported. Self-reported rates of mental health diagnoses or substance use frequency may also be under-reported in health research. This is a relevant gap in the current sample and will affect the representativeness of the study results as there are disproportionately more Indigenous people in Canada incarcerated and homeless (73).

It was not possible in this study to explore specific experiences of RSA, including experiences of child maltreatment, duration of time spent within residential schools, and various protective factors such as individual level factors (such as access to culture, prosocial relationships, community engagement) or broader social determinants of health (including housing, health care, income stability). We did not explore predictors of poly-substance use (often a more clinically-relevant measure) which could be examined in future studies. We also could not contextualize who in the individual's family was their primary caregiver, which is particularly relevant given that many Indigenous individuals live in skip-generation households. One limiting assumption made within the current study, and within many studies which examine intergenerational RSA, is that parental RSA is somehow more influential on an individual's health outcomes than grandparent RSA, and that two-generational RSA exposure may contribute to a more cumulative effect on individual mental health. Undoubtedly, being directly raised by an individual with a history of RSA, may negatively influence individual outcomes, regardless of if they are one's biological parent or grandparent. Future research can either control for or directly examine the mediating role of primary caregiver, rather than formally defined biological relationships of grandparent or parent, on individual mental health outcomes.

This study could not assess how moderators and mediators of parent or grandparent substance use potentially influence the relationships among experiencing household dysfunction as a child and individual substance use. For example, although Indigenous individuals are more likely to engage in risky alcohol use, they are also more likely to be entirely abstinent from alcohol when compared to national Canadian samples (47). The current analyses did not contextualize aspects that promote resilience to reduce the negative health effects of RSA on substance use frequency, mental health, or suicide ideation. By examining mediators and moderators of increased health and wellbeing among those with histories of family RSA, it is possible that such studies can inform broader public health approaches to addressing the continued harm from RSA within Indigenous communities. For example, although current retribution efforts have aimed to provide financial compensation for residential school survivors in one approach to reconcile these histories, such efforts do not necessarily address subsequent mental or physical health difficulties from abuse, neglect, isolation, death, and disrupted relationships with family, community, and culture. It is possible that for First Nation individuals seeking treatment for experiences of trauma and subsequent mental health disorders, particularly with a family history of similar concerns, such complexity can impede initial engagement in services, treatment outcomes, and availability of treatment options.

Future studies can explore aspects of resilience and wellbeing among individuals with prior family histories of RSA who do not identify as experiencing substance use difficulties. There are likely pathways that have mitigated the detrimental effects of RSA, including individual, family, community, and cultural strengths. Although individual community has unique strengths, concerns, and health needs, it is possible that findings from previous community-based interventions could potentially be adapted to other communities or regions with careful community review and consultation. Prospective studies that explore longitudinal health outcomes across a lifespan are warranted, including those that assess specific social determinants of Indigenous health, including histories of child welfare involvement, lower educational attainment, and food insecurity (74). Interventions that address the intergenerational disruptions to cultural connectedness and ceremony, language use, parenting practices, and overall health or wellbeing can also be explored through such studies.

5.3. Conclusion

Understanding the mechanisms underlying the relationship between family histories of RSA and Indigenous mental health outcomes is undoubtedly complex, and cannot necessarily be contextualized using cross-sectional survey designs. Previous research has explored both theoretical and quantifiable relationships related to the transmission of mental health difficulties, and most studies reflect a need to expand current understanding of the mechanisms of action within both specific mental health disorders and broader concerns (27, 75–78). Studies highlight the need to disentangle genetic differences from non-genetic ones (including cultural transmission), focus on paternal and maternal experiences, and the influence of maladaptive parenting or care-giver stress (79). Given that offspring of have partially shared genetic make-up from their biological parents, and often, a shared environment, it can be difficult to confidently determine predictors of transmission or factors influencing heritability.

The current study could not associate how specific experiences within residential schools could contribute to further mental health difficulties across generations, however did describe broader trends across families. A history of RSA can be conceptualized as a series of exposure to cumulative traumas, however the exposure of specific experiences of adversity vary at an individual level. Although the history of these institutions is unfortunately shared across all Indigenous communities in Canada, individuals differ in their response to exposure. Despite the last residential school closing in 1996, the unfortunate legacy of these institutions will be long-lasting in regards to the detrimental influence on the mental health and wellbeing of generations of Indigenous families. Community-based approaches are being developed to address harm from residential schools, which harness the resilience and tenacity of Indigenous people and communities who aim to close the gap in these health disparities for their children and families.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: https://crdcn.ca/data/aboriginal-peoples-survey/.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

ET completed all analyses and reporting of results. ET and JL drafted this manuscript. AM and CM reviewed final drafts. All authors contributed to the conceptualization of this manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Examining the influence of substance use on mental health rating during COVID-19: A Canadian perspective

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Introduction: Substance use and mental health symptoms (e.g., depression and anxiety) have increased during the COVID-19 pandemic, partly due to implementation of physical distancing measures aimed at containing the spread of the SARS-CoV-2 virus. However, there is limited pandemic-specific research that has examined the relationship between substance use and mental health with other correlates of well-being, including life satisfaction and social confidants.
Methods: In the current study, we used ordered logistic regression analyses to examine whether a greater frequency of substance use (e.g., alcohol, cannabis, and opioids) during the pandemic predicted poorer ratings of self-reported mental health in a large sample of Canadians aged 15 to 64 years. We further considered whether life satisfaction and number of social confidants interacted with substance use to influence mental health, and stratified the models by sex and personal feelings of shame surrounding the use of substances (i.e., high and low shame).
Results: Findings indicated that frequency of substance use was significantly associated with increased odds of reporting poorer mental health for males and females exhibiting both low and high shame. In females reporting low shame, we found that as frequency of cannabis use increased, life satisfaction has a much greater positive association with mental health. Whereas, in females disclosing high shame, maintaining social relations was particularly important to benefit the mental health of current users of opioids, relative to past and non-users. No such interaction was found in males.
Discussion: Overall, the findings of the current study showed the negative mental health consequences of substance use during COVID-19 in a large Canadian sample, and most importantly revealed a critical sex difference in the way in which social determinants interact with substance use to influence mental health.

KEYWORDS

COVID-19, mental health, substance use, social determinants, sex differences, ordered logistic regression

1. Introduction

The spread of the coronavirus disease (COVID-19) has emerged as a global pandemic, and has had a profound impact on the existing economic, social, and political landscape of communities around the world (1). For example, COVID-19 outbreak has led to fewer social interactions due to implementation of social distancing measures, a reduction in employment opportunities, and limited accessibility to social and health services (1). Another adverse outcome of the COVID-19 pandemic is the psychological distress experienced by public in response to social restrictions (2, 3). For instance, a survey conducted by Wang and colleagues (4) examined the psychological outcomes of early

stages of COVID-19 restrictions among the Chinese population. They showed that nearly half of the sample (1,211 participants) in their data rated the mental health distress of the outbreak to be moderate or severe. Another survey conducted on university students in China showed that anxiety was a common concern experienced among students due to the pandemic, and family-income, living with parents, and overall social support served as protective factors against anxiety (5). Since these early studies, a similar trend (an increase in self-reported levels of depression and anxiety during COVID-19) has been reported in surveys conducted in Italy (6), Spain (7), Germany (8), India (9), United States (10), and Canada (11). Solomou and Constantinidou (12) particularly emphasized the crucial role of individual and social contextual differences when evaluating the severity of mental health symptoms during COVID-19. For example, they observed that women, younger adults (18–29), students, and those with prior psychiatric history, were at a higher risk to experience depressive and anxiety symptoms during the pandemic. It is also possible that implementation of social distancing measures have pushed people to consume drugs, such as alcohol, cannabis, and opioids, that evoke a sedative effect to cope with more time spent indoors in solitude (13). Finally, both rates of transmission and mortality from the SARS-CoV-2 virus has been higher among males than in females (14). Such critical differences in virus contraction and remission between both sexes could reflect differences in maladaptive coping strategies, such as, the consumption of substances, and subsequent poorer outcomes in mental health (15). Thus, in the current study, we stratified our analyses by sex to determine any group differences pertaining to the influence of substance use on mental health ratings.

In light of these results, the objective of the current study was to examine whether the frequency of substance use (e.g., alcohol, cannabis, and opiates) during COVID-19 significantly predicted ones' perceived mental health. We further considered whether life satisfaction and number of social confidants (i.e., the number of social connections one has maintained over the course of the pandemic) interacted with substance use to influence mental health ratings. In this cross-sectional study, we used the "Substance Use and Stigma During the Pandemic" dataset from the Canadian Perspective Survey Series 2021 from Statistics Canada (16). The use of this dataset allowed us to examine the influence of substance use on mental health in a large Canadian sample, with the aim of offering novel insight about the critical relationship between substance use and mental health within the context of COVID-19.

1.1. Link between substance use and perceived mental health

Past studies have established a significant association between substance use and mental health symptoms such as depression and anxiety [see (17) for review]. In the context of COVID-19, we hypothesized substance use to be a critical predictor of mental health as long periods of home confinement could have prompted individuals to consume substances as a means to cope with social isolation and loneliness (13, 18). In addition, limited

accessibility to legal, health and social services during national lockdowns in Canada may have further exacerbated the use of substances as coping mechanisms (19). It is also worthwhile to note that governing agents in many countries around the world, including Canada, deemed substances such as alcohol and tobacco as "essential commodities" to be sold during lockdowns (18). Thus, we believe that the unique social situation presented by COVID-19 could have encouraged a greater frequency of substance use among Canadians relative to pre-pandemic.

1.2. The role of life satisfaction and social confidants

In addition to assessing the influence of substance use on perceived mental health (outcome variable), we also sought to examine the interaction between life satisfaction (measured on a 11 point Likert-scale ranging from 0 to 10) and social confidants (measured as ordered levels with options "None", "One or two", "Three to five", "Six to nine", "Ten or more.") with substance use on our outcome. Prior research suggests that self-reported life satisfaction is measured in relative to one's global cognitive functioning and achievements obtained across a broad range of human activities at school, work, family, and social relations (20). Previous studies have reported life satisfaction to be a significant predictor of how well an individual optimally responds to life's stressors [(21, 22); see (23) for review]. Another social factor considered in our analysis was the number of family and friends an individual feels connected to during the pandemic, denoted as social confidants in the current study. Past studies support the view that imposed social isolation inflicts considerable psychological harm to people (24). Thus, it is beneficial for one to maintain social connections, even if it is virtual, to overcome the mental burden of social isolation (25). Thus, individuals who use substances in greater frequency, and as a result report poorer mental health ratings, might particularly benefit from social relations and having greater life satisfaction to alleviate mental distress.

1.3. Current study

In our current study, we hypothesized substance use (measured by frequency of alcohol, cannabis, and opioid use) to be negatively associated with one's subjective reporting of their mental health (outcome variable). That is, we were particularly interested in predicting whether an increase in the frequency of substance use, irrespective of the type of substance, resulted in an increase in the odds of reporting poorer mental health. On the other hand, we hypothesized greater life satisfaction and number of social confidants to increase the odds of reporting better mental health. Specifically, the influence of life satisfaction and social confidants on mental health was predicted to differ based on the frequency of substance use during the pandemic. Further, we stratified our analyses by sex and personal feelings of shame and guilt surrounding general substance use, since we predicted these variables to distinctively influence the association between

substance use and perceived mental health. Shame is conceptualized as an intense negative emotion resulting in feelings of inferiority and powerlessness (26). For example, past research suggests that in adults, shame has been strongly implicated in behaviors that allow individuals to escape feelings of loneliness and failure, such as, sexual risk-taking, binge eating, and substance use (26, 27). Another important distinction is that females seeking treatment for substance use face greater stigma than males, often risking the loss of intimate relationships, as well as the custody of children (28). Therefore, females who participate in treatment programs for substance use often experience enhanced shame and guilt compared to males (28). Further, there are critical sex differences between men and women at all stages of substance consumption, that is, at initial use, maintenance, withdrawal, and relapse [see (15) for review]. For example, women experience a stronger pleasurable response to drugs than men do, and are more likely to self-medicate than men. Whereas, men are more likely to use substances to engage in risky behavior or to be associated with a particular social group. Similarly, women tend to progress more rapidly than men from initial use, and are more prone to experience stronger withdrawal symptoms [See (15) for review]. The differences in the manner in which men and women initiate and sustain substance use could also distinctively influence mental health outcomes in both sexes. In light of these findings, we stratified our analyses by both sex and personal feelings of shame and guilt to detect any possible group differences on our outcome measure. Finally, education and employment status served as covariates in our model, as past research suggests these variables to be significant contextual social differences linked to mental health during the COVID-19 pandemic (12).

2. Materials and methods

2.1. Dataset

The current study used the "Canadian Perspectives Survey (CPSS) Series 6, 2021: Substance Use and Stigma During the Pandemic" dataset from Statistics Canada to examine whether substance use predicted mental health reporting (16). The data was collected from a cross-sectional survey administered to target residents (15 years of age or older) of the 10 Canadian provinces. The survey included questions on socio-economic background, mental health, social interactions, utilization of services, and the frequency of use of alcohol, cannabis, opioids, and non-prescription substances during the pandemic. The survey was distributed to a randomly selected population using stratified, multi-stage probability sampling design[1]. The original dataset

included a sample of 3,941 participants. Surveys with a missing response (i.e., "not stated") to covariate, independent, or dependent variables were omitted from the analysis, resulting in a final sample size of 3,790 (see notes under Table 1 for exclusion criteria).

The independent variables of the current study included education and employment status serving as covariates, and life satisfaction, number of social confidants, alcohol use, cannabis use, and opioid use, serving as predictors. Self-rating of perceived mental health was the outcome variable. Education, employment status, social confidants and substance use variables were recoded to reflect ordered levels. That is, for these variables, participants were grouped in an ordinal manner based on their responses. For example, participants who had never used opioids were coded as 0, participants who did not use opioids in the past 30 days were coded as 1 and were classified as past users, and respondents who answered "Yes" were current users, and they were coded as 2. Hence, these variables were ordinal in nature. Life satisfaction and self-rating of mental health were continuous variables.

2.2. Measures

2.2.1. Covariates

Covariates in the study were education and employment status. Each of the variables were measured using one survey question. Employment status was measured as a set of categories including "not employed", "employed and at work at least part of the reference week", "employed but absent from work for reasons not related to COVID-19", and "employed but absent from work due to COVID-19". Unemployment was coded as 0. "Employed but absent from work due to COVID-19" was coded as 1. "Employed but absent from work not due to COVID-19" was coded as 2. "Employed and at work" was coded as 3.

Education status was operationalized by five levels. The first level was coded as 0, it consisted of the group who obtained "less than high school diploma or its equivalent". The second level was coded as 1. It consisted of categories including "High school diploma or a high school equivalency certificate" and "Trade certificate or diploma". The third level was coded as 2. It consisted of people who obtained "College/CEGEP/other non-university certificate or diploma" or "University certificate or diploma below the bachelor's level". The fourth level was coded as 3, it consisted of people who obtained "Bachelor's degree (e.g., B.A., B.Sc., LL.B.)." The fifth level was coded as 4, it consisted of people who obtained "University certificate, diploma, degree above the BA level".

2.2.2. Predictors

Frequency of alcohol use was measured by one item that assessed how many times the individual had 5 or more drinks on one occasion in the past 30 days. The levels of this variable were "4 times a week or more", "2 or 3 times a week", "once a week", "2 to 3 times in the past 30 days", "Once in the past 30 days", "Not in the past 30 days". People who never had alcohol were

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[1]Persons living on reserves, Aboriginal settlements, and households in extremely remote areas with very low population density were excluded from the survey.

TABLE 1 Sample characteristics.

	Low Shame (*n* = 1698)	High Shame (*n* = 2092)
Stratification and Ordinal variables, *n* (%)		
Stratification variable		
Sex		
Male	608 (36%)	1,120 (54%)
Female	1,090 (64%)	972 (46%)
Covariates		
Employment		
Not employed	689 (41%)	830 (40%)
Employed but absent for reasons related to COVID	21 (1%)	38 (2%)
Employed but absent for reasons not related to COVID	43 (3%)	41 (2%)
Employed and at work	945 (56%)	1,183 (57%)
Education		
Less than high school	77 (5%)	104 (5%)
High school diploma or trade certificate	304 (18%)	393 (19%)
College or other non-university degree	545 (32%)	692 (33%)
University degree that is below Bachelor's or Bachelor's degree	504 (30%)	611 (29%)
Above Bachelor's degree	268 (16%)	292 (14%)
Predictors		
Alcohol use		
Non-user	655 (39%)	524 (25%)
Past user	783 (46%)	784 (37%)
Light user	169 (10%)	410 (20%)
Moderate user	47 (3%)	137 (7%)
Heavy user	44 (3%)	237 (11%)
Cannabis use		
Non-user	1,318 (78%)	1,384 (66%)
Past user	243 (14%)	253 (12%)
Light user	70 (4%)	151 (7%)
Moderate user	28 (2%)	129 (6%)
Heavy user	39 (2%)	175 (8%)
Opioid use		
Non-user	1,367 (81%)	1,603 (77%)
Past user	257 (15%)	346 (17%)
Current user	74 (4%)	143 (7%)
Number of social confidants		
None	55 (3%)	110 (5%)
1 or 2	543 (32%)	829 (40%)
3 to 5	692 (41%)	726 (36%)
6 to 9	238 (14%)	237 (11%)
More than 10	170 (10%)	154 (7%)
Continuous variables, *M* (*SD*)		
Predictor		
Life satisfaction	7.80 (2.11)	7.47 (2.23)
Outcome		
Perceived mental health	3.41 (1.01)	3.21 (1.07)

Note. Surveys with missing responses to any of the items of interest were excluded. The number of excluded responses for each item is as follows: alcohol use (*n* = 3), cannabis use (*n* = 2), opioid use (*n* = 4), social confidants (*n* = 1), life satisfaction (*n* = 3), perceived mental health (*n* = 7).

coded as 0. People who did not have 5 or more drinks in the past 30 days were classified as past alcohol users and were coded as 1. Participants who had 5 or more drinks once or two to three times in the past 30 days, were aggregated into one group (we classified this group as "light alcohol users") and were coded as 2. The group of moderate users included those who had 5 or more drinks once a week, and were coded as 3. Participants who had five or more drinks 2 or 3 times a week, or 4 times a week or more were classified to be heavy alcohol users and were coded as 4.

Frequency of cannabis use was measured by one item, which assessed how many days the individual had used cannabis in the past 30 days. The levels of this variable were "Never used cannabis", "No, not during the past 30 days", "1 day in the past 30 days", "2 or 3 days in the past 30 days", "1 or 2 days per week", "3 or 4 days per week", "5 or 6 days per week", "Daily." Participants who never used cannabis were given a code of 0. Participants who did not use cannabis in the past 30 days were coded as 1 and were classified as past cannabis users. Light cannabis users consisted of those who had cannabis either once, or two to three times, in the past 30 days. This group was coded as 2. Moderate cannabis users included those who used cannabis up to four days per week. They were coded as 3. Heavy cannabis users were those who used cannabis either five or six days per week or daily. They were coded as 4.

Opioids use in the past 30 days was measured by one item, which asked whether the individual had used drugs containing opioids, prescribed or not, in the past 30 days. The levels of this variable were "Yes", "Not during the past 30 days", and "Never used opioid products". Participants who had never used opioids were coded as 0. Participants who did not use opioids in the past 30 days were coded as 1 and were classified as past users. Respondents who answered "Yes" were current users, and they were coded as 2.

Number of social confidants was measured using one question which asked, "Approximately how many relatives and friends do you have who you feel close to, that is, who you feel at ease with and can talk to about what is on your mind?" The options included "None", "One or two", "Three to five", "Six to nine", "Ten or more." Each level was represented by a value from 0 to 4 that corresponded with increasing numbers of social confidants.

Life satisfaction was measured using one item "How do you feel about your life as a whole right now?" This variable was rated using a 11-point Likert scale, ranging from "0-very dissatisfied" to "10-very satisfied".

2.2.3. Stratification

We stratified our data by sex (i.e., groups of males and females). We also stratified the dataset by shame. Shame was measured on the basis of agreeing to the following statements about substance use in general: "Problem with alcohol/drugs, embarrassed to tell friends/family", "Alcohol/drug problem, embarrassing to seek help/treatment", "Embarrassing to tell friends/family about my alcohol/drug use", "Embarrassing to seek help/treatment for my alcohol/

drug use", "Scared how people will react if they find out about my alcohol/drug use", and "Need to hide my problems with alcohol/drugs from my friends/family". These items were rated using a Likert scale. Cronbach's alpha between these items was 0.82; indicating good internal consistency among the items for the construct (shame) measured (29). An average composite score was calculated for each individual. Using a median split, people who scored above the median was classified as "high shame", and anyone who scored below the median was classified as "low shame".

2.2.4. Outcome

The outcome of our analytical model was perceived mental health. This was measured using the question: "In general, how would you describe your mental health?" This variable was rated using a 5-point Likert scale, from 0 to 4, with higher values indicating better mental health.

2.3. Statistical analysis

We stratified our sample by sex and feelings of shame towards general substance use and conducted an ordered logistic regression analysis to assess whether frequency of substance use influenced mental health differentially across these groups. We added variables of interest into our model in a hierarchical manner. In the first step, employment, education, and the frequency of alcohol, cannabis, and opioid use were entered into the model. In the second step, we sought to assess the association between social confidants and life satisfaction with our outcome measure, while controlling for the covariates and substance use variables. In the third step, we entered interaction terms between each substance use variable and social determinants of well-being to evaluate whether life satisfaction and social confidants interacted with substance use to influence mental health.

All models were estimated using the "*polr*" function in the MASS package [version 7.3.57 (30);] using R 4.1.3 (31). Statistical tests were performed to test the assumptions of ordinal regression. Multicollinearity between independent variables was examined by computing inter-variable correlations and variance inflation factors (VIF). All VIF values of the predictor variables fall below 2, indicating low multicollinearity. The assumption of proportional odds was tested using a $\chi 2$ test using the "*vglm*" function from the VGAM package [version 1.1.6 (32);]. Separate models were created with and without the proportional odds assumption. The deviances and degrees of freedom of the models were entered into a $\chi 2$ test. The result indicated that there was not a significant difference between the Akaike information criterion of the models. Thus, the proportional odds assumption was not violated.

3. Results

3.1. Sample descriptives

The sample was stratified by sex and feelings of shame towards substance use. Thus, resulting in groups of females with high

shame, females with low shame, males with high shame and males with low shame (see Table 1 for demographic characteristics). Parallel analyses were run for each group.

3.2. Ordered logistic regression results

3.2.1. People reporting lower levels of shame towards substance use

3.2.1.1. *Males*

For males reporting low levels of shame towards general substance use, only cannabis use was significantly associated with mental health (Step 1; see Table 2). That is, increase in one level of frequency of cannabis use was associated with a 24% increase in the odds of reporting poorer mental health (OR = 0.76, *p* = .002). Opioid and alcohol use did not significantly correlate with mental health reporting (*ps* > .122; *ps* > .391 respectively) for males exhibiting low shame towards substance use. In Step 2 of our analyses, we entered life satisfaction and social confidants to examine their influence on our outcome measure, above and beyond education, employment status, and frequency of substance use. Life satisfaction significantly correlated with mental health, such that one unit increase in life satisfaction was associated with 2.14 times increase in the odds of reporting better mental health, *p* < .001. Number of social confidants was also significantly associated with better mental health reporting (OR = 1.61, *p* < .001). As in Step 1, an increase in the frequency of cannabis use (OR = 0.80, *p* = .016) was significantly associated with increased odds of poorer mental health reporting, and this pattern was not true for both alcohol and opioid intake. In Step 3 of our analyses, we probed for the interaction between life satisfaction and social confidants with frequency of substance use on one's perceived mental health. The interaction terms between life satisfaction and the various substances were not significant for this sub-group (see Step 3 in Table 2). However, the association between life satisfaction and social confidants with mental health reporting remained to be highly significant in Step 3 (OR = 2.25, *p* < .001 for life satisfaction; OR = 1.53, *p* = .001 for social confidants), as in Step 2.

3.2.1.2. *Females*

For females reporting low levels of shame towards general substance use, cannabis and opioid use significantly correlated with mental health (see Table 2). Increase in one level of frequency in cannabis use was associated with 24% increase in the likelihood of reporting poorer mental health (OR = 0.76, *p* < .001). Increase in one level of opioid use was associated with 30% increase in the likelihood of reporting poorer mental health (OR = 0.70, *p* = .001). Step 2 of this model revealed that, accounting for substance use and the covariates, higher levels of life satisfaction and social confidants were associated with increased odds of reporting better mental health (life satisfaction: OR = 2.20, *p* < .001; social confidants: OR = 1.35, *p* < .001). As in Step 1, both cannabis and opioid use remained to be significantly associated with mental health reporting

TABLE 2 Regression model for people reporting low feelings of shame towards substance use.

Predictors	Males			Females		
	OR	95% CI	p	OR	95% CI	p
Step 1	R^2 Nagelkerke = 0.042			R^2 Nagelkerke = 0.039		
Employment	0.87	0.79–0.97	**0.009**	0.88	0.81–0.95	**0.001**
Education	1.14	1.00–1.30	**0.043**	1.06	0.95–1.17	0.307
Alcohol use	1.07	0.92–1.25	0.391	1.07	0.94–1.22	0.291
Cannabis use	0.76	0.64–0.90	**0.002**	0.76	0.66–0.87	**<0.001**
Opioid use	0.80	0.59–1.06	0.122	0.70	0.57–0.86	**0.001**
Step 2	R^2 Nagelkerke = 0.481			R^2 Nagelkerke = 0.481		
Employment	0.84	0.76–0.94	**0.002**	0.88	0.81–0.95	**0.001**
Education	1.13	0.98–1.29	0.089	0.95	0.85–1.06	0.388
Alcohol use	1.04	0.88–1.22	0.674	1.06	0.93–1.21	0.398
Cannabis use	0.80	0.67–0.96	**0.016**	0.77	0.67–0.89	**<0.001**
Opioid use	0.75	0.55–1.02	0.070	0.77	0.62–0.96	**0.018**
Life satisfaction	2.14	1.94–2.36	**<0.001**	2.20	2.04–2.38	**<0.001**
Social confidants	1.61	1.36–1.90	**<0.001**	1.35	1.20–1.52	**<0.001**
Step 3	R^2 Nagelkerke = 0.482			R^2 Nagelkerke = 0.484		
Employment	0.85	0.76–0.94	**0.003**	0.88	0.81–0.95	**0.001**
Education	1.13	0.98–1.30	0.085	0.95	0.85–1.06	0.356
Alcohol use	1.54	0.70–3.32	0.277	1.02	0.56–1.85	0.951
Cannabis use	0.73	0.37–1.39	0.346	0.37	0.19–0.69	**0.002**
Opioid use	0.97	0.22–4.08	0.970	0.91	0.41–1.93	0.801
Life satisfaction	2.25	1.97–2.57	**<0.001**	2.16	1.96–2.38	**<0.001**
Social confidants	1.53	1.19–2.97	**0.001**	1.30	1.09–1.56	**0.004**
Alcohol*Life satisfaction	0.94	0.86–1.03	0.207	1.00	0.92–1.07	0.895
Alcohol*Social confidants	1.04	0.88–1.24	0.618	1.04	0.91–1.19	0.545
Cannabis*Life satisfaction	1.02	0.94–1.11	0.676	1.09	1.01–1.18	**0.031**
Cannabis *Social confidants	0.97	0.82–1.15	0.763	1.05	0.90–1.23	0.511
Opioid*Life satisfaction	0.96	0.81–1.14	0.607	0.99	0.90–1.10	0.860
Opioid*Social confidants	1.06	0.78–1.46	0.694	0.95	0.77–1.18	0.650

(Cannabis: OR = 0.77, $p < .001$; Opioid: OR = 0.77, $p = .018$). In step 3 of this model, we also observed a significant relationship between cannabis use (OR = 0.37, $p = .002$), life satisfaction (OR = 2.16, $p < .001$), and social confidants (OR = 1.30, $p = .004$) with mental health. Importantly, life satisfaction significantly interacted with cannabis use to influence mental health ratings, OR = 1.09, $p = .031$. Tests of simple slope at each level of cannabis use revealed that the positive association between life satisfaction and mental health ratings increased sequentially as a function of greater cannabis consumption (see Figure 1). The odds ratios of life satisfaction was 2.16 for people who never used cannabis [95% CI (1.96, 2.38), $p < .001$], 2.35 for previous users of cannabis [95% CI (2.09, 2.64), $p < .001$], 2.56 for light users [95% CI (2.16, 3.04), $p < .001$], 2.79 for moderate users [95% CI (2.19, 3.55), $p < .001$], and 3.04 for heavy users (95% CI [2.22, 4.16], $p < .001$. No other interaction terms were significant.

FIGURE 1
Odds ratio of life satisfaction predicting self-reported mental health at each level of cannabis use for females reporting low shame surrounding substance.

3.2.2. People reporting higher levels of shame towards substance use
3.2.2.1. Males
For males reporting high levels of shame towards general substance use, alcohol, cannabis, and opioid use were significantly associated with mental health (see Table 3). Increase in one level of frequency of alcohol use was associated with a 15% increase in
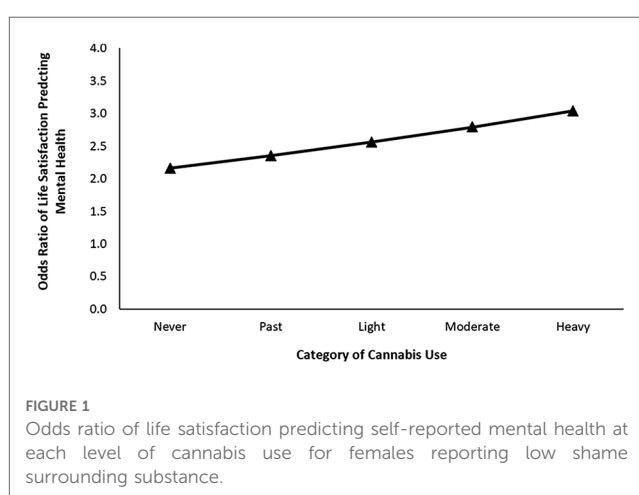
the odds of reporting poorer mental health (OR = 0.85, $p < .001$). Increase in one level of frequency of cannabis use was associated with a 25% increase in the odds of reporting poorer mental health (OR = 0.75, $p < .001$). One level increase in frequency of opioid use was associated with 33% increase in disclosing poorer mental health (OR = 0.67, $p < .001$). Accounting for substance use and the covariates in Step 2 of this model, life satisfaction and

TABLE 3 Regression model for people reporting high feelings of shame towards substance use.

