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Mediated moderation of the relation between maternal and adolescent depressive symptoms: role of adolescent physical health

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Abstract

Background To examine the mediating effect of family functioning on the relation between maternal and adolescent depressive symptoms and determine whether the magnitude of the mediating effect is different for adolescents with and without chronic physical health conditions. *Methods* Data come from the National Longitudinal Survey of Children and Youth. A representative survey of 11,813 adolescents and their mothers was included. Maternal and adolescent depressive symptoms were measured using the 12-item Center for Epidemiological Studies Depression Scale. Family functioning was measured using the McMaster Family Assessment Device. Multilevel multiple-group path analysis was used to examine potential mediating and moderating effects. *Results* Family functioning measured when adolescents were 14–15 years mediated the relation between maternal depressive symptoms (measured at 10–13 years) and adolescent depressive symptoms (measured at 16–19 years) for both adolescents with [$\alpha\beta = 0.02$ (0.02, 0.03)] and without chronic health conditions [$\alpha\beta = 0.01$ (0.00, 0.01)]. These findings provided evidence to suggest mediated moderation, $\Delta\alpha\beta = 0.02$ (0.01, 0.03), that is, the mediating effect of family functioning was significantly larger for adolescents with chronic health conditions.

Conclusions The mediating effect of family functioning in the relation between maternal and adolescent depressive symptoms is larger for adolescents with chronic health conditions. Within the framework of family-centered care, maternal depressive symptoms and family functioning are suitable targets for preventive intervention for adolescents with chronic health conditions.

Introduction

There is substantial literature documenting the relation between maternal depression (or depressive symptoms) and child or adolescent psychopathology, particularly depression [1]. While the precise mechanisms linking maternal and adolescent depression are not completely elucidated, it is clear that genetic, environmental, and psychosocial factors and their interactions are implicated [2]. One area of investigation that has received considerable attention has been the interrelations among symptoms of maternal and adolescent depression and family processes including parent–child relations, expressiveness, and functioning [3]. Consistently, symptoms of maternal depression are associated with disruptions in family functioning [4, 5]. Likewise, poorer family environments, including family climate and functioning are associated with depressive symptoms in children and adolescents [6, 7]. Advancing the literature in this field, more recent studies have examined the potential role of family functioning as a mediating factor in

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the relation between maternal and adolescent depressive symptoms [8–11]. Similar findings have been reported in clinical samples of adolescents who have a chronic physical health condition, such as asthma, diabetes, and epilepsy [12–14].

A literature gap exists in that it is unknown whether the magnitude of this mediating effect is different for adolescents with and without a chronic health condition. Focusing on adolescents with a chronic health condition is relevant for three main reasons. First, the prevalence of chronic health conditions in child and adolescent populations is substantial and increasing due to improvements in diagnosis and medical treatment [15]. As a result, over 90 % of adolescents with a chronic health condition live as adults with chronic health conditions [16].

Second, adolescents with chronic health conditions are at elevated risk for emotional and behavioral problems compared to their healthy counterparts [17–19]. Research has provided evidence suggesting that psychosocial consequences (e.g., limiting activities, social exclusion) [20, 21], shared biological pathways (e.g., up-regulated pro-inflammatory cytokines) [22–25], or a combination of both leading to disequilibrium of the hypothalamus–pituitary–adrenal axis [26, 27] may be at least partly responsible for the elevated risk for mental health problems in adolescents with chronic health conditions. Furthermore, adolescents with physical–mental comorbidities have increased mortality and poorer functioning [28, 29] and are heavy consumers of health services, placing considerable burden on the health system [30–32].

Third, having a child with a chronic health condition affects the entire family. Generally, these families experience greater stress, manifesting as symptoms of maternal depression [33–35]; marital stress, divorce, and poorer family functioning [36–38]; and financial hardship [39, 40]. Also, there is evidence that maternal depression differentially impacts the psychological functioning of adolescents—adolescents with chronic health conditions experience a more negative impact as a result of exposure to maternal depression in childhood compared to adolescents without chronic health conditions [41]. Given evidence of this elevated vulnerability, understanding whether the magnitude of the mediating effect of family functioning on the relation between maternal and adolescent depressive symptoms may provide useful insights to the development of depression among adolescents with a chronic health condition and potentially inform interventions that target upstream factors—maternal depression and family functioning.

