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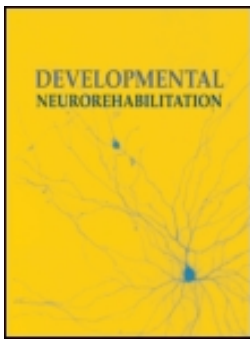
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ORIGINAL ARTICLE

The Child and Adolescent Scale of Environment (CASE): Further validation with youth who have chronic conditions

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Abstract

Objective: To further validate the Child and Adolescent Scale of Environment (CASE).

Methods: Baseline data ($n = 430$) were analyzed from a longitudinal study on quality of life for youth with chronic conditions ages 11–17 in Ontario, Canada. Internal consistency and structure, and convergent and discriminant validity were examined via Cronbach's alpha (α), exploratory factor analyses, correlation analyses and ANOVA.

Results: The CASE had high internal consistency ($\alpha = 0.89$). A three-factor solution was produced with 55% variance explained: (1) Community/Home Resources, (2) School Resources and (3) Physical Design/Access). CASE total and factor scores were significantly correlated with scores from measures of impairment and participation (i.e. youth with more problematic environments had more severe impairment and more restricted participation). Significant differences in CASE scores existed for primary condition and impairment severity, but not for age or gender. **Conclusion:** Results provide additional CASE validation evidence. Further testing is needed with more diverse and representative samples.

Keywords

Chronic conditions, disability, environment, measurement, participation, youth

History

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Introduction

Physical, social and attitudinal features of the environment have an impact on the participation of children and youth with chronic conditions and disabilities across home, school and community contexts [1–6]. Environmental factors are categorized into five broad domains in the World Health Organization's International Classification of Functioning, Disability and Health (ICF) and the more recent child and youth version (ICF-CY) [7, 8]: (1) products and technology; (2) natural environment and human-made changes to environment; (3) support and relationships; (4) attitudes; and (5) services, systems and policies. Each of these broad domains consists of a number of sub-domains of environmental factors that could act as facilitators or barriers to the child's participation in activities.

Anaby and colleagues [1] recently conducted a scoping review of the effects of environmental factors on participation of children and youth with chronic conditions/disabilities and identified that each of the five broad ICF domains influenced participation in some way as both a facilitator and barrier. More environmental barriers than facilitators were reported in the studies reviewed with the most common barriers being negative

attitudes, followed by inaccessible physical environments and inadequate or lack of services, policies and support from staff or service providers. The most common facilitators were social support from family and friends followed by geographic location (i.e. the policies, resources and opportunities associated with home, community or country of residence). Anaby and colleagues also found that most studies focused on children ages 6 to 12 with physical conditions/disabilities and recommended that more research was needed on children with other conditions/disabilities who were older or younger than the 6 to 12 year age range.

Recent reviews have identified strengths and limitations of measures of environmental factors for use with children and youth with chronic conditions and disabilities in terms of coverage of the ICF domains, practical utility and/or psychometric evidence [9, 10]. The *Child and Adolescent Scale of Environment (CASE)* [11] is one promising environmental measure identified in these reviews. Reported strengths of the CASE are that it is brief but has good overall coverage of the five ICF environmental domains; is easy to complete and score (no formal training is required); is free to use; has evidence of reliability and validity; and was developed specifically to assess environmental factors affecting children and youth [9, 10]. A key criticism of the CASE is that most psychometric evidence comes from studies on children and youth with traumatic and other acquired brain injuries rather than a broad range of potentially disabling conditions.

The purpose of this study was to further examine the validity of the CASE for Canadian youth aged 11–17 years with

Table I. Sample characteristics and CASE scores: Descriptive statistics.