Predictors	Male			Female		
	OR	95% CI	*p*	OR	95% CI	*p*
Step 1	R^2 Nagelkerke = 0.093			R^2 Nagelkerke = 0.061		
Employment	0.92	0.85–0.99	**0.028**	0.95	0.87–1.03	0.181
Education	1.03	0.93–1.14	0.557	1.00	0.90–1.11	0.960
Alcohol use	0.85	0.78–0.92	**<0.001**	0.94	0.85–1.04	0.244
Cannabis use	0.75	0.69–0.82	**<0.001**	0.76	0.69–0.83	**<0.001**
Opioid use	0.67	0.55–0.82	**<0.001**	0.71	0.59–0.86	**<0.001**
Step 2	R^2 Nagelkerke = 0.478			R^2 Nagelkerke = 0.515		
Employment	0.89	0.82–0.96	**0.003**	0.92	0.84–1.00	**0.049**
Education	1.02	0.92–1.13	0.752	0.92	0.82–1.03	0.172
Alcohol use	0.90	0.83–0.99	**0.024**	0.94	0.84–1.04	0.225
Cannabis use	0.77	0.71–0.84	**<0.001**	0.79	0.72–0.87	**<0.001**
Opioid use	0.83	0.67–1.02	0.071	0.89	0.73–1.08	0.246
Life satisfaction	2.03	1.89–2.17	**<0.001**	2.09	1.94–2.26	**<0.001**
Social confidants	1.29	1.14–1.46	**<0.001**	1.53	1.34–1.75	**<0.001**
Step 3	R^2 Nagelkerke = 0.480			R^2 Nagelkerke = 0.520		
Employment	0.89	0.82–0.96	**0.003**	0.92	0.85–1.00	0.061
Education	1.01	0.91–1.12	**0.829**	0.92	0.82–1.03	0.141
Alcohol use	0.81	0.58–1.11	0.189	0.66	0.45–0.97	**0.037**
Cannabis use	0.73	0.52–1.01	0.061	0.77	0.55–1.08	0.134
Opioid use	0.60	0.28–1.25	0.186	0.76	0.39–1.45	0.406
Life satisfaction	1.93	1.75–2.14	**<0.001**	2.04	1.83–2.27	**<0.001**
Social confidants	1.32	1.08–1.61	**0.007**	1.34	1.08–1.67	**0.009**
Alcohol*Life satisfaction	1.02	0.98–1.06	0.322	1.03	0.99–1.09	0.174
Alcohol*Social confidants	0.97	0.88–1.08	0.615	1.05	0.94–1.18	0.361
Cannabis*Life satisfaction	1.02	0.97–1.06	0.500	1.00	0.96–1.05	0.885
Cannabis *Social confidants	0.97	0.88–1.07	0.517	1.00	0.89–1.11	0.936
Opioid*Life satisfaction	1.00	0.91–1.11	0.963	0.96	0.88–1.05	0.384
Opioid*Social confidants	1.20	0.96–1.51	0.104	1.28	1.03–1.59	**0.027**

social confidants significantly predicted better mental health. Specifically, the odds of reporting better mental health were 2.03 times higher for each unit increase in life satisfaction (OR = 2.03, *p* < .001). While, the odds of reporting better mental health were 1.29 times higher for each unit increase in social confidants (OR = 1.29, *p* < .001). Moreover, both alcohol (OR = 0.90, *p* = .024) and cannabis (OR = 0.77, *p* < .001) remained to be significantly correlated with mental health reporting as in Step 1; however, opioid use was no longer significantly associated with our outcome. In Step 3 of this model, life satisfaction (OR = 1.93, *p* < .001) and social confidants (OR = 1.32, *p* = .007) also significantly correlated with one's perceived mental health. Contrary to our prediction, the social determinants of well-being did not significantly interact with substance use to influence mental health rating for this sub-group.
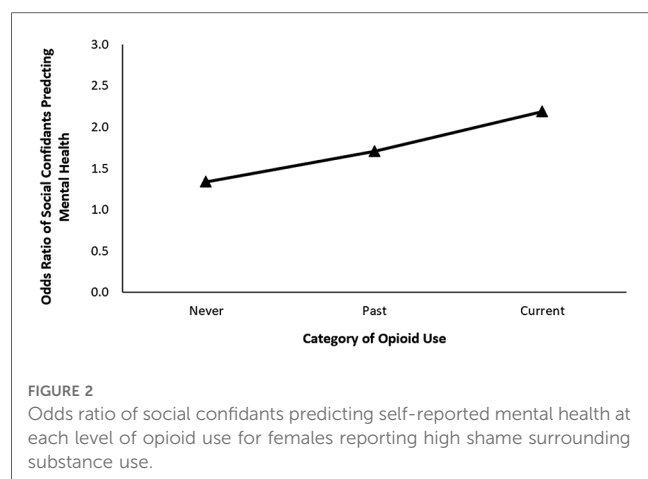
3.2.2.2. Females

For females reporting high levels of shame towards substance use in general, increase in frequency of cannabis use was significantly associated with 24% increase in the odds of reporting poorer mental health (OR = 0.76, *p* < .001). Increase in one level of frequency of opioid use was also significantly associated with 29% increase in the odds of reporting poorer mental health (OR = 0.71, *p* < .001). Alcohol did not significantly influence mental health (*p* = .244). Controlling for substance use and the covariates in Step

2 of our model, higher ratings of life satisfaction (OR = 2.09, *p* < .001) and social confidants (OR = 1.53, *p* < .001) were significantly associated with increased likelihood of reporting better mental health ratings. Cannabis remained to be significantly associated with mental health scores (OR = 0.79, *p* < .001), but not opioid use (*p* = .246). In Step 3, we also observed that life satisfaction (OR = 2.04, *p* < .001) and social confidants (OR = 1.34, *p* = .009) were significantly correlated with the outcome measure. Importantly, social confidants significantly interacted with opioid use to influence mental health, OR = 1.28, *p* = .027. That is, for females who reported higher feelings of shame towards substance use, we found the greatest association between social confidants and mental health ratings in current opioid users, in comparison to past and non-users (see Figure 2). Specifically, the odds of ratio of social confidants increased from 1.34 [95% CI (1.08, 1.67), *p* = .009] for those who never used opioids, to 1.71 [95% CI (1.32, 2.23), *p* < .001] for previous users, and 2.19 [95% CI (1.41, 3.37), *p* < .001] for current users.

4. Discussion

The COVID-19 pandemic has had a profound influence on the social, economic, and health policies governing the Canadian

FIGURE 2
Odds ratio of social confidants predicting self-reported mental health at each level of opioid use for females reporting high shame surrounding substance use.

population (11). Government restrictions put in place to contain the transmission of the virus have isolated individuals both physically and socially from family, friends, and other social support networks, resulting in feelings of loneliness and psychological distress (3). Further, past work has shown a global increase in recreational drug use during the COVID-19 pandemic (12). However, to date, there are limited studies examining the influence of substance use on the mental health ratings of a large Canadian sample during COVID-19, especially considering the correlates of well-being such as life satisfaction and social confidants. The current study addressed these research gaps by analyzing the "Canadian Perspectives Survey (CPSS) Series 6, 2021: Substance Use and Stigma During the Pandemic" dataset from Statistics Canada to examine the influence of substance use on mental health (16). Specifically, we examined whether substance use measured by frequency of alcohol, cannabis, and opioids use significantly predicted one's subjective reporting of mental health. In line with previous studies, we found that greater substance use was significantly associated with increased odds of reporting poorer mental health [(33); see (17) for review], for both males and females. Specifically, for males reporting low levels of shame towards substance use, we observed that only greater use of cannabis was significantly associated with poorer mental health. Further, greater life satisfaction and number of social confidants were associated with increased odds of reporting better mental health as suggested by past work (25), but did not significantly interact with substance use to influence mental health ratings. For females disclosing low shame surrounding substance use, greater use of cannabis and opioid significantly correlated with higher odds of reporting poorer mental health. Critically, our results revealed a significant interaction between life satisfaction and substance use in predicting mental health ratings. We found that as frequency of cannabis use increased, life satisfaction has a much greater positive association with mental health. Such a significant finding found only in females, but not in males, highlights a critical sex difference when considering the benefit of social and contextual factors on mental health. For males reporting high levels of shame, greater frequency of alcohol, cannabis, and opioid use

were all significantly associated with greater odds of reporting poorer mental health. Moreover, both life satisfaction and social confidants did not significantly interact with substance use to predict mental health rating for this sub-group. For females reporting high shame, we found that greater frequency of cannabis and opioid use were associated with increased odds of reporting poorer mental health. Importantly, in this sub-group, maintaining social relations was particularly important to benefit the mental health of current users of opioids, relative to past and non-users.

As this was one of the few studies examining the influence of life satisfaction and social confidants on the association between substance use and mental health ratings during the context of COVID-19, we find it is critical to note that in females, social determinants exerted a greater influence on mental health than in males. This finding bolsters evidence to previous results suggesting differences in coping strategies used by both men and women (34). For example, past work shows that women experience internalizing symptoms such as feelings of despair, loneliness, and helplessness associated with mental health disorders (34). Whereas, males are shown to exhibit externalizing symptoms like excessive verbal and/or physical aggression, and involvement in socially deviant behaviors (34). We suggest that in females, the presence of greater social support and life satisfaction are important to diminish the internalizing symptoms associated with mental health disorders. Although in males, social determinants (life satisfaction and social confidants) failed to interact with substance use to influence mental health ratings in our data, we do believe social contextual correlates are still an important area of investigation for males. Future work should identity other critical constituents like family dynamic, parenthood, and occupation, predicted to greatly influence mental health of males (35).

The current study has a few limitations, mainly stemming from the lack of data that was available to us by Statistics Canada. First, no data was available on the purpose and nature of substance use. The substance use could be prescribed or un-prescribed. We acknowledge that the purpose, context, and nature of substance use can play a role in its relation to mental health. Similarly, data was only collected in participants aged 15 and up, and in the overall sample, only a few reported use of multiple substances, thus limiting our analyses from examining the influence of poly-drug use on perceived mental health. Future studies should assess how the use of multiple substances (i.e., poly drug use) may have an additive influence on mental health relative to the use of only one substance. The findings of the current study merely focused on the relation between the use of opioids, alcohol, and cannabis and mental health; thus, limiting the applicability of our findings to other types of substances. However, it is important to note here that these drugs are most commonly abused worldwide, and in Canada, due to its accessibility from commodification (36). Finally, shame surrounding substance use was measured as a general feeling towards the use of any substance. Therefore, we do not know whether self-reported ratings of shame would differ in relation to a particular type of substance use.

The results of the current study should be taken into consideration when evaluating the influence of substance use on mental health in males and females when developing treatment programs. It is critical that intervention programs direct attention to social determinants of mental health such as life satisfaction and the social network of the person who is under the influence of substances, to gain a comprehensive assessment of factors affecting one's mental health. Given that the transmission of COVID-19 continues to be a global health concern, the findings of this study offers valuable insight into areas that should receive attention from health and policy makers in order to reduce the mental health distress faced by the Canadian population. Specifically, we suggest investments into social services that offer resources at an individual level, such as career workshops, and focus groups that may help one to regain self-control and agency in their life and consequently report greater life satisfaction in the midst of an economic crisis (20). For example, females who express shame towards substance use may particularly benefit from social groups that will offer both social support and tangible resources to seek help and overcome maladaptive patterns of substance use. In addition, we also recommend community-building activities that instill a sense of social connection even in the presence of physical distancing. In conclusion, the results of this current study revealed that greater frequency of substance use was associated with poorer mental health ratings in both men and women; and crucially, at higher levels of substance use, the positive influence of life satisfaction and social confidants on mental health increased only for females.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: https://doi.org/10.17605/OSF.IO/APMQS.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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A national-level examination of First Nations peoples' mental health data: Predicting mental well-being from social determinants of health using the 2017 Aboriginal Peoples Survey

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Introduction: A history of colonization and assimilation have resulted in social, economic, and political disparities for Indigenous people in Canada. Decades of discriminatory policies (e.g., the Indian Act, the Residential School System) have led to numerous health and mental health inequities, which have been intergenerationally maintained. Four main social determinants of health (i.e., income, education, employment, and housing) disproportionately influence the health of Indigenous peoples. These four social determinants have also been used within the Community Well-Being (CWB) index, which assesses the socio-economic wellbeing of a community. This study sought to extend previous research by assessing how specific indicators of CWB predict self-reported mental wellbeing within First Nations populations across Canada in a national dataset with more recent data.

Methods: This study utilized the 2017 Aboriginal Peoples Survey, which includes data on the social and economic conditions of First Nations people living off reserve aged 15 years and over.

Results: Results from a factorial ANOVA indicated that perceptions of income security, housing satisfaction, higher education, and employment are associated with increased self-reported mental health among First Nations individuals living off-reserve.

Discussion: These results support the idea that individual mental health interventions on their own are not enough; instead, broader social interventions aimed at addressing inequities in various social determinants of health (e.g., housing first initiatives) are needed to better support individual wellbeing.

KEYWORDS

social determinants of health, Indigenous mental well-being, First Nations mental well-being, Aboriginal Peoples Survey, Community Well-Being Index

1. Introduction

Indigenous[1] populations in Canada experience a disproportionate burden of ill health and social challenges than non-Indigenous populations in Canada (1). Health *disparities* are indicators of a relative disproportionate burden of health conditions on a particular population (1). Widespread disparities in morbidity, mortality, and chronic diseases (e.g., diabetes, arthritis, and high blood pressure) exist between Indigenous and non-Indigenous populations (1, 2). Disparities also exist in social challenges (sometimes called diseases of despair), with higher rates of suicide and self-injury (2), and family violence, sexual abuse, and addiction for Indigenous populations in Canada (1).

Health *inequities* are the underlying mechanisms of such health disparities, which are rooted in social, economic, cultural, and political imbalances (1). Reading and Wien's (3) *Social Determinants Model of Aboriginal Health* was put forward to better understand how health disparities are related to various social determinants of health. This model examines social determinants of health for Indigenous populations within the socio-political context that they were established in. Contrary to other social determinants of health frameworks, Reading and Wein embrace a holistic model of health, which highlights the interrelatedness of physical, spiritual, emotional, and mental dimensions and contrasts with a "silo" approach to prevention and treatment that is commonly found in non-Indigenous health literature (3). This model demonstrates how inequities in social determinants of health can lead to additional burdens of health problems over the life course, but also how health problems themselves can perpetuate conditions (or determinants) that further impact health.

1.1. Distal determinants of health

Distal determinants of health include the historic, political, social, and economic contexts that influence a wide range of health vulnerabilities, capacities, and behaviors (3). While distal determinants are noted to have the most wide-reaching influence on health, they are often the most difficult to intervene on because they represent the context in which intermediate (e.g., community infrastructure and resources, social systems) and proximal (e.g., direct impacts on health, such as health behaviors and physical environments) determinants exist (3).

Among studies of First Nation health, colonialism is a commonly cited distal determinant of health and wellbeing within these populations (3, 4). Such practices include the use of colonial institutions (e.g., the Canadian government) and systems (e.g., residential schools) that were imposed upon Indigenous peoples with culture and lifestyles disrupted in various ways (e.g., the seizure of land, banning of languages, persecution of spiritual practices, and disruption of cultural values and identity (5)).

Experiences of colonization have produced political, economic, and social inequalities *via* the construction of unfavorable intermediate and proximal determinants (3), which are often beyond the individual or community's control or means to intervene upon (4).

Additional distal determinants include racism and social exclusion, as well as self-determination (3). Constructed social stratifications along "racial" lines have subsequently led to inequitable distribution of resources, power, control, and freedom. Unequal distribution of such resources can increase exposure to health damaging intermediate and proximal determinants, which in turn increases vulnerability to illness and creates further barriers for addressing health issues. Self-determination similarly influences intermediate and proximal determinants (e.g., education, housing, and health opportunities), ensuring that Indigenous peoples participate in political decision making and have control over their lands, economies, education systems, and health systems (3). Self-determination of land claims, economic decisions, and self-governance structures have been described to be more common among First Nation communities with higher wellbeing scores (6), and self-determined treaty rights have been associated with higher community income (7).

1.2. Intermediate determinants of health

Intermediate determinants of health are constructed by the distal determinants and can be thought of as the source or foundation of proximal determinants (3). For Indigenous peoples in Canada, intermediate determinants include health care systems (e.g., limited culturally- and contextually-appropriate services), educational systems (e.g., underfunded programming), community infrastructure and capacities (e.g., inadequate social resources), environmental stewardship (e.g., inabilities to benefit from the profits of resource extraction), and cultural continuity (e.g., traditional intergenerational connectedness with language and spirituality). Examples of how intermediate determinants impact proximal determinants include: deleterious physical environments rooted in limited community resources; and barriers to developing health promoting behaviors due to inequitable health care (3).

1.3. Proximal determinants of health

Proximal determinants of health are the conditions that directly impact physical, emotional, mental, and/or spiritual health (3). These determinants include: health behaviors (e.g., misuse of alcohol, excessive smoking); physical environments (e.g., housing shortages and poor quality of existing homes); employment and income (e.g., scarce economic opportunities and community resources); education (e.g., poor literacy); and food insecurity (e.g., compromised diets when food is no longer available or of poor nutritional quality). While each of these determinants are important, education, employment, income, and housing have been highlighted often within the literature because of their inclusion in the Community Well-Being (CWB) Index of Canada (8, 9). The CWB is described in further detail below following a review of these key social determinants.

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1 The terminology used to describe Indigenous populations matches the terminology referenced in the literature cited. Various terms cannot be used interchangeably. For example, the term "Indigenous" in Canada represents distinct groups of people including First Nations, Inuit, and Métis populations.

1.3.1. Education

Indigenous populations are less likely to complete high school and post-secondary education than non-Indigenous populations (8, 10). The largest gaps in levels of high school completion and completion of a university degree occur between First Nations individuals living on reserve and Inuit when compared to non-Indigenous populations (10). Completing a formal education (i.e., at the high school level or above) ensures individuals learn the literacy and numeracy skills needed to participate in society and access the benefits they are entitled to (10). Post-secondary educational attainment has been associated with increased employment rates and income (11). In contrast, low rates of youth engagement in education, low literacy levels, and low numeracy levels have been listed as indicators of poverty (12). Low levels of educational attainment have also been associated with various health outcomes [e.g., type 2 diabetes prevalence (8)].

1.3.2. Employment

Indigenous populations have lower employment rates than non-Indigenous populations in Canada (8, 10). This differs between Indigenous groups, with First Nations individuals living on reserve and Inuit having lower employment rates than First Nations individuals living off reserve and Métis individuals (10). Unemployment has been closely linked with greater risks of chronic diseases, cardiovascular mortalities, and mental health challenges (13–15).

1.3.3. Income

Indigenous populations are more likely to have lower income and higher poverty rates than non-Indigenous populations (8, 10). The gap in median income for the working age population (aged 25–64) is largest for First Nations individuals living on reserve, whose median income is less than half of that of the non-Indigenous population. Registered First Nations individuals living off reserve and Inuit have median incomes that are about 75–80% of that of the non-Indigenous population, while Métis have a median income similar to that the non-Indigenous population (10). The relationship between income and health-related outcomes is well-established: the poorer one is, the more likely they are to experience health risks in daily life (16). Key health risks that have been found for individuals with lower income include: higher rates of smoking and reporting multiple chronic conditions, as well as lower rates of physical activity and inadequate fruit and vegetable intake (16). Individuals with lower income are also less likely to receive quality health care (e.g., reduced routine screenings, such as for cervical or colorectal cancer; reduced access to prescription medical insurance; increased visits to the emergency department (16)). In addition, individuals with lower income are more likely to have worse health outcomes, such as increased rates of hospitalization for conditions that could be managed outside the hospital (16).

1.3.4. Housing

Indigenous populations are more likely to live in inappropriate housing conditions (8). In 2016, close to one-fifth (18.3%) of the Indigenous population in Canada lived in housing that was overcrowded (i.e., dwellings that have more than one person per room (10)). The percentage of overcrowding varies drastically between Indigenous groups, with crowded dwellings being less common among First Nations individuals living off reserve and Métis individuals. In contrast, crowding is more common for First Nations individuals living on reserve and Inuit (10). As well, in 2016, close to one-fifth (19.4%) of Indigenous people in Canada lived in a dwelling that needed major repairs (17). Again, First Nations individuals living on reserve and Inuit had the largest percentages of dwellings in need of major repair (10). Inappropriate housing conditions have been associated with a variety of health issues (8, 18). For example, exposure to indoor dampness and mold has been associated with respiratory conditions, exposure to excessively low indoor temperatures for long periods of time has been associated with cardiovascular diseases, exposure to dwellings with features likely to cause an accident has been associated with physical injuries, and exposure to overcrowding has been associated with the spreading of infections such as tuberculosis (18). Poor housing can also induce chronic stress with symptoms of anxiety, depression, hostility, and frustration, and exposure to lead-based paint (commonly found in poor housing) can lead to various cognitive, developmental, neurological, and behavioral effects (18).

1.4. The Community Well-Being Index

To better conceptualize the disparities in these proximal determinants specifically between First Nations communities and other communities in Canada, McHardy and O'Sullivan developed the Community Well-Being (CWB) Index (9). The CWB summarizes four community level indicators: education, labor force, income, and housing. Scores range from 0 to 1, (with higher scores indicating greater wellbeing in each of these domains) and provide a quantitative comparator of First Nations communities and non-Indigenous communities. Such standardization allows for examination of variability in well-being within communities to be assessed and compared and also allows for trends in well-being to be tracked over time by examining if scores are improving, declining, or remaining stable (19).

There is a striking inequity among CWB scores of First Nations and non-Indigenous Canadian communities in Canada, which continues to persist across five-year iterations of CWB analyses. While the average CWB score for First Nations communities has been steadily increasing over the 35 years that CWB scores were being indexed (i.e., starting in 1981 and analyzed in 2016), a substantial gap was found in 2016 between CWB scores of First Nations and non-Indigenous communities. That is, the average CWB score for First Nations communities was 19.1 points lower than the average for non-Indigenous communities (20). Gaps in each CWB component (i.e., education, labor force, income, and housing) have remained relatively stable across time, and even where the gaps have been documented to be narrowing (e.g., education, employment, and income), they still remain wide. Overall, these socio-economic gaps between First Nations and non-Indigenous communities are significant in size and longstanding across cycles of the CWB Index (20).

Research has examined how the CWB Index relates to reports of personal (in contrast to community) well-being. For example, Wingert and White (21) examined the relationship between First Nations communities' CWB total scores and subjective dimensions of individual well-being. CWB total scores were calculated using

community level data from the Census of Canada and subjective reports of individual well-being were assessed *via* telephone surveys. Personal well-being scores were reported from 1,274 individuals. Results indicated that those in lower CWB communities more strongly agreed to feeling sad or depressed, and to having no hope for the future. Those in higher CWB communities most strongly agreed to having control over things in their lives. As well, respondents in communities with higher CWB scores most strongly agreed that they were a good person and that they were a person of worth. The authors highlighted that these patterns fit with the expectation that higher CWB communities better support the wellbeing of residents. However, this study did not examine the specific relationships between individual CWB indicators (i.e., education, employment, income, and housing) and wellbeing variables, leaving a gap in the literature in need of further explanation. The authors also highlighted that the study may be limited by low response rates and the possible systematic differences within the sample (e.g., an overrepresentation of university-educated individuals, an underrepresentation of individuals without access to a telephone) and suggested that results should be corroborated with those from other datasets, such as the Aboriginal Peoples Survey (APS) (21).

1.5. Study purpose and hypotheses

The purpose of the present study is to provide a more recent investigation into how indicators from the CWB framework (i.e., education, employment, income, and housing) predict subjective mental health reports for First Nations individuals in national-level, population data from the APS 2017 survey. This is the first study to our knowledge that examines this relationship between specific indicators of CWB and subjective wellbeing *via* the 2017 APS dataset. It is hypothesized that increased access to higher levels of each the four proximal determinants of health (i.e., education, employment, income, and housing) will significantly and positively predict self-reported mental wellbeing. Age, sex, and place of residence will also be examined in this model as control variables as these variables have been found to impact mental health outcomes (e.g., younger First Nations adults are more likely to speak with a professional regarding mental health concerns than older adults (22); being female is predictive of meeting criteria for various mental disorders (23); and distress scores are higher in remote communities than in urban communities (22)).

2. Methods

2.1. Use of population-level data to explore mental well-being predictors

The 2017 APS provides an opportunity to explore the relationships between social determinants of health and self-reported mental health among various communities of Indigenous people in Canada. The 2017 APS was the fifth iteration of a cross-sectional survey of Indigenous health outcomes, sociodemographic information, social determinants of health, and other variables, for First Nations individuals living off-reserve, as well as for Métis and Inuit individuals living in Canada. This cycle was conducted between January 16, 2016

and August 15, 2017 (24). Questions in the APS 2017 were designed for and administered in a Computer Assisted Interviewing (CAI) environment, which allows for more complex questionnaire flow as well as real-time edits when logical inconsistencies between questions are detected. Computer assisted telephone interviews and computer assisted personal interviews were used for this survey (25). The 2017 APS Public Use Microdata File (PUMF) was publicly accessed online for this study. As this data file is provided to a much wider range of users than the 2017 APS analytic file (available through Statistics Canada's Research Data Centers), the level of detail is not as fine as that of the analytic file. Actions have been taken to reduce or eliminate the risk of disclosure on the PUMF, including limiting the geographic detail available on the PUMF and limiting the amount of family and household information available on the PUMF. Additional actions to lessen risk of disclosure can be found in the APS 2017 User's Guide to the PUMF (24).

2.2. Participants

Participants were selected from survey respondents of the APS (2017) aged 15 years or older. Individuals who responded, "First Nations" to the survey item "Are you First Nations, Métis, or Inuk?" were included in the present analyses. Relevant participant demographic information obtained from the APS 2017 is included in Table 1.

2.3. Variables from the 2017 APS dataset

2.3.1. Demographics

Age, sex, and place of residence variables (Table 1) were obtained from the APS 2017. Age was reported in terms of the age group that the respondent belonged to as of the survey reference date (i.e., January 15th, 2017). Categories included between the ages of 15–18, 19–24, 25–34, 35–44, 45–54, and 55 and over. Sex of the respondent was collected and coded as either Male or Female. Place of residence indicated whether the person was living in a Census Metropolitan Area (CMA), other population center, or other rural area. A CMA is formed when one or more adjacent municipalities are centered on a population center (i.e., the core). A CMA has a total population of at least 100,000, of which 50,000 or more live in the core. CMAs are counted as large population centers (100,000 or more people), while other population centers include medium population centers (30,000–99,999 people) and small population centers (1,000–29,999 people). The "Other rural area" category includes all areas outside of population centers (i.e., areas with less than 1,000 people), which are collectively defined as rural areas (24). For the present analysis, place of residence was coded as 0 indicating "Small population center—1,000–29,999," 1 indicating "Medium population center—30,000–99,999," and 2 indicating "Large population center—100,000 or more."

2.3.2. Mental wellbeing

Self-reported mental health was used directly from the APS. Participants rated mental health on a five-point Likert-type scale, ranging from "Poor" to "Excellent." Higher scores indicated positive perceived mental health status.

TABLE 1 Participant demographics and ratings of self-reported mental health.

	Demographic	Survey responses		Self-reported mental health	
		Frequency	%	M	SD
Sex	Male	3,617	44.28	2.70	1.07
	Female	4,551	55.72	2.45	1.12
Age	15–18	349	4.27	2.37	1.17
	19–24	1,918	23.48	2.45	1.14
	25–34	1,170	14.32	2.57	1.08
	35–44	1,022	12.51	2.62	1.09
	45–54	1,137	13.92	2.51	1.14
	55+	2,572	31.49	2.65	1.06
Place of Residence	Other rural area	1,602	19.61	2.66	1.07
	Other population center	2,505	30.67	2.56	1.08
	Census metropolitan area	4,061	49.72	2.52	1.13
Income	Not enough	1,904	23.31	2.03	1.17
	Enough	4,439	77.66	2.60	1.03
	More than enough	1,825	22.34	3.01	0.98
Employment	Unemployed	3,525	43.16	2.38	1.14
	Employed	4,643	56.84	2.70	1.05
Education	Grade 8 or lower	438	5.36	2.25	1.10
	Some secondary education	1,075	13.16	2.35	1.13
	Secondary school diploma	1,373	16.81	2.55	1.10
	Some postsecondary education	1,721	21.07	2.52	1.12
	Post-secondary diploma	2,662	32.59	2.62	1.08
	Bachelor's degree or more	899	11.01	2.85	1.03
Housing	Dissatisfied or very dissatisfied	837	10.25	2.03	1.19
	Neither satisfied nor dissatisfied	170	2.08	2.05	1.01
	Satisfied	4,007	49.06	2.42	1.05
	Very satisfied	3,154	38.61	2.90	1.06

2.3.3. Income

Income was assessed in the APS *via* the question, "Overall, in the past 12 months, was your household income enough to meet your household's needs for transportation, housing, food, clothing, and other necessary expenses?" with options being "More than enough," "Enough," and "Not enough." Items were reverse coded to reflect higher scores being associated with having enough income.

2.3.4. Employment

Employment was assessed in the APS *via* a variable that identified if a person was employed or not employed during the reference week (i.e., the most recently completed seven-day period beginning on a Sunday and ending on the following Saturday). Options were "Employed" and "Unemployed," and these were reverse coded with the higher score indicating being employed.

2.3.5. Education

Education was assessed in the APS *via* a question about one's highest level of education. Responses were grouped into the following categories: (1) Grade 8 or equivalent or lower; (2) Some secondary education; (3) Secondary school diploma or equivalent; (4) Some postsecondary education; (5) Postsecondary certificate or diploma below bachelor level; and (6) Bachelor decree or university certificate/diploma/degree above bachelor level. Higher scores indicated higher levels of educational attainment.

2.3.6. Housing

Housing was assessed in the APS *via* the question, "How would you rate your level of satisfaction with your housing conditions?" with options being "Very satisfied," "Satisfied," "Neither satisfied nor dissatisfied," and "Dissatisfied or very dissatisfied." Response options were reverse coded with higher scores indicating greater satisfaction with living conditions.

2.4. Analytic procedure

The 2017 APS Public Use Microdata File (PUMF) was freely accessed online for this study. Consistent with the Tri-Council Policy Statement *Ethical Conduct for Research Involving Humans* (26), an

approve request and documented exemption from the Lakehead University Research Ethics Board for use of secondary data was provided. Aligning with Statistics Canada regulations for use of the 2017 APS analytic file, all data were weighted by person to represent themselves as an individual case (i.e., person) as well as others within the population who were not sampled. Each individual case had a calculated weight that was used to calculate the number of people each individual case represented, which was based on intersecting population-level demographic characteristics (e.g., age, sex, Indigenous status, and region; (27)). Participant data with a response coded as "Valid skip," "Do not know," "Refusal," or "Not stated" for any of our variables of interest was listwise deleted, resulting in initial analysis being completed with $n = 8,168$ respondents. Finally, aligning with Statistics Canada policies, cell counts were reviewed for any less than or equal to 10 individuals to correspond with respondent confidentiality protocols. No cell counts less than or equal to 10 were found for these analyses.

All statistical analyses were conducted using STATA. First, descriptive statistics were analyzed to collect frequency information. Second, bivariate associations between our social determinant of health variables were reported *via* Spearman rank correlations. Third, an ANOVA was used to determine the proportion of variance in self-reported mental health explained by the control variables only. Then, a second ANOVA was used to determine the proportion of variance in self-reported mental health explained by both control variables and our social determinant of health variables.

3. Results

3.1. Descriptive statistics

There were 8,168 First Nations individuals living off reserve whose responses were analyzed in this study. There were more female respondents than male respondents (55.7 vs. 44.3%, respectively). Compared to recent census data (28), females were slightly overrepresented within this sample. Respondents ranged in age from 15 to 55+, with the largest respondent age group being 55+ (31.5%) and the smallest respondent age group being 15–18 (4.3%). Proportions of age groups within this sample match those reported in recent census data (28), aside from a slight over representation of the age category "55 and over" and an under representation of individuals aged 14 or younger, who were not included in the APS 2017 survey. About half of respondents lived in a census metropolitan area (i.e., large population center; 49.7%), followed by those in other population centers (i.e., medium and small population center; 30.7%), followed by those living in rural areas (19.6%). Compared to census data, individuals living in rural areas were underrepresented

within this sample (29). Additional sample characteristics regarding the social determinant of health variables (i.e., education, employment, income, and housing) for this sample is available in Table 1. Descriptive information for self-reported mental health was also calculated for the total sample ($M = 2.54$, $SD = 0.02$) and for each subgroup of each control and predictor variable included in our models (see Table 1).

3.2. Bivariate associations between predictor variables

Spearman rank correlations were run to assess the relationships between our predictor variables (i.e., income, employment, education, and housing). All correlations between variables were statistically significant, and all were positively correlated; however, the strengths of correlations varied. Income and housing were moderately correlated, while all other combinations of correlations were weakly correlated. Spearman rank correlation values and significance values are displayed in Table 2.

3.3. Control variables ANOVA

First, an ANOVA was conducted with the control variables (i.e., age, sex, and place of residence). All control variables had significant main effects on self-reported mental health. Specifically, a significant main effect of sex indicated that men had higher self-reported mental health ($M = 2.67$) than women ($M = 2.47$), $F(1, 8,159) = 107.29$, $p < 0.001$, $\eta^2_p = 0.01$. A significant main effect of age was also found, $F(5, 8,159) = 10.95$, $p < 0.001$, $\eta^2_p < 0.01$, with increasing age bins corresponding with increasing self-reported mental health. A significant main effect of place of residence was also found, $F(2, 8,159) = 7.71$, $p < 0.001$, $\eta^2_p < 0.01$, with increasing size of a population center corresponding with decreasing self-reported mental health. Overall, 2.03% of the variance in self-reported mental health was explained by age, sex, and place of residence variables. See Table 3 for additional details of this analysis.

3.4. Social determinants of health ANOVA

Next, a second ANOVA was conducted with both control variables (i.e., age, sex, and place of residence), as well as predictor variables (i.e., education, employment, income, and housing). All control and predictor variables had significant main effects on self-reported mental health. Again, there was a significant main effect of sex indicating that men had higher self-reported mental health ($M = 2.67$) than women

TABLE 2 Spearman rank correlations and significance values for predictor variables.

	Education	Employment	Income	Housing
Education	1.00			
Employment	0.26	1.00		
Income	0.17	0.21	1.00	
Housing	0.13	0.09	0.37	1.00

*All correlations presented here are significant (i.e., p = < 0.001).

TABLE 3 Predictors of self-reported mental health for First Nations individuals living off-reserve.

