

Trajectories of childhood neighbourhood cohesion and adolescent mental health: evidence from a national Canadian cohort

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Background. The objective of this study was to examine associations between trajectories of childhood neighbourhood social cohesion and adolescent mental health and behaviour.

Method. This study used data from the National Longitudinal Survey of Children and Youth, a nationally representative sample of Canadian children. The sample included 5577 children aged 0–3 years in 1994–1995, prospectively followed until age 12–15 years. Parental perceived neighbourhood cohesion was assessed every 2 years. Latent growth class modelling was used to identify trajectories of neighbourhood cohesion. Mental health and behavioural outcomes were self-reported at age 12–15 years. Logistic regression was used to examine associations between neighbourhood cohesion trajectories and outcomes, adjusting for potential confounders.

Results. Five distinct trajectories were identified: ‘stable low’ (4.2%); ‘moderate increasing’ (9.1%); ‘stable moderate’ (68.5%); ‘high falling’ (8.9%); and ‘stable high’ (9.3%). Relative to those living in stable moderately cohesive neighbourhoods, those in stable low cohesive neighbourhoods were more likely to experience symptoms of anxiety/depression [odds ratio (OR) = 1.73, 95% confidence interval (CI) 1.04–2.90] and engage in indirect aggression (OR = 1.62, 95% CI 1.07–2.45). Those with improvements in neighbourhood cohesion had significantly lower odds of hyperactivity (OR = 0.67, 95% CI 0.46–0.98) and indirect aggression (OR = 0.69, 95% CI 0.49–0.96). In contrast, those with a decline in neighbourhood cohesion had increased odds of hyperactivity (OR = 1.67, 95% CI 1.21–2.29). Those in highly cohesive neighbourhoods in early childhood were more likely to engage in prosocial behaviour (‘high falling’: OR = 1.93, 95% CI 1.38–2.69; ‘stable high’: OR = 1.89, 95% CI 1.35–2.63).

Conclusions. These results suggest that neighbourhood cohesion in childhood may have time-sensitive effects on several domains of adolescent mental health and behaviour.

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Introduction

The detrimental effects that the social and physical environment can have on individual health are well documented, including evidence that those in disadvantaged neighbourhoods are more likely to suffer from mental health problems (Latkin & Curry, 2003). Neighbourhood disorder has been associated with poor mental health outcomes for several disorders. This includes an association between neighbourhood disorganization and depression, both cross-sectionally (Aneshensel & Sucoff, 1996; Araya *et al.* 2006) and longitudinally (Latkin & Curry, 2003; Buu *et al.* 2009).

Actual lack and perceived lack of neighbourhood safety are also strong predictors of adverse mental health outcomes, including depression, anxiety and substance use (McCulloch, 2001; Meltzer *et al.* 2007).

Neighbourhood social capital and social cohesion have demonstrated protective effects on physical and mental health (Kalff *et al.* 2001; Fitzpatrick *et al.* 2005; Xue *et al.* 2005; Araya *et al.* 2006; Fone *et al.* 2007; Mulvaney-Day *et al.* 2007; Echeverria *et al.* 2008; Fujiwara & Kawachi, 2008). Social capital may be defined as the set of resources available to an individual by virtue of their group membership to social networks (Coleman, 1988), which may provide community resources to facilitate more desirable social, political, economic, educational or health outcomes. Social cohesion is a related concept, comprised of several inter-related constructs such as the presence of shared values, a sense of social order, social solidarity,

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the availability of social networks and support, and a sense of community belonging or identity (Kearns & Forrest, 2000; Forrest & Kearns, 2001). A cohesive neighbourhood is one in which neighbours trust one another, are engaged in their community, and are willing to cooperate with one another to attain shared goals (i.e. community events, neighbourhood watch, neighbourhood clean-up initiatives) (Stanley, 2002).

Several effects of social capital and cohesion on mental health symptoms have been found in cross-sectional research. For example, one study reported that high levels of social capital found in an inner city, disadvantaged neighbourhood had an inverse relationship with depressive symptoms in African-American adolescents (Fitzpatrick *et al.* 2005). Other studies have reported that higher perceived neighbourhood cohesion is associated with fewer symptoms of depression (Echeverria *et al.* 2008) and better general mental health (Macintyre & Ellaway, 2000; Mulvaney-Day *et al.* 2007). Moreover, recent evidence suggests that perceived social cohesion may mediate the relationship between neighbourhood disadvantage and residents' mental health (Hurd *et al.* 2013; Hong *et al.* 2014). Social cohesion may act on mental health via several mechanisms. Neighbourhood social cohesion may achieve protective effects by enhancing access to instrumental help from neighbours (e.g. childcare, carpooling, loaning possessions, home maintenance), promoting health-related behaviours, as well as fostering connectedness and emotional support (Fone *et al.* 2007; Echeverria *et al.* 2008).