Theoretical framework

The current study adapted Pearlin's stress process model as the a priori theoretical framework [42]. The stress process identifies and specifies the interrelations among experiences and social and personal resources hypothesized as relevant to a health outcome [43–48]. It is through these relations that researchers are able to elucidate potential causal mechanisms between stressors and health outcomes, and identify potential targets for intervention to ameliorate the negative effect a stressor may have on an individual's health. When considering symptoms of depression in adolescents with chronic health conditions, the stress process (Fig. 1) consists of several components. Maternal depressive symptoms are the *primary stressor* and *stress exposure*, which can arise from discrete life events (e.g., death of family member) or chronic strains (e.g., poverty). Family functioning is a family process, classified as a *resource mediator* which is influenced by the symptoms of maternal depression and, in turn, influences adolescent depressive symptoms. Having a chronic health condition is the *stress moderator*, potentially augmenting the relations between maternal depressive symptoms and family functioning and family functioning and adolescent depressive symptoms. Symptoms of adolescent depression are the *health outcome*, representing the converging consequences in the stress process.

The current study

The objectives of this study were to examine whether family functioning mediates the relation between maternal and adolescent depressive symptoms and whether the magnitude of the mediating effect is moderated by the presence of a chronic health condition in an epidemiological sample of adolescents from age 10 to 19 years. It was hypothesized that family functioning would mediate the relation between maternal and adolescent depressive symptoms, and the effect would be significantly larger for adolescents with a chronic health condition.

Methods

Study sample

Data were obtained from the National Longitudinal Survey of Children and Youth (NLSCY), a voluntary study of children from birth to early adulthood in Canada. It was designed to collect information about factors influencing children's psychosocial development. Detailed study methods are available elsewhere [49]. Briefly, the NLSCY used a stratified, multistage, probability design to enlist representative children aged 0–11 years. Institutionalized children and those living on Aboriginal reserves were excluded. Participants completed measures assessing demographic, medical, psychological, and behavioral variables. In cycle 1, as many as four children per

Fig. 1 The stress process model
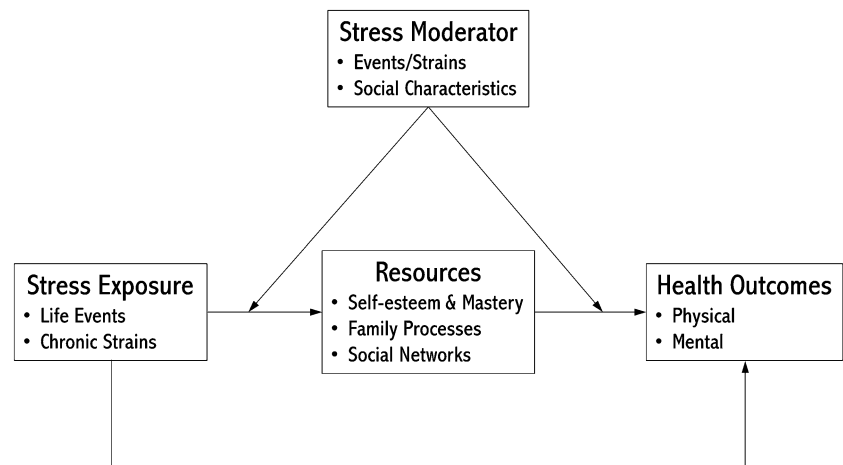
household could be included in the NLSCY. At cycle 2, this was reduced to two children for reasons of feasibility. Fifty-three percent of the original cohort responded 14 years later in the final cycle [49].