Predictor	Model 1: Control variables only					Model 2: Control and predictor variables				
	F	p	η^2_p	Lower 95% CI	Higher 95% CI	F	p	η^2_p	Lower 95% CI	Higher 95% CI
Age	10.95	<0.001	<0.01	0.003	0.010	18.49	<0.001	0.01	0.007	0.017
Sex	107.29	<0.001	0.01	0.009	0.018	79.71	<0.001	<0.01	0.006	0.014
Place of Residence	7.71	<0.001	<0.01	0.000	0.004	9.85	<0.001	<0.01	0.001	0.005
Education						5.54	<0.001	<0.01	0.001	0.006
Employment						50.80	<0.001	<0.01	0.003	0.010
Income						170.14	<0.001	0.04	0.032	0.049
Housing						81.15	<0.001	0.03	0.022	0.036
Constant	22.14	<0.001	0.02	0.014	0.027	74.38	<0.001	0.15	0.132	0.160
$R^2_{adjusted}$	0.020					0.146				

($M = 2.47$), $F(1, 8,159) = 79.71$, $p = 0.001$, $\eta^2_p = 0.01$. A significant main effect of age was found again, $F(5, 8,159) = 18.49$, $p < 0.001$, $\eta^2_p = 0.01$, with increasing age bins corresponding with increasing self-reported mental health. A significant main effect of place of residence was found again as well, $F(2, 8,159) = 5.54$, $p < 0.001$, $\eta^2_p < 0.01$, with increasing size of a population center corresponding with decreasing self-reported mental health.

Examining the predictor variables of interest, a significant main effect of education was found, $F(5, 8,159) = 9.85$, $p < 0.001$, $\eta^2_p < 0.01$, with greater educational attainment corresponding with increased self-reported mental health. A significant main effect of employment was also found, $F(1, 8,159) = 50.80$, $p < 0.001$, $\eta^2_p = 0.01$, with employed respondents reporting higher self-reported mental health ($M = 2.64$) than unemployed respondents ($M = 2.46$). A significant main effect of income was found, $F(2, 8,159) = 170.14$, $p < 0.001$, $\eta^2_p = 0.04$, with perceptions around having enough or more than enough income corresponding with increasing self-reported mental health. Simple effects tests revealed significant self-reported mental health differences across income conditions, with those indicating they had enough income reporting higher self-reported mental health ($M = 2.60$) than those indicating they did not have enough income ($M = 2.17$), $t(6,341) = 14.33$, $p < 0.001$, and with those indicating they had more than enough income reporting higher self-reported mental health ($M = 2.85$) than those indicating they had enough income ($M = 2.60$), $t(6,264) = 8.33$, $p < 0.001$. Finally, a significant main effect of housing was found, $F(3, 8,159) = 81.15$, $p < 0.001$, $\eta^2_p = 0.03$, with increased satisfaction with housing corresponding with increased self-reported mental health. Overall, 14.58% of the variance in self-reported mental health was explained by these control and predictor variables, with the education, employment, income, and housing variables explaining an additional 12.55% of variance compared to the model with only control variables (i.e., age, sex, and place of residence). See Table 3 for additional details of this analysis.

4. Discussion

The purpose of the present study was to extend findings regarding CWB and individual mental wellbeing by examining the relationship between individual indicators of CWB (i.e., education, employment, income, and housing) and subjective mental health reports for First Nations respondents living off reserve *via* the data from a national, population level survey. Higher self-reported mental health was associated with individuals reporting having enough or more than enough income, being employed, having higher levels of educational attainment, and having greater satisfaction with their current housing conditions. These findings support existing models that describe how various social determinants of health can impact individual well-being, such as the CWB Index (9) and the *Social Determinants Model of Aboriginal Health* (3). These results also corroborate previous findings that linked the CWB total scores to other measures of subjective wellbeing (21).

Numerous studies have depicted how lower socio-economic status, including lower personal and household income, contributes to decreased mental health outcomes (30–32). The current study described how participants' subjective reports of not having enough income were associated with decreased self-reported mental health among First Nations adults living off-reserve; to our knowledge, this is the first study of this kind to include this specific indicator of income instead of grouped income brackets. Subjective reports of having enough or not enough income provide the benefit of indicating whether participants feel they have enough income to meet their financial needs (e.g., rent, groceries) in various contexts (e.g., rising costs of rent, rising inflation), which cannot be obtained from income brackets alone. Our results are aligned with previous research with APS 2012 data from Indigenous individuals (First Nations, Inuit, and Métis) describing how falling in lower income categories (less than $40, 000) was affiliated with lower self-reported general health (33). Contrary to Bethune and colleagues (33), who found higher education was most strongly associated with better health outcomes, we found that perceptions of having sufficient income (i.e., enough or more than enough) were most strongly associated with higher mental health ratings.

One's ability to meet their individual financial demands is associated with increased mental health outcomes (34). Preliminary analyses of an Ontario-based universal basic income program indicated those who received additional income reported improved mental health status (35). Similarly, Hajizadeh and colleagues (2021) demonstrated that if socio-economic status among Indigenous populations in Canada was bolstered to be similar to non-Indigenous, mean psychological distress scores and suicidal ideation/planning would decrease by over 25% (36). Given that there are bi-directional

influences among social determinants of education, employment, income, and housing, assessing the singular effect of one determinant remains challenging, as factors are contextualized among one another. In large scale population studies, mediating one of these factors has affected the subsequent relationship of another factor on mental health outcomes, with a large emphasis placed on the mediating role of socioeconomic status (37–39).

Social disparities are inherently experienced differently across age, sex, and gender demographics. Although it was not possible to contextualize such differences across various gender categories due to a lack of data on gender, results of sex-based comparisons from the current study depicted that females were more likely to report lower mental health ratings. This is consistent with previous analyses of the APS and other studies of mental health of Indigenous individuals. Indigenous women are disproportionately exposed to stressors that can affect mental health outcomes, such as being likely to be single parents (40) or experience intimate partner violence (41) than their non-Indigenous or male counterparts. Analyses of a previous iteration of the APS have shown that when mental health outcomes were compared across sexes with consideration of income inequity, women reported significantly higher distress scores, while men had higher suicidal behaviors (36). With respect to age, studies with non-Indigenous populations have found that older adults tend to report fewer problems related to mental illness (42, 43). In line with these findings, analyses reported here indicated that increased age was predictive of increased self-reported mental health for First Nations individuals living off reserve.

Analyses showed that living in smaller communities was predictive of higher self-reported mental health. Although these results contrast previous literature depicting urban and rural differences in mental health outcomes within predominately non-Indigenous populations, these results align with some findings depicting wellness among Indigenous populations (33, 44). For example, although suicide attempts and deaths by suicide are higher in rural communities when examining population level data for individuals living in Ontario (36, 45), among Indigenous populations living off-reserve, those living in rural communities had statistically significant lower lifetime suicide ideation, attempts, and psychological distress compared to those living in larger communities (36). A further challenge remains extending these findings to be inclusive of all Indigenous communities, as the APS is designed solely for Indigenous individuals living off-reserve. With respect to deaths by suicide, living on-reserve (specifically in a remote community) is associated with significantly higher rates among First Nations populations, particularly among younger age groups (46). Differences with respect to self-reported mental health and social determinants across types of geographical locations are challenging to authentically contextualize within the current analyses, although these findings may be useful to inform future work regarding geographical differences in mental health outcomes. It is possible that geographical rurality may facilitate greater access to land-based activities, an ability to be more connected to one's cultural through engagement in cultural practices or improve community belonging.

4.1. Study implications

Contrary to the findings presented here, interventions for those experiencing mental health concerns are largely individually-based (e.g., psychological or pharmacological vs. social interventions) and put the onus on individuals to apply tailored skills to mitigate one's own mental health concerns (47). Emphasis is placed on one's self-determination, autonomy, and motivation within treatment to apply provided strategies that can bolster mental health. Although such interventions are useful and will continue to be facilitated through individually-based psychological and counseling options, the clinical utility of such treatments may be overshadowed by one's broader access to health promoting factors such as stable housing, employment, educational opportunities, or income stability (48). It can be challenging to engage in complex, introspective, or difficult behavioral-change processes when one's basic needs are not consistently met, one must provide care to children or other dependents, or when one does not feel safe in their home or community environment. Similarly, when such individually-based mental health interventions fail due to increased barriers or poor living conditions created through inaccessibility to proximal or intermediate social determinants, onus is placed on the individual for this treatment failure, which can further exacerbate mental distress or reduce the likelihood of seeking similar services in the future.

Upstream interventions to address social determinants that can interfere with treatment or exacerbate mental health outcomes are required to authentically address mental health disparities experienced among First Nations populations. When such interventions are prioritized to be provided first, or even in conjunction with additional mental health treatments, they can facilitate increased engagement in individual mental health treatments, and potentially decrease likelihood of symptom exacerbation or recurrence. Research has demonstrated various ways in which each of the four social determinants of health can bolster mental well-being. In terms of housing stability, research examining Housing First options for First Nation youth have found that when youth are provided with safe and secure housing, without any requirements to engage in mental health services, they are more likely to seek these supports (49). Similarly, nutrition assistance programs, universal health care, universal basic income, and urban planning programs show increased mental health outcome for program users (35, 50). As well, access to education can also support increased access to school-based mental health programs and members of the community trained to respond to young people in crisis, which has been shown to be effective for reducing suicide rates in First Nations youth (51). Relevant mental health interventions may also require a shift to focus on, or simultaneously prioritize, not only the presenting mental health symptoms but also social determinants as a clinically and culturally-relevant focus of treatment.

4.2. Study limitations and future directions

The present research is not without limitations. First, this paper assessed only the four social determinants of health included in the CWB Index, and only mental wellbeing; in contrast, well-being can be shaped by many other variables and can be defined in many other ways. For example, the First Nations Mental Wellness Continuum Framework (FNMWCF) (52, 53) is rooted in culture and takes a more holistic approach when defining wellness and describing the factors that impact wellness. In the FNMWCF, there are four facets of mental wellness that correspond to the four quadrants of the medicine wheel (i.e., mental, physical, emotional, and spiritual wellbeing). However, only self-reported mental well-being was available in the APS 2017

data-set so self-reported physical, emotional, and spiritual wellbeing could not be assessed. In future iterations of the APS, questions regarding physical, emotional, and spiritual wellbeing should be included. However, examining mental well-being itself is still useful because it can come from increased hope, belonging, meaning, and purpose and because it intersects with the wellness of one's family, community, society, and culture. Culture is highlighted as being at the center of mental wellness, implying that all health services and programs related to First Nations must go above and beyond creating culturally relevant programs by using culture as a starting point and then integrating current policies, strategies, and frameworks (52).

While study findings are not particularly novel, they provide corroboratory analyses using national, population-level data for theoretical frameworks such as those presented in Reading and Wein (3) regarding the associations between social determinants of health and mental well-being. To our knowledge, systematic reviews have mostly been used for assessing the individual impacts of various social determinants of health on mental well-being for First Nations individuals living in Canada (54, 55), and more broadly, for Indigenous individuals living in Canada (8, 56–59). We highlight the relationship between social determinants of health and mental wellbeing for First Nations individuals living off reserve using national, population-level data from the APS 2017, which fills a gap within the literature. Future research assessing First Nations wellness *via* large datasets like the APS 2017 should examine how accessing culture in various ways (e.g., *via* language, practices, ceremonies, knowledge, land, and values) (52) can impact a more holistic conceptualization of wellbeing (i.e., mental, physical, emotional, and spiritual wellbeing). Drawson and colleagues (60) also note that future research should consider other confounding factors when examining this relationship. This recommendation came after Drawson and colleagues (60) purposely demonstrated the importance of this statistically, using national data to show that, when examined in isolation, knowledge of traditional Indigenous language predicted reduced CWB scores, but when geographic remoteness was included as a predictor in the model, the relationship between knowledge of traditional language and CWB scores was no longer significant and instead geographic remoteness accounted for much of the variance. The former finding could have led to disastrous implications for funding or program planning if used alone (i.e., reduced funding for programs supporting the revitalization of traditional language use), and the latter finding demonstrates the necessity of contextualizing data interpretations (60). Additional recommendations for researchers using large-scale datasets from Indigenous communities can be found in Drawson and colleagues (60).

Another limitation of this research relates to additional gaps and challenges that exist within the APS survey. While the introduction of the APS was a significant improvement for addressing health related questions as it increased the quantity and quality of available Indigenous health data, there are still several issues that exist (3). For example, the APS includes First Nations individuals living off-reserve only, and First Nations individuals living on-reserve are accounted for *via* the First Nations Regional Longitudinal Health Survey (FNRLHS) (3). As different authorities are responsible for each survey, questions may be worded differently, and this makes it challenging to compare how the same concepts may differ for First Nations individuals living on- vs. off-reserve (3). Nelson and Wilson (57) also highlight that the broad categorization of Indigenous peoples into First Nations, Métis, and Inuit is a crude measure of identity that creates three homogeneous

categories of Indigenous peoples and misses out on important variation. Because of this broad categorization, researchers are unable to point to specific nuances among groups or provide specific prevalence rates of mental illnesses for specific groups of First Nations peoples in Canada. Similarly, as the APS 2017 survey only reported binary responses for sex and do not capture gender, the results here cannot explicitly speak to the associations between social determinants of health and mental health for individuals whose gender does not correspond to their sex at birth (i.e., transgender men and transgender women) or responses from individuals who gender is not exclusively "man" or "women" (e.g., Two-Spirit individuals). Future iterations of the APS survey that allow for refined categorizations of gender will similarly allow for understanding and discussion of nuances between specific subgroups of First Nations peoples in Canada.

Future directions for assessing the relationship between First Nations well-being and various social determinants of health at a population level would include examining these concepts more holistically as outlined above. This could include models with strengths-based predictors, such as indicators of cultural connectedness (61), and models with broader well-being outcomes, such as those that assess mental, emotional, physical, and spiritual well-being (52, 53), and future iterations of the APS survey should assess each of these aspects of well-being. More complex statistical models could also be used, such as latent class analysis (62), which could be used to identify qualitatively different subgroups within populations (e.g., examining subgroups that have access to differing combinations of our social determinants of health variables, such as access to housing but not education, or access to income but not housing, and determining how these classes may be differentially associated with mental health outcomes). Other social determinants of health, such as presence of young children and accessibility to free childcare could also be included in future models. In addition, while the present results are cross-sectional (i.e., from many individuals at *one* time-point), if future models could be analyzed while including multiple iterations of the APS (i.e., longitudinal data points), such models could then be used to further support funding and public policy change for further access to additional resources (e.g., funding to support communities with increased access to cultural activities in addition to funding to support communities with better housing infrastructure). As well, using a community-based participatory framework (CBPR) to ensure that communities are involved in all stages of the research process involving the APS (from conception to interpretation to dissemination) could allow community members to define and conceptualize wellness and various social determinants in ways that are most meaningful for them (60). Incorporating these definitions and conceptualizations into the APS could then allow for collection of more accurate and valid data as well.

Future research could explore how changes to social determinants of health differentially affect mental health outcomes for First Nations individuals living off reserve when compared to other populations (e.g., First Nations individuals living on reserve, Métis populations, non-Indigenous populations, etc.). As comparisons of mental health outcomes between First Nations individuals living off reserve and living on reserve are difficult to obtain (likely due in part to the different authorities responsible for collecting these data as noted above, as well as limitations in data collection approaches with Indigenous people in general (63)), we present in this paragraph some literature showing differences in mental health outcomes for Indigenous vs.

non-Indigenous populations after implementing changes directed at improving various social determinants of health. For example, while there are efforts to acknowledge and preserve Indigenous languages, knowledge, ceremonies, and traditional parenting practices in some schools, there are still instances that hinder positive relationships between school personnel and Indigenous families (e.g., reports to child welfare agencies causing family disruption) (64). These institutional practices continue to contribute to anxiety among Indigenous families in ways that are not experienced by non-Indigenous families, and can lead to poorer mental health outcomes (64). Similarly, while an urban Housing First initiative for Indigenous participants in Winnipeg, Canada contributed to a range of positive outcomes (e.g., environments of safety, self-control, and privacy), there were also significant structural constraints (e.g., a lack of culturally appropriate affordable housing; systemic erasure of Indigeneity from the urban sociocultural and political landscape of the city) (65) which could attenuate the mental health benefits in comparison to the mental health benefits that a non-Indigenous person might experience in an adjacent setting. A study summarizing the experiences of individuals experiencing houselessness also found that Indigenous participants described narrative identities filled with stories of racism, historical trauma, and disconnection from one's culture(s), while those of non-Indigenous participants (specified in this study as White Canadian or European) (66) did not. These results indicated again that access to housing alone may not be enough to see similar improvements in mental health outcomes across populations—access to methods of cultural healing and reclamation will be required as well (66). Finally, one study found that gaps in suicide-related behaviors between Indigenous populations living off-reserve and non-Indigenous populations in Canada were largely due to differences in the effects of unobserved determinants (i.e., not socioeconomic factors such as income and employment which had been included in the analytical model) (67). The authors highlighted that variables they were unable to observe were impacting these differences in suicide-related behaviors (67); such differences could include factors such as systemic discrimination, and other systemic impacts stemming from colonization. These studies highlight that, while addressing the social determinants of health included in this paper are important, providing access to resources that support cultural resilience and advancing the process of Canadian reconciliation (e.g., addressing the 94 Calls to Action put forward by the Truth and Reconciliation Commission of Canada (68)) is needed to improve mental health outcomes for Indigenous people.

5. Conclusion

The current study has extended previous work, demonstrating that income security, housing satisfaction, higher education, and employment are associated with increased self-reported mental health among First Nations individuals living off-reserve. We have shown that individual perceptions of having enough or more than enough income are most strongly associated with increased mental health outcomes. The subjective nature of income reports is a novel contribution to existing literature, and depicts that is not necessarily one's socioeconomic status, but also one's perception of having basic needs met, is affiliated with increased mental health. Although future work can examine various interventions among social determinants

of mental health experienced among First Nations communities, we hope the present findings can broaden understanding of existing disparities exist among First Nation communities by depicting the nature of these trends in a large-scale, population-based dataset. Addressing social determinants of mental health in an authentic way that centers Indigenous self-determination and knowledge is what will close these gaps. Careful consideration of how existing mental health services, and how subsequent health interventions to address these social determinants contribute to quantifiable reductions in mental health outcomes is required. Until this occurs, we will continue to be engaged in crisis-focused, symptom-based, or downstream approaches that will not fully address factors associated with decreased mental wellbeing.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: https://abacus.library.ubc.ca/dataset.xhtml?persistentId=hdl:11272.1/AB2/U0UXQJ.

Ethics statement

Consistent with the Government of Canada's Tri-Council Policy Statement "Ethical Conduct for Research Involving Humans", an approve request and documented exemption from the Lakehead University Research Ethics Board for use of secondary data was provided. Before the start of the 2017 APS survey, participants received introductory letters explaining the purpose of the survey and provided informed consent to participate in that survey.

Author contributions

ET, LH, and CM: conceptualization, interpretation, and writing—review and editing. ET and LH: methodology and writing—original draft preparation. LH: analysis. ET and CM: supervision. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Association between maternal occupational exposure to cleaning chemicals during pregnancy and childhood wheeze and asthma

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Background: Asthma is a leading cause of childhood morbidity in the U.S. and a significant public health concern. The prenatal period is a critical window during which environmental influences, including maternal occupational exposures, can shape child respiratory health. Cleaning chemicals are commonly encountered in occupational settings, yet few studies have examined the potential link between prenatal occupational exposures to cleaning chemicals and risk of childhood wheeze and asthma.

Methods: We evaluated the potential influence of maternal occupational exposure to cleaning chemicals during pregnancy on pediatric asthma and wheeze at child age 4–6 years in 453 mother-child pairs from two longitudinal pregnancy cohorts, TIDES and GAPPS, part of the ECHO prenatal and early childhood pathways to health (ECHO-PATHWAYS) consortium. Maternal occupational exposure to cleaning chemicals was defined based on reported occupation and frequency of occupational use of chemicals during pregnancy. Child current wheeze and asthma outcomes were defined by parental responses to a widely-used, standardized respiratory outcomes questionnaire administered at child age 4–6 years. Multivariable Poisson regression with robust standard errors was used to estimate relative risk (RR) of asthma in models adjusted for confounding. Effect modification by child sex was assessed using product interaction terms.

Results: Overall, 116 mothers (25.6%) reported occupational exposure to cleaning chemicals during pregnancy, 11.7% of children had current wheeze, and 10.2% had

current asthma. We did not identify associations between prenatal exposure to cleaning chemicals and current wheeze [RR$_{adjusted}$ 1.03, 95% confidence interval (CI): 0.56, 1.90] or current asthma (RR$_{adjusted}$ 0.89, CI: 0.46, 1.74) in the overall sample. Analyses of effect modification suggested an adverse association among females for current wheeze (RR 1.82, CI: 0.76, 4.37), compared to males (RR 0.68, CI: 0.29, 1.58), though the interaction *p*-value was >0.05.

Conclusion: We did not observe evidence of associations between maternal prenatal occupational exposure to cleaning chemicals and childhood wheeze or asthma in the multi-site ECHO-PATHWAYS consortium. We leveraged longitudinal U.S. pregnancy cohorts with rich data characterization to expand on limited and mixed literature. Ongoing research is needed to more precisely characterize maternal occupational chemical exposures and impacts on child health in larger studies.

1. Introduction

Childhood asthma affects approximately 8% of children in the U.S. and represents a significant public health concern (1). Asthma is a complex, chronic inflammatory respiratory disease, characterized by airway hyperresponsiveness, inflammation, and obstruction, and is often triggered by environmental factors (2). Symptoms include episodes of breathlessness, coughing, and wheezing, and asthma that develops in childhood has a profound impact on lifelong lung health, including airway remodeling and increased risk for adult asthma (3, 4). The prenatal period is a significant window during which interactions between genetics and environmental exposures, including environmental toxicants, modulate fetal lung development and immunologic responses that influence the risk, incidence, and severity of allergic diseases and asthma (3, 5–8).

Cleaning and disinfectant products are complex mixtures of chemicals, including irritants and potential sensitizers (9–11). Prior investigations have found robust, consistent epidemiological evidence that both home and occupational exposures to chemicals involved in cleaning and janitorial tasks, including disinfectants, fragrances, and solvents, increase risk for respiratory symptoms and asthma in adults (9, 11–18). In children, evidence also suggests a link between use of cleaning chemicals and sprays in the home with airway inflammation, persistent wheeze, lung function abnormalities, and increased risk of asthma (19–21).

By contrast, maternal environmental exposures during pregnancy and preconception, including occupational exposures to cleaning chemicals, have been found to be associated with childhood wheeze and asthma, though mechanisms are not yet fully understood (3, 10, 22–24). Several parental occupations are associated with higher risk of childhood respiratory outcomes, including jobs involving cleaning and chemical disinfection (22, 23, 25). Thus far, few studies have examined the potential link between maternal occupational exposures to cleaning agents specifically in the prenatal period and childhood asthma. A recent European cohort study found that both asthma and a related atopic condition in childhood (e.g., allergic rhinitis) were

linked to prenatal exposure to cleaning agents (10). Finally, pre-adolescent boys have an increased prevalence of asthma, and child sex has been found to modify the relationship between prenatal environmental exposures and child airway outcomes (26–28), but few studies have specifically focused on the modifying role of child sex in prenatal occupational exposure to cleaning chemicals (22).

We contribute to this limited evidence base by evaluating the potential influence of maternal occupational exposure to cleaning chemicals during the prenatal period on pediatric asthma and wheeze outcomes at child age 4–6 years. Furthermore, we evaluate whether there is evidence of sex-specific associations. We utilize asthma and wheeze data collected in middle childhood in the ECHO prenatal and early childhood pathways to health consortium (ECHO-PATHWAYS), a multi-site longitudinal study combining three U.S. pregnancy cohorts with extensive pregnancy exposure, child outcome and covariate characterization. We hypothesize that maternal exposure to cleaning chemicals during pregnancy will be associated with increased risk of asthma and wheeze at age 4–6 years and that effects will vary by child sex.

2. Materials and methods

2.1. Study setting and population

The study participants were mother-child pairs from two ECHO-PATHWAYS consortium pregnancy cohorts: the Global Alliance to Prevent Prematurity and Stillbirth (GAPPS) and The Infant Development and Environment Study (TIDES) (29).

GAPPS participants were enrolled between 2011 and 2014 from three hospitals in Seattle, WA and Yakima, WA. Inclusion criteria included being 18 years or older, able to speak and write English, and planning to deliver at the study hospital in which they were enrolled. Eligible mother-child dyads were recruited into ECHO-PATHWAYS when the children were 4–6 years old and attended clinic visits at age 4–6 years and age 8–9 years.

TIDES participants were recruited during the first trimester of pregnancy from participating academic medical centers, from 2010 to 2012: San Francisco, CA; Minneapolis, MN; Rochester, NY; and Seattle, WA. Women were eligible if they were 18 years old or older, planning to deliver at one of the participating study hospitals, and having a low-risk singleton pregnancy at enrollment. Mother-child pairs were administered questionnaires and/or attended clinic visits at ages 4–5 years, 6 years and 7 years (30, 31). This analysis includes participants who completed both the occupational exposure questionnaire and the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire (32, 33) at child age 4–6 years. Because visits varied in composition and not all surveys were administered at all visits, only a subset of the participants who attended visits have both exposure and outcome data required for the main study question and are included in these analyses.

Participants provided informed consent. Data were analyzed by the University of Washington (UW) ECHO-PATHWAYS team and study protocols were approved by the UW Institutional Review Board (IRB).

2.2. Occupational prenatal exposure to cleaning chemicals

Our primary exposure of interest, maternal occupational exposure to cleaning chemicals during the prenatal period, was assessed using questionnaires administered to primary caregivers regarding job titles, occupational activities, and exposures during the prenatal period. Questionnaires were administered at the GAPPS child age 4–6 visit (GAPPS 4–6), GAPPS child age 8–9 visit (GAPPS 8–9) or TIDES child age 7 visit (TIDES 7). In both GAPPS and TIDES, prenatal exposure to cleaning chemicals was defined as meeting any of the following: (1) answered "Yes" to "*Did the biological mother work in any of the following industries during pregnancy: Janitor or house cleaner?*"; (2) answered "Yes" to "*Did the biological mother do any of the following activities at her job during pregnancy: Clean floors, sinks, or toilets?*"; (3) answered "Some days" or "Every day" to "*How often did the biological mother use janitorial chemicals or cleaners at her job during pregnancy?*".

2.3. Child airway outcomes

We defined our primary outcomes as current wheeze and current asthma and our secondary outcome as strict asthma as reported between child ages 4–6 using the ISAAC questionnaire. The categorization of outcomes is similar to that used previously in ECHO-PATHWAYS consortium research (27–29, 34, 35). Current wheeze was defined as a positive response to "*Has the child had wheezing or whistling in the chest in the past 12 months?*" Current asthma was defined as positive responses to two of the following: current wheeze, ever asthma (defined as positive response to the question "*Has your child ever had asthma?*"), and asthma medication use ("*Does the child use any*

medications for treatment of recurrent cough, recurrent wheezing or asthma?"). Strict asthma was defined as positive response to the question "*Has your child ever had asthma?*" as well as either current wheeze or asthma medication use (35, 36).

2.4. Statistical analysis

Demographic and behavioral characteristics of mother-child pairs were summarized overall and by cohort.

Modified multivariable Poisson regression with robust standard errors was used to estimate associations [adjusted risk ratios (RR)] between exposure and outcomes. The primary analyses investigated the association between prenatal exposure to cleaning chemicals (yes/no) and primary outcomes (current wheeze and current asthma) using separate models for each outcome. Secondary analyses investigated the association between prenatal exposure to cleaning chemicals and strict asthma.

We used a staged modeling approach for covariate adjustment by fitting minimally adjusted, fully adjusted (main model), and extended models. Covariates were selected *a priori* based on a literature search to identify asthma and wheeze risk factors that may be correlated with the exposure and included maternal, child, and household demographic, health, and socioeconomic factors. Minimally adjusted models were adjusted for child age, child sex, and study site. Main models further adjusted for self-identified maternal race (White, Asian, or other) and maternal ethnicity (Hispanic/Latino or non-Hispanic/Latino), education at enrollment (less than high school, high school completion, graduated college/technical school, or any graduate school/professional), maternal history of asthma (yes/no), maternal age at delivery (years, continuous), maternal self-report of smoking status at enrollment (yes/no), household size category (<4, 4, 5, >5), region-and inflation-adjusted household income (continuous, $USD), postnatal second-hand smoke exposure (yes/no), season of birth (warm [April through September]/cold [October through March]), and firstborn status (yes/no). Extended models additionally adjusted for two potential confounders that may also act as mediators: preterm birth at less than 37 weeks (binary) and birthweight (continuous). To evaluate whether the association between prenatal exposure to cleaning chemicals and childhood asthma is modified by child sex, we tested for a statistical interaction using multiplicative interaction terms. The primary models, effect modification analysis, and sensitivity analyses utilized multiple imputation by chained equations (MICE) to impute missing covariates (37).

We conducted multiple sensitivity analyses to assess the robustness of findings to modeling approach. In all cases, the sensitivity analyses were compared to the main model. Demographic and behavioral characteristics were also summarized for participants included in this study and those who were excluded but still attended the age 4–6 visit. To explore whether results were influenced by site- and cohort-specific associations, leave-one-out analyses were conducted in which the main analysis was repeated with one cohort or site removed in each iteration. To assess whether bias was introduced

TABLE 1 Descriptive characteristics of the study population by cohort.

	Cohort[a]		
	Total[b]	TIDES	GAPPS
	(N = 453)	(N = 214)	(N = 239)
Maternal race			
White	346 (76.4%)	187 (87.4%)	159 (66.5%)
Black	20 (4.4%)	0 (0%)	20 (8.4%)
Asian	24 (5.3%)	15 (7.0%)	9 (3.8%)
Native Hawaiian/Other Pacific Islander	1 (0.2%)	0 (0%)	1 (0.4%)
American Indian/Alaska Native	2 (0.4%)	1 (0.5%)	1 (0.4%)
Other	26 (5.7%)	17 (7.9%)	9 (3.8%)
Multiple race	16 (3.5%)	1 (0.5%)	15 (6.3%)
Missing	18 (4.0%)	18 (8.4%)	0 (0%)
Maternal ethnicity			
Hispanic or Latino	38 (8.4%)	17 (7.9%)	21 (8.8%)
Not Hispanic or Latino	401 (88.5%)	197 (92.1%)	204 (85.4%)
Missing	14 (3.1%)	0 (0%)	14 (5.9%)
Maternal education			
Less than high school	14 (3.1%)	11 (5.1%)	3 (1.3%)
High school	79 (17.4%)	28 (13.1%)	51 (21.3%)
College/technical school	170 (37.5%)	65 (30.4%)	105 (43.9%)
Graduate or Professional degree	190 (41.9%)	110 (51.4%)	80 (33.5%)
Maternal history of asthma			
Yes	60 (13.2%)	24 (11.2%)	36 (15.1%)
No	365 (80.6%)	177 (82.7%)	188 (78.7%)
Missing	28 (6.2%)	13 (6.1%)	15 (6.3%)
Maternal Delivery Age (years)			
Mean (SD)	32.1 (5.3)	31.8 (5.4)	32.3 (5.1)
Median (IQR)	32 (29–36)	32 (28–36)	32 (29–36)
Missing	29 (6.4%)	0 (0%)	29 (12.1%)
Child sex			
Male	246 (54.3)	110 (51.4%)	136 (56.9%)
Female	207 (45.7)	104 (48.6%)	103 (43.1%)
Preterm birth			
Yes	67 (14.8%)	13 (6.1%)	54 (22.6%)
No	364 (80.4%)	198 (92.5%)	166 (69.5%)
Missing	22 (4.9%)	3 (1.4%)	19 (7.9%)
Season of birth			
Warm	237 (52.3%)	109 (50.9%)	126 (52.7%)
Cold	216 (47.7%)	105 (49.1%)	113 (47.3%)
Birthweight (grams)			
Mean (SD)	3,252 (705.6)	3,387 (500.8)	3,122 (839)
Median (IQR)	3,316 (2940–3710)	3,358 (3071–3700)	3,274 (2755–3716)
Missing	120 (26.5%)	15 (7.0%)	22 (9.2%)
Firstborn status			
Yes	130 (28.7%)	35 (16.4%)	90 (37.7%)
No	305 (67.3%)	172 (80.4%)	138 (57.7%)
Missing	18 (4.0%)	7 (3.3%)	11 (4.6%)
Ever bronchiolitis[c]			
Yes	31 (6.8%)	14 (6.5%)	17 (7.1%)
No	302 (66.7%)	185 (86.4%)	117 (49.0%)
Missing	120 (26.5%)	15 (7.0%)	105 (43.9%)
Child age at 4-6 visit (years)			
Mean (SD)	5.8 (0.7)	6.2 (0.4)	5.5 (0.7)
Median (IQR)	6 (5.3–6.2)	6.1 (6.0–6.2)	5.4 (5.1–5.9)
Missing	18 (4.0%)	7 (3.3%)	11 (4.6%)
Household size			
<4	80 (17.7%)	40 (18.7%)	40 (16.7%)
4	204 (45.0%)	101 (47.2%)	103 (43.1%)
5	83 (18.3%)	35 (16.4%)	48 (20.1%)
>5	50 (11.0%)	19 (8.9%)	31 (13.0%)
Missing	36 (7.9%)	19 (8.9%)	17 (7.1%)
Adjusted income ($USD)			
Mean (SD)	$114,004 ($56,745)	$117,237 ($59,070)	$111,188 ($54,193)
Median (IQR)	$110,813 ($67,648–$172,511)	$110,813 ($67,676–$172,511)	$105,682 ($67,648–$147,955)
Missing	32 (7.1%)	18 (8.4%)	14 (5.9%)
Smoking self-report			
Yes	15 (3.3)	10 (4.7%)	5 (2.1%)
No	436 (96.2%)	104 (48.6%)	232 (97.1%)
Missing	2 (0.4%)	0 (0%)	2 (0.8%)
Averaged cotinine[d]			
Mean (SD)	29.7 (169.2)	40.7 (206.1)	11.4 (79.2)
Median (IQR)	0.01 (0.01–0.06)	0.01 (0.01–0.07)	0.01 (0.001–0.02)
Missing	113 (24.9%)	2 (0.9)	111 (46.4%)
Postnatal second-hand smoke exposure			
Yes	127 (28.0%)	121 (56.5%)	16 (6.7%)
No	300 (66.2%)	93 (43.5%)	207 (86.6%)
Missing	16 (3.5%)	9 (4.2%)	16 (6.7%)
Cohort Site			
GAPPS			
Seattle, WA	164 (36.2%)		164 (68.6%)
Yakima, WA	75 (16.6%)		75 (31.4%)
TIDES			
Minneapolis, MN	56 (12.4%)	56 (26.2%)	
Rochester, NY	49 (10.8%)	49 (22.9%)	
San Francisco, CA	63 (12.9%)	63 (29.4%)	
Seattle, WA	46 (10.2%)	46 (21.5%)	

[a]Percentages are within cohort.