There is increasing evidence that neighbourhood characteristics during childhood may have lasting effects on mental health. For example, exposure to neighbourhood disadvantage in childhood and early adolescence has been associated with a range of youth mental health and behaviour problems (Aneshensel & Sucoff, 1996; Kohen *et al.* 2002; Schneiders *et al.* 2003; Xue *et al.* 2005; Jelliman & Spencer, 2008). Conversely, neighbourhood social cohesion has demonstrated protective effects against depressive symptoms and behaviour problems (Kohen *et al.* 2002; Curtis *et al.* 2004; Xue *et al.* 2005). However, much of the existing research on neighbourhood factors and mental health in childhood and adolescence has been cross-sectional (Aneshensel & Sucoff, 1996; Kohen *et al.* 2002; Curtis *et al.* 2004; Fone *et al.* 2007), or has employed short follow-up periods (i.e. 2 years; Schneiders *et al.* 2003; Xue *et al.* 2005), and is therefore limited with respect to causal inference and temporality of the relationship. Moreover, to fully examine the effects of neighbourhood cohesion on mental health, it is important to consider changes in neighbourhood environment over time, in addition to fixed exposure. Neighbourhood cohesion may have different impacts at different times, and children's cumulative and changing experience of cohesion may have a greater impact than

cohesion at any single time point. To our knowledge, no study has examined the cumulative effects of childhood neighbourhood cohesion over time.

The aim of the present study was to examine the longitudinal effects of neighbourhood cohesion throughout childhood on mental health and behavioural outcomes in adolescence.

Method

Study sample

This study used survey data from Statistics Canada's National Longitudinal Survey of Children and Youth (NLSCY) (Human Resources Canada and Skills Development Canada, 2007). The NLSCY is a prospective study of Canadian children designed to collect information about child health and development. The present sample included 5577 children aged 0–3 years in 1994–1995 (cycle 1) who were followed prospectively every 2 years until the age of 12–15 years in 2006–2007 (cycle 7). Sample characteristics are presented in Table 1.

Neighbourhood cohesion

The person most knowledgeable about the child (PMK; approximately 90% were biological mothers) responded to questions regarding residential neighbourhood quality. Perceived neighbourhood cohesion was repeatedly assessed in every cycle, except cycle 2 (1996–1997). It was based on assessment of five statements: 'If there is a problem around here, the neighbours get together to deal with it'; 'There are adults in the neighbourhood that children can look up to'; 'People around here are willing to help their neighbours'; 'You can count on adults in this neighbourhood to watch out that children are safe and don't get in trouble'; 'When I'm away from home, I know that my neighbours will keep their eyes open for possible trouble'. Scores on each item ranged from 0 ('strongly disagree') to 3 ('strongly agree'). Scores on these items were summed to create a total neighbourhood social cohesion score, ranging from 0 to 15; higher scores indicated greater neighbourhood cohesion. Recent work has supported the validity of self-report scales of neighbourhood cohesion (Mujahid *et al.* 2007), and this scale has previously been used in studies of neighbourhood cohesion in childhood and adolescence (Kohen *et al.* 2002; Curtis *et al.* 2004), demonstrating good psychometric properties. Internal consistency in the present sample ranged from $\alpha=0.86$ (cycle 3) to 0.90 (cycle 6).

