Testing the theory of holism: A study of family systems and adolescent health

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ABSTRACT

Holism is an ancient theory that can be applied contemporarily to adolescent health and its determinants. This theory suggests that there is value in considering factors that influence health together as integrated wholes, in addition to consideration of individual components. Characteristics of families are fundamental determinants of health and provide opportunity for exploration of this theory. In a "*proof-of-concept*" analysis we therefore: (1) developed a multidimensional, composite (holistic) measure to be used to characterize family systems; and (2) related this measure and its individual components to adolescent health outcomes, in order to test the theory of holism. Cross-sectional analyses of survey reports from the 2014 Canadian Health Behaviour in School-aged Children study (weighted n = 19,333) were performed. Factor analysis was used to confirm the psychometric properties of the holistic measure to describe a family system (the "holistic measure"). Associations between this holistic measure, its individual components, and various indicators of health were examined descriptively and using binomial regression. The holistic measure (4 items, α = 0.62; RMSEA = .04; SRMR = 0.01; AGFI = 0.99) included components describing family: material wealth, meal practices, neighbourhood social capital, and social connections. It was consistently associated with various health behaviours, and social and emotional health outcomes. In 22/24 comparisons, this holistic measure related to positive health outcomes more strongly than did its individual components; for negative health outcomes this occurred in 20/24 comparisons. Study findings suggest that it is possible to assess family systems holistically. Such systems are strongly associated with adolescent health outcomes, and there is etiological and theoretical value in considering family systems as integrated wholes.

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1. Introduction

Holism is a theoretical concept with ancient roots that has re-emerged during recent years (Smuts, 1926/1961). By definition, this theory suggests that *organic or unified 'wholes' have value and being which is inherently different from, and cannot be reduced to, the sum of their individual parts* (Christakis, 2012). This implies that complex systems cannot be fully understood by only understanding the individual components (Stempsey, 2001). While reductionist approaches have value, holism suggests that new properties emerge with the whole that are not present in the individual parts. This thinking is common to many longstanding philosophies related to ancient cultures (Svenson & Lafontaine, 1999; Strong, 2005), and it has the potential to provide new insights that can inform etiological and preventive research.

Family characteristics provide some of the most consistent influences on the health of young people. Families represent the first point of contact between children and the larger world. For most, they provide basic essentials of life and an environment that fosters early childhood development (Bronfenbrenner, 1986). Families offer early elements of community and provide formative influences on physical development, cognition, knowledge, socialization, attitudes, behaviours, and beliefs. Families prepare children, or not, for the demands of wider social contexts and challenges in life. Aspects of family environments are modifiable as one strategic approach to prevention (Lewis et al., 1976), a fact recognized for decades in such initiatives as the "family movement" that, amongst other goals, attempted to foster positive life trajectories in children and adolescents (Bowen, 1966).

In a theoretical sense, families also provide an ideal context for exploring the theory of holism methodologically. All families are different, and each will have a number of individual components that come together in a unique system that can be measured in composite or holistically. Both the components and the resultant family systems will influence the health of young people; however, what remains unknown is whether family systems as viewed holistically will have influences on health that differ from those of their individual components. Many of the etiological studies in this field focus on the effects of individual dimensions of family behaviours or dynamics (Stadler et al., 2010;

Wilkinson, 2004). In part this is for practical reasons: categorizing behaviours into individual parts allows for specific intervention, and most validated modes of measurement are also based on such a reductionist approach. However, holism suggests that there are emergent properties that can be best understood by measuring the whole system.

In this study, we modeled the potential effects of family characteristics, both individually and collectively, on the health of young Canadians in order to: (1) develop a multidimensional, composite (holistic) measure to be used to characterize a family system; (2) relate this measure and its individual components to adolescent health outcomes, in order to test the theory of holism in a *proof-of-concept* analysis. Our primary intention was methodological, and was not to develop and promote a definitive model of what would be included in a holistic family system, but rather to explore this concept using available population health data. Our hope was that study findings would also provide practical insights for preventive research and associated etiological thinking.