[b]Percentages are within total group.

[c]Bronchiolitis history was not surveyed for the subset of GAPPS participants who completed the recall survey at age 4–6. Bronchiolitis was unavailable for N = 11 from the GAPPS age 8–9 recall group.

[d]Measured in nanograms per milliliter (ng/mL). Cotinine was not measured for the subset of GAPPS participants who completed the recall survey at age 4–6. Cotinine was unavailable for N = 15 from the GAPPS age 8–9 recall group.

due to variation in ability to recall exposures at different child ages, we additionally adjusted for visit of exposure questionnaire completion [age 4–6 or 7/8–9 visit (binary)]. We performed additional sensitivity analyses in which we adjusted for urinary cotinine (continuous) as a marker of maternal smoking and exposure to environmental tobacco smoke during pregnancy (38), measured during the second trimester visit, and whether

TABLE 2 Occupational exposure to cleaning chemicals[a] among pregnant individuals in the study population.

	Cohort		
	Total	TIDES	GAPPS
	(N = 453)	(N = 214)	(N = 239)
Exposure (composite, prenatal)			
Yes	116 (25.6%)	48 (22.4%)	68 (28.5%)
No	337 (74.4%)	166 (77.6%)	171 (71.5%)
Works as janitor or house cleaner			
Yes	10 (2.2%)	5 (2.3%)	5 (2.1%)
No	442 (97.6%)	209 (97.7%)	233 (97.5%)
Missing	1 (0.2%)	0 (0%)	1 (0.4%)
Cleans floors, sinks, or toilets at job			
Yes	77 (17%)	40 (18.7%)	37 (15.5%)
No	375 (82.8%)	173 (80.8%)	202 (84.5%)
Missing	1 (0.2%)	1 (0.5%)	0 (0%)
Use janitorial chemicals or cleaners at job			
Some days	72 (15.9%)	22 (10.3%)	50 (20.9%)
Every day	16 (3.5%)	6 (2.8%)	10 (4.2%)
Never	362 (79.9%)	183 (85.5%)	179 (74.9%)
Missing	3 (0.7%)	3 (1.4%)	0 (0%)

[a]Maternal occupational exposure to cleaning chemicals during the prenatal period was assessed using questionnaires administered to primary caregivers and were completed at the GAPPS child age 4–6 visit, GAPPS child age 8–9 visit or TIDES child age 7 visit. Exposure was defined as meeting any of the following: (1) answered of "Yes" to "Did the biological mother work in any of the following industries during pregnancy: Janitor or house cleaner?"; (2) answered "Yes" to "Did the biological mother do any of the following activities at her job during pregnancy: Clean floors, sinks, or toilets?"; (3) answered "Some days" or "Every day" to "How often did the biological mother use janitorial chemicals or cleaners at her job during pregnancy?".

TABLE 3 Asthma and wheeze outcomes at age 4–6 years in the study population.

	Cohort		
	Total	TIDES	GAPPS
	(N = 453)	(N = 214)	(N = 239)
Current wheeze			
Yes	53 (11.7%)	33 (15.4%)	20 (8.4%)
No	373 (82.3%)	174 (81.3%)	199 (83.3%)
Missing	27 (6.0%)	7 (3.3%)	20 (8.4%)
Current asthma			
Yes	49 (10.2%)	13 (6.1%)	36 (15.1%)
No	389 (85.9%)	183 (85.5%)	206 (86.2%)
Missing	15 (3.3%)	7 (3.3%)	8 (3.3%)
Strict asthma			
Yes	35 (7.7%)	14 (6.5%)	20 (8.4%)
No	392 (86.5%)	193 (90.2%)	199 (83.3%)
Missing	27 (5.8%)	7 (3.3%)	20 (8.4%)

the child had ever been diagnosed with bronchiolitis (yes/no). Maternal pregnancy tobacco smoke exposure and early childhood bronchiolitis are both associated with development of childhood asthma (1, 39); however, we did not include these in the main models because they were not collected for the GAPPS participants who completed the exposure recall at age 4–6 (N = 96) per study protocols. To more precisely capture clinically

relevant exposure to cleaning chemicals, prenatal cleaning practices and prenatal cleaning frequency were assessed independently. Separate analyses were performed defining prenatal exposure as either (1) answered "Yes" to "*Did the biological mother do any of the following activities at her job during pregnancy—Clean floors, sinks, or toilets?*" or (2) answered "Some days" or "Every day" to "*How often did the biological mother use janitorial chemicals or cleaners at her job during pregnancy?*" Finally, we repeated the primary analysis using complete cases only.

All analyses were conducted in R version 4.2.2 and significance was assessed at an α level of 0.05.

3. Results

Overall, 453 pregnancy exposure and occupation recall questionnaires were completed, 239 in GAPPS and 214 in TIDES (Table 1). Of these, 116 mothers (25.6%) were classified as having been exposed to cleaning chemicals at their job during pregnancy. There was overlap among classification of exposure: ten mothers (2.2%) worked as a janitor or house cleaner, 77 (17%) cleaned floors, sinks, or toilets as part of their job, and 88 (19.4%) used janitorial chemicals or cleaners in their job some days or every day (Table 2). Mean child age at outcome assessment was 5.8 years [standard deviation (SD) 0.7] with an interquartile range (IQR) of 5.3–6.2 (Table 1). The child participants were 54.3% male and 45.7% female. The overall prevalences of current wheeze, current asthma, and strict asthma were 11.7% (N = 53), 10.8% (N = 49), and 7.7% (N = 35), respectively (Table 3).

In our primary analysis, we did not observe associations between the composite measure of prenatal cleaning chemical exposure and current wheeze in the main model (RR 1.03, CI: 0.56, 1.90) or current asthma (RR 0.89, CI: 0.46, 1.74) (Table 4). Results were similar in the minimally adjusted and extended models. Similarly, our secondary analysis found no association between prenatal exposure to cleaning chemicals and strict asthma (RR 0.82, CI: 0.33, 2.02) (Table 4).

We did not observe statistical evidence of an interaction between prenatal exposure to cleaning chemicals and sex on development of current wheeze and current asthma. Results suggest an adverse association limited to females for the current wheeze outcome (RR 1.82, CI: 0.76, 4.37, $p_{interaction} = 0.13$) compared to males (RR 0.68, CI: 0.29, 1.58); however, the confidence interval was wide and included the null. Effect estimates for current asthma were less than one and did not meet statistical significance in stratified analyses by child sex (Figure 1).

The participants included in our study population were similar in all characteristics except maternal education and household income, which were both somewhat higher in the analytic sample, on average, than those excluded (Supplementary Table S1). We did not observe any statistically significant associations between our primary exposure and current wheeze or current asthma in the sensitivity analyses described above (see

TABLE 4 Association between maternal occupation exposure to cleaning chemicals during pregnancy and airway outcomes.

	Minimally-adjusted model[a]		Main model[b]		Extended model[c]	
Primary outcomes	Adjusted RR (95% CI)	p-value	Adjusted RR (95% CI)	p-value	Adjusted RR (95% CI)	p-value
Current wheeze	0.90 (0.49–1.64)	0.72	1.03 (0.56–1.90)	0.92	1.03 (0.55–1.90)	0.65
Current asthma	0.86 (0.45–1.64)	0.65	0.89 (0.46–1.74)	0.74	0.88 (0.45–1.71)	0.74
Secondary outcome						
Strict asthma	0.70 (0.31) – 1.55	0.38	0.82 (0.33–2.02)	0.67	0.80 (0.33–1.96)	0.63

[a]Minimally adjusted models were adjusted for child age, child sex, and study site.
[b]Main models were further adjusted for maternal race, maternal ethnicity, education at enrollment, maternal history of asthma, maternal age at delivery, and maternal self-report of smoking status at enrollment, household size category, regional-and inflation-adjusted household income, postnatal second-hand smoke exposure, season of birth, and firstborn status.
[c]Extended models were additionally adjusted for preterm birth and birthweight.

Supplementary Material for results). Specifically, when excluding the GAPPS 4–6 exposure recalls, we observed no significant association between the exposure and current wheeze (RR 0.94, CI: 0.50, 1.79) or current asthma (RR 0.92, CI: 0.48, 1.75) (Supplementary Table S2). However, additional adjustment for cotinine and bronchiolitis in a subpopulation in which these data elements were collected led to elevated effect estimates, though with 95% confidence intervals that included the null (RR 1.88, CI: 0.78–4.55) (Supplementary Table S1).

Additionally, upon disaggregation of the exposure classification by question, we did not observe a significant association between exposure and current wheeze (RR 0.81, CI: 0.42, 1.54) or current asthma (RR 0.88, CI: 0.42, 1.85) among mothers who cleaned floors, sinks, or toilets at their job during pregnancy. Similarly,

there was not a significant association between exposure and current wheeze (RR 1.39, CI: 0.71, 2.73) or current asthma (RR 1.03, CI: 0.49, 2.15) among mothers who used janitorial chemicals or cleaners some days or every day at their job during pregnancy (Supplementary Table S3).

4. Discussion

This study investigated the association between occupationally related maternal exposure to cleaning chemicals during pregnancy and childhood respiratory outcomes in a combined U.S. pregnancy cohort. We found no evidence of an association between prenatal exposure to cleaning chemicals
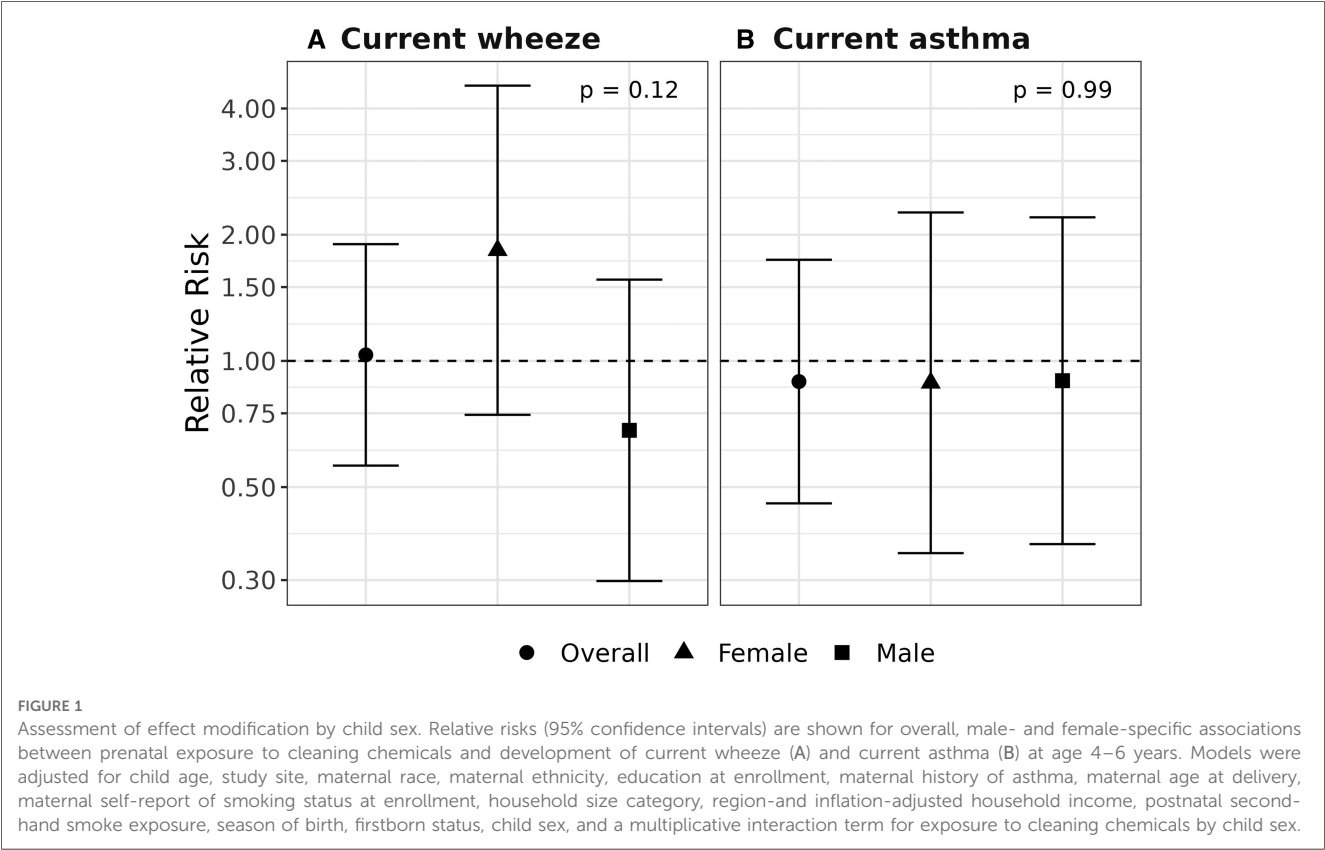
FIGURE 1
Assessment of effect modification by child sex. Relative risks (95% confidence intervals) are shown for overall, male- and female-specific associations between prenatal exposure to cleaning chemicals and development of current wheeze (A) and current asthma (B) at age 4–6 years. Models were adjusted for child age, study site, maternal race, maternal ethnicity, education at enrollment, maternal history of asthma, maternal age at delivery, maternal self-report of smoking status at enrollment, household size category, region-and inflation-adjusted household income, postnatal second-hand smoke exposure, season of birth, firstborn status, child sex, and a multiplicative interaction term for exposure to cleaning chemicals by child sex.

and childhood wheeze or asthma. Our findings suggested a possible sex-specific adverse association between exposure and current wheeze in females, although this result was not statistically significant.

Prior studies have investigated the link between maternal occupational exposures to cleaning products in the prenatal period and childhood respiratory outcomes. Our findings are consistent with results reported by Pape et al., who studied the association between parental occupational pre- and post-conception exposure and asthma in 3,985 offspring participating in the Respiratory Health in Northern Europe, Spain and Australia generation study (24). The authors found that parental occupational exposure to reactive chemicals, including disinfectants and cleaning chemicals, in pre- and post-conception (including the prenatal period) was not related to offspring asthma at 0–15 years of age. While maternal exposure to reactive chemicals increased the odds for early-onset asthma (0–3 years) [odds ratio (OR) 1.65, CI: 0.98, 2.77], no association was found for maternal chemical exposures and late-onset asthma (4–15 years) (OR 1.03, CI: 0.73, 1.45). The latter corresponded to a more similar child age group to our study population. Tagiyeva et al. found that maternal prenatal occupational exposure to biocides/fungicides was associated with wheeze at medium/high intensity exposure (OR 1.23, CI: 1.07, 1.40), but not with wheeze at low exposure intensity (OR 1.06, CI: 0.93, 1.20), asthma at low exposure intensity (OR 0.96, CI 0.79, 1.17) or asthma at medium/high exposure intensity (OR 1.20, CI: 0.98–1.47) in 7,088 children at 7 years of age (23). Christensen et al. found that prenatal exposure to low molecular weight (LMW) agents, identified as an exposure based on job codes for cleaners, had a borderline non-significant adverse association with asthma in 7-year-old children in the Danish National Birth Cohort (22). However, both maternal postnatal exposure to LMW agents and the combined effects of prenatal and postnatal exposure were associated with asthma. In contrast, Tjalvin et al. found that maternal occupational exposure to cleaning agents starting before conception and continuing through pregnancy were associated with childhood asthma: (OR 1.56, CI: 1.05, 2.31), childhood asthma with nasal allergies (OR 1.77, CI: 1.13, 2.77), and childhood wheeze and/or asthma (OR 1.71, CI: 1.19, 2.44) before 10 years of age among 3,318 children in two multi-national cohorts (10).

Previous studies investigating non-occupational exposures to cleaning products during pregnancy and childhood asthma and allergic disorders offer useful paradigms for comparison when evaluating our results. These studies also yielded mixed results. Bably et al. analyzed 400 children with a mean age of 6 years (SD 2.9) from Pakistan and demonstrated an association between prenatal exposure to scented cleaning products or perfume in the home with nocturnal cough among children, but not current asthma status or nocturnal symptoms of wheezing, shortness of breath, and chest tightness (40). In a study investigating household use of cleaning products during pregnancy, Casas et al. found that use of sprays or air fresheners was associated with higher prevalence of lower respiratory tract infections (LRTI) and use of sprays or solvents during pregnancy was associated with a higher prevalence of wheezing in the first year of life (41). Sherriff and colleagues reported a dose-dependent relationship between prenatal domestic use of chemical products, including disinfectants, cleaners, and fragrances, and persistent wheezing in the first 3.5 years of life, though significance differed by wheeze phenotype (42).

Biological mechanisms by which cleaning chemical exposure during the prenatal period affect respiratory health in children are not fully understood. Many cleaning products contain both irritants and sensitizers (9). The main sensitizers contained in cleaning products are disinfectants, quaternary ammonium compounds, amine compounds, and fragrances, whereas airway irritants in cleaning products include bleach, solvents, hydrochloric acid, alkaline agents, and phthalates all of which are commonly mixed together (9, 43). Many cleaning agents are LMW chemicals and are lipophilic, so transplacental diffusion may alter fetal airway development (10, 44, 45). Several human studies suggest maternal cytokines, specifically cytokines released from CD4+ Th2 T helper cells and type 2 innate lymphoid cells, mediate childhood asthma risk; however, whether this association is due to maternal cytokines passing through the placenta from maternal to fetal circulation or by modulating placental cytokine release is not clear (3). Another review found that prenatal exposure to common environmental allergens and chemicals, including tobacco smoke, organic pollutants, metals and outdoor air pollutants, may alter distributions of immune system cells, immunoglobulins and cytokine patterns in neonate cord blood (8). This derangement was postulated to result in predisposition of infants to respiratory infections during the early postnatal period and potentially an increased risk of wheeze and asthma in childhood.

Sex-dependent biological mechanisms have been implicated in asthma development (26). Prior findings have been mixed regarding effect modification by sex in the relationship between prenatal environmental exposures and child airway outcomes (27, 28) but few studies have specifically focused on prenatal occupational exposure to cleaning chemicals. Similar to our results, Christensen et al. did not find effect modification by child sex in the association between occupational exposure to LMW agents and childhood asthma (22). The prevalence of asthma is higher in boys than in girls in pre-adolescence, though the mechanism by which sex hormones regulate asthma pathophysiology is complex and requires further investigation (21, 46).

Excluding GAPPS 4–6 recall survey data and adjusting the main model for cotinine and/or bronchiolitis altered the effect estimates from less than one to greater than one. The greatest change was in the association between exposure and current asthma; after adjusting for bronchiolitis, the estimated risk ratios approached 2, though the CIs widened significantly potentially due to reduced sample size. Acute LRTI such as bronchiolitis during infancy has been found to be a strong risk factor for childhood asthma (1, 47, 48). More research on the relationship between environmental factors, including prenatal occupational cleaning product exposures, and early childhood LRTI and asthma is warranted.

Because our characterization of mothers' cleaning chemical exposure was based on a composite measure that included job category, specific task, and frequency of chemical use, we separately examined two classifications of exposure, defined by single survey questions, as a sensitivity analysis. While the questionnaire did allow for more granular and comprehensive ascertainment of mothers' exposure by including specific tasks and frequency rather than a single job title or category, mothers may have been misclassified as not exposed based on the wording of the questions. As in studies defining exposure through job exposure matrices, in which job titles constitute a proxy for exposure to specific agents and average exposures are often based on expert evaluation of job category, any exposure misclassification is likely to be non-differential, biasing the association towards the null (10, 24). There were very few (N = 10) respondents who worked as a janitor or house cleaner, suggesting that we were underpowered to investigate routine, intense occupational exposure. Furthermore, this group exhibited complete overlap with those who cleaned floors, sinks or toilets at her job, so they could not be disaggregated for separate analysis. While none of the associations reached significance, the effect estimates for those who cleaned floors, sinks or toilets at their job were less than one, whereas the effect estimates for those who used janitorial chemicals or cleaners at their jobs some days or every day were greater than one. This suggests that improved exposure classification that better approximates "dose" through frequency of use and more specific chemical data vs. more crude measures based on job duties or job type are important considerations for future research.

Our study had several strengths. Our findings contribute to a very limited and mixed literature on maternal occupational exposures, specifically during the prenatal period, and child airway health. We were able to examine the association between prenatal exposure to occupationally associated cleaning chemicals and risk of developing childhood wheeze and asthma in a U.S. based cohort comprising several cities with robust adjustment for mother and child demographic, behavioral and socioeconomic covariates and potential confounders (29).

Several limitations should be considered. Maternal occupational exposures during pregnancy were assessed retrospectively at visits with existing knowledge about whether the respiratory outcomes had occurred, which may introduce recall bias. Despite having a robust set of covariates known to influence asthma risk, we did not have data on other chemicals and products that mothers could have been exposed to associated with occupational use of cleaning chemicals or outside of work. The specific wording of the job information could include a myriad of job tasks, and occupational cleaning tasks could also confer more or less exposure to other agents, such as dust, animal dander, microbes, indoor air pollutants, all of which may impact risk of childhood asthma. Our exposures of interest in the prenatal period were highly correlated with those in the preconception and postnatal period; however, we did not have the power in this study to differentiate exposure periods to

perform separate analyses. Thus, despite inclusion of numerous covariates in our models, we cannot rule out residual confounding by other factors. Furthermore, we were unable to control for application method, dose, job duration, or use of protective equipment. The sample size and number of outcomes in our final study population limited our statistical power to detect differences among exposed compared to non-exposed. The outcomes of interest were only observed among mothers who identified as White, Asian and other race and these race categories along with median income of the overall sample (>$100,000) limit generalizability of this analysis, especially given that asthma has been found to be more prevalent among Black and Hispanic children and among children living in households with lower income (49). Finally, diagnosis of asthma in children can be challenging especially in younger ages, though our study population was comprised of children at or near school age where clinical history allows more confident detection despite lack of more objective measures such as spirometry. Child airway outcome definitions may be influenced by caregiver recognition of symptoms in their children, healthcare access and utilization, and accurate recall of symptoms, medications, and diagnoses at the time of ISAAC survey administration. However, any outcome misclassification would have likely been non-differential with regards to exposure. Furthermore, symptom-based history is a broadly accepted approach to childhood asthma diagnosis and our questions were derived from the validated ISAAC questionnaire (32, 33) which remains the most widely used across the globe standardized survey to assess asthma in children (27, 28, 35, 50–54).

Childhood asthma is a chronic disease and serious public health problem that can have significant lifelong health implications. The prenatal period is a crucial period during which environmental influences, including maternal occupational exposures, can shape child respiratory health. Given the widespread use of cleaning products, amplified during the COVID epidemic, research is needed to address the role of maternal occupational exposure to specific compounds found in cleaning chemicals on offspring respiratory outcomes. Future studies should investigate more diverse and representative U.S. populations and larger sample sizes to inform our understanding. Better characterization of exposure to include ingredients of cleaning products are needed, and future studies should include more quantitative assessment of exposure, including dose, timing, and duration. Such data can better inform appropriate strategies for protecting pregnant individuals from potentially hazardous occupational exposures.

In conclusion, we did not find support for our hypothesis that maternal report of occupations using cleaning chemicals or use of cleaning chemicals at work is associated with childhood wheeze or asthma in the ECHO-PATHWAYS combined cohort, nor did we find statistically significant evidence of sex-specific associations. However, our results provide support for needed further investigation in other cohorts. Our study contributes to the emerging body of literature of prenatal occupational exposures and risk of adverse child health outcomes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by University of Washington Institutional Review Board. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

ARS, CK, CL, MH, and LD contributed to conception and design of the study. ARS and LD obtained and organized the data and performed statistical analysis. MH wrote the first draft of the manuscript. AAS, ARS, CK, CL, EB, KC, LD, MA, MH, PM, and RN revised the manuscript and/or contributed critical content expertise and/or study design knowledge. All authors contributed to the article and approved the submitted version.

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Conflict of interest

AAS received funding from the National Institutes of Health (NIH) and the Health Effects Institute (HEI). Neither the NIH nor HEI were involved in the study design, collection, analysis, interpretation of data, the writing of this article, or the decision to submit it for publication. All other authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fepid.2023.1166174/full#supplementary-material.

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Parenting and pandemic pressures: Examining nuances in parent, child, and family well-being concerns during COVID-19 in a Canadian sample

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Introduction: The COVID-19 pandemic has caused vast disruptions in family life for Canadian parents since early 2020. While numerous environmental stressors have been identified, including job loss and the demands of balancing work-life conflicts and at-home schooling, relatively less is known about the areas of family life parents are most concerned about and how these worries relate to well-being across the family system.

Methods: Canadian parents ($n = 29{,}831$, 90.29% mothers, 57.40% Ontario residents) of children aged 0−14 were surveyed about their concerns related to child, parent, and family well-being in June 2020. Structural equation modelling was used to model the relationship between concerns about children, parenting, and the whole family, in association with several sociodemographic variables including child disability status, parent sex and education, job loss during COVID-19, and caregiver employment.

Results: Parenting, child, and family concerns were positively correlated. Higher child and family concerns were reported by parents who had not attended university, those who had experienced employment loss or reduced hours, and families with all adults working outside the home. Parents of children with a disability reported higher concerns across all three domains: child, parenting, and family psychosocial well-being.

Discussion: These results showcase distinct associations between social determinants of health and the types of worries caregivers exhibited across multiple areas of family life during the first wave of the COVID-19 pandemic in Canada. Findings are interpreted in relation to clinical intervention and public policy targets for families.

KEYWORDS

COVID-19, family, well-being, parenting, child health, Canada

Introduction

Parents and families have been adversely impacted by the COVID-19 pandemic [1]. Seismic shifts in daily life have occurred since early 2020, with changes to work-life schedules, at-home schooling, and public health mandates [2, 3]. Because of lockdowns and repeated disruptions to social and economic life, the prominence and multiplicity of stressors has led to strain across social, emotional, and occupational contexts for many Canadian families [1]. However, there is still a paucity of research explicating the specific areas of family functioning parents are most concerned about, and how sociodemographic vulnerabilities relate to caregiver worries [4]. There are widely used models of how

adversity impacts family relationships [e.g., the family stress model, (5)]; however, far less is known about how COVID-19 has led to particular areas of parental concern (6). Most of this work has focused on caregiver "anxiety" in contexts of clinical levels of distress, thus there is a need to better understand and document the population-level, non-clinical (i.e., normative) concerns that all families are facing in order to extend working models of family stress within the pandemic context (7–10). This study sought to apply a family systems lens to the study of Canadian families during the pandemic by (a) modelling the dimensional structure of child, parent, and family well-being concerns, and (b) exploring the relation between sociodemographic factors (i.e., social determinants of health) and parents' levels of worry in different domains. This research will provide timely clarification regarding the specificity of stressors experienced by Canadian families during the first wave of the pandemic and their associations with child, parent, and family well-being.

Parenting under pandemic pressures

Developmental science and family research is regularly focused on identifying the ways in which adversity "*gets inside the family*" (p. 398) (11). Within the family stress model framework, parents' experiences of stress and adversity (such as poverty, disaster, recession, or the pandemic) pose risks for a suboptimal environment within the family home through increased levels of couple conflict and harsh or insensitive parenting, with cascading effects on parent and child mental health and overall well-being (4, 5). Parents often experience immense pressures related to ensuring their family manages well amidst stressors and crises; thus, their relative well-being during these times may become compromised and serve to increase risks towards maladaptive patterns of adjustment (4, 12).

Increased incidence of mental health challenges has been a widespread consequence of COVID-19-related disruptions to daily life, and Canadian parents have been identified as especially vulnerable to pandemic-related stress (1). Given the myriad personal, economic, occupational, and health-related stressors many are facing during the pandemic, it is valuable to explore parents' specific perceptions of these challenges, including the factors that are associated with their variation. A recent study found evidence to demonstrate shared risks between caregiver burden, parent mental health, and deleterious impacts to the parent-child relationship during the pandemic (13). A systematic review and meta-analysis of maternal mental health in mothers of young children found high prevalence estimates of clinically significant depression (26.9%) and anxiety (41.9% overall; 36.4% after adjusting for publication bias) which were markedly increased from pre-pandemic rates [17% and 15% respectively (9)]. Further, child-specific health behaviours have also been associated with parent psychological well-being. McCormack and colleagues (7) studied self-reported anxiety levels surrounding the pandemic in Canadian parents and found that higher anxiety levels were associated with fewer health promotive physical activities and increased duration of sedentary behaviours in

children. This pattern of results suggests that even subtle fluctuations in parent stress and psychological well-being are associated with widespread changes across the family unit (2).

Vulnerabilities towards child maladjustment during COVID-19

Canadian children were identified as being less vulnerable to experiencing COVID-19 medical complications compared to older-aged adults (14). However, children have faced significant disruptions to routines and family-life, access to education, and other supports during this time, rendering them vulnerable to the onset or exacerbation of existing mental health difficulties (15). A survey of 350,000 parents in the United States found pervasive mental health challenges for children that had increased since school closures near the start of the pandemic (16). Compared to pre-pandemic levels, parents reported a greater prevalence of mental health challenges in their children (anger, anxiousness, depressed or low mood, loneliness), less positive adjustment (positive social relationships, hopefulness, outlook, overall demeanor), and less positive family interactions (sibling and whole-family dynamics), demonstrating systemic impacts from pandemic-related stressors across layers of the family system and developmental ecology (16).

Numerous studies during the pandemic have brought attention to concerns for children's academic and social development, following school closures and shifts between online and in-person schooling. According to a United Nations (17) report on global education impacts, COVID-19-associated academic losses have been considered "*the largest disruption of education systems in history*" (p. 2). They estimated that almost 1.6 billion students across more than 190 countries have faced partial or complete loss of access to education during this period. In addition to educational losses, many children lost access to daycare, extracurricular activities, learning supports, and opportunities for socialization outside of the family unit (18). These disruptions were enduring and significantly negative for many children, with lost opportunities for meaning-making, socialization, and personal and academic development (19).

Whole-family impacts of pandemic-related stressors

Though often understudied in the epidemiological literature, the family system is an emergent whole that warrants analysis as a unique and distinct entity, not merely reducible to "children and parents" (20, 21). Numerous studies have identified an ambient, family-wide relational climate in the domains of emotional positivity and negativity, sensitivity in relationships, and other interpersonal processes such as attachment and perceived closeness (22–24). For many, the family home became the hub, not only for family life, but also work, schooling, leisure, socializing, and other everyday tasks during pandemic-related closures and lockdowns. As such, families may have been

susceptible to greater "spillover" of stress between domains like work and family relationships (25). Thus, applying a family-level framework when evaluating parents' COVID-19-related worries may be particularly informative for understanding how families are coping during the pandemic.