Trajectories of neighbourhood social cohesion throughout childhood were modelled using latent class growth models (see below), from cycle 1 (aged 0–3 years) to cycle 6 (aged 10–13 years). All individuals

Table 1. Sample characteristics, with percentages representing weighted values

Trajectory	n	Male gender, %	Any maternal depression, %	Stressful life event, %	Family SES: mean (s.d.)	Family SES change ^b : mean (s.d.)	Neighbourhood deprivation: mean (s.d.)	Neighbourhood deprivation change ^b : mean (s.d.)
All respondents	5577	50.8	39.3	33.7	3.53 (11.37)	0.50 (1.67)	0.52 (1.94)	0.14 (1.93)
Low	234	57.5 ^c	61.8 ^c	39.6 ^c	3.13 (13.46) ^{bcd}	0.66 (2.57)	0.25 (1.98)	-0.01 (1.99)
Moderate increasing	506	52.7 ^d	38.9 ^d	32.9 ^c	2.78 (1.87) ^c	0.57 (1.47)	0.35 (1.85)	0.21 (1.90)
Moderate	3821	49.2 ^d	39.8 ^d	33.6 ^c	3.48 (11.46) ^{bcd}	0.45 (1.64)	0.59 (1.95)	0.17 (2.00)
High falling	495	50.8 ^d	33.8 ^c	29.4 ^d	4.23 (13.80) ^d	0.73 (1.72)	0.44 (1.74)	-0.14 (1.51)
High	521	54.6 ^d	28.9 ^c	36.7 ^c	4.16 (13.06) ^{bcd}	0.45 (1.54)	0.39 (2.03)	0.24 (1.75)

SES, Socio-economic status; s.d., standard deviation.

^a Family SES calculated as the ratio of family income to corresponding low-income cut-off.

^b Change in family SES and neighbourhood deprivation calculated from cycle 1 to cycle 6.

^{c,d,e} Values within a column with unlike superscript letters were significantly different ($p < 0.05$).

included in the sample had an assessment of neighbourhood cohesion in cycle 1 (1994–1995) and at least at one other assessment cycle.

Adolescent mental health and behaviour

Mental health and behavioural outcomes were assessed in cycle 7 (2006–2007), when participants were aged 12–15 years. The NLSCY includes a behaviour scale for children and youth, adapted from questionnaires used in the Montreal Longitudinal Survey and the Ontario Child Health Study, which were designed to identify children who would most likely qualify for psychiatric diagnosis based on symptom criteria for the Diagnostic and Statistical Manual of Mental Diseases, third edition, revised (DSM-III-R) (Boyle *et al.* 1993). Adolescents were asked to self-report the frequency of various feelings/behaviours experienced in the past week (e.g. 'I bully or am mean to others'). Scores on each item ranged from 0 ('never or not true') to 2 ('often or very true'). Composite scores were created by summing the item scores on each of six subscales: depression/anxiety (seven items, e.g. 'I am not as happy as other people my age', $\alpha = 0.79$); hyperactivity (seven items, e.g. 'I am impulsive, I act without thinking', $\alpha = 0.78$); indirect aggression (five items, e.g. 'When I am mad at someone, I say bad things behind his/her back', $\alpha = 0.73$); conduct disorder/physical aggression (six items, e.g. 'I kick or hit other people', $\alpha = 0.77$); property offences (six items, e.g. 'I vandalize', $\alpha = 0.73$); and pro-social behaviour (10 items, e.g. 'I try to help someone who has been hurt', $\alpha = 0.87$). Consistent with precedence, participants with a subscale score in the top tenth percentile were classified as having the mental health or behavioural outcome (Browne *et al.* 2010).

Covariates

The analysis accounted for the effects of family socioeconomic status (SES), neighbourhood deprivation, stressful life events (SLEs), maternal depression, maternal alcohol abuse and gender. Given that our main exposure (changes in neighbourhood cohesion) may have been confounded by changes in SES and neighbourhood deprivation over time, we also adjusted for these variables.

The occurrence of any SLE in the previous 2 years was reported by the PMK at cycle 7. Participants were considered to have experienced a SLE if the PMK reported any of 13 specific events, as well as 'other traumatic events' (Table 2). Maternal depression was assessed at each time point using a 12-item version of the Centre for Epidemiological Studies-Depression scale (CES-D-12) (Poulin *et al.* 2005). Children were considered to have been exposed to maternal depression if