2. Methods

2.1. Study populations and procedures

Health Behaviour in School-aged Children (HBSC), a cross-national study affiliated with the World Health Organization, aims to increase understanding of health and its determinants in populations of young people (Currie et al., 2011; Freeman et al., 2011). It involves written health surveys conducted with students in classroom settings with a focus on the early adolescent years. Nationally in Canada, Cycle 7 of the HBSC was conducted in 2013–14. The Canadian sample was stratified by province/territory, type of school board (public vs. separate), urban-rural geographic status, school population size, and language of instruction (French or English) with standardized population weights generated to ensure representativeness. Inclusion criteria for the current analysis were: (1) participation in the 2013–14 survey; (2) valid responses to all core HBSC items required for the present analysis. Children from private schools, home school situations. First Nation or Inuit reserves, street youth not in school, incarcerated youth, and youth not providing informed consent (explicit or implicit, as per local school board customs) were excluded.

2.2. Measures

2.2.1. Family systems

We developed our holistic measure to describe a family system for our "proof-of-concept" analysis. This was guided in part by socio-ecological theory as it relates to adolescent development. According to this theory first espoused by Urie Bronfenbrenner (Bronfenbrenner, 1986; Bronfenbrenner & Morris 1998), in addition to factors that are associated with the individual (e.g., personal demographics, health status, etc.), adolescent development is impacted by contextual factors in five nested environmental systems: the microsystem (family, peers, school, neighbourhood, church, etc.); mesosystem (relationships between microsystems); exosystem (environmental factors that originate beyond the immediate realm of the individual); macrosystem (cultural attitudes and ideologies), and the chronosystem (socio-historical conditions or patterns of events and transitions over a life course). Therefore, adolescents exist within the family microsystem that is in turn embedded in these other layers of influence. In order to be considered for inclusion in our holistic measure, the indicators considered had to belong to at least one of these nested social systems.

The measures were also required to be continuous or semi-continuous variables, which limited our list to 11 available HBSC items (Table 1). Here we describe in detail the origins and psychometric properties for the four items and scales that were ultimately included in the holistic measure (Fig. 1); the remaining items listed in Table 1 are described elsewhere (Freeman et al., 2011). The four domains that were included are: frequency of family meals, a family support scale, a neighbourhood social capital scale, and an indicator of relative material wealth.

Frequency of family meals (an activity within the microsystem ring of the socio-ecological model), a standard indicator of parenting and associated family practices that constitute one component of a family system, was indicated via a combined measure ($\alpha = 0.59$) consisting of responses to two items: (1) "how often do you have breakfast together with your mother or father (or other adult family member)"; (2) "how often do you have an evening meal together with your mother or father (or other adult family member)" (6 response options: "*never*" through "*every day*") (Elgar et al., 2012).

The family support scale (also activities within the microsystem) ($\alpha = 0.90$), a standard indicator of social climate within families, consisted of the summed responses to four items: (1) "my family really

Table 1
Derivation of a holistic measure to describe family systems according to the theory of holism. Results reflect the findings of an exploratory then confirmatory factor analysis conducted with split half samples. Analysis limited to variables available in the 2014 Canadian Health Behaviour in School-aged Children Study.

Measure or scale	Available in HBSC	Included in composite scale	Factor loadings[a] Split Sample 1 *Exploratory* (n = 9666)	Split sample 2 *Confirmatory* (n = 9667)
Relative material wealth scale	X	X	0.41	0.40
Frequency of breakfast consumption[c]	X	…	–	–
Frequency of family meals (breakfast and dinners)	X	X	0.50	0.49
Number of people in primary home[c]	X	–	–	–
Relative family wealth (FAS)[c]	X	–	–	–
Ease of communication within family[c]	X	–	–	–
Family support scale	X	X	0.75	0.76
Frequency of screen time on weekdays[d]	X	–	–	–
Social capital in family neighbourhood social capital	X	X	0.49	0.51
Parental trust and communication scale[c]	X	–	–	–
Home climate scale[c]	X	–	–	–
Eigenvalues[a]			2.16	2.24
Cronbach's Alpha (Standardized)[a]			0.61	0.62
Confirmatory Factor Analysis[b]: RMSEA			–	0.04 (0.02, 0.06)
Confirmatory Factor Analysis[b]: SRMR			–	0.01
Confirmatory Factor Analysis[b]: AGFI			–	0.99