A qualitative study of families in Australia in April 2020 found that some families reported positive consequences from COVID-19 life changes (26), keeping with the concept of family resilience (27). These included greater shared workload between partners at home, increased family time and opportunities for relational connection, and a slower pace of life. Conversely, other families in the study commented on the struggles of social isolation, immunocompromised family members and worries about infection, financial burdens, balancing work, parenting challenges, and reduced (or lack of) access to psychological and physical health supports for their children.

Multinational Canadian research on family adaptation during the pandemic echo Evans et al.'s (26) findings. Based on a dataset with families from the United Kingdom, United States of America, Canada (4%), and Australia, Shoychet and colleagues (28) found several positive factors associated with family-wide benefits from COVID-19 including prioritizing family more than work, finding new meaning in life, and engaging in new family activities. Notwithstanding, another recent study of multi-level family stress and COVID-19 disruption from the same sample identified that experienced disruptions to well-being during this period were associated with differences in parenting quality and mental health status between siblings in the same family (29). From such investigations, it appears that families experienced increased stress on the one hand, and enhanced connectedness on the other. Certainly, there is widespread variability in the ways in which families were impacted by the pandemic, particularly for vulnerable groups such as single-parent families and those facing systemic barriers like poverty, racism, or marginalization (4). Further evaluation of specific factors impacting whole-family resilience and well-being will be especially valuable in understanding how to best support families as COVID-19 restrictions ease.

The current study

This study sought to identify the domains of parents' concerns during the COVID-19 pandemic, while exploring the sociodemographic factors that were related to those unique areas of worry. By modelling child-specific, parenting, and whole family areas of concern, this work is unique in that it offers multilevel conceptualizations of parent concerns for family well-being, while also considering social determinants of health that have been associated with increased stress and hardship. To date, much research has demonstrated the deleterious impacts of COVID-19 across the world; however, limited research has explored multiple levels within the family system and sought to isolate disparate sources of worry. This analysis was informed by two primary research questions: (1) What is the relationship amongst caregivers' concerns with parenting, children, and

family? and (2) How do parent and family sociodemographic variables (e.g., economic factors, parent sex, child disability) relate to parent concerns for child-specific, parenting, and whole family well-being during the COVID-19 pandemic? Our hypotheses and analytic plans were pre-registered and can be accessed at: https://osf.io/x89cd.

Materials and methods

Sample

We used the *Impacts of COVID-19 on Canadians—Parenting during the Pandemic* dataset from Statistics Canada for this study, which asked parents about their parenting experiences between March-June of 2020. The *Impacts of COVID-19 on Canadians* study survey was open to participation from all adults across Canada who had a child under the age of 15 years residing in their home. Parents were recruited through online crowdsourcing (e.g., social media and outside parties like government agencies and news outlets) and data collection occurred through an anonymous Statistics Canada portal. Recruitment was initiated by Statistics Canada as the 5th iteration of crowdsourcing data collection cycles, with the goal of inviting participation from any parent in the Canadian population who met the above criterion. Participants were not randomly selected and, as such, interpretations from these data are limited to the sample that was studied and may not be reflective of all Canadian parents of a child under 15 years. The sample included $N = 32,228$ parents who participated in the survey, which asked parents about their parenting experiences between March and June of 2020. This dataset is publicly available, and Statistics Canada has previously conducted and disseminated certain analyses [e.g., (30–32)], though the research questions from this study have not been examined.

Procedure and measures

Sociodemographic variables

Sociodemographic variables of interest in this study included parent sex, child disability status, and economic factors (e.g., parent education, job loss, and whether families were working inside or outside the home). In accordance with Statistics Canada's confidentiality guidelines, several sociodemographic variables were collapsed across responses to limit disclosure risk. Descriptive statistics are reported in Table 1. Regarding parent sex, parents were provided with the response options of male, female, or gender diverse. Due to limited responses, gender was benchmarked to sex and gender diverse responses were randomly assigned to either male or female by Statistics Canada for participant confidentiality. Parents in this study were categorized into four age groups by Statistics Canada: 15–34 years (19.68%), 35–44 years (64.05%), 45–54 years (15.49%), and 55+ years (0.78%).

TABLE 1 Descriptive statistics for study variables.

Variable & level		% or M	SD
Parent sex	Male	9.70	–
Child with a disability	No	83.21	–
Parent education	Did not attend university	24.14	–
Job loss or reduced hours	No	60.96	–
Employment structure	Inside home	49.12	–
	Outside home	16.36	–
	Mixed	34.52	–
Child health		1.99	0.83
Child loneliness		2.69	0.88
Child mental health		2.54	0.88
Child school/academics		2.32	1.00
Child socialization		3.04	0.82
Parent balancing		3.15	0.92
Parent managing child behaviours		2.80	0.90
Parent patience		2.54	0.94
Family connection		2.45	0.77
Family supportiveness		2.27	0.89
Family loneliness		2.07	0.98

Values reflect the number of complete cases within each level of the variable, after exclusion of missing data (i.e., "Not Stated" and "Not applicable" responses) and multivariate outliers. The range for all concern variables was 1 (Not at all concerned)–4 (Extremely concerned).

For parent education, parents were asked to report the highest level of education they had attained, ranging from "less than high school diploma or equivalent" to "University certificate, diploma, or degree above the BA level." Responses were dichotomized by Statistics Canada into a binary variable reflecting whether parents had or had not completed university-level education. Similarly, for job loss, parents were asked to endorse yes or no to the following statement: *Someone in my family lost their job, was laid off, or has reduced work hours due to COVID-19*. To ascertain employment structure of working individuals in the home, participants were asked to endorse yes or no to the following statements: *Someone in my family is working at a fixed location outside the home; Someone in my family is working outside the home with no fixed location; Someone in my family is working from home*. Statistics Canada then collapsed the responses into 3 options for the publicly available data file: *All family members working are doing so from home*; *All family members working are doing so outside the home*; and *Mixed*. Unfortunately, no other data were collected to identify change in job role (i.e., individuals who were previously working from home prior to the pandemic).

The majority of respondents in this study were Ontario residents (57.40%), with a smaller percentage of participants from British Columbia (12.85%), Alberta (8.93%), Quebec (7.50%) and Nova Scotia (5.20%). Very few participants in this study were from other provinces and territories (<5% each from Newfoundland and Labrador, Prince Edward Island, New Brunswick, Manitoba, Saskatchewan, and the territories). Related to child age, parents were asked to report on the age brackets of children in their home (unfortunately no data was available on how many children each parent cared for). In this sample, 61.37% had a child(ren) aged 0–5 in the home and 64.14% had a child(ren) aged 6–14 in the home (see the *Missing Data* section below). Related to older teens and adult children, 8.95% of participants had a child(ren)

aged 15–24, though parents were only asked to report on concerns for their children aged 0–14 in this study.

For child disability status, parents were asked whether a child under the age of 15 in their home had a disability. This included permanent physical disabilities, cognitive, behavioural, or emotional disabilities, the option to select "other disability," or "no disability." Responses to this question were collapsed into a dichotomous variable based on whether parents disclosed the presence or absence of any child in the home with any type of disability. Though not available in the data used in the present study, another analysis of this dataset identified that, of the parents reporting that a child in their home had a disability, 84% endorsed a cognitive, emotional, or behavioural disability, with a smaller proportion of parents reporting a permanent physical disability (4%), other disability (7%), and/or at least two types of disabilities (6%) (30). The data in this study are not able to clarify whether children had more than one type of disability and do not inform whether more than one child in the home had a disability (30). These limitations are respectively due to redacted demographic information in the publicly available dataset and the wording of the survey question related to disability, which only asked a binary (yes/no) question about the presence of *any* child in the home with a disability.

Concern variables

Child concerns were assessed through five items. Parents were asked, *Due to the COVID-19 pandemic, how concerned are you about the following for your child or children aged 0–14 years?* for the following domains: general physical health, general mental health, loneliness or isolation, school year and academic success, and opportunities to socialize with friends. For child concern questions, if parents had more than one child, they were asked to report the response that best captured their level of concern across all children in the home aged 0–14.

Parenting concerns were assessed through three items. Parents were asked, *Due to the COVID-19 pandemic, how concerned are you about the following for your family?* for the following domains: Balancing child-care, schooling and work; managing your child's or children's behaviours, stress levels, anxiety, emotions; and having less patience, raising your voice, scolding or yelling at your child or children. With the same starting question, parents were also asked about their degree of concern for several whole-family domains: staying connected with family or friends; getting along and supporting each other; and feeling lonely in your own home. For all concern questions, parents provided responses on a scale ranging from (1) *Not at all* to (4) *Extremely*. Parents were also able to select (5) *Not Applicable* (for child concern questions only) or skip questions. Such responses, along with missing data, were excluded from the final analysis.

Analysis

We conducted descriptive statistics in SPSS v. 28 (**Table 1**) and structural equation modelling in Rstudio version 1.2.5033 using the *lavaan* package (33, 34). We applied survey weights from Statistics Canada in the analysis of this dataset with the *lavaan.survey* package (35). When multivariate outliers were assessed with the

Mahalanobis Distance Test (which uses complete cases only $n =$ 29,702), 2,397 multivariate outliers were found at the $p \leq .05$ level, these were removed, leaving a sample of 29,831 from the original 32,228. The final sample size included 27,305 complete cases after removing both outliers and missing data (see section below).

Confirmatory factor analysis was used to explore the hypothesized associations between parent concerns, child concerns, and family concerns. Parent responses to concern questions in the survey were respectively combined into three latent variables reflecting concerns for child(ren), parenting, and family well-being (see Figure 1). Maximum likelihood estimation with robust standard errors (MLM) was used due to restrictions

with *lavaan-survey* package not correcting the standard errors in the chi-square statistic with regular maximum likelihood estimation. MLM uses the Satorra-Bentler chi-square correction statistic (36). The use of Full Information Maximum Likelihood (FIML) estimation for missing or incomplete data is not currently available with the use of survey weights in *lavaan* (37). To explore any potential differences that would have resulted from the use of this function, the measurement model (Figure 1) was tested without survey weights, using FIML (which included all cases with "missing" or "Not Applicable" responses); the fit statistics were nearly identical to the retained model. A likelihood ratio test was not able to be completed in this case due to differing sample sizes between models. When the structural
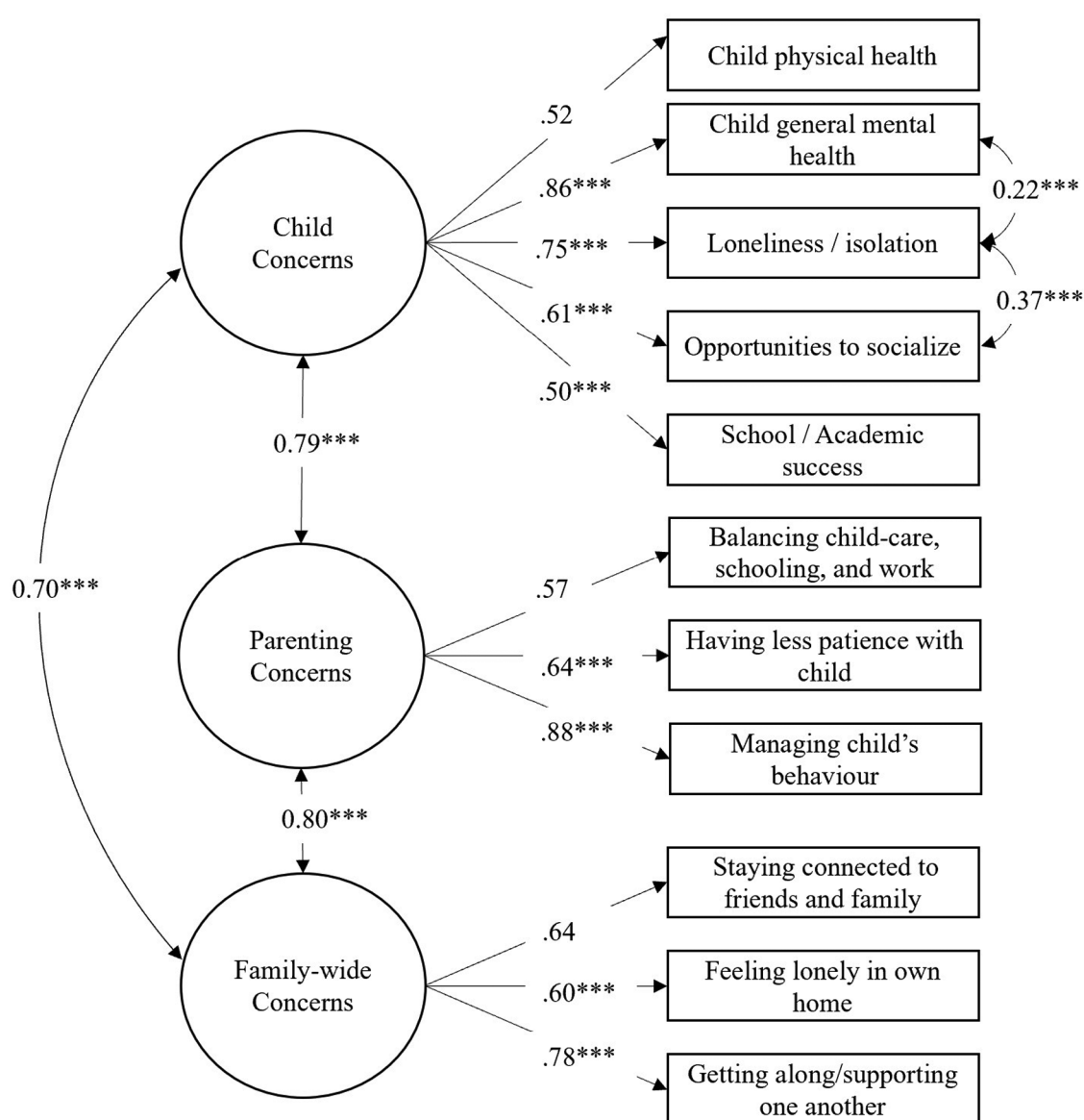
FIGURE 1
Measurement model. Circles reflect latent variables, boxes reflect factors. Double-sided arrows reflect correlations, single-sided arrows depict factor loadings. Standardized estimates reported, restricted sample depicted—without multivariate outliers. For each factor, the first indicator was fixed to 1.0. Within-factor correlations for the *Child Concerns* latent variable were added based on consideration of modification indices and theoretical justification. ***p < .001.

model was tested with additional regressions with the full sample, a similar pattern was observed. Ultimately, for the results to be consistent with other published analyses of this dataset, we applied survey weights in the analysis without the use of FIML to handle missingness.

For the measurement model, we constructed three correlated factors (parenting concerns, child concerns, and family concerns) using the respective survey items (described above) as reflective indicators, and allowed the factors to covary. To reflect the bidirectionality and reciprocal influence between levels of the family system (consistent with existing theoretical models and empirical research) correlations between the latent variables were retained in the structural regression model (20, 24). This specification diverged from the pre-registered analytic plan to include regressions from the parent concerns to child and family concern variables, for the sake of parsimony and interpretability of results.

In the structural regression model, we regressed all three latent variables (child concerns, parenting concerns, family concerns) onto the sociodemographic variables within the model (which were dummy coded). These included: child disability status (0 = no child disability, 1 = child with a disability); parent education (0 = did not attend university, 1 = did attend university); family employment with all adults working inside the home (1), outside the home (2), or mixed employment structure (3); job loss or reduced hours (0 = did not experience, 1 = did experience), and parent sex (0 = male, 1 = female). For interpretability, after the original model was run, the family employment variable was re-coded into 3 dummy variables and multiple contrasts were run, to ascertain the differences between all three levels: inside the home compared to outside of the home, outside the home compared to mixed working arrangement, and inside the home compared to mixed working arrangement, with the first value of each variable coded as 0 and the second as 1. As such, the reference variable changed between contrasts. The following specifications were utilized to evaluate model fit: a non-significant chi-square test, Comparative Fit Index (CFI) ≥ .95, Root Mean Square Error of Approximation (RMSEA) < .06, and Square Root Mean Residual (SRMR) < .08 (38).

Missing data

The dataset contained few missing responses (between 22 and 52 cases, <1%) across all concern variables due to skipped questions. Similarly, across all but one of the five child concern variables (concern for children's school/academic success), a very small number of participants selected "Not Applicable" for their responses (between 87 and 103 cases). Conversely, there were 2120 cases (7.12%) where parents reported "Not Applicable" for concerns related to children's school/academic success, resulting in missing data from the dataset. Of parents who reported "Not applicable" for concerns related to children's academic success, 99.48% ($n = 2,109$) were parents who also reported having a child (ren) aged 0–5 years old in the home. Similarly in this subgroup, a very small proportion of respondents reported having a child

(ren) aged 6–14 ($n = 16$, 0.7%), suggesting that these responses were selected by parents of infants or young children that were not yet attending school. To explore how the absence of data related to the child concerns variable impacted the overall distribution of parents of children of varying ages, we ran separate frequencies to assess child ages with this exclusion specifically; however, the final analysis excluded any case with missing data across any variable. Thus, the final sample is approximately composed of parents of a child(ren) aged 0–5 years (40.8%), 6–14 years (72.7%), and 15–24 years (11.4%).

Results

When the original measurement model was fit and tested, it achieved adequate model fit ($n = 27,305$; $\chi^2(41) = 6,333.36$, $p < .001$, CFI = .92, RMSEA = .094 (CI = .092–.095), SRMR = .041). All three latent variables were significantly positively correlated (Child and parent concerns: $r = .76$; child and family concerns: $r = .69$, parent and family concerns: $r = .80$; ps < .001) and all the specified factor loadings for each latent variable were statistically significant (ps < .001; Figure 1). Modification indices suggested adding within-factor correlations between several indicators: (1) between concerns about child loneliness and child opportunities to socialize, and (2) between concerns about child loneliness and child mental health. Given that these were theoretically justified, these two correlations were added to the model, which significantly improved model fit [Likelihood ratio test: $\chi^2(2) = 1,383.7$, $p < .001$, note, this test compares the *non-adjusted* chi-square statistic between both models]. Fit indices for the adjusted model were as follows: n = 27,305; $\chi^2(39) = 4,696.19$, $p < .001$, CFI = .94, RMSEA = .082 (CI = .080–.084), SRMR = .040. The correlation matrix for the data can be found in the Supplementary Material accompanying this article. Similarly, when the structural model was tested with the addition of regressions for the sociodemographic variables, the model fit was within the acceptable range, though the CFI was slightly lower than the recommended ≥.95 cut off: $n = 20,244$; $\chi^2(79) = 4460.84$, $p < .001$; CFI = .924; RMSEA = .065 (CI = .063–.067); SRMR = .034 (38).

Several significant associations were found when the path model was tested (see Table 2 for path estimates). As in the measurement model, parenting concerns were positively correlated with family ($r = .80$) and child concerns ($r = .77$), and family and child concerns were also positively correlated ($r = .68$, ps < .001). No significant parent sex differences were found for any of the parent concern variables. Though parents demonstrated commensurate *degrees* of concern for child, parenting, and family-based factors, additional exploratory analyses were conducted to identify patterns in the sociodemographic *predictors* of concerns between male and female caregivers by re-running the analyses in sex-separated subsets of the data (see the accompanying Supplementary Material). When these analyses were conducted, many of the associations were non-significant for male caregivers. Other associations were maintained from the original model but were

TABLE 2 Structural regression model parameter estimates for social determinants of health in association with parent-reported concerns.

Variable	Child concerns		Parenting concerns		Family concerns	
	Unstandardized (SE)	Standardized	Unstandardized (SE)	Standardized	Unstandardized (SE)	Standardized
Male (vs. Female)	0.01 (0.12)	0.00	0.03 (0.02)	0.02	−0.01 (0.02)	−0.01
Completed university	**−0.06 (0.01)**	**−0.07*****	0.01 (0.01)	0.00	**−0.05 (0.01)**	**−0.04*****
Job/hours loss	**0.03 (0.01)**	**0.04*****	0.01 (0.01)	0.01	**0.07 (0.01)**	**0.7*****
Child disability	**0.16 (0.01)**	**0.17*****	**0.20 (0.01)**	**0.15*****	**0.08 (0.01)**	**0.07*****
Employment						
In vs. out	**0.03 (0.01)**	**0.04****	**−0.07 (0.02)**	**−0.06*****	**0.05 (0.01)**	**0.4*****
In vs. mixed	**0.03 (0.01)**	**0.04*****	0.01 (0.01)	0.01	0.01 (0.01)	0.01
Out vs. mixed	0.00 (0.01)	0.00	**0.09 (0.02)**	**0.08*****	−0.03 (0.02)	**−0.03***

Note: Variables were dummy coded such that **males**, parents who **did not** complete university, parents who **did not** experience job loss and those **without** a child with a disability were all coded 0.
Significant paths bolded: *$p \le .05$, **$p \le .01$, ***$p \le .001$.

reduced in magnitude (e.g., Child disability predicting higher child and parenting concerns, job loss predicting higher family concerns, and mixed employment structure being associated with higher child concerns than when all adults were working either inside or outside of the home).

Specific to economic factors, parents who had not attended university and parents who had experienced job loss or reduced hours during the pandemic reported greater family and child concerns in this sample, with non-significant differences for parenting concerns. Regarding child disability status, parents who had a child under 15 with a disability reported more concerns across all three variables, with significantly greater child, parenting, and family concerns than parents without a child with a disability in the home.

Subsequently, this model was re-run in three iterations to test the differences between all 3 levels of the employment structure variable with dummy coding [0 = inside vs. 1 = outside the home ($n = 14,087$); 0 = inside vs. 1 = mixed employment structure ($n = 16,785$); and 0 = outside the home vs., 1 = mixed employment structure ($n = 9,616$)]. Parents of families with all adults working outside of the home reported greater concerns for family and child well-being compared to families where all adults were working inside the home. They also reported more family concerns than parents in a mixed employment structure. Conversely, parents with all adults working inside the home, or in a mixed employment structure, reported a greater number of parenting concerns than families with all adults working outside the home. Lastly, among families where all adults were working inside the home, parents reported greater concerns for child well-being when there was a mixed employment structure, with non-significant differences for parenting and family concerns.

Discussion

This study explored Canadian parents' concerns related to multiple aspects of family well-being during the first wave of the COVID-19 pandemic. In this study, parent worries were clustered in the spheres of child, parenting, and whole-family

well-being and were positively associated with one another. These findings align with other family studies that have explored interpersonal processes within and between levels of family functioning (23, 24). They also support bidirectional relational processes across levels of the family, demonstrating an interplay or "spillover" between parent concerns in one domain and related changes across the family system (39). The results of this analysis support systems conceptualizations of family functioning and clarify unique patterns of whole-family disruption related to sociodemographic factors (12, 20). Our findings depict unique manifestations of parent-concerns, differentially occurring at various levels of the family system, and demonstrate the value of modelling pandemic disruption from a family systems lens.

Sociodemographic stressors on the family unit

This study found several sociodemographic stressors to be associated with parent-reported concerns for well-being across the family system, supporting the tenets of the family stress model framework (12). Our findings also support the putative pathways within the family stress model, which posits increased risk for maladjustment (in this case, degree of parental concerns) in the context of socio-economic pressures—a prominent concern for many families during this time (5, 6). The observed interplay between parent-reported concerns and sociodemographic stressors across spheres of family functioning is critical given that parents were experiencing increased stressors due to difficulty with work-life balance during the pandemic and many children suffered academic, social, and personal losses (4). This suggests that the proliferation of pandemic-related stressors may "get inside the family" through interpersonal exchanges across the family system and may also have a direct impact on parent perceptions of child mental and physical health (29). These results also highlight potential pathways of resilience in the quality of parent-child interactions, aligning with research suggesting that nurturant and involved parenting supports positive child adaptation, even during times of stress and economic risk (4, 40).

Economic factors predicting child and family concerns

This study evaluated several economic factors in relation to parent-reported concerns, including parent education, job loss or reduced hours during the pandemic, and home employment structure. Related to parent education, parents who had not attended university reported a higher degree of family-wide and child well-being concerns. This finding contradicts those of Vogelbacher and Attig (41) who found that higher educated parents reported more stress. However, parents who had not attended university may have been facing greater financial concern during the first wave of the pandemic, which could have led to strain on family relationships and concern for child well-being (though this may not characterize all parents). Parallel findings were observed for job loss or reduced hours at work due to COVID-19 in this study, with affected parents reporting greater family and child well-being concerns than those who had not experienced occupational disruption. Parents in these circumstances were likely to be spending more time at home with fewer role conflicts between work and home (which may underscore the non-significant relationship to parenting concerns); however, they may have also been job-seeking, caring for children or family members, or experiencing non-work-related stressors that could have enhanced the ambient level of stress in the home, limited positive benefits related to increased time for family-bonding, or restricted financial resources for families (25).

Unique differences in family concerns were observed based on family employment structure in this study. Families that had all adults working inside the home or a mixed employment structure reported a higher degree of parenting concerns related to caring for children compared to families with all adults working outside the home. Parents working from home may have experienced both the benefits of at-home presence with children and lower coronavirus infection risk, leading to fewer concerns for child health and family interpersonal dynamics, but also the challenges of juggling the balance of work and childcare, the task of supporting their child(ren) through virtual learning, and/or challenges with a cramped living and working space. Conversely, the greater number of child and whole-family concerns reported by parents working outside compared to inside the home may reflect heightened home-stress or family chaos for parents whose jobs were not hindered in the same way by the lockdown measures (e.g., healthcare workers or those working in essential service sectors that were stressed beyond regular capacity during the pandemic). Parents in these work sectors may have also specifically faced challenges with restricted freedom to take leaves from work (42). As a result, parents working outside the home may have experienced heightened concerns for their own, their children's, and their family's health due to concerns about COVID-19 exposure and loss of opportunities to remain at home with children during this period (43). These parents may have had limited access to daycares and child supervision, which also may have increased concerns about general psychological well-being and

opportunities for early-learning and socialization (43). Collectively, these results align with other studies during COVID-19 highlighting that the overall degree of economic risk posed towards families is associated with disruptions in well-being (44).

Our results showed commensurate levels of concern across mothers and fathers in this sample, related to parenting, child, and family well-being. This similarity is consistent with an analysis of family adaptation during COVID-19 by Shoychet and colleagues (28) who observed that the factor structure of perceived family coping and adaptation during the pandemic was similar across caregiver sex. Results from exploratory analyses demonstrated some, though comparatively fewer significant associations between socioeconomic predictors and the degree of paternal concerns when the statistical model was independently tested in sex-stratified analyses. Overall, this result suggests that female and male caregivers are similarly concerned for child, parenting, and family well-being (a commensurate *degree* of concerns was reported across groups in the same model), and that the *predictors* of those concerns may vary, though the difference in the magnitude of these associations between male and female caregivers was not explicitly measured (i.e., Differences in the statistical significance of parameters between models do not necessarily inform whether those parameters significantly vary from one another). Together, these findings demonstrate the value of considering both maternal and paternal perspectives in family well-being research (45, 46).

Increased need and loss of supports: Parent concerns for children with disabilities

Families of children with a disability were disproportionately affected during COVID-19 due to lack of access to specific services (30). This study found that parents of a child(ren) with a disability reported a greater degree of family, parenting-related, and child well-being concerns than the general population of parents. In another analysis of this dataset focused on Canadian children with disabilities, parents of children with disabilities were significantly more likely to report concerns specifically related to managing children's behaviours and emotional well-being, school year and academic success, and mental health compared to parents of children without disabilities (30). One study on the impact of COVID-19 on families of children with autism found that families more intensely experienced challenges that were present pre-pandemic during the early lockdown periods [aligned with the timeline of data collection in this study (47)]. For many families, pandemic-related closures and lockdowns meant that they experienced disruptions to everyday routines, difficulties managing parent work schedules alongside childcare, delays in receiving assessment or treatment services, and their children requiring more one-on-one support in the absence of school-based and other specialized services (26, 47, 48). Putting these results in context, parents of children with disabilities reported greater concerns across all family domains–both proximal day-to-day challenges during the pandemic surrounding children's academics, time management, or overall psychosocial well-being, and distal family-related concerns

regarding overall interpersonal dynamics and relational well-being within the broader family ecology.

Parental resilience to pandemic pressures

Surprisingly, few of the included sociodemographic stressors were associated with parenting concerns (other than child disability and family employment structure). This pattern overlaps with findings from a longitudinal study evaluating family functioning pre-post pandemic in the United States, suggesting substantial impacts of COVID-19 disruption on child internalizing and externalizing problems and parent depression, but comparatively smaller effects for (co)parenting quality (44). Furthermore, our findings of whole family differences in the absence of detriments to the parent-child relationship also parallel an Australian study of families pre- and post-pandemic between March 2020 and August 2021. Overall and colleagues (49) demonstrated declines in parent psychological and physical health and couple and family functioning across this period (e.g., higher problem severity and family chaos, and less family commitment and cohesion), but found no differences in parent-child relationship quality or parenting practices between lockdowns. It is possible that parent-child relationships were an area of resilience among parents in this sample, buffering them from the risks associated with pandemic-related economic losses (4). Amidst the stressors of the initial lockdowns, parent-child interpersonal dynamics may have been one component of the pandemic over which parents had relatively more control–maintaining sensitivity towards their child(ren)'s needs, enhanced caregiving due to fewer time-demands outside the family home, and increased opportunities for relational connection (26).

More broadly, considering the factor structure of the parent concern variable, the results of this analysis capture child-directed parenting concerns related to balance of schedules and responsiveness to child(ren); it is possible that parents were more concerned about other factors that were not captured in the dataset (and therefore, the analysis) such as pandemic-related food and resource accessibility, the well-being of extended family and friends, or their own mental or physical health [as discussed by Fisher and colleagues (6)]. Furthermore, parenting concerns appeared most prominent for adults at home and those in mixed employment structures. Our findings align with studies demonstrating that parenting challenges are greater in the presence of role-conflicts and when there are fewer coparenting supports (25, 50). They may also be reflective of individual factors such as coping style and personality, which were not measured in this sample but were observed to predict worry surrounding lockdowns in an Italian sample during the first wave of the pandemic (51).

Limitations and future directions

A primary limitation of this analysis is its cross-sectional design, though our results align with other longitudinal studies conducted in the early waves of the pandemic [e.g., (46)]. Future studies should continue to evaluate the long-term family-wide

sequalae that emerge as the response to COVID-19 evolves and families adapt to life with fluctuating pandemic restrictions. Additionally, the dataset used in the present study lacks information pertaining to parent mental health, and child concerns were averaged across all children in the family, precluding analyses of sibling differences and parent psychological well-being. Future studies should consider these factors and continue to apply systems-level conceptualizations of family stress when evaluating family well-being [see (1, 29)]. Due to the sampling design, the results are not necessarily representative of all Canadian parents of a child under 15 and are limited to those included in this sample. Relatedly, though this study included both male and female caregivers, the latter were over-represented. Lastly, due to missing data surrounding school attendance in very young children, our findings may not generalize to single-child households of parents with a child aged 0–5 years.

Relevant intervention and public policy targets

Concerns for well-being were an unfortunately normative experience for many parents during the pandemic. Notwithstanding, parent and child mental health are not isolated to individuals but occur within the interpersonal climate of the whole family system (2, 25). Clinical implications of this work include the application of a family-wide framework to clinical service provision across broad healthcare spheres. These data support that care-providers—particularly for children and families—should be aware of both the family stress and family systems frameworks when considering post-pandemic parenting concerns (20, 40). Our results are complimentary to the findings from a longitudinal study during the pandemic by Calvano and colleagues (52) that advocate for family-oriented intervention efforts to mitigate risks for both parents and children in relation to parent-reported stress and psychological well-being during the course of the pandemic. Thus, it is critical that risk-mitigating policy targets are also considered in view of the results from the current study. Several recommendations are proposed.

1. On-going availability of government funding for those affected by job-loss or reduced employment hours due to pandemic-related closures. The results of this study—demonstrating associations between job loss and enhanced parent concerns for child and family—are aligned with other studies of pandemic-related child and family stress, and the broader family stress model framework that links economic stress and disruptions to family well-being (5, 52). The Canadian Government responded to the COVID-19 crisis with numerous financial support offerings for those affected by job and income loss due to pandemic-related factors. These supports should continue to be available as Canadian citizens face the current post-lockdown recovery period.

2. Enhanced social and financial supports for families with children who have disabilities. These results demonstrate that parents in this group may be particularly vulnerable to enhanced child, parenting, and family well-being concerns during COVID-19 due to loss of external supports and

reduced access to services [e.g., in-person schooling and learning supports, medical, and psychosocial assessment and intervention services, alongside loss of child-care—specific challenges that have been highlighted by this population to date (26, 47)].

3. Increased availability and accessibility of mental health services for parents and families. Though parent mental health was not directly measured in this study, our results demonstrate that sociodemographic factors and COVID-19 stressors were significantly related to the degree of concern parents reported for their family's well-being (including child mental health). Previous studies have identified high prevalence rates of parent and child mental health challenges during the pandemic (1) and these findings demonstrate that parent concern during this time spanned multiple domains of well-being in the family. Thus, increased government funding should be allocated to expanding public access to mental health care for parents and children, particularly for families facing barriers to service access [echoing the recommendations of Racine and colleagues (53) who discuss the limitations of COVID-19-related changes in mental health interventions].