Table 2. Percentage of participants experiencing stressful life events

Life event	Participants experiencing event, %
Death of parents	4.00
Other family death	24.65
Divorce	11.05
Moving	5.55
Hospital	0.51
Foster home	0.43
Other separation	2.65
Illness/injury	4.47
Family illness/injury	10.76
Abuse or fear of abuse	1.30
Change in household member	2.57
Alcoholism	0.92
Conflict between parents	3.89
Other traumatic event	26.77
Any stressor	33.71

their mothers were depressed at any cycle from 1 to 7. Maternal alcohol abuse was defined as reporting more than one occasion of binge drinking (more than five drinks on one occasion) per month. Family SES was based on the ratio of Canadians' total household income to their corresponding low-income cut-off (LICO) (Human Resources Canada and Skills Development Canada, 2007). LICO is the level below which a family is likely to spend a significantly higher proportion of its income to purchase necessities such as food, lodging and clothing than the average family, and is calculated depending on family size and area of residence. For example, a family with an SES ratio of 4 has an income of four times the LICO for their area and family size. To ensure that changes in neighbourhood cohesion were not a function of changing socio-economic position, for both family SES and neighbourhood deprivation, we included two covariates: one to control for socio-economic position in cycle 7, and one to control for changes in socio-economic position over time from the beginning to the end of the trajectories. These variables were calculated by subtracting SES/deprivation at cycle 1 from the value at cycle 6.

Neighbourhood deprivation was assessed using the 2001 Canadian Census. Statistics Canada 2001 census dissemination areas (DAs) were selected to approximate the neighbourhood environment. The DA has a population range of 400–700 individuals and represents a convenient geographical unit that has been used in other NLSCY neighbourhood studies (Kohen *et al.* 2002; Oliver & Hayes, 2005). Based on previous work (Oliver & Hayes, 2005), three census variables (unemployment rate, median family income, and

population over 20 years without post-secondary education) were used as markers of neighbourhood deprivation, reflecting work-force participation, income and educational attainment. These variables were standardized and summed to create an index of neighbourhood deprivation, which was linked to the NLSCY dataset. Children's postal codes at cycle 1 and cycle 6 were used to assign DAs at these time points, which were then used to calculate the change in children's neighbourhood deprivation from the beginning to the end of the trajectories. Neighbourhood deprivation at cycle 7 was also included in the model.

Data analysis

Latent class growth modelling (LCGM) was conducted on neighbourhood cohesion scores, from cycle 1 (1994–1995) to cycle 6 (2004–2005). Trajectories were modelled using the PROC TRAJ procedure in SAS, using the technique described by Jones *et al.* (2001). LCGM uses a semi-parametric, group-based modelling strategy to identify homogeneous latent trajectory classes based on longitudinal data (Nagin, 1999). The Bayesian information criterion and optimization of posterior probabilities were used to identify the best-fitting model. PROC TRAJ handled missing data during the follow-up period under the missing-at-random assumption, which allows patterns with missing values to share information with patterns with more data points through the latent variable (Dodge *et al.* 2008).

To determine whether perceptions of neighbourhood cohesion during childhood are related to various indicators of adolescent mental health and behaviour, logistic regressions were conducted with each mental health and behavioural outcome. These regressions used trajectories of neighbourhood cohesion throughout childhood (ages 0–3 to ages 10–13 years) as categorical predictors of adolescent mental health and behaviour at ages 12–15 years while controlling for the effects of the covariates described above. The NLSCY used a multistage sampling design with unequal selection probabilities. To account for this complex survey design, we included normalized sampling weights in all analyses. SAS 9.2 (USA) was used for all statistical analyses.

Ethical standards

All procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Results

Trajectory analysis identified a five-group model as the best-fitting model (Fig. 1). The following trajectories of