[a] Exploratory factor analysis using maximum likelihood estimation.
[b] Eliminated from holistic measure due to high correlation with similar paired item that was included.
[c] Eliminated from holistic measure due to low factor loadings (<0.30).
[d] Confirmatory factor analysis using maximum likelihood estimation.
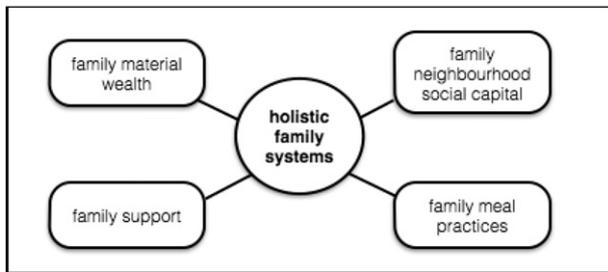
Fig. 1. Schematic diagram illustrating key items that contribute to the holistic measure used to describe the family systems within the context of the 2014 Canadian Health Behaviour in School-aged Children Study.

tries to help me"; (2) "I get the emotional help and support I need from my family"; (3) "I can talk about my problems with my family"; (4) "my family is willing to help me make decisions" (5 response options: "*strongly agree*" through "*strongly disagree*") (Zimet & Grodaon, 1988).

The neighbourhood social capital scale (reflects some aspects of the mesosystem and exosystem) (α = 0.79), a standard indicator of social support within communities, consisted of a summary of responses to five items: (1) "people say 'hello' and often stop to talk to each other in the street"; (2) "it is safe for younger children to play outside during the day"; (3) "you can trust people around here"; (4) "there are good places to spend your free time (e.g., recreation centres, parks, shopping centres)"; (5) "I could ask for help or a favour from neighbours" (5 response options: "*strongly agree*" through "*strongly disagree*") (Elgar et al., 2010).

Relative material wealth (microsystem), a standard measure of socio-economic status, was measured by a semi-continuous item: (1) "how well off do you think your family is?" (5 response options: "*very well off*" through "*not at all well off*") (Goodman et al., 2007).

2.2.2. Health outcomes

The World Health Organization and others classify health according to three major domains, physical, social, and emotional (WHO, 1946). We therefore modeled the health of young people according to these three domains. Our measures included both negative and positive indicators of health within each domain, and included self-reported engagement in health and risk behaviours, the nature and quality of social environments (measured by proxy at school), and various emotional health outcomes.

2.2.3. Health behaviour outcomes

After being provided with a definition and examples, participants were asked: "how many days in the past week" and "how many days in a typical week ("*none*" through "7") were you physically active for ≥60 min?" These questions are based on a moderate-to-vigorous physical activity measure (Prochaska et al., 2001), have excellent test-retest reliability (ICC = 0.79), and are averaged into a summary measure of physical activity. Overt risk engagement was measured using a scale (α = 0.77) consisting of summed responses (scored 0 for "*never*"; 1 for "*infrequent*"; 2 for "*frequent*") to questions asking about engagement in risk behaviours: (1) lifetime smoking; (2) use of alternative tobacco products; (3) frequency of alcohol consumption; (4) lifetime drunkenness history; (5) bullying others; (6) physical fighting; (7) energy drink consumption (Kwong et al., 2015).

2.2.4. Social health outcomes

Items comprising the peer support scale (α = 0.92) were: (1) "my friends really try to help me"; (2) "I can count on my friends when things go wrong"; (3) "I have friends with whom I can share my joys and sorrows"; (4) "I can talk about my problems with my friends" (each with 5 response options: "*strongly agree*" through "*strongly disagree*"). Similarly, items in the student support at school scale (α = 0.80) were: (1) "the students in my class(es) enjoy being together";

(2) "most of the students in my class(es) are kind and helpful"; (3) "other students accept me as I am" (5 response options: "*strongly agree*" through "*strongly disagree*") (Freeman et al., 2011).

2.2.5. Emotional health outcomes

Based upon precedent (Freeman et al., 2011), the emotional health of young people was examined via two of many possible standard indicators. First, youth reported the frequency (5 point scale; "*rarely or never*" to "*almost every day*") of the following psychological or somatic symptoms: headache, stomach-ache, back-ache, feeling low (depressed), irritability or bad temper, nervousness, difficulty in getting to sleep, dizziness. These were combined into a composite scale of psychosomatic symptoms (Hetland et al., 2002). The second validated emotional health indicator was the Cantril Ladder, a measure adapted from adult research whereby young people rated their life on a scale from 0 ("*worst possible life*") to 10 ("*best possible life*") (Cantril, 1965). This item is used as a measure of life satisfaction (Institute of Mother and Child, 2010).