Conclusion

This work is novel as it models multiple levels of family organization, analyzing whole-family well-being from a systems framework. Our findings advance existing research on the pertinence of family-wide analysis in the developmental context and highlight areas of family-need in response to the COVID-19 pandemic (4, 11). Though some studies have explored well-being at more than one level of the family system [e.g., (44)], this study provides nuance and specificity related to areas of parental concern, in addition to the role of various social determinants of health. Using a large Canadian sample ($n = 27,305$), unique insights into the family system emerged: economic risk factors appeared to inform parental worries most prominently for the whole family and child(ren), while fewer parenting concerns were found, demonstrating resilience within the parent-child relationship. These results inform putative pandemic-related pathways of risk for families, reflected in parent worries for children, parenting, and whole-family well-being. Findings demonstrate the value of modelling the bidirectionality and multi-level nature of the family system during and beyond the COVID-19 crisis, depicting points of vulnerability for families during the first wave of this global crisis.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: This data was accessed through the Southwestern Ontario Research Data Centre at the University of Waterloo, accessible at the following link: https://uwaterloo.ca/

southwestern-ontario-research-data-centre/. This enabled access to the Crowdsourcing: Impacts of COVID-19 on Canadians survey data from Statistics Canada through the Odesi platform, accessible at the following link: http://odesi2.scholarsportal.info/webview/.

Ethics statement

The studies involving human participants were reviewed and approved by Data Ethics Secretariat at Statistics Canada. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

Funding

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fepid.2023.1073811/full#supplementary-material.

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Children's activities, parental concerns, and child care service utilization in the early stages of the COVID-19 pandemic

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Introduction: In the early stages of the COVID-19 pandemic, most Canadian provinces and territories enacted public health measures to reduce virus spread, leading most child care centers across the country to limit or halt in-person service delivery. While it is broadly known that the range of activities available to children and youth reduced drastically as a result, research has yet to explore *if* and *how* children's activities shifted in relation to changes in child care arrangements.

Method: Children's activities during the early months of the pandemic were assessed based on parent-report data ($n = 19,959$). Activity patterns were extracted via latent profile analysis. Thereafter, differences in child-care related outcomes across profiles were compared via logistic regression models.

Results: Latent profile analysis yielded three distinct activity patterns: *Screenies* (91.5%) were children who engaged in high amounts of screen use relative to all other activities; *Analog* children (3.1%) exhibited mostly off-screen activities (e.g., reading, physical exercise); and children in the *Balanced* group (5.4%) appeared to pursue a wide variety of activities. Children were more likely to fall into the *Screenies* or *Balanced* profiles when caregivers reported changes in child care arrangements. Moreover, parents of children with *Balanced* activity profiles were more likely to be planning to use child care when services reopened post-pandemic, compared to parents of children in the *Analog* group.

Discussion: The present findings call attention to heterogeneity in children's activities during COVID-19, which should be considered in the context of pandemic-related child care closures. Implications for children, families, and child care services during and beyond COVID-19 are discussed.

1. Introduction

Child care programs provide children with valuable experiences that foster socioemotional, cognitive, and academic growth (1). Unfortunately, this landscape shifted drastically due to service loss during the COVID-19 pandemic, which brought about extensive public health restrictions that significantly limited the range of activities available to children (2). A considerable body of literature has documented sedentary lifestyles in children during the pandemic comprising reduced physical activity and surges in digital media use (3, 4). However, there remains a need for more comprehensive examinations of children's activities during COVID-19 to better understand the wider impacts of reduced child care services on children's daily lives. The present study examined Canadian children's activity patterns and their associations with child care service utilization in the early months of COVID-19. This knowledge will provide insight on how the pandemic has affected

children's opportunities to engage in developmentally enriching experiences, with important implications for post-pandemic planning in the child care sector.

When the World Health Organization declared the COVID-19 pandemic in March 2020 (5), governments across Canada implemented sweeping public health measures (e.g., physical distancing, working from home, and remote learning) to help limit virus spread. Although effective in reducing COVID-19 transmission (6), these restrictions created a myriad of disruptions that redefined normal life. Families with children have been particularly strained by the pandemic's downstream effects on social circumstances, with abrupt school and child care closures ranking among the most significant challenges (7–10). A nationwide survey of the Early Learning and Child Care Service sector in Canada reported that most child care centers and family care homes were closed between April 27 and May 1, 2020 (11). Attendance decreased dramatically in the centers that remained open; median enrolment fell from 50 children pre-COVID-19 to merely 5.5 children during the pandemic. These changes hold significant societal consequences. Child care constitutes a vital element of the circumstances in which children live, learn, and play; accordingly, 7, 2) maintain that "child care is a social determinant of health that crucially impacts the health, development, and economic wellbeing of children and families" [(8), p. 2]. Abundant literature suggests that child care participation facilitates cognitive development and socioemotional adjustment across the lifespan (12–14). Access to child care services also represents an important protective factor that fosters resilience within the family system, particularly for at-risk populations (15–17).

As the pandemic ensued, research from around the world documented striking declines in children's mental wellbeing (18, 19). Child care closures appear to underlie several mechanisms linked to these concerning trends, including increased unpredictability, disrupted routines, decreased in-person socialization, and reduced support from figures outside of the family home (20, 21). A related but currently understudied consequence is a marked reduction in the activities available to children in lockdown. Parents faced the daunting task of keeping their children safe while simultaneously offering activities that promote growth and learning. This was at the forefront of caregivers' minds in the early months of the pandemic. In a survey of caregivers in Pakistan during the pandemic, nearly three-quarters endorsed experiencing stress related to a lack of recreational opportunities for their children (22). Likewise, Lee et al. (10) reported that parents in the United States were most worried about the impacts of reduced physical activity, increased social isolation, and the loss of enriching experiences (e.g., extracurricular classes and religious services) on their children's wellbeing. Other studies highlighted increased sedentary screen use alongside reductions in physical activity as prominent sources of apprehension (23, 24). While concerning, these changes were inevitable (25, 26) and must be considered in tandem with the other activities in which children engaged. For example, Moore et al. (27) reported that Canadian children found creative ways to use their leisure time at home during lockdown, including arts and crafts, puzzles and games, and physical activities. Similarly, Stucke et al. (28) assessed U.S. and U.K. preschoolers' engagement in 32 activities during the initial months of the pandemic. Caregivers reported that children participated in a diverse set of activities, and playing with toys and physical games were ranked the most popular pastimes. Yet, beyond these findings, few studies have undertaken comprehensive examinations of children's activities aside from screen time and physical activity. Moreover, children's daily activities during COVID-19 were largely a result of child care service disruptions, but the links between these changes yet to be explored. Examining these associations will garner nuanced insight into the extent to which pandemic-related closures may have interacted with children's lifestyles.

From a service provision perspective, understanding children's activity patterns in the context of child care disruptions holds important implications for their social, recreational, and educational needs during and after the pandemic. Indeed, systemic formulations of the developmental ecology highlight that child care services encompass integral experiences that promote positive outcomes and the attainment of milestones (29, 30). For instance, the microsystem of Bronfenbrenner's (31) Ecological Systems Theory captures the immediate physical, financial, and social circumstances surrounding development. Children's activities are closely embedded within this level of development, as child care services represent a primary environment to access enriching pastimes and learning opportunities (29). Child care further creates a mesosystemic context for interactions between specific components of the microsystem (29). Examining the links between activity patterns and post-pandemic child care service utilization intentions could therefore lend additional knowledge to identifying children and families who are most in need of support.

The pandemic also raised many questions about the future of child care services (32, 33), many of which remain unanswered. Parents faced complex decisions about whether to enroll their children in care as they attempted to balance familial and occupational demands on the one hand and the risks of exposing their children to the virus on the other. Previous studies indicate that health and safety factors (e.g., gathering limits, exposure risk, and positive case counts) heavily influence parents' decisions on whether to send their children back to daycare and school following COVID-19 (34). However, other work indicates that caregivers also value the wide range of development-enhancing experiences offered by child care; quality-related factors such as access to activities for cognitive and social growth are among the most powerful drivers of parents' child care choices (35). This, combined with evidence supporting the benefits of child care services and parental concerns for children during lockdowns, suggests that decisions to access child care following COVID-19 could vary based on children's activities at home. Examining activity patterns thereby offers a unique and direct avenue to understanding the extent to which children's needs factor into service utilization following the pandemic. Knowledge of the factors related to parents' intentions about child care service utilization could help identify children and families who are most in need of support in the aftermath of COVID-19. This will further aid policymakers and service providers in developing supports for families with young children as the world adapts to the pandemic.

The present study sought to understand the links between children's activities, parental concerns, and child care service

utilization in the early stages of COVID-19. The primary objectives were to explore patterns in children's activities (Objective 1) and assess their associations with parental concerns (Objective 2). We also aimed to examine child care service changes during the pandemic as predictors of children's activity patterns in the context of key sociodemographic characteristics (Objective 3). Finally, we evaluated the most salient factors, including children's activity patterns, linked to caregivers' child care utilization intentions for when services reopen (Objective 4). Figure 1 depicts a theoretical model that summarizes the study goals. By incorporating children's activity patterns, these findings will enhance the current understanding of Canadian families' child care needs in times of stress and unpredictability.

Given the exploratory nature of the methodology we employed to determine children's activity patterns (i.e., Latent Profile Analyses; LPA), we had several broad hypotheses. First, we predicted that distinguishable patterns (i.e., profiles) in children's activities would emerge, with some profiles characterized by high levels of sedentary behaviors (i.e., high screen use and low physical activity; Hypothesis 1). Given previous work illustrating that sedentary lifestyles were prominent sources of worry for caregivers during the pandemic, we predicted that these profiles would be linked with higher levels of parental concern (Hypothesis 2). While specific hypotheses were difficult to generate without prior knowledge about profiles, it is plausible that disruptions in child care may be associated with activity patterns that reflect higher levels of parental concern. We also hypothesized that children's activity patterns would vary in relation to whether they experienced changes in child care service utilization during the early months of COVID-19 (Hypothesis 3). Finally, we anticipated that caregivers' post-pandemic child care service utilization intentions would differ based on children's activity profiles (Hypothesis 4). Specifically, we expected caregivers to be more inclined to use services post-pandemic if their children's activity patterns were related to parental concerns and child care service changes (i.e., children forgoing enriching experiences at home). In contrast, caregivers whose children are engaged in developmentally appropriate and stimulating activities at home may be less intent on using services when they reopen.

2. Materials and methods

2.1. Participants and procedure

Data for this study were drawn from the *Impacts of COVID-19 on Canadians–Parenting During the Pandemic* (ICC-PDP) Data Collection Series (36, 37), which aimed to gather information regarding family functioning in the early stages of the pandemic. The data were collected by Statistics Canada, from a sample of Canadian caregivers ($N = 32,228$) with at least one child under 15 years old who resided in the same household. As outlined in the study documentation (37), the sample was crowdsourced, such that participants were self-selected through open advertising. Given this non-probabilistic approach to data collection, findings should not be generalized to draw conclusions about the larger population of Canadian adults who are caregivers to a child under 15 years old. The ICC-PDP dataset also includes a standardized benchmarking

factor to correct for differing participation rates across three groups of families: those with children aged 0–5 years only, those with children aged 6–14 years only, and those with children aged 0–14 years (37). This benchmarking factor was applied as a weight in most statistical analyses.

Caregivers provided demographic information and reported on the pandemic's impacts on their child care service utilization, employment changes in the home, children's activities, and concerns for the wellbeing of their children and the overall family. In cases of families with multiple children, parents were instructed to provide an overall average. Caregivers were asked to consider the period from March 15, 2020 to the time of data collection, which took place from June 9–22, 2020. During this period, most regions in Canada enacted public health restrictions to mitigate virus spread. Lockdowns mandated the closure of non-essential businesses and restricted citizens from leaving their homes for non-essential reasons (38). Gatherings were prohibited in some provinces or restricted to small groups in others. With regard to education centers, most child care services were temporarily closed, and schools shifted to virtual learning (32, 36). As such, most participants in the present sample were likely experiencing some degree of COVID-19-related disruption at the time of data collection.

2.2. Measures

2.2.1. Child care service utilization
2.2.1.1. Changes in child care arrangements

The ICC-PDP survey included several items regarding child care service utilization. Caregivers answered the question, "*during the COVID-19 pandemic shutdown, have you used child care services for your child or children aged 0 to 14?*" Responses were coded in a binary manner (1 = *yes*, 0 = *no*). Subsequently, caregivers were prompted to further elaborate on their situation. Those who used child care services selected from the options of "*same child care arrangement and fees as pre-COVID-19*," "*same child care arrangement but different fees (including no fees)*," "*different child care arrangement and fees (including no fees)*," and "*different child care arrangement but same fees*." Caregivers who did not use child care selected from the following options: "*did not attend child care and did not pay any fees*," "*did not attend but paid child care fees to hold a space*," and "*did not use child care prior to the COVID-19 pandemic*."

We created a binary variable to represent whether caregivers reported changes in child care based on their responses to the above questions (1 = *yes*, 0 = *no*). For parents who used services, responses of "*same child care arrangement and fees as pre-COVID-19*" or "*same child care arrangement but different fees (including no fees)*" were coded as not experiencing changes in child care on the new variable. Caregivers who selected "*different child care arrangement and fees (including no fees)*" or "*different child care arrangement but same fees*" were coded as "*yes*" to reflect experiencing changes in child care services. Participants who "*did not attend services and did not pay any fees*" or "*did not attend but paid child care fees to hold a space*" were also coded as "*yes*" to reflect experiencing a change in child care

FIGURE 1
Conceptual model of the associations between study variables. We first established latent profiles of children's activities and validated these through comparing groups on the associated degree of parental concerns. Then, we evaluated a statistical model of the links between child care service changes during the COVID-19 pandemic and activity patterns, while considering sociodemographic characteristics (Model 1, components and paths depicted in blue). Thereafter, we examined links between children's activity patterns and their caregivers' post-pandemic child care service intentions, again accounting for sociodemographic characteristics (Model 2, components and paths depicted in green).

FIGURE 2
Flow chart depicting the response options and coding of child care service changes variables.

arrangements. Finally, caregivers who reported that they "*did not use child care prior to COVID-19*" were coded as not experiencing a change in child care services on the binary variable. Of note, these response options included information about changes in both child care arrangements and fees. We categorized participants based on the former, as this was more directly relevant to our study objectives. This means that whether participants experienced changes in child care fees did not influence coding. Figure 2 presents a visual flowchart illustrating the questions that were asked in the ICC-PDP survey, and the coding of these variables in the present study.

2.2.1.2. Post-pandemic child care intentions

Caregivers' child care enrollment intentions for their children were assessed via the following item: "*when formal child care services reopen, will your child or children attend?*." Response options included "*yes*," "*no*," "*my child or children never stopped attending child care*," and "*I did not use child care services prior to the COVID-19 pandemic*." The latter two options were recoded in a binary manner, such that "*my child or children never stopped attending child care*" was designated "*yes*," and "*I did not use child care services prior to the COVID-19 pandemic*" was recoded as "*no*" (Figure 3).

FIGURE 3
Flow chart depicting the response options and coding of post-COVID-19 child care service utilization intentions variables.
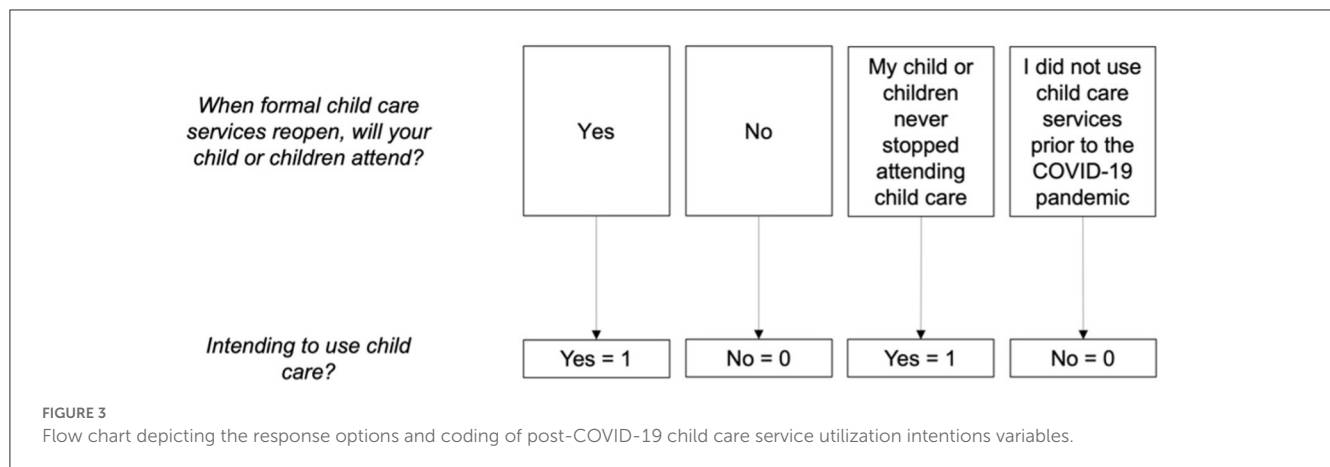
2.2.2. Children's activities at home during COVID-19

Caregivers reported on the extent to which their child or children engaged in various activities at home. Options included reading books or stories, using screen time (e.g., watching movies, videos, or television programs, playing games using any electronic device), playing games (e.g., cards, puzzles, board games), engaging in music, drama, or visual arts, doing physical activities (e.g., walking, cycling, dancing, yoga), participating in structured academic activities (e.g., worksheets, online school resources), and spending time developing other skills (e.g., cooking, sewing, gardening, crafts or making things). Frequency ratings were provided on a 4-point Likert scale, with points representing *"never, 1–2 times per week"*, *"3–5 times per week"*, and *"daily/almost every day"*. An additional option of *"not applicable"* was also included. However, these were recoded as missing values because they did not provide further information beyond the other options on the scale.

2.2.3. Parental concerns
2.2.3.1. Concerns for children

Caregivers responded to nine items that assessed the extent to which they held concerns about different aspects of their children's wellbeing during the COVID-19 pandemic. Areas probed included children's general physical health, general mental health, loneliness or isolation, school year and academic success, opportunities to socialize with friends, amount of screen time, online safety, amount of physical activity, and eating junk food or sweets. The level of concern for each item was rated on a 4-point Likert scale ranging from 1 = *not at all* to 4 = *extremely*. Although an additional option of *"not applicable"* was also included, this was recoded as missing data as it did not add further information.

2.2.3.2. Concerns for the family

Parents' worries for the overall family unit during pandemic shutdowns were assessed via six items spanning the areas of staying connected with family or friends, getting along and supporting each other, balancing childcare, schooling and work, managing the child's or children's behaviors, stress levels, anxiety, and emotions, feeling lonely in the family home, and exhibiting negative behaviors toward the child or children (i.e., having less patience, using raised voices, scolding or yelling). Caregivers rated their level of concern for each item on a 4-point Likert scale (1 = *not at all* to 4 = *extremely*). An additional option of *"not applicable"* was also included. Again, these were recoded as missing responses.

2.2.4. Covariates
2.2.4.1. Caregiver age

Caregivers reported their age in years on the original ICC-PDP survey. In the public use microdata file available for download, parental age was provided as frequencies in the age brackets of 15–34 years, 35–44 years, 45–54 years, and 55+ years.

2.2.4.2. Caregiver gender

In the original ICC-PDP questionnaire, caregivers were asked to report their gender through the options of *"male,"* *"female,"* or *"other."* The publicly available dataset included imputed values, which were benchmarked based on sex (36). Hence, participants who originally reported their gender as *other* were randomly reassigned as either *male* or *female*. It is important to note that this imputation approach restricts the generalizability of the sample, and gender-related findings must therefore be interpreted with caution.

2.2.4.3. Caregiver education

The ICC-PDP survey asked parents to provide the highest certificate, diploma, or degree that they completed. Options included *"less than high school diploma or its equivalent,"* *"high school diploma or a high school equivalency certificate,"* *"trades certificate or diploma,"* *"college, CEGEP or other non-university certificate or diploma,"* *"university certificate or diploma below the bachelor's level,"* *"Bachelor's degree,"* and *"university certificate, diploma or degree above the bachelor's level."* However, in the ICC-PDP public use media file, caregiver education was only available as a binary variable representing whether caregivers attended university (1 = *yes*, 0 = *no*), which was included in statistical analyses.

2.2.4.4. Employment status of family members
2.2.4.4.1. Working from home

Caregivers completed several items addressing the impacts of the pandemic on the employment status of family members.

TABLE 1 Frequencies of key demographic variables in the original study sample and the sample included in statistical analyses.

	All participants (N = 32,228)[a]		Participants included in analyses (n = 19,959)[b]	
	n	%	n	%
Caregiver age				
15–34 years	6,062	18.81	2,990	4.98
35–44 years	20,200	62.68	13,103	65.65
45–54 years	5,670	17.59	3,648	18.28
55+ years	296	0.92	81	0.41
Caregiver gender[c]				
Female	29,060	90.17	18,014	90.26
Male	3,168	9.83	1,808	9.06
Caregiver education				
Did not attend university	8,213	25.49	4,798	24.04
Attended university	23,815	73.90	15,025	75.28
Missing	199	0.62	–	
Province of residence				
Newfoundland and Labrador	411	1.28	187	0.94
Prince Edward Island	120	0.37	64	0.32
Nova Scotia	742	2.30	445	2.23
New Brunswick	606	1.88	319	1.60
Quebec	7,238	22.46	4,175	20.92
Ontario	12,191	37.83	7,904	39.60
Manitoba	1,241	3.85	743	3.72
Saskatchewan	1,147	3.56	696	3.49
Alberta	4,408	13.68	2,794	14.00
British Columbia	3,989	12.38	2,434	12.20
Territories	134	0.42	61	0.31

Results are reported in weighted proportions, calculated using the benchmarking factor of family type based on child age. [a]All participants refers to the original sample of caregivers included in the ICC-PDP study; [b]Participants included in analyses refers to those who were retained following listwise deletion of cases with missing data; [c]Parental gender was imputed for benchmarking based on sex, such that participants who reported a gender of "Other" were randomly reassigned a gender of either "Male" or "Female" (36).

Specifically, participants provided binary responses (1 = yes, 0 = no) regarding whether the following statements were true of their situation: "*someone in my family is working at a fixed location outside the home*," "*someone in my family is working outside the home with no fixed location*," and "*someone in my family is working from home*." In the ICC-PDP public use microdata file, responses to these three items were collapsed into a single variable representing whether family members were working outside of the home or from home, with the following options: "*all family members working*

are doing so from home," "*all family members working are doing so outside the home*," and "*mixed*." These variables were recoded in a binary manner in the present study to reflect whether any family members were working from home (1 = yes, 0 = no). As such, responses of "*all family members working are doing so from home*" and "*mixed*" were recoded as "*yes*." Responses of "*all family members working are doing so outside the home*" were recoded as "*no*."

2.2.4.4.2. Changes in employment status

COVID-19-related changes in work status were assessed via the following item: "*someone in my family lost their job, was laid off, or has reduced work hours due to COVID-19*." Binary responses were provided (1 = yes, 0 = no).

2.3. Analytical plan

In our study's pre-registration (https://osf.io/3zb94/), we indicated that statistical analyses would only include data from parents whose children were not enrolled in child care services during the pandemic. This decision aimed to maximize responses from the group of caregivers who may be able to provide more accurate reports on their children's activities at home during the pandemic, which may have been difficult to report on if children were attending child care. However, this relies on the assumption that caregivers in the study sample would also be at home with their children. Upon reviewing the frequencies presented in the codebook, it was not evident that most caregivers were working from home in the presence of their children. Hence, we analyzed the full sample regardless of whether children attended child care services. This enabled wider coverage of caregivers who may have been under different circumstances, as well as the retention of more participants.

Data analysis proceeded in several stages. We conducted data cleaning and descriptive analyses using the *dplyr* (39) and *psych* (40) packages in RStudio. The benchmarking factor to correct for differing participation rates across three types of families was applied. Subsequently, we conducted an exploratory factor analysis (EFA) to determine the factor structure of parental concerns via the *REdaS* package (41). Data factorability was tested via the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Barlett's Test of Sphericity, which examines the strength of the correlations across all the variables included in the factor analysis. KMO values of ≥ 0.50 and a statistically significant ($p < 0.05$). Bartlett's test statistic are desirable, as they suggest that factor analysis is an appropriate approach (42). The number of factors to be extracted was determined via a Scree plot and parallel analysis (43).

In the third stage of data analysis, we extracted patterns in children's activities via mixture modeling in Mplus Version 8.7. The seven child activities variables were subject to Latent Profile Analysis (LPA). Contrary to variable-centered approaches, which focus on examining relations among variables, person-centered techniques such as LPA aim to identify subgroups within a population based on a set of variables (44). We compared the solutions of models with two to seven profiles, then selected the
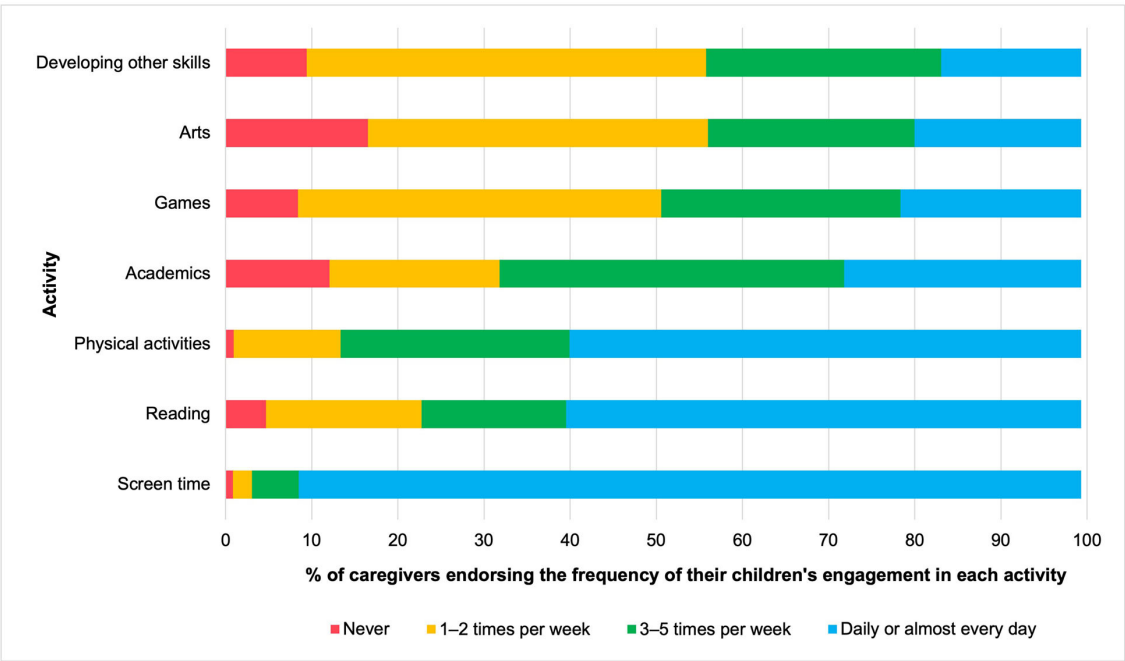
FIGURE 4
Children's engagement in activities by frequency, presented in proportions. Activities are ordered from least to most popular among children, based on the proportion of caregivers endorsing engagement in the activity *daily or almost every day*. Proportions are weighted based on the age range of children in the family. Reading, Reading books/stories; Arts, Music, drama, or visual arts; Academics, Structured academic activities; Other skills, Developing other skills.

FIGURE 5
Parental concerns for children by frequency, presented in proportions. Concerns are ordered from least to most frequently endorsed among caregivers, based on the proportion who endorsed being *extremely* concerned about each area. Proportions are weighted based on the age range of children in the family.
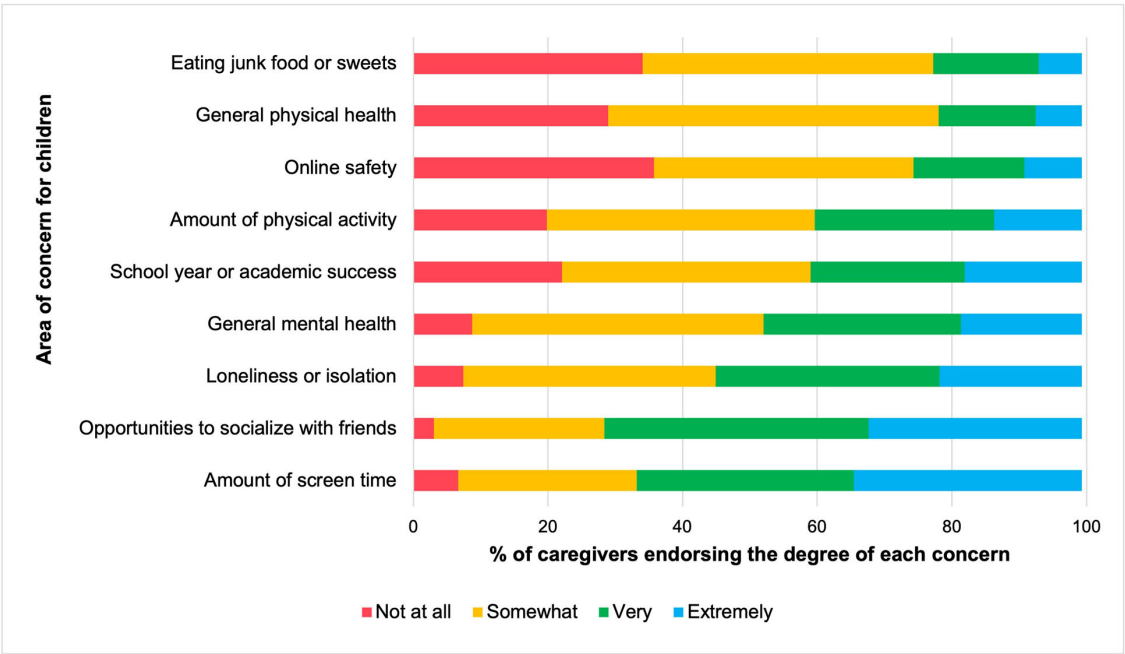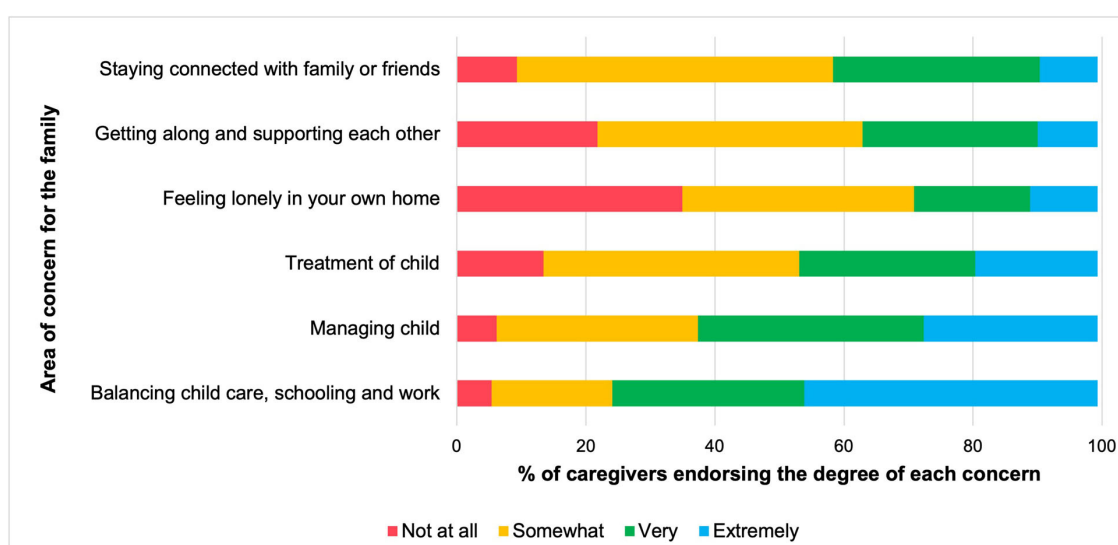
FIGURE 6
Parental concerns for the family by frequency, presented in proportions. Concerns are ordered from least to most frequently endorsed among caregivers, based on the proportion who endorsed being extremely concerned about each area. Proportions are weighted based on the age range of children in the family. Managing child, Managing your child's or children's behaviors, stress levels, anxiety, emotions; Treatment of child, Having less patience, raising your voice, scolding or yelling at your child or children.

best-fitting number of profiles based on Asparouhov and Muthen ([44]) recommendations. Specifically, we evaluated model fit through the Akaike information criterion (AIC), Bayesian information criterion (BIC), and the sample size adjusted Bayesian information criterion (aBIC) statistics. Low values on these statistics indicate stronger fit. We also relied on entropy statistics to determine the number of profiles. Entropy values can range from 0 to 1, where larger values indicate well-defined profiles with little ambiguity in group membership, and therefore, higher classification utility of the model. Furthermore, we conducted Lo-Mendell-Rubin (LMR) adjusted likelihood ratio tests to compare the fits of models with k profiles against the model with k-1 profiles.