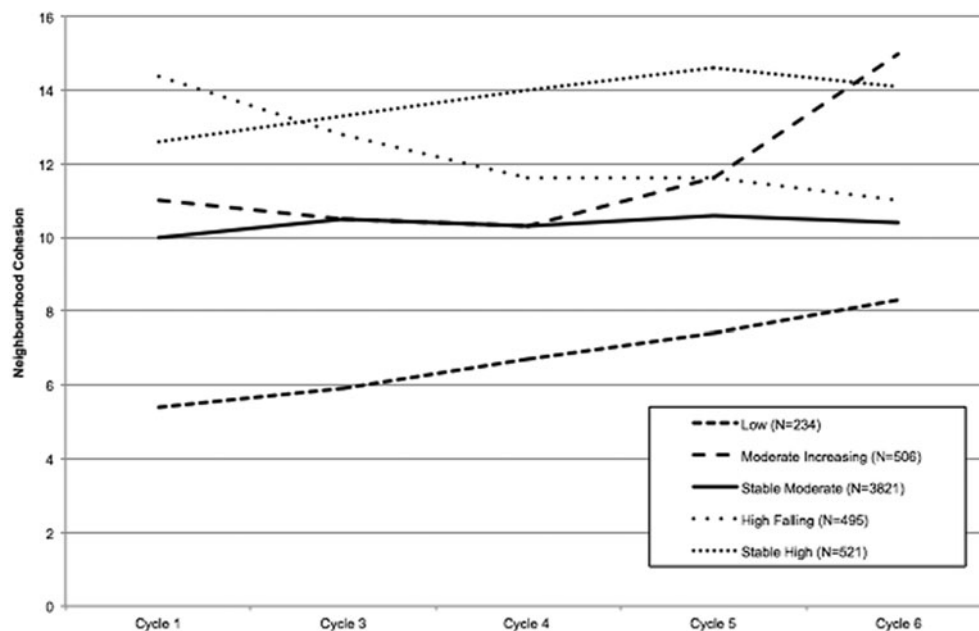


Fig. 1. Trajectories of neighbourhood social cohesion over a 10-year follow-up period.

Table 3. Descriptive statistics for mental health outcomes

Outcome	Mean (s.d.)
Emotional disorder	3.32 (3.18)
Hyperactivity	3.85 (3.27)
Conduct disorder	0.99 (1.87)
Indirect aggression	1.38 (1.93)
Property offences	1.00 (1.64)
Prosocial behaviour	12.07 (4.74)

s.d., Standard deviation.

neighbourhood social cohesion were identified: 'stable low' (4.2%); 'moderate increasing' (9.1%); 'stable moderate' (68.5%); 'high falling' (8.9%); and 'stable high' (9.3%). Sociodemographic characteristics varied across the five groups (Table 1).

Descriptive statistics for mental health outcomes are presented in Table 3. Adjusted odds ratios (ORs) for mental health outcomes in association with neighbourhood social cohesion trajectories are shown in Table 4. Relative to those living in a moderately cohesive neighbourhood across childhood ('stable moderate'), those with improvements in neighbourhood cohesion in late childhood ('moderate increasing') had significantly lower odds of hyperactivity [OR=0.67, 95% confidence interval (CI) 0.46–0.98] and indirect aggression (OR=0.69, 95% CI 0.49–0.96). Those living in a highly cohesive neighbourhood across childhood ('stable high') were more likely to exhibit prosocial behaviour (OR=1.89, 95% CI 1.35–2.63), and less likely to commit property

offences (OR=0.66, 95% CI 0.44–0.99), but were also more likely to experience elevated symptoms of depression/anxiety (OR=1.65, 95% CI 1.14–2.37). Those who experienced a decline in neighbourhood cohesion across childhood ('high falling') were significantly more likely to report hyperactivity (OR=1.67, 95% CI 1.21–2.29) and prosocial behaviour (OR=1.93, 95% CI 1.38–2.69). Finally, children living in neighbourhoods characterized by low cohesion ('low') had significantly higher odds of indirect aggression (OR=1.62, 95% CI 1.07–2.45) and depression/anxiety (OR=1.73, 95% CI 1.04–2.90).

Post-hoc interactions

We also examined interactions between trajectories of neighbourhood cohesion and maternal depression *post-hoc*. Results of logistic regression with interaction terms revealed significant interactions between maternal depression and neighbourhood trajectory to predict emotional disorder and prosocial behaviour.

In the prediction of emotional disorder, the interaction between maternal depression and membership in the stable high trajectory was significant ($\beta=1.05$, s.e.=0.38, $p<0.01$). Follow-up analyses stratified by maternal depression status indicated that the association between membership in the trajectory of stable high cohesion and emotional disorder was significant only among adolescents whose mothers had reported depression (OR=3.20, 95% CI 1.83–5.57 *v.* 1.09, 95% CI 0.66–1.84).