Data from all cycles (eight in total) were merged, and the sample was then restricted to 10- to 19-year-old adolescents whose mothers were the participating person most knowledgeable ($n = 12{,}740$). A total of 927 individuals were excluded from this analysis due to missing household or participant identifiers, and inconsistent reports of adolescent sex and chronic health conditions (e.g., participants who reported asthma at age 10–11 and 14–15 years but not at 12–13 years were excluded). Thus, there were $n = 11{,}813$ mother–adolescent dyads included in the current study. While the research and analyses are based on data from Statistics Canada, the opinions expressed do not represent the views of Statistics Canada. Ethical approval for the analyses was obtained from McMaster University.

Measures

Exposure and outcome

Symptoms of maternal and adolescent depression were measured using a reduced version of the Center for Epidemiological Studies Depression Scale (CES-D), a 12-item scale assessing depressive symptoms over the past week [50, 51]. A four-point Likert scale (0–3) was used to rate the frequency of symptoms. Higher scores indicate greater impairment. The scale demonstrated good reliability (mothers: $\alpha = 0.86$; adolescents: $\alpha = 0.82$). Maternal depressive symptoms were measured when adolescents were at 10–11 and 12–13 years of age ($r = 0.57$) and adolescent depressive symptoms at 16–17 and 18–19 years of age ($r = 0.45$; $p < 0.001$ for both). Participants' two CES-D scores were then averaged for the analysis.

Mediator

Family functioning was measured when adolescents were 14–15 years of age using the 12-item General Functioning subscale of the McMaster Family Assessment Device (FAD), providing an overall measure of the health/pathology of the family [52, 53]. The scale was derived by summing items that sampled from six domains: problem solving, communication, roles, affective responsiveness, affective involvement, and behavioral control. The scale instructs respondents: "Next are statements about families and family relationships. For each one, mark the circle beside the category which best describes your family." Items are rated on a four-point Likert scale (0–3) with higher scores indicating poorer overall family functioning. The scale was completed by mothers and had excellent reliability ($\alpha = 0.91$). Using the FAD score when adolescents were 14–15 years of age provided temporal order to the mediation model.

Moderator

Adolescent chronic health conditions were measured at each cycle by asking mothers, "Has a health professional diagnosed any of the following long-term conditions for this child…?" [asthma, $n = 682$; cerebral palsy, $n = 37$; diabetes, $n = 43$; epilepsy, $n = 65$; heart condition, $n = 83$; kidney condition, $n = 33$; any other long-term physical condition, $n = 923$]. The non-categorical approach was adopted whereby chronic health condition was coded as present or absent [54]. In total, 1866 adolescents were classified as having a chronic health condition and 9947 were classified as healthy. This classification was based on consistently reporting the presence or absence of any chronic health condition at each measurement occasion.

Covariates

All covariates were measured when adolescents were 10–11 years of age and were included in the analysis to provide unbiased estimates of effects in the relations among variables in the stress process. Mothers provided information on a number of sociodemographic characteristics: age in years, immigrant status (born in/out of Canada), the presence of a chronic health condition (yes/no), education attainment (elementary school, secondary school graduate, some post-secondary, post-secondary graduate), employment status (working full- or part-time/unemployed), marital status [yes (includes common-law relationships)/no], and annual household income (categorized by $20,000 intervals, ranging <$20,000 to ≥$80,000).

Data Analysis

Univariable descriptive statistics described the study sample, whereas bivariable analyses compared sociodemographic characteristics between adolescents with and without chronic health conditions. Multilevel multiple-group path analysis was used to examine the interrelations among variables in the stress process, accounting for potential clustering effects at the household level. Evidence of family functioning mediating the relation between maternal and adolescent symptoms of depression was quantified using the product of coefficients method and calculation of the associated 95 % confidence intervals [55]. Following published guidelines, estimates were examined to determine the presence of moderated mediation or mediated moderation [56]. Differences in estimates between adolescents with and without a chronic health condition were quantified using the method of variance estimates recovery and associated 95 % confidence intervals [57]. Common thresholds for model fit indices were implemented to determine the adequacy of fit of the data to the specified model. These were the χ^2 goodness-of-fit $p > 0.05$, comparative fit index (CFI) >0.95, standardized root mean square residual (SRMR) <0.08, and root mean square error of approximation (RMSEA) and associated 90 % confidence intervals <0.06 [58].