Upon determining the number of profiles to extract, we assigned participants to the latent profile in which they had the highest probability of membership. Thereafter, we recoded resulting nominal profile membership into a series of dummy variables, with the group with the lowest levels of parental concerns as the reference. To validate latent profiles, we employed the BCH method in Mplus to compare the level of concerns held by caregivers in each latent class ([45]). This approach allows for tests of relationships between latent classes and an auxiliary outcome variable without causing shifts in latent class membership.

The final stage of analysis aimed to assess the associations between child care service utilization factors (i.e., changes during the pandemic and intentions following the pandemic), children's activity profiles, and parental concerns. We originally proposed path analysis to examine these relationships but shifted our analytical plan due to significant challenges with model fit. A logistic regression approach was adopted to better accommodate the categorical and binary nature of several study variables. We examined the predictive effect of child care service utilization changes on children's activity pattern profiles through

a multinomial logistic regression model, conducted through the R package *nnet* ([46]). Predictors of profile membership included demographic characteristics (caregiver age, gender, education, and family employment changes during the pandemic), as well as child care service changes. Thereafter, we estimated a binary logistic regression model to examine the predictive relations between children's activity profile membership and caregivers' plans for child care once services re-open. Associations with demographic characteristics were also included in this model.

2.4. Missing data

Due to the non-probabilistic nature of the crowd-sourced sample, as well as the categorical nature of several items included in the study, we applied listwise deletion to remove data from participants who were missing values on any variable ([47]). The final sample included in statistical analyses consisted of n = 19,959 caregivers, which represents approximately two-thirds (61.93%) of the original ICC-PDP sample. The sociodemographic characteristics of both the initial study sample and the final sample included in analyses, reported in weighted frequencies and proportions, are displayed in Table 1.

3. Results

3.1. Descriptive statistics

Figure 4 presents the descriptive statistics of children's activities in weighted proportions, organized from the least to most frequently endorsed activities by caregivers. Children in the present sample engaged in all of the activities that were assessed in the

TABLE 2 Bivariate Spearman correlations of study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Child activities																					
1. Reading																					
2. ST	−0.09**																				
3. Games	0.27**	0.01																			
4. Arts	0.29**	−0.06**	0.31**																		
5. Phy act	0.34**	−0.06**	0.21**	0.24**																	
6. Academ	0.01	0.14**	0.04**	0.00	0.01																
7. Other	0.25**	−0.06**	0.25**	0.34**	0.29**	0.07**															
Concerns for children																					
8. Phys hlth	−0.10**	0.05**	−0.02**	−0.05**	−0.19**	0.01	−0.07**														
9. Ment hlth	−0.09**	0.12**	−0.02**	−0.07**	−0.12**	0.01*	−0.06**	0.45**													
10. Lonely	−0.05**	0.10**	−0.02*	−0.05**	−0.10**	−0.03**	−0.06**	0.32**	0.67**												
11. School success	−0.22**	0.14**	−0.08**	−0.15**	−0.15**	0.17**	−0.12**	0.23**	0.36**	0.31**											
12. Social	0.02*	0.07**	0.01	−0.04**	−0.05**	−0.05**	−0.04**	0.17**	0.46**	0.59**	0.31**										
13. Amt ST	−0.20**	0.32**	−0.12**	−0.19**	−0.21**	0.04**	−0.20**	0.22**	0.32**	0.29**	0.33**	0.26**									
14. Online safety	−0.22**	0.15**	−0.08**	−0.12**	−0.18**	0.22**	−0.08**	0.27**	0.30**	0.22**	0.35**	0.12**	0.40**								
15. Amt phys act	−0.20**	0.16**	−0.11**	−0.16**	−0.38**	0.08**	−0.19**	0.44**	0.39**	0.35**	0.34**	0.29**	0.44**	0.40**							
16. Junk food	−0.24**	0.17**	−0.09**	−0.13**	−0.24**	−0.00	−0.13**	0.27**	0.29**	0.26**	0.29**	0.18**	0.41**	0.36**	0.47**						
Concerns for the family																					
17. Stay connected	0.03**	−0.01	0.04**	0.00	−0.00	−0.05**	0.00	0.22**	0.34**	0.36**	0.20**	0.38**	0.15**	0.16**	0.24**	0.17**					
18. Get along	−0.03**	0.04**	0.00	−0.04**	−0.05**	−0.03**	−0.03**	0.26**	0.39**	0.34**	0.24**	0.27**	0.23**	0.23**	0.27**	0.24**	0.50**				
19. Balance	0.06**	0.07**	0.02**	−0.02**	0.01	−0.04**	−0.01	0.13**	0.28**	0.27**	0.24**	0.29**	0.26**	0.13**	0.19**	0.16**	0.27**	0.34**			
20. Manage child	−0.04**	0.13**	−0.01	−0.05**	−0.08**	−0.01	−0.05**	0.27**	0.58**	0.51**	0.32**	0.40**	0.33**	0.26**	0.33**	0.29**	0.36**	0.50**	0.46**		
21. Lonely at home	−0.08**	0.03**	−0.01	−0.06**	−0.10**	−0.10**	−0.07**	0.20**	0.35**	0.39**	0.21**	0.30**	0.22**	0.17**	0.24**	0.24**	0.33**	0.41**	0.21**	0.39**	
22. Child treatment	0.04**	0.08**	0.00	−0.06**	−0.02*	−0.10**	−0.07**	0.14**	0.33**	0.30**	0.20**	0.28**	0.28**	0.11**	0.19**	0.25**	0.25**	0.43**	0.38**	0.51**	0.42**

*$p < 0.05$. **$p < 0.01$. Weights were not applied in correlations. Reading, Reading books/stories; ST, Screen time; Arts, Music, drama, or visual arts; Phy act, Physical activities; Academ, Structured academic activities; Other skills, Developing other skills; Phy hlth, General physical health; Ment hlth, General mental health; Lonely, Loneliness or isolation; School success, Socializing, Opportunities to socialize with friends; Amt. screen time, Amount of screen time; Junk food, Eating junk food or sweets; Stay connected, Staying connected with family or friends; Get along, Getting along and supporting each other; Balance, Balancing child care, schooling and work; Manage child, Managing your child's or children's behaviors, stress levels, anxiety, emotions; Lonely at home, Feeling lonely in your own home; Child treatment, Having less patience, raising your voice, scolding or yelling at your child or children.

TABLE 3 Factor loadings of parental concerns indicators onto an overall concerns latent variable.

Item	Loading
Concerns for children	
General physical health	0.46
General mental health	0.76
Loneliness or isolation	0.72
School year and academic success	0.48
Opportunities to socialize with friends	0.59
Amount of screen time	0.49
Online safety	0.41
Amount of physical activity	0.55
Eating junk food or sweets	0.46
Concerns for the family	
Staying connected with family or friends	0.51
Getting along and supporting each other	0.59
Balancing child care, schooling and work	0.47
Managing child	0.74
Feeling lonely in your own home	0.53
Treatment of child	0.53

Managing child, Managing your child's or children's behaviors, stress levels, anxiety, emotions; Treatment of child, Having less patience, raising your voice, scolding or yelling at your child or children.

ICC-PDP survey. However, the popularity of each activity varied. Most caregivers reported that their children read books or stories at least once per week (95.30%). A very small proportion reported that their children never used screen-based devices, while the rest noted that their children engaged in screen time daily or almost every day (99.17%). Almost all (98.39%) caregivers reported that their children participated in physical activity at least once per week, and a majority also reported that their children spent time on structured academic activities (87.94%), playing games (i.e., cards, puzzles, board games; 91.63%), doing creative activities (i.e., music, drama, or visual arts; 83.50%), and developing other skills (90.59%).

Caregivers also endorsed various areas of concern for their children and families during the pandemic shutdown. Figure 5 depicts concerns from least to most highly endorsed. Moderate levels of worry regarding children's general mental and physical wellbeing emerged. Most participants (92.57%) reported being at least "somewhat" concerned about their children being lonely or isolated; worries about reduced socialization opportunities were also prevalent (96.27% expressed being somewhat, very, or extremely concerned). Furthermore, most parents (93.33%) reported some degree of concern about the amount of screen time that their children were engaging in. In terms of family-related concerns (Figure 6), caregivers reported the highest degrees of worry about the ability to balance child care, schooling, and work (94.58% endorsed being somewhat, very, or extremely concerned). Relatedly, the family's ability to manage their children's behaviors was a prominent area of concern.

3.2. Exploratory factor analysis of parental concerns

Initially, we examined the factorability of the 15 parental concerns items. As shown in Table 2, which displays Spearman inter-item correlations between study variables, all concern items were significantly and positively correlated. Tests of assumptions revealed that factor analysis was appropriate: the KMO Measure of Sampling Adequacy was 0.89, and Bartlett's Test of Sphericity was statically significant [$\chi^2(105) = 101{,}372.63$, $p < 0.001$]. These results indicated that the strength of partial correlations between the parental concern variables was adequate, and therefore supported the use of a factor-analytic approach. Examinations of a Scree plot and parallel analysis indicated a one-factor solution. Table 3 displays the loadings of each item onto a latent concerns construct. These results suggested that parental concerns about their child and family would be best represented as one construct in the present study. Thus, we conducted all further analyses using an overall concerns variable derived from calculating the mean of each participant's responses across all items that assessed concerns for children and the overall family.
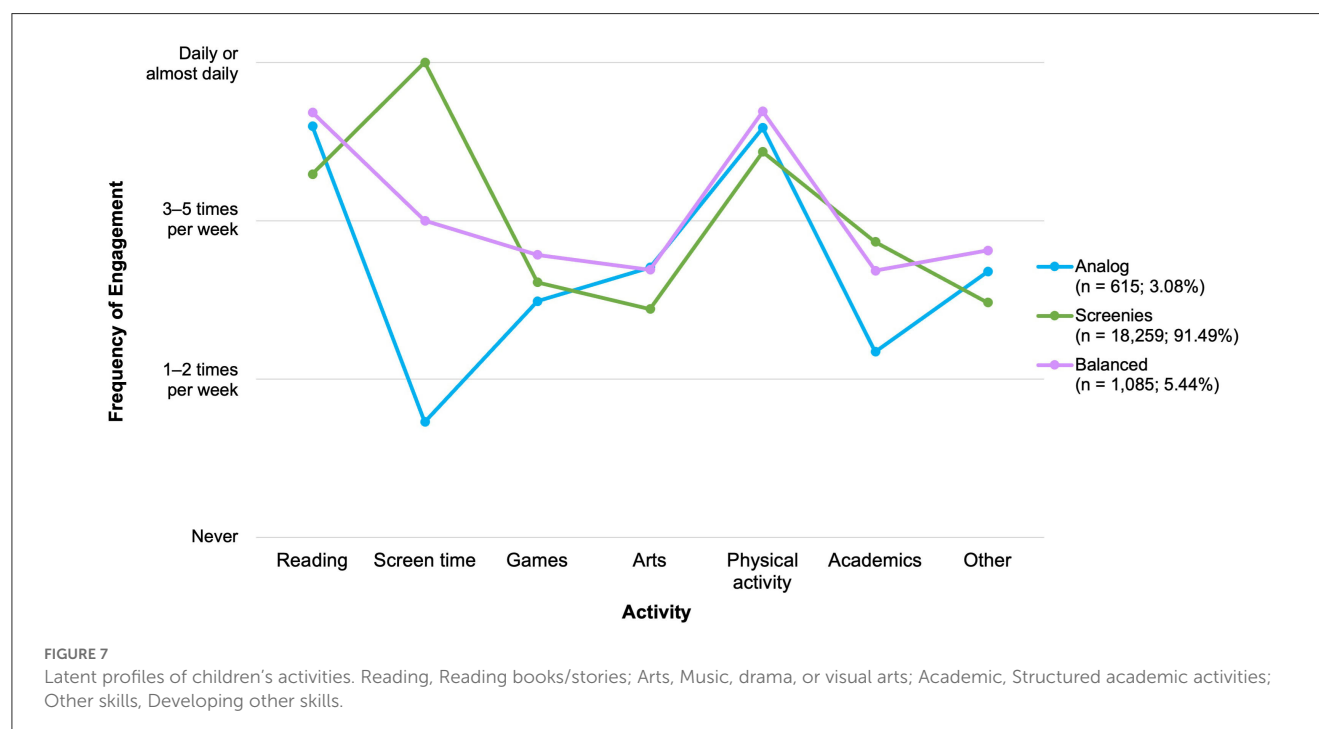
3.3. Children's time use profiles and parental concerns

Model fit statistics of children's latent activity profiles are presented in Table 4. Entropy values were similar across all models, ranging from 0.82 to 1.00. The AIC, BIC, and aBIC values decreased from models with one through six profiles, then began to increase in the seven-profile solution. Although this may suggest that a six-profile solution represents the best fit to the data, model estimation was unreliable for models with over five profiles. A solution comprising six profiles was also difficult to interpret due to the presence of many profiles with few clear differences in activity patterns between them. Furthermore, LMR adjusted likelihood ratio tests suggested that two- and three-profile solutions fit the data significantly better than solutions with $k{-}1$ profiles. This test was not significant for solutions with four or more profiles. A three-class solution was therefore deemed the best-fitting model. Random starts and final stage optimizations for the three-profile solution were increased, to which the optimal log-likelihood was robust. Examination of the distribution of participants across profiles indicated that each group included a sizable number of members (i.e., all three profiles contained over 600 participants).

Figure 7 displays the final three-profile solution representing children's latent activity profiles. Children in the largest group, the *Screenies* ($n = 18{,}259$; 91.49%), engaged in more screen time relative to all other activities. A second profile ($n = 1{,}085$; 5.44%) included children who seemed to be engaging in a wider variety of activities. Children with these *Balanced* profiles read books or stories and engaged in physical exercise on a near-daily basis. They also used screens, participated in structured academic activities, and spent time developing other skills several times per week. Finally, a small group of children ($n = 615$; 3.08%) appeared to read and do physical exercise on a near-daily basis while using relatively little screen time. These children also engaged in lower levels

TABLE 4 Fit indices for latent profile models of child activities.

Number of profiles	AIC	BIC	aBIC	Entropy	pLMR
2	316255.97	316429.80	316359.88	1.00	<0.001
3	**281840.62**	**282077.66**	**281982.33**	**1.00**	**0.032**
4	267822.21	268122.46	268001.70	0.95	0.138
5	264851.20	265214.67	265068.48	0.82	0.410
6[a]	258783.26	259209.94	259038.33	0.89	–
7[b]	261904.64	262394.52	262197.49	0.83	–

A three-class solution (in bold) was evaluated to be the best-fitting model. AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, sample size adjusted Bayesian information criterion; p (LMR), p-value of the LMR adjusted likelihood ratio test for k versus k-1 classes. [a,b]The best loglikelihood was not replicated in the six- and seven-profile solutions, and was reported to be untrustworthy due to local maxima. The likelihood ratio test for these models could not be computed due to model non-convergence.

FIGURE 7
Latent profiles of children's activities. Reading, Reading books/stories; Arts, Music, drama, or visual arts; Academic, Structured academic activities; Other skills, Developing other skills.

of structured academic activities. As such, they were designated the *Analog* group to reflect a lifestyle that was more off-screen in nature.

Caregivers of children with each activity profile (*Analog*, *Screenies*, and *Balanced*) reported slight variations in their overall level of concern for children and families. Specifically, parents of children in the *Analog* profile reported the lowest levels of concern with a mean of 2.0 ($SE = 0.03$), representing being "somewhat" worried. Parents of *Screenies* noted slightly higher mean concerns ($M = 2.5$, $SE = 0.01$), which descriptively reflects being between "somewhat" and "very" concerned. Finally, parents of children who were classified in the *Balanced* group reported a mean concern level of 2.2 ($SE = 0.02$). This most closely corresponds to being "somewhat" concerned. To further explore these differences, we conducted equality tests of concern levels across profiles (*Analog*, *Screenies*, and *Balanced*) via the BCH method in Mplus. The overall test was significant ($\chi^2 = 512.45$, $p < 0.001$). Results also revealed significant differences between all three groups (Table 5). Caregivers of children in the *Analog* group

tended to rate significantly lower levels of concerns compared to parents of children in the *Screenies* ($\chi^2 = 316.99$, $p < 0.001$) and *Balanced* profiles ($\chi^2 = 38.63$, $p < 0.001$). Parents of the *Screenies* group reported significantly higher concerns compared to children from the *Balanced* group ($\chi^2 = 219.12$, $p < 0.001$). Of note, the interpretation of these results must be qualified by both the small magnitude of the between-group differences, as well as the study's large sample size. As such, these group differences in parental concerns likely hold limited practical implications.

3.4. Multinomial logistic regression model predicting children's activity profiles

Following the estimation of latent profiles to represent activity patterns, we performed multinomial logistic regression analyses to examine the extent to which changes in child care

TABLE 5 Mean parent concerns and pairwise comparisons across profiles.

Latent profile	M	(SE)		χ^2	p-value
			General concern		
Analog	2.0	(0.03)	Analog vs. Screenies	769.71	<0.001
Screenies	2.5	(0.01)	Analog vs. Balanced	405.39	<0.001
Balanced	2.2	(0.02)	Screenies vs. Balanced	239.03	<0.001

TABLE 6 Multinomial logistic regression model examining predictors of latent activity profile membership (Model 1).

	Balanced vs. Analog				Screenies vs. Analog			
	B	(SE)	OR	OR CI$_{0.95}$	B	(SE)	OR	OR CI$_{0.95}$
Effect								
Intercept	−0.18	(0.21)	0.84	0.55–1.27	1.69**	(0.17)	5.40	3.86–7.56
Child care change	0.43**	(0.11)	1.53	1.25–1.89	0.38**	(0.09)	1.45	1.23–1.72
Caregiver demographics								
Age	0.45**	(0.09)	1.57	1.31–1.88	1.08**	(0.07)	2.94	2.54–3.41
Gender	−0.36*	(0.16)	0.70	0.51–0.96	−0.55**	(0.13)	0.58	0.45– 0.74
University attendance	−0.44**	(0.14)	0.64	0.49–0.84	−0.71**	(0.11)	0.49	0.39–0.62
Family employment								
Working from home	0.09	(0.14)	1.09	0.84–1.42	0.12	(0.11)	1.13	0.91–1.40
Job loss	0.02	(0.11)	1.02	0.82– 1.26	−0.10	(0.09)	0.90	0.76–1.07

$^*p < 0.05$, $^{**}p < 0.01$.

service arrangements and family demographic covariates predicted children's latent activity group membership (Model 1). The *Analog* profile was designated as the reference due to having the lowest level of parental concerns, making it a more neutral group for comparisons. A likelihood ratio test revealed significant increases in model fit with the addition of predictor variables, as compared with a null model containing only the intercept [$\chi^2(12) = 373.50$, $p < 0.001$].

3.4.1. Predictors of balanced vs. analog groups

Table 6 displays the full results of Model 1. The first set of comparisons aimed to establish the predictors of whether children were assigned to the *Balanced* group vs. the *Analog* group. Odds ratios (ORs) revealed that when caregivers reported experiencing changes in child care services, their children were 1.53 times more likely to exhibit a *Balanced* activity profile than an *Analog* profile ($B = 0.43$, $p < 0.001$). All demographic predictors of membership in the *Balanced* group were significant. Specifically, each increase in caregivers' age group was related to a 1.57 times higher likelihood of being assigned to the *Balanced* group ($B = 0.45$, $p < 0.001$). However, children were 30% less likely to be assigned to the *Balanced* time use profile when their caregivers were male (OR $= 0.70$; $B = −0.36$, $p = 0.027$). Children of caregivers who reported attending university were also less likely to be classified in the *Balanced* activity profile compared to the *Analog* profile (OR $= 0.64$; $B = −0.44$, $p = 0.001$). Regarding COVID-19 employment changes, whether family members worked from home or experienced job loss (i.e., lost their job, were laid off, or

TABLE 7 Binary logistic regression model examining predictors of post-pandemic childcare service attendance intentions (Model 2).

Effect	Estimate	(SE)	OR	OR CI$_{0.95}$
Intercept	0.46**	(0.10)	1.58	1.29–1.94
Activity profile				
Screenies vs Analog	0.05	(0.09)	1.05	0.88–1.25
Balanced vs Analog	0.21*	(0.11)	1.24	1.00–1.53
Caregiver demographics				
Age	−0.84**	(0.03)	0.43	0.41–0.46
Gender [a]	0.31**	(0.05)	1.37	1.24–1.52
University attendance	0.50**	(0.04)	1.66	1.53–1.79
Family employment				
Working from home	0.12**	(0.04)	1.13	1.04–1.23
Job loss	−0.17**	(0.03)	0.85	0.79–0.90

$^*p < 0.05$, $^{**}p < 0.01$; ^{a}Female gender was designated the reference group.

had reduced work hours) due to the pandemic did not significantly predict children's membership in the *Balanced* vs. *Analog* groups.

3.4.2. Predictors of screenies vs. analog groups

The second set of comparisons in Model 1 examined the predictors of being assigned to the *Screenies* group vs. the *Analog* group. A significant intercept suggested that children were

approximately five times more likely to be assigned to the *Screenies* group (OR = 5.40; B = 1.69, p < 0.001) before adding predictors to the model. Experiencing changes in child care attendance significantly increased children's likelihood of being a *Screenie* by 45% (OR = 1.45; B = 0.38, p < 0.001), as did having an older parent (OR = 2.94; B = 1.08, p < 0.001). However, having caregivers who were male (OR = 0.58; B = −0.55, p < 0.001) or who attended university (OR = 0.49; B = −0.71, p < 0.001) were both associated with lower odds of being assigned to the *Screenies* group than the *Analog* group. Again, having family members work from home or experience job loss during COVID-19 did not predict membership in the *Screenies* profile over the *Analog* profile.

3.5. Binary logistic regression model predicting post-pandemic child care service utilization intentions

The second set of analyses aimed to identify the factors that were associated with parents' intentions to enroll their children in child care when services reopened. We estimated a binary logistic regression model (Model 2), presented in Table 7, to examine children's activity profiles (*Balanced* vs. *Analog*, *Screenies* vs. *Analog*) and family demographic characteristics as predictors of caregivers' child care plans. Model 2 showed statistically significant improvements in fit compared to a null model that did not include predictors (Table 7) [$\chi^2(7) = 1123.36$, p < 0.001].

A significant intercept (OR = 1.58, B = 0.46, p < 0.001) in Model 2 suggested that parents were typically more likely to plan to have their children attend child care services when they reopened, before including other predictors. In terms of children's activity profiles, caregivers of *Screenies* did not report significantly different child care service utilization intentions compared to parents of *Analog* children. Interestingly, parents of children with *Balanced* activity patterns were more likely to report planning to send their children to child care when services reopened compared to parents of *Analog* children (OR = 1.24; B = 0.21, p = 0.046). Caregivers who were male (OR = 1.37, p < 0.001) and attended university (OR = 1.66, p < 0.001) were also more likely to plan for their children to attend child care services upon reopening. In contrast, higher caregiver age was related to a lower likelihood of future service use (OR = 0.43; B = −0.84, p < 0.001). Regarding employment, caregivers were slightly more likely to report planning to have their children attend child care if at least one family member was working from home (OR = 1.13; B = 0.12, p < 0.005). Experiencing employment loss due to the pandemic was associated with a reduced likelihood of utilizing child care services (OR = 0.84, p < 0.001).

4. Discussion

The present study aimed to delineate associations between Canadian children's activities, parental concerns, and child care utilization during the COVID-19 pandemic. Analyses revealed that children's participation in various pastimes combined to create three meaningful profiles, which we named *Screenies*, *Analog*, and

Balanced. These patterns were associated with parental concerns, which were highest for the *Screenies* group, followed by the *Balanced* and *Analog* groups. Profile membership also interacted with aspects of pandemic-related child care service utilization. Experiencing changes in child care arrangements in March–June 2020 predicted a higher likelihood of membership in the *Balanced* and *Screenies* groups over the *Analog* group. Additionally, parents of children in the *Balanced* group were more likely to endorse intentions to use child care services following the pandemic compared to parents of *Analog* children. These findings collectively illustrate heterogeneity in how children and families responded to child care disruptions during COVID-19, with important implications for post-pandemic planning.

4.1. Children's activity profiles during the pandemic

Reflecting the reality that increased digital media use was inevitable during the pandemic, an overwhelming majority of children in the present study were designated *Screenies*. This group of children engaged in daily screen use and some physical exercise but participated less in other activities. This pattern converges with a considerable amount of literature to suggest that most children were highly reliant on screen-based devices to access social, educational, and recreational opportunities during COVID-19 (48, 49). Notably, not all children in the present study exhibited activity patterns dominated by screen use. A small group exhibited an *Analog* activity profile that comprised more non-digital activities (e.g., reading books and stories, games) and lower amounts of screen time relative to the other profiles. As such, *Analog* children may represent those who adjusted to the pandemic by turning to offline activities. Several alternative explanations should also be considered. Past studies consistently show that screen time increases across childhood and adolescence (50, 51) and the *Analog* group may have comprised younger children who naturally engaged in less digital media use. Moreover, inconsistent access to digital technologies (e.g., internet, devices) increased the vulnerability of many Canadian children by reducing opportunities to participate in virtual activities (52). This warrants future research on the specific mechanisms that relate to different levels of on- vs. off-screen activities both during and after the pandemic, particularly as activity profiles were most divergent in their screen use in the present study. Finally, children who exhibited a *Balanced* profile seemed to engage in the widest variety of activities. This group showed moderate levels of physical exercise and screen use, and pursued various other endeavors (e.g., creative arts, and developing other skills). As access to diverse activities in childhood is central to positive outcomes (53), a *Balanced* activity profile may be linked to benefits across multiple domains of development, particularly during COVID-19. However, it is also essential to examine the extent to which this may be feasible in unique circumstances such as the pandemic. Future work should assess activity patterns as a principal social determinant of wellbeing and its role within specific contexts in which activities are less accessible. Overall, variations in children's activity patterns detected in the present study illustrate that children's responses to the pandemic

likely differ. Post-pandemic efforts to promote wellbeing and foster healthy lifestyles in children should be designed with the needs of specific groups of children in mind.

4.2. Children's activity patterns and parental concerns

The present study found small but significant variations in parental worries across children's activity profiles. Consistent with our second hypothesis, parents of *Screenies* expressed the highest levels of concern, followed by the *Balanced*, then *Analog* groups. The largest between-group differences emerged in children's screen use frequency, suggesting that this activity may have been a primary contributor to parents' worries. This aligns with considerable literature documenting excessive screen time as a top-priority concern that parents felt for children during lockdowns (23, 24). Nevertheless, only a small correlation between overall parental concerns and children's screen use frequency emerged in the present study. Screen use constituted a major aspect of altered lifestyles during the pandemic, and though this became the primary activity for many children in the present study, a subset seems to have incorporated digital media as one of several similarly pursued pastimes. A more nuanced interpretation could therefore suggest that parents' concerns are more closely associated with children's screen use levels *relative to* their engagement in other activities, rather than the absolute amount of screen time in and of itself. Consequently, digital media use may be a notable but not standalone indicator of children's activities—nor is it an independent target of caregiver concern during the pandemic. Strategies to address parents' worries for their children's wellbeing could take this into consideration by promoting engagement in a wide range of activities, rather than merely promoting reductions in screen use (54). Notwithstanding, it is also possible that the correlation between children's screen use and parents' concerns in the present study was, in part, due to the use of a one-dimensional measure (i.e., average score) across specific indicators of concerns. Of these, only one indicator captured worries about screen use, with a moderate factor loading. It is further important to note that between-group differences in concern levels were quite small and the large sample size may have inflated the statistical significance of these differences. Ongoing work must continue exploring links with parental perceptions and concerns to further validate profiles.

4.3. Activity profiles and child care service utilization

Examining associations between children's activities and child care service utilization in the present study provided additional insight into the ways in which the pandemic shaped multiple levels of the developmental ecology. The negative impacts of pandemic-related child care disruptions are well-documented, highlighting increases in stress and mental health symptoms, educational setbacks, and social development (10, 20, 22). We built on this literature by examining child care service changes as they relate to children's daily lifestyles. This enabled us to obtain detailed knowledge on the interactions between changes across various developmental settings (i.e., child care and home contexts). In line with our third hypothesis, child care changes early in the pandemic were related to children's activity patterns, shown through a greater likelihood of displaying a *Screenies* or *Balanced* activity profile over the *Analog* group. This finding exemplifies the downstream effects that child care changes likely imparted on children's daily lives and that they may be proxied through children's activities. *Screenies* and *Balanced* children specifically showed higher screen use relative to other activities and compared with the *Analog* group, implying that child care disruptions may have been linked with more coping via technology. This is plausible given evidence suggesting that screen-based devices played a major role in children's social, academic, and recreational functioning during COVID-19, for better and for worse (48, 55). In contrast, the *Analog* group may represent a small subset whose lives maintained more normalcy due to avoiding child care disruptions. This may have led to lower reliance on screens and more engagement in other activities. Of note, it is possible that children in the present study maintained similar lifestyles before and after the pandemic. Ongoing longitudinal evaluations are warranted to further explore the extent to which changes in children's activities preceded or followed changes in child care utilization.

The parental sociodemographic characteristics that were linked to membership in the *Screenies* and *Balanced* groups—female gender, lower educational attainment (i.e., not having attended university)—may further highlight factors that predisposed children to experiencing higher degrees of pandemic-related disruption. The disproportionately high burdens of COVID-19 on female caregivers, largely due to higher parenting and household labor demands, are well-documented (56, 57). It is possible that female caregivers in the present study were more affected by COVID-19, resulting in spillover effects on children that were detected through activity profiles involving higher parental concerns. Based on the strong links between parent education and family socioeconomic status, having a caregiver with lower education status may also have exacerbated the impacts of pandemic-related disruptions (58). In the present study, the challenges faced by some families and caregivers may have been reflected in children's likelihood of falling into the *Screenies* and *Balanced* profiles—activity patterns associated with greater experiences of child care disruption. Interestingly, older parental age also predicted membership in these two groups, whereas some work has indicated that older caregivers were less likely to report negative family outcomes in the context of the pandemic (59). However, older caregivers may also be less likely to limit their children's screen time (60). As this activity was lowest in the *Analog* profile, older caregivers in the present study could have placed fewer restrictions on their children's screen-based activities, thereby increasing membership in the *Balanced* or *Screenies* profiles. This mechanism is speculative, and further research is required to evaluate this possibility. Ongoing work should also continue to investigate family-based factors linked with pandemic-related responses and how they translate into children's engagement with various activities to inform the supports that are best suited to each family unit.

Another study goal was to examine the associations between children's activities and caregivers' intentions to use child care services following the COVID-19 pandemic. This may generate insight into the children and families who are most in need of services as informed by children's lifestyles. We anticipated that activity profiles would be differentially associated with differences in parents' post-pandemic child care service utilization intentions. This hypothesis was partially supported: Caregivers of children in the *Balanced* profile were more likely to report planning to have their children attend services post-pandemic compared to parents of *Analog* children. Taken with the slightly higher levels of parental concern and greater likelihood of experiencing child care disruptions associated with the *Balanced* profile, this may reflect that these children reacted more strongly to COVID-19 disruptions. Their caregivers also could have felt more demands, leading to requiring more support from child care services. It is also possible that children in the *Balanced* profile required more hands-on parenting to maintain high engagement across a diverse set of activities. Again, the burdens of sustaining this level of involvement for their children may have resulted in greater inclinations to use child care. Additional research that directly explores caregivers' motivations behind child care use, including consideration of their perceptions of developmental opportunities and children's activities, is needed to substantiate these possibilities.

Regarding demographic characteristics, we found that younger caregivers were more likely to report planning to enroll children in care, which again highlights that some groups of parents were more heavily burdened and therefore in greater need of child care support during COVID-19 (61). Interestingly, caregivers who attended university showed similar patterns. Previous research suggests that those with higher education are more likely to hold careers in sectors that are more amenable to flexibility and working from home (62). It is possible that university-educated parents were more likely to face the stressful act of balancing parenting with tending to children's needs at home. Difficulties balancing remote work and parenting responsibilities during COVID-19 have been an overwhelming source of distress for many caregivers (63). In line with this, caregivers in the present study were more likely to report planning to use child care if at least one family member was working from home. Our findings may therefore reflect a need to provide families with extra support when they lack child care arrangements. Interestingly, caregivers from families in which at least one member lost their job, was laid off, or received reduced work hours due to COVID-19 expressed lower intentions to have their children attend child care when services reopen. Families who experienced employment loss may have been required to reallocate their child care expenses due to reduced financial resources. Alternatively, those who faced employment loss could have felt more well-equipped to care for their children at home due to lower occupational constraints. Further studies are required to better elucidate the motivation behind parents' decisions in relation to economic impacts on family units. Nonetheless, our results collectively highlight several key factors which may help identify families with greater needs for child care services during the pandemic. Caregivers' decisions to use services may vary based on both the sociodemographic characteristics of the family and children's activity patterns. Hence, policymakers must carefully consider the experiences of the overall family unit when making decisions about child care service availability throughout the pandemic, bearing in mind those who are most in need of support.