2.3. Confirmation of the holistic measure to describe a family system

Analyses were conducted in SAS 9.4 (SAS Institute, CARY, NC). Correlations between the family items and scales were examined using Pearson correlation coefficients. We randomly divided the 2014 Canadian HBSC dataset into two approximately equal halves and using the first half, we considered all of the available family measures in an exploratory factor analysis using the SAS procedure PROC FACTOR with results based upon maximum likelihood estimates. A one-factor solution was indicated by eigenvalues, the Scree plot, and factor loadings. We excluded measures that were highly correlated with each other (Clark & Watson, 1995) and also family measures with poor factor loadings (<0.30). A final exploratory factor analysis was run on the remaining four indicators (Table 1), and the internal consistency of the resultant 4-component scale was estimated.

The above process was repeated on the second half of the 2014 data. We also confirmed model fit using the SAS PROC CALIS procedure. The following statistics are indicative of an acceptable model fit in confirmatory factor analysis: RMSEA of 0.06 or less, SRMR of 0.08 or less, and an AGFI of 0.90 or more (Hu & Bentler, 1999).

Based upon a methodological approach proposed by UNICEF (UNICEF, 2010), we then standardized each of the four indicators to a common scale with a mean of 100 and standard deviation of 10. The factor analysis was repeated with standardized versions of the four measures, and findings were essentially the same as the unstandardized method. We then combined the four indicators into the holistic measure to describe a family system by averaging their values with equal weighting.

2.4. Associations between the holistic measure and health outcomes

We used the full 2014 HBSC dataset for subsequent analyses. Scores for the holistic measure to describe a family system were estimated for each student and the study population was divided into quintiles. We examined percentages of students reporting specific physical, social and emotional health outcomes by quintile. Binomial regression was used to estimate relative risk (RR) and associated 95% confidence intervals for each health outcome using the SAS procedure PROC GENMOD, with final estimates presented for those in quintile 5 relative to quintile 1. The analysis was repeated for positive and then negative health outcomes with all models adjusted for age in years (≤11 to ≥15) and sex (boy, girl). The clustered nature of the sample, with students nested within schools, was adjusted for using generalized estimating equations. All analyses were weighted to ensure that they were representative.

In a complimentary descriptive analysis, we examined mean levels for the holistic measure to describe a family system by reported levels

of the health outcomes. We tested for differences in these means using the SAS procedure PROC GLM. We used one-way ANOVA (Park, 2003) as a global test and then tested for difference in means using the Student-Newman-Keuls test (Abdi & Williams, 2010). Bonferroni corrections for multiple comparisons were applied (Bender & Lange, 2001).

The binomial regression analyses were repeated for each of the health outcomes, but this time using each of the four items that comprised the holistic measure to describe a family system, again adjusting for age and sex. Relative risks were compared between models estimated using the holistic family systems score and those obtained from the individual components. A priori, an increase in relative risk of 10% or more for the holistic vs. individual measures was considered to be a higher relative risk, a decline of 10% or more was considered to be a lower relative risk, and all other values were considered as equivalent.

3. Results

3.1. Derivation and confirmation of the holistic measure

The exploratory factor analysis identified a 4-item holistic measure (Table 1). Factor loadings ranged from 0.40 to 0.76, with a very good internal consistency ($\alpha = 0.62$) and an Eigenvalue consistent with a one-factor solution. Confirmatory factor analysis on the same scale indicated excellent model fit in terms of error (RMSEA, SRMR) and variance explained (AGFI). It was therefore possible to describe family systems empirically using a single composite (holistic) scale.

3.2. Associations between the holistic measure and health outcomes

In Table 2, associations between the holistic measure and various health outcomes are summarized. These health outcomes included two each for physical, social and emotional indicators, each expressed as positive and then negative outcomes. The consistency, strength, significance and dose-related natures of these associations were notable, with marked increases in positive health outcomes and marked decreases in negative health outcomes associated with higher levels on the holistic measure. When expressed in terms of a relative risk (RR) for the health outcomes (quintiles 5 vs. 1), again the findings were strong and consistent with findings that spanned from RR = 1.87 to 9.50 for positive health outcomes, and RR = 0.82 to 0.03 ($\approx$20-fold

reduction). Positive family systems were strongly and consistently associated with improved health outcomes.