Analyses conducted in this study implemented sampling weights based on the probabilities of selection and participation, developed by Statistics Canada to ensure comparability between the NLSCY sample and Canadian population (Statistics Canada, 2007). Univariable and bivariable analyses were conducted using SAS 9.4 (SAS Institute Inc.) and path analysis using Mplus 6.11 (Muthén & Muthén). All hypothesis tests were two sided.

Missing data

Multiple imputation using the expectation-maximum likelihood algorithm was used to account for data assumed to be missing at random. This assumption is plausible because all variables, including those predicting missingness, were included in the imputation model [59]. Ten datasets were created and used to generate the estimates reported in the path model. Seventeen percent of participants had missing responses for one time-point, 9 % for two time-points, and 1 % for three or more time-points. Attrition was associated with mothers who were younger (38.3 vs. 39.1 years), not in a partnered relationship (22 vs. 15 %), and had lower education (34 vs. 41 % post-secondary graduate) and income (18 vs. 23 % income ≥ $80,000; $p < 0.001$ for all).

Results

Sample characteristics

Mothers were, on average, 38.9 (SD 5.2) years of age, and most were in partnered relationships (83 %). Over one-third (39 %) had completed post-secondary education and 22 % reported annual household incomes of ≥$80,000. Seventeen percent of mothers were immigrants. Almost half of mothers (44 %) reported having a chronic health condition. Forty-nine percent of adolescents were male, 4 % were immigrants, and 16 % had a chronic health condition.

Compared to healthy adolescents, those with a chronic health condition were more likely to be male (61 vs. 49 %), have mothers with a chronic health condition (60 vs. 42 %) and elevated symptoms of depression (4.42 vs. 4.07), and have families with more indicators of worse functioning (8.56 vs. 8.32; $p < 0.05$ for all). Additional characteristics of the study sample are presented in Table 1.

Path model of the stress process

Correlations among variables in the path model were small to medium in magnitude for both adolescents with and without a chronic health condition (Table 2). The stress process illustrating the mediating effect of family functioning on the relation between maternal and adolescent symptoms of depression is diagrammed in Fig. 2. The data fit the model well: $\chi^2(8) = 22.25$, $p = 0.005$; CFI = 0.970; SRMR = 0.011; RMSEA = 0.017 (0.009, 0.026). Estimates of the relations among variables were mostly similar and statistically significant for both adolescents with and without a chronic health condition. Noteworthy differences were observed in the relation between maternal and

Table 1 Sample characteristics

	Chronic health condition ($n = 1866$)	Healthy ($n = 9947$)	$\chi2$ or t
Adolescent			
Male (%)	61.3	49.4	38.33***
Immigrant (%)	3.6	3.7	0.01
Depressive symptoms, CES-D	7.32 (0.13)	7.28 (0.05)	0.32
Mother			
Age (years)	38.7 (0.12)	38.9 (0.05)	2.21*
Immigrant (%)	14.9	18.2	2.89
Chronic health condition (%)	60.2	41.8	46.73***
Living in partnered relationship (%)	83.2	82.7	0.09
Post-secondary education (%)	38.8	39.2	1.49
Depressive symptoms, CES-D	4.42 (0.11)	4.07 (0.05)	2.85**
Family			
Annual income ≥$80,000 (%)	19.5	22.1	2.58
Family functioning, FAD	8.56 (0.10)	8.32 (0.04)	2.39*

Values are reported as mean (standard error) unless noted otherwise

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2 Correlations among path model variables

	Maternal depression	Family functioning	Adolescent depression
Maternal depression		0.23	0.12
Family functioning	0.22		0.10
Adolescent depression	0.16	0.07	

Results are reported as Pearson correlation coefficients, r. Values above the diagonal are from the sample of adolescents with a chronic condition and those below the diagonal are from the healthy sample