With regards to prosocial behaviour, the interactions between maternal depression and membership in the

Table 4. Adjusted odds ratios^a for mental health outcomes in association with neighbourhood social cohesion trajectories

	Low	Moderate increasing	Moderate	High falling	High
Depressive/anxious symptoms	1.73 (1.04–2.90)*	0.70 (0.46–1.08)	Reference	1.09 (0.72–1.65)	1.65 (1.14–2.37)*
Hyperactivity	1.06 (0.65–1.73)	0.67 (0.46–0.98)*	Reference	1.67 (1.21–2.29)*	0.96 (0.65–1.41)
Conduct disorder	0.88 (0.55–1.41)	1.32 (0.90–1.92)	Reference	1.06 (0.71–1.57)	1.33 (0.86–2.04)
Indirect aggression	1.62 (1.07–2.45)*	0.69 (0.49–0.96)*	Reference	0.71 (0.49–1.04)	0.76 (0.53–1.09)
Prosocial behaviour	0.88 (0.48–1.64)	1.06 (0.75–1.51)	Reference	1.93 (1.38–2.69)*	1.89 (1.35–2.63)*
Property offences	1.00 (0.62–1.62)	1.11 (0.83–1.50)	Reference	1.19 (0.86–1.66)	0.66 (0.44–0.99)*

Data are given as odds ratio (95% confidence interval).

^a Controlling for age, gender, any maternal depression, maternal binge drinking, recent stressful life events, family socio-economic status and neighbourhood deprivation in cycle 7, and change in neighbourhood deprivation and family socio-economic status from cycle 1 to cycle 6.

* Statistically significant odds ratio ($p < 0.05$).

high falling ($\beta = 1.55$, $s.e. = 0.35$, $p < 0.001$) and stable high ($\beta = 1.55$, $s.e. = 0.04$, $p < 0.05$) trajectories were significant. Stratified analyses indicated that membership in the high falling trajectory predicted greater prosocial behaviour among offspring of depressed mothers (OR = 4.62, 95% CI 2.83–7.60) but not non-depressed mothers (OR = 1.00, 95% CI 0.61–1.63). Similarly, membership in the stable high trajectory predicted prosocial behaviour among offspring of depressed (OR = 3.23, 95% CI 1.84–5.64) but not non-depressed (OR = 1.34, 95% CI 0.88–2.04) mothers.

Discussion

Principal findings

In this large prospective study of 5570 Canadian children, we found evidence to suggest that neighbourhood cohesion throughout childhood may play a role in the development of adolescent mental health and behaviour. Our findings are consistent with previous work that has demonstrated protective effects of neighbourhood social capital on physical and mental health (Aneshensel & Sucoff, 1996; Kalff et al. 2001; Xue et al. 2005; Araya et al. 2006; Fone et al. 2007; Fujiwara & Kawachi, 2008). Our study extends this literature by demonstrating that exposure to neighbourhood social cohesion may have timing-specific effects with regard to later adolescent mental health and behaviour.

Interpretation of findings

In the present study, children whose caregivers reported a decline in neighbourhood cohesion over time were more likely to exhibit symptoms of hyperactivity in adolescence, whereas children whose caregivers reported increases in neighbourhood cohesion over time had lower odds of hyperactivity. These results are consistent with one underlying theory

which posits that childhood and adolescent behavioural symptoms, such as hyperactivity and attention-deficit/hyperactivity disorder, occur in reaction to environmental stressors (Enoch et al. 2010; Hjern et al. 2010); in our study more unstable environments, indexed by declining caregiver perceptions in neighbourhood cohesion over time, predicted such risk amongst adolescents. It is also important to consider the impact of SLEs related to changes in neighbourhood social cohesion. If these changes in neighbourhood perception were attributable to moving to a new environment, such a potentially disruptive experience may have a negative impact on children's adjustment. Indeed, family relocation has been associated with increased risk of behaviour problems (Wood et al. 1993; Jolleyman & Spencer, 2008) and general maladjustment (Adam & Chase-Lansdale, 2002). For those moving to a more advantaged neighbourhood, however, the benefits of upward mobility are thought to outweigh the disruptive effects of relocation (Scanlon & Devine, 2001; Leventhal & Brooks-Gunn, 2003). To test this possibility, we conducted a *post-hoc* sensitivity analysis to inspect the additional effect of self-reported number of moves from cycles 1–6 and change in postal code between cycles 1 and 6 in our models. This did not result in any significant changes to the model, suggesting that changing exposure to neighbourhood characteristics may have independent effects on child and adolescent mental health, over and above disruptive experiences associated with moving.

Our results in regard to prosocial behaviour suggested that early childhood environmental factors may have had a greater impact on this outcome than later neighbourhood environments. Previous research has indicated that prosocial behaviour develops early in life and is relatively stable after early childhood (Cote et al. 2002). It has been argued that prosocial behaviour reflects an aspect of temperament or

personality (Cote *et al.* 2002; Knafo & Plomin, 2006), and is thus relatively unchanged by acute stressors later in life. In the present study, trajectories characterized by high initial levels of reported neighbourhood cohesion were associated with increased odds of prosocial behaviour, potentially supporting the hypothesis that early experiences of social cohesion may foster the development of prosocial tendencies.