Characteristics	n (%)	CASE Scores	
		M (SD)	Minimum-Maximum
<i>Age</i>			
11	101 (24)	25.17 (6.52)	18–48
12	58 (14)	25.78 (6.77)	18–44
13	56 (13)	25.22 (6.49)	18–40
14	49 (11)	26.17 (6.67)	18–45
15	41 (10)	25.85 (6.56)	18–42
16	57 (13)	24.77 (6.29)	18–40
17	68 (16)	26.88 (7.05)	18–48
<i>Gender</i>			
Female	194 (45)	25.11 (6.27)	18–48
Male	236 (55)	26.08 (6.85)	18–48
<i>Primary Chronic Condition</i>			
Cerebral Palsy	149 (35)	26.96 (6.84)	18–48
Acquired Brain Injury	59 (14)	24.72 (6.06)	18–37
Autism Spectrum Disorder & Asperger's Syndrome	37 (9)	28.03 (6.33)	18–44
Spina Bifida	35 (8)	27.44 (7.17)	18–48
Cleft Lip-Palate	33 (8)	20.35 (3.52)	18–33
Developmental Delay & Down's Syndrome	33 (8)	25.31 (6.09)	18–40
Amputation	17 (4)	20.29 (2.30)	18–26
Communication Disorder	11 (3)	25.40 (6.85)	18–39
Other	56 (13)	25.19 (6.44)	18–42

Sample ($n = 430$); percentages rounded up to the nearest whole number.

a broad range of chronic conditions. There were four research aims:

- (1) To examine the internal structure of the CASE through exploratory factor analyses.
- (2) To examine the internal consistency of the CASE and the CASE factor subscales that were informed by the components extracted from exploratory factor analyses.
- (3) To examine the convergent validity of the CASE scores and CASE factor scores through correlation analyses with scores from the *Child and Adolescent Scale of Participation* (CASP) and *Child and Adolescent Factors Inventory* (CAFI) [11–14].
- (4) To examine the discriminant (known-groups) validity of the CASE total score and CASE factor scores through analyses of group differences according to primary chronic condition and impairment severity.
 - (a) We hypothesized that youth in our sample with primary conditions that are more often associated with greater physical and/or social problems would have significantly higher CASE scores than youth with conditions that are less often associated with these environmental problems.
 - (b) We also hypothesized that youth with more severe impairment in cognitive, physical and psychological functioning, regardless of primary health condition, would have significantly higher CASE scores than youth with less severe impairment in these areas.

Methods

Recruitment and data collection

The research presented in this article was approved by the institutional review boards of authors conducting this study. Baseline data were examined from an ongoing longitudinal prospective cohort study examining predictors of changes in quality of life for youth with chronic conditions [15, 16]. Data were collected on a random sample of 430 Canadian youth

aged 11–17 with various chronic conditions. Youth and their parents were recruited from eight children's treatment centers in the province of Ontario. Youth had one or more chronic conditions (Table I).

Baseline data collection occurred in the respondent's home or in a private office at the youth's treatment center according to the parent's and youth's preferences. Interviewers obtained written informed consent in person from youth and parents just prior to conducting the baseline assessment. Only data collected from the parent report measures were examined in this study. The parent questionnaire that included the CASE, CASP and CAFI was self-completed (30–60 minutes), most often by the youth's mother, in a separate room from the youth [15, 16]. These three measures (described next) were initially developed as part of the *Child and Family Follow-up Survey* (CFFS), a parent-report measure used to monitor outcomes and needs of children with traumatic and other acquired brain injuries (TBI/ABI) and their families [12–14, 17, 18] and subsequently have been used to assess children with other conditions and disabilities [12, 15, 19].

Measures

Child and Adolescent Scale of Environment

The CASE [11] is an adaptation of the *Craig Hospital Inventory of Environmental Factors* (CHIEF) [20], an instrument initially designed to assess the frequency and impact of environmental barriers experienced by adults with disabilities. Items from the CHIEF were modified and additional items were developed to create the CASE for use as a parent-report measure to assess children and youth with ABI and other chronic conditions and disabilities.

The CASE consists of 18 items that ask parents/guardians only about the impact (*not frequency*) of problems that their child directly or indirectly encounters with physical, social and attitudinal environment features of the child's home,

school and community and problems with the quality or availability of services or assistance that the child receives or might need. The list of CASE items with shortened names is presented later in Table II. The actual item names have more description and often include examples. For example, item 1, ‘Home: Physical design’, is short for ‘‘Problem with design and layout of home (*Hard to get to places and things, or hard to see or hear important information*)’’ and item 7, ‘Community: Attitudes’ is short for ‘‘Problems with people’s attitudes toward your child in the community or neighborhood’’.