Table 3 provides a depiction of the same relationships, but this time expressed in terms of mean levels of the holistic measure by health outcome status. Again, the results of this analysis were strong, consistent, statistically significant and followed a dose-dependent pattern. As the levels of reported health outcomes became more negative, the mean level of the holistic measure decreased, without exception.

The final step of our analysis was to compare the relative risk estimates for the health outcomes for the holistic measure vs. its individual components. In Table 4, we show that for the 24 associations examined with the positive health outcomes (4 scale components $\times$ 6 outcomes), in 22/24 (92%) the RR for the composite score was at least 10% higher than that estimated for the individual components. For the 24 associations that were based on the negative health outcomes, in 20/24 (83%) the RR for the composite score was at least 10% lower (meaning more protective) than that estimated for the individual components.

4. Discussion

This study of family systems and their influences on the health of young people had two main objectives: (1) to model the potential effects of family characteristics, both individually and collectively, on the health of young Canadians; (2) more theoretically, to study empirically the theory of holism as applied to the assessment of family systems. We derived a composite measure in order to describe a family system holistically. Our findings confirmed that family systems are fundamental to the physical, social and emotional health of young people. What was novel in our study was not a demonstration of the importance of family systems per se; rather, what our findings suggest is that when viewed as a holistic construct, family systems may be even more important than previously understood. To illustrate, the group of young people for whom the holistic measure to describe a family system was used who reported scores in the top quintile also reported almost 10-fold increases in the prevalence of high life satisfaction relative to those in the lowest family systems quintile. Protective effects for the most negative health outcomes were also consistent and even more substantial, for example representing >20-fold relative differences in life satisfaction. In contrast, when the individual components of the holistic measure were analyzed, relationships between family systems and

Table 2
Associations between scores on the holistic measure to describe family systems and physical, social and emotional health outcomes in young people, 2014 Canadian Health Behaviour in School-aged Children Study.

Health outcome	Percentage with health outcome by quintile of holistic family systems measure					Relative risk[a] (Q5 vs. Q1)	
	Q1 (lowest)	Q2	Q3	Q4	Q5 (highest)	RR	(95% CI)
Positive health outcomes							
Health behaviours							
Daily physical activity	14.5	16.6	19.9	24.3	34.4	1.87	(1.68–2.09)
Overt risk avoidance	21.7	31.1	37.4	43.1	55.1	2.36	(2.10–2.66)
Social							
High peer support	14.2	15.2	19.4	26.9	49.3	3.44	(3.04–3.89)
High student support at school	9.7	14.9	20.4	28.1	46.6	4.02	(3.32–4.86)
Emotional							
High life satisfaction	6.8	15.5	23.6	36.3	59.5	9.50	(7.97–11.3)
Infrequent psychosomatic symptoms	7.5	14.9	18.3	24.6	35.0	3.65	(3.10–4.31)
Negative health outcomes							
Health behaviours							
Physical inactivity (less than daily)	85.5	83.4	80.1	75.7	65.6	0.82	(0.78–0.85)
Overt risk engagement	48.2	34.0	28.6	23.7	15.3	0.44	(0.38–0.50)
Social							
Low peer support	36.4	25.9	19.2	13.9	7.5	0.21	(0.17–0.25)
Low student support at school	33.6	15.9	11.0	9.2	6.0	0.19	(0.15–0.24)
Emotional							
Low life satisfaction	26.8	8.2	4.0	2.5	0.8	0.03	(0.02–0.05)
Frequent psychosomatic symptoms	42.7	22.7	16.0	11.1	5.7	0.18	(0.15–0.22)

[a] Relative risk estimates have been weighted and adjusted for age, sex, and clustering by school.

Table 3
Mean scores on the holistic measure to describe family systems by reported levels of different indicators of physical, social and emotional health, 2014 Canadian Health Behaviour in School-aged Children Study.