Results suggested that, as expected, children whose caregivers reported low levels of cohesion were more likely to experience symptoms of depression and anxiety. This finding adds to previous literature suggesting that low social capital is a risk factor for depression (Aneshensel & Sucoff, 1996; Fujiwara & Kawachi, 2008). Somewhat paradoxically, risk of depression and anxiety was also increased for children whose caregivers reported high neighbourhood cohesion throughout childhood. One possible aetiological explanation for this finding is that although parents may report high social cohesion, children's experience may differ (Moore *et al.* 2009). High social cohesion among adults may have a stifling effect for some adolescents, as increased neighbourhood involvement may translate into more adult supervision and monitoring. As Baum (1999) points out, close-knit communities are not always healthy, especially for those who do not agree with the majority. Notably, this counterintuitive effect was only noted for problems along the internalizing dimension (depressive and anxious symptoms), and not for externalizing behaviour problems. These more overt adjustment issues may be curbed in communities characterized by greater adult supervision, leaving youth to turn their distress inward.

Our analyses revealed associations between childhood neighbourhood cohesion and indirect aggression, but not physical aggression (i.e. conduct disorder). Specifically, increasing perceptions of neighbourhood cohesion over time were associated with decreased odds of indirect aggression compared with stable moderate levels of cohesion. Membership in the trajectory characterized by stable low reported cohesion, by contrast, was associated with increased odds of indirect aggression. Thus, improvements in neighbourhood cohesion over time may lead to reductions in socially aggressive behaviour. One further possibility is that indirect aggression requires a degree of establishment in a community – that is, 'new kids' may not be in a position to engage in social political activities such as gossip, rumour spreading and social exclusion. In support of this notion, it has previously been shown that relatively high status in the peer group is a prerequisite for indirect aggression (Salmivalli *et al.* 2000). Indeed, indirect or relational aggression tends to be positively associated with perceived popularity (Rose *et al.*

2004), and the most relationally aggressive adolescents tend to be nuclear members of their social clusters (Cairns *et al.* 1988). Continued residence in a neighbourhood may therefore allow children to become entrenched in dysfunctional social hierarchies characterized by indirect aggression. Moving, in turn, may disrupt these social hierarchies, resulting in reductions in indirect aggression. This hypothesis is rendered more plausible in light of the marginal negative effects of high falling neighbourhood cohesion on indirect aggression. A change in neighbourhood, for better or for worse, may disrupt adolescents' ability to engage in indirect aggression.

Post-hoc analyses suggested that the associations between mothers' reported neighbourhood cohesion and offspring mental health and behaviour may depend on other maternal factors – in this case maternal depression. The pattern of these interactions was complex, probably reflecting the realistic complexity with which neighbourhood factors may affect mental health outcomes. While we did not have sufficient data to explore the possible causes for these *post hoc* interactions, we noted a general trend – both prosocial behaviour and depression in adolescence were only associated with high neighbourhood cohesion in the presence of a maternal history of depression. This suggests that more proximal family factors, such as familial well-being and social support, may generally be more important predictors of children's development than more distal environmental factors such as neighbourhood cohesion. In the presence of maternal depression, however, supportive neighbourhood environments in early childhood may play a more important role, fostering prosocial behaviour. With regards to adolescent depression, several possibilities arise. For example, children of depressed mothers may be more likely to be excluded from accessing neighbourhood social cohesion than their peers without a maternal history of depression.

Though these are interesting findings, they should be interpreted with caution given the *post-hoc* nature of the analysis. Future researchers may wish to examine more explicitly the complex interactions between multiple levels of influence at the individual, family, school and neighbourhood levels.

The lack of significant results regarding conduct disorder was somewhat surprising. However, other authors have reported that neighbourhood social connectedness may be less strongly related to violent behaviour than other factors, such as parental monitoring and strong school affiliation (Wright & Fitzpatrick, 2006). In contrast, results of the present study did suggest a protective effect of social cohesion on another form of externalizing behaviour – children who lived in highly cohesive neighbourhoods

throughout childhood were less likely to commit property offences.