Each CASE item or problem is rated on a 3-point scale: 1 = No problem; 2 = Little problem; 3 = Big problem. There are a number of ways to score the CASE depending on the purpose of the project or research being conducted [11]. For this study, a simple sum of the items was used to compute the total CASE score (with possible score ranges from 18 to 54) as well as the CASE factor subscale scores that were informed by factor analyses (described later in the results). Higher scores indicate a greater impact of environment problems or overall, a more problematic environment.

The CASE has reported evidence of test–retest reliability [intra-class correlation coefficient (ICC) = 0.75], and internal consistency (Cronbach’s $\alpha = 0.84$ and 0.91) [2, 9, 11, 13]. With respect to construct validity, higher CASE scores were significantly associated with lower participation scores on the CASP, with lower functional skills scores on the Pediatric Evaluation of Disability Inventory (PEDI) [21], and with higher impairment scores on the Child Adolescent Factors Inventory (CAFI) [2, 9, 11–14]. More recent analyses demonstrated that as a group, children with chronic conditions/disabilities had significantly higher CASE scores than children without identified chronic conditions/disabilities [11].

Initial results from factor analyses and Rasch analyses suggested that the CASE is best viewed as an inventory of environmental factors or a multidimensional scale rather than a unidimensional scale [13]. More recent factor analyses identified four main factors that explained 58% of the variance: (1) problems associated with home/community (includes inadequate information, problems with government policies); (2) school-related problems (support, assistance, services, equipment, attitudes); (3) problems with physical design of school, home and community; and (4) other family/neighborhood problems (family stress, problems with finances, inadequate transportation and neighborhood crime/violence) [9, 11].

Child and Adolescent Scale of Participation

The CASP [11–14] was initially designed as a parent/guardian report measure to assess the extent to which children and youth participate in home, school and community activities in comparison to same-age children and youth. The 20 items of the CASP are rated using a 4-point scale (4 = age expected/full participation; 3 = somewhat limited; 2 = very limited; 1 = unable), or scored as ‘‘not applicable’’ (i.e. for younger children). The ‘‘not applicable option’’ was not needed for this sample because all items pertained to youth aged 11–17 [16]. For this study, a simple sum of the items was used to compute the total CASP score (with possible score ranges

from 20 to 80). A higher score on the CASP represents a greater extent of participation.

The CASP has reported evidence of inter-rater reliability (ICC = 0.95), internal consistency ($\alpha = 0.96$) and construct validity [2, 12–14]. A recent study examined the psychometric properties of a new youth-report version of the CASP and the original parent-report version using the same data set that was evaluated in this study [15]. The results indicated that the parent-report CASP (i.e. the version used in this study) had somewhat higher internal consistency (Cronbach’s $\alpha = 0.96$) than the youth-report CASP (Cronbach’s $\alpha = 0.87$). Fairly high internal consistency was also found for the three CASP factor subscales that were informed by factor analyses of the parent-report CASP: 1) social, leisure and communication ($\alpha = 0.90$); 2) advanced daily activities ($\alpha = 0.86$); and 3) basic daily activities and mobility ($\alpha = 0.89$).

Internal consistency for the CASP factor subscales was also somewhat higher for the parent-report CASP than the youth-report [16]. We examined only the parent-report CASP scores in this research. This also allowed us to keep all comparisons across measures to parent report (including the CAFI which is described next).

Child and Adolescent Factors Inventory

The CAFI [12, 13] consists of a list of 15 problems or impairments related to health and cognitive, physical and psychological functioning. Similar to the CASE, each item or problem is rated on a 3-point ordinal scale: 1 = No problem; 2 = Little problem; 3 = Big problem. For this study, a simple sum of the items was used to compute the total CASP score (with possible score ranges from 15 to 45). A higher score on the CAFI indicates a greater extent of impairment.