Indicator of health	No. Reporting	Mean score for holistic measure to describe family systems	p-value
Days engaged in physical activity			<0.0001
7 (highest)	4238	102.2 (7.4)	
6	3216	101.2 (6.8)	
5	3717	100.4 (6.7)	NS
4	3005	99.8 (6.6)	NS
3	2512	99.1 (6.8)	
2	1425	98.1 (7.0)	
1	754	97.4 (7.0)	
0 (lowest)	466	95.7 (7.8)	
Engagement in overt risk-taking behaviours			<0.0001
Q1 (0 or lowest)	7282	102.3 (6.4)	
Q2	6260	100.3 (6.8)	
Q3 (highest)	5791	97.8 (7.3)	
Peer support scale			<0.0001
Q5 (highest)	4833	103.3 (7.3)	
Q4	3257	101.0 (6.9)	
Q3	4620	100.0 (6.0)	
Q2	2647	98.8 (6.4)	
Q1 (lowest)	3976	97.1 (6.9)	
Peer school support scale			<0.0001
Q5 (highest)	4630	103.7 (7.7)	
Q4	4595	101.2 (6.5)	
Q3	2807	100.0 (6.1)	
Q2	4378	98.5 (6.2)	
Q1 (lowest)	2923	95.7 (6.5)	
Life satisfaction - Cantril ladder			<0.0001
10 (highest)	2065	105.7 (5.9)	
9	3411	104.0 (5.4)	
8	5023	101.5 (5.7)	
7	3693	99.0 (5.9)	
6	1931	97.5 (6.0)	
5	1570	95.9 (6.2)	
4	813	93.5 (6.5)	NS
3	461	92.4 (7.3)	NS
2	210	90.5 (6.8)	
1	86	88.8 (8.4)	NS
0 (lowest)	70	87.9 (9.3)	NS
Frequency of psychosomatic symptoms			<0.0001
Q1 (lowest)	3880	103.3 (6.3)	
Q2	4094	102.2 (6.2)	
Q3	4080	100.6 (6.3)	
Q4	3478	98.7 (6.7)	
Q5 (highest)	3801	95.8 (7.3)	

NS: pair of means not significantly different based on Student-Newman-Keuls test.

Table 4
Relative risks for physical, social and emotional health outcomes in young people obtained from the holistic measure to describe family systems versus its four individual components, 2014 Canadian Health Behaviour in School-aged Children Study.

	Holistic family system measure vs. Individual components		
	Higher RR	Equivalent RR	Lower RR
Positive health outcomes			
Physical activity	3	1	0
Overt risk avoidance	4	0	0
High peer support	3	0	1
High student support at school	4	0	0
High life satisfaction	4	0	0
Low psychosomatic symptoms	4	0	0
Subtotal	*22*	*1*	*1*
Negative health outcomes			
Physical inactivity	0	3	1
Overt risk engagement	0	0	4
Low peer support	0	1	3
Low student support at school	0	0	4
Low life satisfaction	0	0	4
Frequent psychosomatic symptoms	0	0	4
Subtotal	*0*	*4*	*20*

Higher: Increase in RR of 10% or more; Lower: Decrease in RR of 10% or more; Otherwise equivalent.

symbol of health for many North American Indigenous peoples (Svenson & Lafontaine, 1999). Modern definitions such as Hancock's (1985) *Mandala of Health* or analogously the World Health Organization (1946) definition of health, also capture the integration of the whole person (physical, emotional, social and even spiritual aspects) into some sort of integrative whole. The WHO describes health as "the extent to which an individual or group is able on the one hand to realize aspirations and satisfy needs, and, on the other hand, to change and cope with the environment" (WHO, 1946). This is also fundamentally holistic in its nature. Kendell challenges a reductionist separation of body and mind, arguing that neither minds nor bodies develop illnesses, "only people… and when they do, both mind and body… are usually involved"(Kendell, 2001). Related concepts such as quality of life (Burckhardt & Anderson, 2003), wellness (Myers & Sweeney, 1999), and emotional well-being (Tennant et al., 2007) can all be viewed, conceptually, as holistic ideas. Our findings, then, while novel in terms of measurement, fit into a wide range of thinking about the value of approaching health in a holistic manner.

At a contextual level, researchers have performed innovative studies in order to describe schools, communities, families and peer environments in terms of their social climates and associated levels of support (Freeman et al., 2011; Torsheim & Wold, 2001; Cheng & Chan, 2004), which by definition appears to represent holistic thinking and assessment. Our findings extend this idea by moving beyond simply theorizing about the concept, and demonstrating that it may be true in practice and be borne out empirically in practical settings. We believe there is value in viewing such systems as integrative wholes. Holism tells us that there is an emergent property present in the whole that is "more than" or "different from" the sum of the parts (Christakis, 2012; Stempsey, 2001). Our study findings provide evidence for this idea in that associations between health outcomes and our holistic measure to describe a family system were consistently different, and in this situation stronger, than those observed for its individual components.