4.4. Limitations and future directions

The findings of the present study must be interpreted bearing in mind several limitations. First, the results are not generalizable to a broader population, Canadian or otherwise, due to the crowdsourced nature of the ICC-PDP sample. This issue was further exacerbated by only including a subset of participants due to missing data. The ICC-PDP dataset also included little information about the children of the caregivers who participated in the study, such as child age and gender, which may impact their time use (64). To address these limitations, future research should include a more diverse set of participants to improve generalizability.

There were also limitations regarding the measurement of children's activity patterns in the ICC-PDP study. Some variables lacked specificity. For instance, it was unclear as to what constitutes the category of the activity "developing other skills." The list of activities included was also not exhaustive. Future work may consider employing alternative methods such as ecological momentary assessment to capture a more detailed and comprehensive view of children's activities. The parent-report nature of the present study is another limitation. Given that caregivers were required to balance a wide range of demands during the pandemic, their reports of concerns and children's activities may have been skewed by personal stressors. Moreover, previous work indicates that parents may over- or underestimate children's engagement in activities such as screen time (65). Hence, the use of different data collection methods (e.g., ecological momentary assessment, multi-informant reports of child activities) may help achieve more reliable reports of children's time use. Finally, the cross-sectional nature of the analyses prevented directional conclusions. Examinations of the trajectories and long-term relations between children's activities, parental concerns, and child care service utilization is an important next step, particularly as Canada begins to emerge from the pandemic and re-establish functions in the Early Learning and Child Care Service sector.

5. Conclusion

The COVID-19 pandemic had undeniable impacts on the lives of children and families, largely as a result of from disruptions to childcare services. The present study aimed to understand these effects in-depth by delineating patterns in children's activities at home during the pandemic, and their relations with parental concerns and child care service utilization. Findings highlight that children's activity engagement typically fell into one of three patterns, with slight differences in parental concerns between them. Notably, children were more likely to fall into groups for which caregivers held slightly higher levels of concern when they experienced changes in child care, illustrative

disruptive impacts on the daily lives of Canadian youth. Caregivers' intentions to have their children attend child care following the pandemic also showed some associations with children's activity patterns, alongside sociodemographic characteristics, emphasizing that children's lifestyles may result in greater child care needs for some families. Overall, these findings suggest that the effects of child care disruptions were not uniform across Canadian families. Disparities can be documented through the characteristics of both children and caregivers, and "one-size-fits-all" supports will likely result in unmet needs for much of the population. As Canada begins to emerge from the pandemic and society resumes in-person functions, policymakers and service providers should work closely with parents to best understand each family's unique needs while navigating life post-pandemic. Doing so will ensure that child care programs are well-prepared for the future, therefore contributing to positive developmental outcomes for Canadian youth.

Data availability statement

The data analyzed in this study is from a publicly available dataset provided by Statistics Canada. Information about the study and access to the dataset can be found at: https://doi.org/10.25318/45250006-eng.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

JZ led the conceptualization and design of the study, performed statistical analyses, and wrote the full draft of the manuscript, under the guidance of JS and DB. DB and JS provided assistance with

analyses and feedback on the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The socioeconomic context of stigma: examining the relationship between economic conditions and attitudes towards people with mental illness across European countries

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Introduction: Efforts to reduce the stigma associated with mental illness have intensified over the past 30 years with a particular focus on improving public attitudes. Difficult economic circumstances can be harmful to intergroup relations, but little is known about whether there is a relationship between socioeconomic conditions and attitudes towards people with mental illnesses.

Methods: Random effects logistic regression modelling was employed to explore the relationship between individual financial circumstances, contextual socioeconomic factors and difficulty speaking to a person with a significant mental illness across European countries.

Results: Lower GDP per capita and higher income inequality at the country level, alongside individual financial difficulties, were each associated with a greater likelihood of reporting difficulty speaking to a person with a significant mental illness.

Discussion: Micro and macro-economic factors are associated with public attitudes towards people with mental illness across Europe. With prolonged economic instability predicted over the coming years in Europe it is important that these findings are taken into consideration when designing mental health and social policies, in order to safeguard the progress that has been made in reducing mental health stigma to date.

KEYWORDS

stigma, mental illness, socioeconomic, income inequality, public attitudes

1. Background

The stigma associated with mental illness has wide-reaching and detrimental effects on those who experience it, including depression, low self-esteem and broader inequalities in life chances (1–3). The past 30 years has seen an intensification of anti-stigma campaigns across Europe seeking to target and ameliorate these harmful consequences. A frequent focus of anti-stigma efforts has been on bringing about a broad scale change in public attitudes towards people experiencing mental illnesses, see for example, Time to Change in the United Kingdom (4, 5) and one of the most effective ways to change public attitudes is to promote social contact between people who experience mental illness and those who do not (6). Social contact allows opportunity for first-hand interactions that reduce the need for reliance on stereotypes of the stigmatised characteristic (7).

Economic conditions can impact on intergroup relations; for example, where there is greater competition for economic resources, there are higher levels of prejudice directed from majority social groups towards minorities such as immigrants (8). Prejudice in these circumstances can arise from both actual and perceived competition for resources (9). Income inequality creates further strain on intergroup relations through mechanisms of status competition (10) and in doing so drives up perceptions of outgroup threat, with damaging effects on social trust and cohesion (11, 12). It is therefore important to consider not only how intergroup relations link with prejudice at the individual level, but also the broader context in which such social interactions take place (13). When economic difficulties intensify, for example during times of recession or economic instability, negative attitudes towards minorities can harden further (14).

People with mental health conditions represent an often-marginalised group who experience entrenched socioeconomic difficulties and for whom the 2007 recession exacerbated existing labour market disadvantage (15, 16). Yet whilst the relationship between socioeconomic conditions and mental illness is well-evidenced, much less is known about whether or not the broader economic context influences public attitudes towards people with mental health conditions.

Historically, much of the focus of stigma research and interventions has been concentrated at the individual level (17) but more recently, attention has turned to the underlying structural factors that produce the societal conditions for stigma to thrive, or indeed that have the potential to mitigate existing prejudices (18). This includes policies, laws, institutional practices and cultural norms which may either intentionally or unintentionally perpetuate stigma.

Measures of stigma in relation to policies, laws and cultural norms have been associated with health inequalities amongst minority groups across a range of indicators such as substance misuse, myocardial infarction and mortality [see Hatzenbuehler and Link (19) for a review]. Specifically relating to mental health stigma, Evans-Lacko et al. (20) used two large European datasets to explore the relationship between public attitudes and self-stigma across fourteen countries. They found that less stigmatising attitudes amongst the general public, higher rates of help seeking, treatment utilisation and better access to mental health information at the country level were associated with lower self-stigma and perceived discrimination at the individual level.

This study seeks to contribute to the evidence base on the structural drivers of stigma associated with mental illness by exploring the relationship between economic conditions and public attitudes. In line with the existing evidence, it focuses specifically on resource competition and inequalities, and uses willingness to speak to a person with a significant mental illness as the outcome variable, a measure of public attitudes and a proxy measure for social distance (20). In doing so, it aims to contribute to further understanding of the role of economic factors in individual experiences of stigma.

A recent global survey suggests that residents in Europe report higher perceptions of social division and tension than in other areas of the world (21) so this research is particularly relevant.

Our study uses a cross-national European sample from 2010 to explore the economic context immediately following the Great Recession, to understand what we can learn for this current period of global macroeconomic instability and in the coming years ahead.

2. Methods

2.1. Sample

The main data source for the analysis, from which the outcome variable and covariates were drawn, was the Eurobarometer, a cross-national survey conducted annually and for 2010, including data on attitudes towards people with mental illness for approximately 26,800 individuals across European countries (22). The survey sample was drawn using multi-stage random probability sampling proportional to population size and density and is representative of the population aged 15 and above in each of the countries [see TNS Opinion and Social (23) for full details of survey methodology]. Interviews were carried out face to face at participant homes, in an appropriate national language (23). The sample for each country includes around 1,000 respondents aside from Luxembourg, Cyprus and Malta where numbers are around 500. This is because sampling is proportionate to population size and so smaller countries have fewer respondents (23). All Eurobarometer data was weighted using the EU27 population weight included in the dataset (22).

The survey used for this analysis represents the second in a special series about mental health across Europe with the first survey taking place in 2006; however, the 2010 Eurobarometer survey is the first and only to explore perceptions of people with mental illness as far as we are aware (22).

2.2. Outcome variable

The following Eurobarometer survey question was selected as the outcome variable, in which respondents are asked to choose from one of the following two statements:

- You would find it difficult talking to someone with a significant mental health problem.
- You would have no problem talking to someone with a significant mental health problem.

This measure has been successfully used across a number of studies previously that seek to explore differences in public attitudes towards people experiencing mental health problems across a European sample, and in particular to measure social distance (20, 24).

Answers were recoded into a categorical variable prior to analysis for ease of interpretation. A new variable was derived from the data with $0 = $ no problem talking to someone with a significant mental health problem and $1 = $ difficulty talking to someone with a significant mental health problem. "Don't know" responses were excluded from the analysis because it is not possible to interpret this response

in relation to desire (or not) for social distance, totalling 9.96% of responses overall (please see **Appendix I** for a breakdown of responses by country).

2.3. Explanatory variables

Two key macro-economic factors were tested for their association with whether or not respondents described difficulty speaking to a person with a significant mental illness. GDP per capita represents the overall financial resources available to a country, whilst income inequality demonstrates how these resources are distributed in the population. Variables were selected from publicly available European data sources and standardised measurements were used to enable cross-national comparison. Data on the 2010 estimates for GDP per capita (Euros) and income inequality (2010 Gini co-efficient) were derived from Eurostat (25).

2.4. Covariates

Individual demographic variables were sourced from the same Eurobarometer dataset as the outcome variable. Age and gender were included in the analyses since these factors are known to impact on individual attitudes towards people with mental illness (26). Individual perceptions of financial circumstances (measured as difficulty paying bills over the past 12 months) were also included based on previous research that suggests links between individual and contextual economic factors, and exclusionary attitudes towards people from other minority populations (27).

2.5. Analytic strategy

To explore both individual and contextual factors, a random effects logistic regression modelling approach was employed. There is ongoing debate about the acceptable number of contextual levels in multilevel models (28) but in an extensive review of cross-national analyses where multilevel modelling has been used, Bryan and Jenkins (29) recommend that data from upwards of 25 countries should be included to generate reliable estimates, a requirement met by the dataset used here.

All analyses were conducted in Stata version 15.1 (30). Scatter plots were used to explore the relationship between the outcome variable and each of the contextual variables. Individual level variables were added to the model first (model 1), followed by each contextual socioeconomic variable independently (models 2a and b) and a final, full model incorporating all individual and contextual variables (model 3). Likelihood ratio tests confirmed that random effects models were an improved fit compared to ordinary logistic regression once contextual variables were included and intraclass correlations were estimated for each of the random effects models. All effect estimates are reported as odds ratios.

3. Results

On average, around a quarter (24.73%) of respondents across the EU-27 reported difficulty speaking to a person with a significant mental illness. Observation of the distribution of responses on the scatter plots (**Figures 1**, **2**) showed that Lithuania (59.59%) and Cyprus (6.97%) were outliers in relation to the proportion of respondents reporting difficulty speaking to a person with a significant mental illness but the decision was taken not to remove these countries because the analysis is intended to be a reflection of the real-world context.

Correlations demonstrated that both income inequality ($R^2 = 0.36$, $p = 0.001$) and GDP per capita ($R^2 = 0.33$, $p = 0.001$) were strongly associated with attitudes towards people with mental illness (**Figures 1**, **2**). Higher income inequality and lower GDP per capita were both associated with greater difficulty talking to a person with a significant mental illness.

The main findings are reported in **Table 1**. Individual financial status was consistently associated with attitudes towards people with mental illness across all models. Compared to those who reported never or almost never having difficulty paying their bills over the past 12 months, those who described difficulties some of the time were 1.25 (1.16, 1.34) times more likely to report having difficulty talking to a person with mental illness and those who described difficulty paying bills most of the time were 1.52 (1.37, 1.68) times more likely.

Age was also relevant, with difficulty speaking to a person with a significant mental illness decreasing with age as compared to those in the 16–24 age category, aside from the oldest age group (55 years and above). Gender had a strong and consistent effect, with males more likely to report experiencing difficulty talking to a person with mental illness than female respondents.

Models 2a and b demonstrate that GDP per capita and income inequality were independently associated with the outcome variable and once both contextual socioeconomic variables were included in the same model, the effects for each were maintained.

In the full model (model 3), GDP per capita was associated with difficulty talking to a person experiencing a significant mental illness, so that higher GDP per capita was related to a lower likelihood of reporting difficulty (0.99; 0.99–0.99), albeit this association appears modest. The association between income inequality and the outcome variable is stronger than that of GDP per capita; the more unequal a country, the less likely respondents were to feel comfortable talking to a person with a significant mental illness (1.06; 1.01–1.10).

We estimated odds ratios from the full model at the 20th and 80th percentile of the distribution of each contextual socioeconomic variable, to show the magnitude of effects (data not shown). Respondents from countries at the 80th percentile of the income inequality range were almost two times more likely to report difficulty talking to a person with a significant mental illness compared to the most equal country (Slovenia), whereas those from countries at the 20th percentile of the income inequality range were only 18% more likely to report such difficulty. In terms of GDP per capita, those living in countries

FIGURE 1
Proportion of respondents finding it difficult to talk to a person with mental illness by GDP per capita across the EU27.

FIGURE 2
Proportion of respondents finding it difficult to talk to a person with mental illness by income inequality across the EU27.
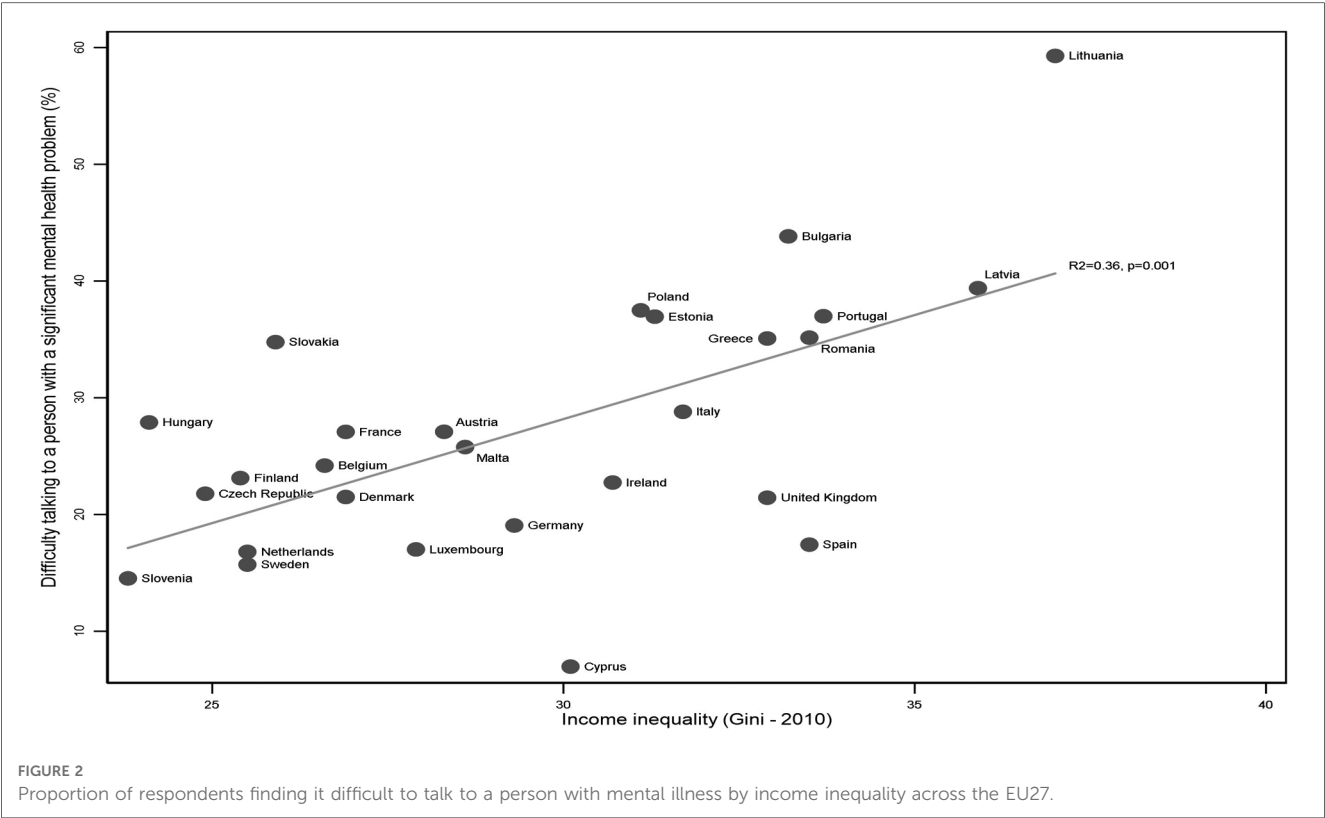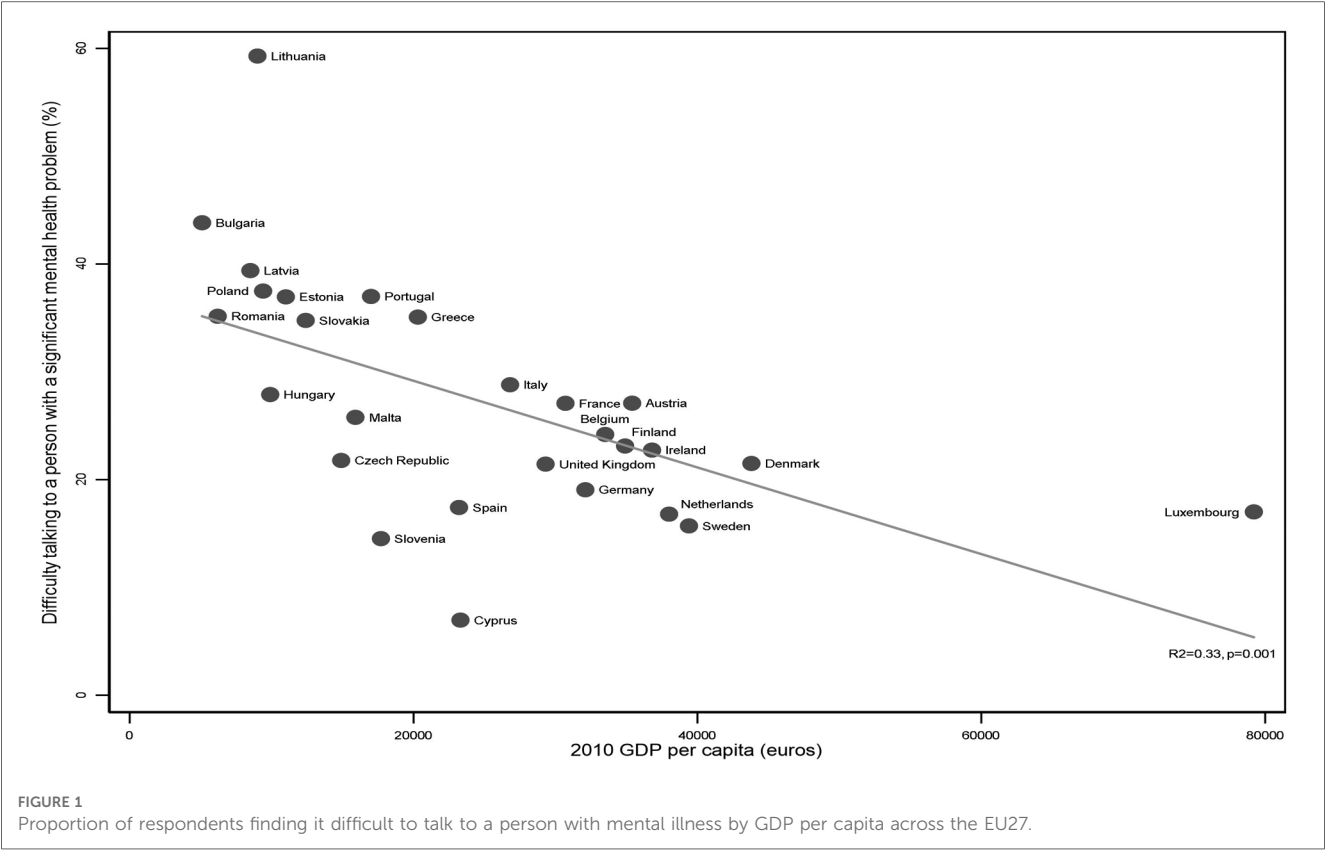
TABLE 1 Results of logistic regression models exploring associations between individual and contextual economic factors, and difficulty speaking to a person with a significant mental illness across the EU-27.

Variable/model	1	2a	2b	3
	N = 23,711	N = 23,427	N = 23,427	N = 23,427
	OR (CI)	OR (CI)	OR (CI)	OR (CI)
Difficulty paying bills never/almost never				
From time to time	1.49 (1.40–1.59)***	1.25 (1.17–1.34)***	1.25 (1.17–1.34)***	1.25 (1.16–1.34)***
Most of the time	1.97 (1.79–2.17)***	1.52 (1.37–1.69)***	1.52 (1.37–1.69)***	1.52 (1.37–1.68)***
Age 16–24				
25–39	0.86 (0.78–0.95)**	0.88 (0.80–0.98)*	0.88 (0.80–0.98)*	0.89 (0.80–0.98)*
40–54	0.79 (0.71–0.88)***	0.82 (0.74–0.91)***	0.82 (0.74–0.91)***	0.82 (0.74–0.91)***
55 years and above	0.92 (0.84–1.01)	0.97 (0.88–1.08)	0.97 (0.88–1.08)	0.97 (0.88–1.08)
Male				
Female	0.83 (0.78–0.88)***	0.81 (0.77–0.86)***	0.81 (0.77–0.87)***	0.81 (0.77–0.87)***
GDP per capita (Euros)		0.99 (0.99–0.99)**		0.99 (0.99–0.99)**
Income inequality (Gini)			1.08 (1.03–1.13)**	1.06 (1.01–1.10)**
LR test		603.13***	605.34***	424.23***
ICC		0.05 (0.03–0.09)	0.05 (0.03–0.09)	0.04 (0.02–0.08)

OR, odds ratios; CI, 95% confidence intervals.
*<0.05.
**<0.01.
***<0.001.

at the 20th percentile were 27% less likely, and those at the 80th percentile two and a half times less likely, to report difficulty talking to a person with a significant mental illness compared to the poorest country (Bulgaria).

The comparison between models indicates that the multilevel structure is a better fit for the data as indicated by the likelihood ratio tests ($p \leq 0.001$). The intraclass correlation associated with each of the models suggests that there is variance present that can be explained by differences between countries as well as within countries (31), here between 4% and 5% depending on the model (see Table 1).

4. Discussion

The findings suggest that both individual and contextual economic factors are relevant in determining whether or not people across the EU27 describe difficulty talking to a person with a significant mental illness.

In relation to demographic characteristics, the findings suggest that females are less likely than males to report difficulty talking to a person with a significant mental illness. Age is more complex, with the oldest and youngest respondents in the sample more likely to report difficulty than those in the 25–54 age group. This is at odds with broader findings in social attitudes research, whereby younger respondents often report more tolerant attitudes than those who are older (32), but this finding of a more tolerant middle age bracket has been demonstrated in other mental health attitudinal research from the same time frame. In the Attitudes to Mental Illness survey, a nationally representative study undertaken in the United Kingdom, respondents aged 35–54 gave the most tolerant responses compared to those in both younger and older age brackets, albeit there were nuances by

particular questions (33). This suggests that tolerance towards people with a mental illness increases rather than decreases with age, perhaps related to a higher likelihood of having had social contact with a person experiencing mental illness during the life course or possibly because younger adults may be less socially confident in general. It is also potentially a cohort effect although further research would be required to explore this, or it is possible that increasing physical vulnerabilities with advanced age, may increase perceived levels of threat and therefore reduce tolerance compared to middle-aged respondents.

Of all the individual factors, however, it was self-reported financial circumstances that had the strongest association with experiencing difficulty talking to a person with a significant mental illness. Here, there was a gradient of decreasing tolerance for each increment of financial difficulty. Those in the worst financial position were 1.52 (1.37, 1.68) times more likely to report difficulty talking to a person with mental illness than those in the most secure financial position. More recent research from both the UK and China finds a similar association between lower socioeconomic status and a greater desire for social distance from people experiencing mental health problems (34, 35).

The findings also suggest a relationship between public attitudes and the contextual socioeconomic factors included in the models. Higher GDP per capita and lower income inequality were associated with less difficulty talking to a person with mental illness. This means that people with mental illnesses who live in countries with lower GDP per capita and that are more unequal, may be more likely to experience stigma than those who live in countries with different socioeconomic characteristics.

The findings in relation to income inequality are in one way surprising given that there is a higher prevalence of mental illness in more unequal countries (10, 12) which should lead to more opportunities for social contact, thereby reducing overall

levels of prejudice. In more unequal countries, however, evidence suggests social contact is less effective as a mechanism for reducing prejudice because intergroup relations are more hierarchical (36). Furthermore, in this context there may be a concentration of individuals experiencing socioeconomic deprivation and mental ill health, which could impact on the attitudes of others in similar socioeconomic positions. Where outgroups are perceived to be larger in size, this has the effect of increasing perceptions of threat (37).

People in countries that are more unequal seem to experience the effects of relative social status more acutely, showing greater status anxiety and an increased desire to enhance self-presentation (38–40). This may lead to greater prejudice and stigmatisation of all groups associated with lower rather than higher social status, including people experiencing mental ill health. Similarly, where GDP per capita is lower, the stress associated with being in a difficult personal financial situation may be more acute because there may be greater competition for economic resources more broadly, though this finding requires further exploration as the effect size here appears to be modest.

4.1. Limitations

One of the key limitations of this study is the age of the data because it is possible that there have been changes to attitudes since 2010, although more recent research evidence is mixed (4, 34, 41). Without updated data, it is not possible to know whether the findings are a reflection of this specific time and context; however, the study does provide valuable information on the type of economic circumstances that may be associated with differences in attitudes.

It is also worth noting that whilst the study has focused on those factors that could produce greater intolerance towards people with mental illnesses, across the European countries in the sample, only 24.73% of respondents reported that they would experience difficulty talking to a person with a mental illness. It should be highlighted then, that most people in Europe report having no difficulty talking to a person with a significant mental illness, although there are considerable differences by individual country.

Whilst encouraging, this also raises the issue of social desirability bias. The Eurobarometer is conducted via face to face interview for the majority of respondents (22) and so it is possible that responses have been affected by interviewees wanting to appear more tolerant. Henderson et al. (42) found that whilst questions relating to knowledge about mental illness are not associated with social desirability bias, questions relating to intended behaviour towards people with mental illnesses are, particularly in face to face interviews compared to online surveys. The outcome variable in this study represents an intended behaviour question and therefore social desirability bias could be implicated here. In this case, it is possible that the study findings understate the links between economic factors and attitudes towards people with mental illness.

The outcome variable used here does not directly reference prejudice in the question which may help to address some of the

issues around social desirability bias but does produce difficulties in determining the exact meaning of responses. A person may be willing to engage with a person experiencing a significant mental illness, but may, for example, lack confidence, therefore this is not necessarily a measure of desire for social distance. More in-depth, qualitative methodological approaches may be needed to assist in understanding the nuances behind these responses, or alternatively the use of more a more detailed scale to understand differences. This applies also to the "don't know" responses in the sample.

Whilst we do not consider it likely that the association between higher levels of income inequality and increased stigmatization could be fully explained by racial/ethnic heterogeneity, our lack of inclusion of this characteristic could be viewed as a limitation of the analysis. Although racial/ethnic heterogeneity has been suggested as a potential confounder in the past by those sceptical of the impact of inequality on health and wellbeing, research has shown that the association between income inequality and health is independent of racial/ethnic heterogeneity in both international and US state comparisons (43). In addition, as income inequality may itself create the social and economic conditions that increase migration/ethnic heterogeneity, which in turn may be a potential cause of higher levels of downward prejudice and stigmatization, we view ethnic heterogeneity as possibly sitting on the causal pathway (i.e., a mediator, not a confounder).

Within a European context, analytical issues around ethnicity are perhaps even more complicated than in the north American context, where most studies adjust for African-American race and Hispanic ethnicity. In the UK, for example, some south Asian groups have high socioeconomic status and do better in terms of wellbeing measures, while others do worse than the White British average. White Eastern European migrants to the UK and White Roma populations can experience considerable disadvantage, so comparing white to non-white groups obscures important complexity.

The analytical treatment of ethnic heterogeneity in relation to income inequality and outcomes, therefore, is a complex matter, worthy of a further paper and beyond the scope of our current analysis. Further exploration of the role of migration status, ethnicity, language and other measures of identity would be a beneficial next step for future research.

4.2. Implications of findings

Both individual demographic differences and contextual economic factors appear to be relevant in explaining the proportion of people who have difficulty talking to a person with a significant mental health problem across European countries. The wider socioeconomic climate is important because it impacts on all people living in a country. Evidence suggests, for example, that income inequality has detrimental effects on health and social outcomes for all residents in more unequal countries (10). Where the wider socioeconomic climate in a country incorporates greater income inequality or lower GDP per capita the population may be more likely to report difficulty speaking to a person with a significant mental illness, though further research is needed to confirm these findings.

Individual perceptions of financial circumstances were consistently and independently associated with difficulty speaking to a person with a significant mental illness which is in keeping with findings relating to attitudes towards minority groups more broadly. It is feasible that the association between individual financial circumstances and attitudes towards mental illness could be a reflection of the wider socioeconomic climate and this would certainly fit with existing research that suggests income inequality is related to more negative outgroup attitudes at the individual level (9, 11, 36). In more unequal countries, the effects of status anxiety are stronger and this impacts on people at all income levels (44). Status anxiety produces more strained interpersonal relationships because it increases concerns about social evaluation, in turn meaning that people are less likely to associate with others who are viewed as a threat to their social status (12). Goffman (45) conceptualises mental illness as a "discredited" characteristic meaning that it is perceived as conferring an inferior social status. It is possible that in socioeconomic climates where status anxiety means that social position carries more weight, people are more likely to disassociate themselves from those perceived as having a discredited characteristic.

This study contributes to the emerging field in mental health research that focuses on the underlying societal level drivers of stigma. These factors are key to improving understanding of the experiences of individuals with mental illnesses since a country may set out intentions for progressive mental health policies in terms of care and treatment, whilst at the same time making economic decisions that perpetuate disadvantage (46) and place strain on intergroup relations. Further research, using more recent data and exploring the underlying mechanisms behind the associations between both micro and macro-economic factors and public attitudes would be beneficial.

Whilst beyond the scope of the current analysis, future research may wish to focus on additional country-level factors that could be associated with GDP per capita and income inequality, and which may impact on attitudes towards people with mental health problems. In particular, differences in healthcare systems, the political, ethnic and religious composition of each country and the prevalence of mental health problems across different populations could each add important detail to the findings. Similarly at the individual level, additional context in relation to individual demographic variables may further strengthen the analyses, for example, ethnicity, religion and educational level. Although not possible with this particular dataset, it would also be interesting to know whether the perceived socioeconomic status of the person experiencing mental illness had any impact on public attitudes.

Significant social, economic and political change seems likely in the United Kingdom and potentially across Europe in the coming years and this may potentially impact on people with mental health conditions, producing further social exclusion. Reducing existing stigma, whilst ensuring that people with mental health conditions do not become further marginalised in this context, should be key priorities for mental health practitioners and policy makers alike. Targeting income inequality should be the first step to improving intergroup relations, and therefore potentially attitudes towards people experiencing mental illness, ultimately reducing the harmful effects of stigma.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was obtained by the original Eurobarometer researchers and was not required for this secondary analysis on existing publicly available data in accordance with the local legislation and institutional requirements.

Author contributions

KP contributed to the analysis, interpretation of data and manuscript preparation. KEP, CL and RW contributed to interpretation of data and revision of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fepid.2023.1076188/full#supplementary-material

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