The CAFI has reported evidence of test–retest reliability (ICC = 0.68), and internal consistency ($\alpha = 0.86$) and construct validity [2, 12–14]. Results from initial factor analyses and Rasch analyses suggest that the CAFI is best viewed as an inventory of child-related impairments rather than a unidimensional scale [12–14].

Data analyses

Descriptive statistics [mean (M), standard deviation (SD), frequency and ranges] were used to examine demographics and CASE summary scores. Exploratory factor analyses with varimax rotation and Kaiser normalization were used to assess the internal structure of the CASE. Cronbach’s alpha was used to assess the internal consistency of the CASE as well as the CASE factor subscales that were created based on the components extracted from factor analyses. Correlation analyses using Pearson’s product moment correlation coefficients (r) assessed convergent validity of the CASE by examining CASE score associations with CASP and CAFI scores.

Analysis of variance (ANOVA) was used to assess discriminant (known-groups) validity of the CASE by examining group differences in CASE total and factor subscale scores according to primary chronic condition and impairment severity. When a statistically significant difference was found, a Scheffé’s *post hoc* comparison test was

used to further examine where specific differences existed among condition groups and impairment severity categories. The effects of youth age and sex on CASE scores were also examined via ANOVA to determine whether they needed to be controlled for when analyzing group differences related to primary condition and impairment severity.

To examine known-groups validity for impairment severity, regardless of the type of primary condition, we selected three items from the CAFI that each represented common but different types of impairments often experienced by youth with chronic conditions/disabilities: “Problem solving/Judgment” (*Cognitive impairment*); “Movement (e.g. balance, coordination, muscle tone)” (*Physical impairment*); “Psychological (e.g. anxiety, depression)” (*Psychological impairment*).

Results

Participant characteristics

Youth age, sex and chronic condition group demographic data and corresponding CASE scores are presented in Table I. The mean age of youth was 14 years ($SD = 2.2$). Eleven-year-olds comprised the largest age group. There were slightly more males (55%) than females, and cerebral palsy was the largest condition group ($n = 149$, 35%). In terms of CASE

scores, there were no statistically significant group differences for age ($F = 0.663$, $p = 0.68$) or sex ($F = 2.102$, $p = 0.15$), and thus these variables were not controlled for in later analyses.

Parents’ average age was 45 years ($SD = 6.5$), with more female (88%) than male parents. Eighty-three percent of parent respondents were birth mothers, 10% were birth fathers, 4% were adoptive mothers and 3% were another type of relationship (e.g. stepfather, grandmother). English was spoken in 90% of families’ homes, French in 2% and various other languages in 8% of homes.

Internal structure and consistency

The results from exploratory factor analysis produced a three-factor solution in five iterations contributing approximately 55% of the explained variance: (1) *Community and Home Resources*; (2) *School Resources*; and (3) *Physical Design and Access* (Table II). More items (i.e. 11 out of 18) loaded (>0.30) on the first factor. Also, six items loaded (shared variance) on two factors (i.e. School Physical design; Community/Home Support; Community Attitudes; Assistive Equipment; Community/Home Assistance; School Programs/Services).

Internal consistency of the 18-item CASE was high (Cronbach’s $\alpha = 0.893$). Three CASE factor subscales were created based on the results of the factor analyses and their item content when items loaded fairly equally on more than one factor (i.e. item 7. Community Attitudes, see Table II). The first factor subscale, *Community/Home Resources*, included nine items (4, 7, 9, 13–18) and had moderately high internal consistency ($\alpha = 0.853$). Scores on this scale could range from 9 to 27. The second factor subscale, *School Resources*, included four items (5, 6, 10, 12) and had moderately high internal consistency ($\alpha = 0.846$). Scores on this scale could range from 4 to 12. The third factor subscale, *Physical Design/Access*, included five items (1, 2, 3, 8, 11) and had moderate internal consistency ($\alpha = 0.756$). Scores on this scale could range from 5 to 20.