Our findings may also have practical value for health promotion efforts. Health professionals who engage with high-risk families often develop interventional strategies around very specific behavioural patterns and family practices. The strength of this reductionist approach is that it is often simple enough that an issue can be addressed efficiently and acted on in a targeted way. Holism, however, challenges such practices and suggests that the collection of multiple aspects of the family system should be viewed as being dynamically and inherently interconnected. Health promotion strategies may be even more

reported health outcomes, while in the same directions (both positive and negative), were consistently of less magnitude.

This intriguing finding suggests a number of things. First, as Christakis (2012) suggests, a unified whole cannot be reduced to the sum of its individual parts. In terms of family systems, our findings suggest that something is potentially happening related to health outcomes that cannot be fully understood by looking at individual components alone. Clearly, examination of the individual determinants of child health is practical in terms of developing preventive and health promotion practices. However, based on our findings in this study, we argue that there are potentially new, or different, properties emergent when systems are studied as a whole. This is in keeping with longstanding philosophies and models of health. Measurement of family systems holistically has the potential to provide new insights that can inform etiological and preventive research.

The holistic theory that underlies this epidemiological analysis is not new to dialogues about health. Indeed, such understandings of health and health-related systems have been central to many cultures historically, including being prominent in the medicine wheel, a holistic

protective if they were addressed holistically, and simultaneously, analogous to a *whole person* approach to clinical care (Hutchinson et al., 2009). This thinking is not new; what is novel is that rarely have these holistic ideas been quantified.

Our study's main strengths are its novelty and its soundness from a methodological perspective. Why? *First*, our study opportunity was helpful in confirming the importance of healthy family systems in the promotion and protection of the health of young people. *Second*, the study base that was used was contemporary, large and national in scope. *Third*, our analyses were straightforward and based upon a longstanding approach to creation of composite scores (most recently employed in the UNICEF (2010) Report Card series) that led us to consider the family as an integrative whole and components of family systems as items that contributed to this whole.

Limitations of this study also warrant comment. *First,* our assessment of family systems was limited to the continuous and semi-continuous family measures that were available on a general health survey compiled for other purposes, and this list, while comprehensive, was not meant to be exhaustive. Many items related to family support that would have been useful to include simply were not available in the HBSC survey on which the analysis was based. This composite measure was never meant to represent a definitive holistic assessment of family systems, rather we intended to provide a valid means by which we could test the theory of holism in the family system context methodologically. *Second*, the cross-sectional nature of our analyses also suggests a need for caution in the interpretation of our findings as causal, due to obvious concerns about temporality. However, we believe that reverse causality in this situation is unlikely, as it is most likely that health outcomes reported by young people, both positive and negative, would be a consequence of family systems as opposed to being a cause of them. *Third*, while our findings suggest that there indeed is some "emergent properties" or qualities of family systems that either protect or put young people at risk, this study does not define these holistic qualities completely.

Our study findings have implications for additional research. With respect to holism, we viewed this analysis as a proof-of-concept in order to demonstrate a methodology for measuring one important determinant of health—the family system—in a composite and holistic manner. We believe that we achieved this study aim. We were able to establish this measure psychometrically and apply it to an etiological analysis, the findings of which were convincing in their strength, consistency and dose-dependency. At a minimum, it appears that such a holistic measure should include components describing household wealth, the nature of the residential environment, common family practices such as eating together, and communication and supports within the family. Additional refinements of this holistic measure would be expected with the availability of additional indicators absent from the 2014 HBSC study. The methodology is applicable to most survey situations that include continuous or semi-continuous measures. It could also be applicable to the study of other contextual environments, as well as the development of an overall indicator of adolescent health status.

In conclusion, this methodological study examined the theory of holism and its potential to be applied to the study of family systems as they relate to child health outcomes. Our findings suggest that it is possible to assess family systems holistically, such systems are strongly associated with child health outcomes, and there appears to be etiological and theoretical value in considering family systems as integrated wholes. Holism tells us that there is an emergent property present in the whole that is different than the sum of its parts; our analysis would suggest that this idea holds true in family systems.

Conflict of interest

The authors declare that there are no conflicts of interest.

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