All correlations are significant at $p < 0.001$
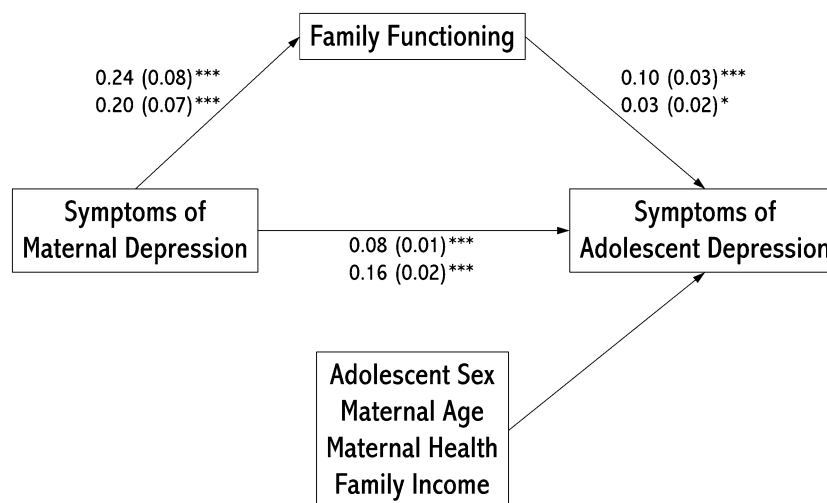
Fig. 2 Path model of the stress process. The model illustrates the relations between maternal depressive symptoms, family functioning, and adolescent depressive symptoms. Symptoms of maternal depression were measured when adolescents were 10–13 years; family functioning when adolescents were 14–15 years; and symptoms of adolescent depression when adolescents were 16–19 years. Sociodemographic covariates were measured when adolescents were 10–11 years (estimates not shown). Simultaneous models were specified for adolescents with (*top*) and without chronic health conditions (*bottom*). Parameter estimates and associated standard errors are unstandardized. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

adolescent depressive symptoms, $\Delta\beta = -0.08$ $(-0.12,$ $-0.04)$ and between family functioning and adolescent depressive symptoms, $\Delta\beta = 0.07$ $(0.01, 0.13)$, providing evidence of mediated moderation.

The mediating effect of family functioning was statistically significant for both adolescents with a chronic health condition, $\alpha\beta = 0.02$ $(0.02, 0.03)$, and healthy adolescents, $\alpha\beta = 0.01$ $(0.00, 0.01)$. The mediating effect among adolescents with a chronic health condition was significantly larger than their healthy counterparts, $\Delta\alpha\beta = 0.02$ $(0.01, 0.03)$. In addition, the proportion of the relation between maternal and adolescent symptoms of depression mediated by family functioning was substantially larger among adolescents with a chronic health condition (23.1 vs. 3.6 %).

Discussion

Summary of findings

Findings from this study add to the growing literature examining the interrelations among maternal and adolescent depressive symptoms and family functioning. Evidence suggested that family functioning mediates the relation between maternal and adolescent depressive symptoms and that the magnitude of this mediated effect is significantly larger for families who have an adolescent with a chronic health condition compared to those who do not. The mediated moderation observed was quite pronounced, whereby the proportion of the relation between maternal and adolescent depressive symptoms mediated by family functioning was more than sixfold greater for adolescents with a chronic health condition.

There was considerable support for the stress process model using these epidemiological data, which also confirmed findings from previous empirical studies. Specifically, symptoms of maternal depression were associated with greater disruptions in the family environment (functioning, parent–child relationships, coherence), which were subsequently associated with increased symptoms of depression in adolescents with [12–14] and without chronic health conditions [8, 9].