Our results support the possibility that efforts to improve community social cohesion may lead to improved behavioural outcomes. The present findings are also congruent with results from previous studies reporting that families who moved to higher-income neighbourhood experienced improvements in children's mental health and behaviour problems (Leventhal & Brooks-Gunn, 2003). Higher social cohesion may increase a child's level of interaction with teachers and other adults in the community, as well as with neighbourhood children, all of which may contribute to advances in social development.

Alternative interpretations

It should be noted that alternative explanations of these associations are possible. For example, parents who promote adaptive behaviour in their children may also be more actively involved in their communities, creating more cohesive neighbourhoods, or alternatively, may be biased towards reporting stronger neighbourhood cohesion. It is also important to consider that there are other potential reasons for an increase in parents' reported neighbourhood quality over time, each of which would have different implications for the interpretation of the results. For example, the child's neighbourhood may have undergone some degree of gentrification over the study period. Alternatively, the parent's perceptions of neighbourhood social cohesion may have improved over time, as, for example, they forged more social connections and made use of neighbourhood services. Parents may naturally become more involved in the community as their child enters school, which could contribute to an increasing sense of community cohesiveness. Thus, parents'/guardians' perceptions of neighbourhood cohesion may reflect, to some extent, their degree of social support.

Methodological limitations

We acknowledge some other limitations of the present investigation. First, the measure of neighbourhood socio-economic deprivation was obtained based on census-level data linked using postal codes. In this study, we used DAs as proxies for neighbourhoods; however, this area may be too small to accurately capture neighbourhood characteristics, as neighbourhoods may spill over across DA boundaries (Oliver & Hayes, 2005). The areas used to capture neighbourhood socio-economic deprivation therefore may not reflect what participants envision when reporting on neighbourhood characteristics. In addition, census information was only available for 2001, and

neighbourhood deprivation for all time points was extrapolated from this information. Changes to neighbourhood deprivation over time may have limited the accuracy of these estimates, especially for cycles most temporally removed from the time of the census. The behaviour scales were developed for the NLSCY based on a questionnaire used in earlier studies, and roughly correspond to DSM-III criteria. However, these scales are not intended as diagnostic instruments. Due to changes in diagnostic criteria over time, these scales may not correspond to DSM-IV or DSM-5 diagnoses. Information on neighbourhood cohesion was self-reported by the PMK, which, as discussed above, may introduce confounds and biases. This study controlled for several possible confounding variables (e.g. neighbourhood deprivation and family SES, SLEs, maternal depression); however, there is still the potential of residual confounding even after controlling for all of these factors. For example, though we adjusted for maternal depression, we were not able to account for other aspects of maternal mental health, the mental health of other caregivers, which may make an impact on children's mental health and wellbeing. Additionally, certain SLEs may not have been captured by the parent-report format of the questionnaire, and the focus on specific events. Interestingly, some authors have reported that individual perceptions of social capital may be more strongly related to mental health than more objective area-level indices (Araya et al. 2006).

Our study had several methodological strengths. Notably, the study made use of a large, prospective, population-based sample of Canadian children and adolescents. The use of trajectory modelling of neighbourhood cohesion allowed us to characterize this aspect of children's environments over the long term. Assessing mental health outcomes 2 years after the last assessment of neighbourhood cohesion allows for some establishment of temporal precedence, lending confidence to the notion that neighbourhood characteristics may have an impact on adolescent mental health, and allowed this study to show that such effects may be time sensitive and vary according to differing domains of mental health and behaviour. Nevertheless, conclusions regarding causality must be made with care given the study design.

Conclusions

Our results require independent replication. If replicated, they may have potential implications for policy and intervention. Programmes aimed at regenerating socially and economically deprived communities may have a positive impact on general health, mortality and mental health (Gibson et al. 2011; Smith et al. 2012, 2015). Programmes which increase the mobility

options for families in deprived neighbourhoods, such as Moving to Opportunity (Leventhal & Brooks-Gunn, 2003), may also lead to improvements in overall health, including mental health, for individuals (Gibson *et al.* 2011). Results of the present study suggest that such improvements in mental health may be due, in part, to processes related to neighbourhood cohesion, and that such programmes may also make an impact on adolescent mental health and behaviour. However, area-level interventions aimed at improving the social and physical environment of a neighbourhood may be more cost-effective than relocation strategies, with the potential added advantage of benefitting the entire community (Sampson, 2008).

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Declaration of Interest

None.

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