Clinical and research implications

Findings have implications for the provision of health services, particularly for adolescents with a chronic health condition and their families. Evidence suggests targeting modifiable aspects of the family environment, such as maternal depression and family functioning, with behavioral interventions is as effective as standard cognitive-behavioral therapy (CBT) for adolescent depression [60]. Findings from this study support targeting these family processes and

present an argument that these processes may be even more relevant targets for intervention among adolescents with a chronic health condition. While interventions directed at improving symptoms of depression in adolescents with a chronic health condition are lacking, one clinician-facilitated, manual-based CBT for adolescents with inflammatory bowel disease shows promise for the development of interventions that can be adopted for adolescents with other chronic health conditions [61–63]. The therapy is a modification of the Primary and Secondary Control Enhancement Training (PASCET) which includes components that draw on behavioral activation, cognitive restructuring, and problem solving to change maladaptive behaviors, cognitions, and coping strategies. The nine-week PASCET-Physical Illness (PASCET-PI) uses a physical illness narrative to address cognitive distortions, teaches relaxation and guided imagery for pain, identifies behavioral motivators to improve medication adherence, and helps youth remain physically and socially engaged during exacerbations. Supplementing these individual youth sessions are independent parent sessions aimed at educating parents about inflammatory bowel disease and depression, as well as teaching them to become CBT coaches. This approach closely aligns with family-centered approaches to health care for adolescents advocated by professional medical societies as integral to patient health and quality of care [64, 65]. Research that aims to identify the most salient aspects of family functioning is needed to inform the development and evaluation of similar interventions in adolescents with chronic health conditions. Given the high prevalence of chronic health conditions and their comorbidity with mental disorder among children and adolescents, such research is warranted and would make an important contribution to adolescent and family mental health.

Strengths and limitations

This study has a several noteworthy strengths. Findings are strengthened by the large, representative epidemiological sample of adolescents, and their mothers. Although causality cannot be inferred, timing of assessments allowed for a clearer delineation of the temporality of relations among variables in the model. Controlling for potential confounding factors in the path analysis was statistically efficient in presenting unbiased estimates of effect. Likewise, including a healthy control group in the multiple-group analysis allowed for a comparison of adolescents with and without a chronic health condition and the identification of mediated moderation. Finally, the use of maternal and adolescent reports avoided potential informant bias associated with depression distortion [66].

This study also has limitations that warrant consideration. First, given the counts for individual chronic health

conditions and the complexity of the stress process model tested, across-condition comparisons could not be executed. However, such comparisons may not be relevant given evidence suggesting the validity of the non-categorical approach to chronic health conditions in children [54], as well evidence suggesting minimal heterogeneity in risk for psychopathology among children and adolescents with chronic health conditions [17, 67]. Second, on account of the assessment schedule for symptoms of maternal and adolescent depression and family functioning in the NLSCY, parallel process latent growth curve modeling could not be used to examine whether changes in maternal depression symptoms were associated with subsequent changes in family functioning and adolescent depressive symptoms. Likewise, the stress process model posits that "events and strains" are broader than maternal depressive symptoms and can include dynamic risk factors for depression such as, physical inactivity, sleep deprivation, and bereavement that were not measured in study. Third, like many prospective epidemiological studies, sample attrition in the current study was associated with socioeconomic disadvantage [68]. As a result, estimates of effect presented are likely underestimated. Fourth, while the model tested hypothesized the direction of effects from mother to adolescent, there is evidence that effects stem from adolescent to mother [69] or are bidirectional [70]. The assessment schedule of the NLSCY would not allow examination of these alternate models.

Conclusions

Findings from this prospective epidemiological study showed that while family functioning partially mediates the relation between maternal and adolescent depressive symptoms, the magnitude of the mediating effect is moderated by the presence of a chronic health condition in adolescents. For adolescents with a chronic health condition, family functioning mediates more of the effect of maternal depressive symptoms on adolescent depressive symptoms. Thus, both maternal depression and family functioning are important targets to consider in the provision of health services to adolescents with a chronic health condition in an effort to prevent or minimize symptoms of depression. Health professionals are encouraged to consider these aspects of the family environment in an effort to ensure the best possible mental health outcomes for adolescents, particularly those with a chronic health condition.

Compliance with ethical standards

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