Convergent validity

The CASE total and factor scores were significantly correlated ($p \leq 0.001$) with the CAFI and CASP scores (see Table III), and these correlations were in the expected directions. Specifically, positive correlations were found between CASE and CAFI scores indicating that, on average, youth with a greater extent of environmental problems also had a greater extent of impairment. Negative correlations were found between the CASE and CASP scores indicating that youth with a greater extent of environmental problems also had a lesser extent of (or more restricted) participation.

Table II. Results from factor analyses.

CASE items	Factor 1	Factor 2	Factor 3
	Community/ Home Resources	School Resources	Physical Design/ Access
1. Home: Physical design	0.105	-0.015	0.782*
2. Community: Physical design	0.103	0.017	0.846*
3. School: Physical design	-0.049	0.389†	0.631*
4. Community/Home: Support	0.613*	0.430†	0.199
5. School: Support	0.207	0.852*	0.073
6. School: Attitudes	0.195	0.791*	0.129
7. COMMUNITY: Attitudes	0.445†	0.475†	0.148
8. Assistive Equipment	0.381†	0.232	0.479*
9. Community/Home: Assistance	0.654*	0.311†	0.099
10. School: Assistance	0.202	0.815*	0.111
11. Transportation	0.265	0.122	0.576*
12. School: Programs/services	0.315†	0.653*	0.106
13. Community: Programs/services	0.622*	0.221	0.264
14. Family Finances	0.750*	0.078	0.209
15. Family Stress	0.683*	0.167	0.210
16. Community: Crime & Violence	0.428*	0.088	-0.021
17. Government agencies/policies	0.709*	0.107	0.207
18. Information	0.611*	0.292	-0.084
Variance explained (total = 55.02%)	21.87%	18.64%	14.51%

*Item loaded more strongly on this factor.

†Item shared variance with this factor; boldfaced items used to create subscales for each specified factor.

Table III. Results from correlation analyses.

CASE Scores	CAFI	CASP: Total	CASP: Social, Leisure, Communication	CASP: Advanced Daily Living	CASP: Basic Daily Living/Mobility
1. CASE: Total	0.52	-0.61	-0.54	-0.57	-0.55
2. CASE: Community/Home Resources	0.56	-0.62	-0.57	-0.60	-0.51
3. CASE: School Resources	0.37	-0.37	-0.36	-0.37	-0.26
4. CASE: Physical Design/Access	0.28	-0.45	-0.31	-0.37	-0.58

CASE (Child & Adolescent Scale of Environment); CAFI (Child & Adolescent Factors Inventory); CASP (Child & Adolescent Scale of Participation). All Pearson product moment correlation coefficients were statistically significant ($p \leq 0.001$).

Overall, the CASE total score and CASE Community/Home Resources factor score had stronger (moderate) associations ($r > \pm 0.50$) with the CAFI and CASP scores than did the CASE School Resources and Physical Design/Access factor scores. One exception to this pattern was the moderate association ($r = -0.58$) found between the CASE Physical Design/Access factor score and the CASP Basic Daily Living/Mobility factor score.

Discriminant (known-groups) validity

The results from ANOVA identified significant CASE score differences related to primary chronic condition group (Table IV) and impairment severity category (Table IV). Due to multiple comparisons, Bonferroni corrected significance levels were set at $p \leq 0.0125$ for disability ($p \leq 0.05$ divided by the four comparison tests) and $p \leq 0.004$ for impairment severity ($p \leq 0.05$ divided by the 12 comparison tests).

Significant condition group differences were found for all CASE scores except for the School Resources factor score (Table IV). As can be seen in Table IV, the overall pattern of *post hoc* differences that were significant or approached significance ($p = 0.001$ to 0.08) for all CASE scores was very similar to the pattern of CASE total score differences shown in Table I. For example, there was a 6- to 7-point difference in mean (M) CASE total scores between youth expected to have lower and higher scores: Youth with cleft palate/lip (M = 20.35) and amputations (M = 20.29) had lower CASE total scores, and youth with cerebral palsy (M = 26.96), autism spectrum disorders (M = 28.03) and spina bifida (M = 27.44) had higher CASE total scores.

Significant ($p \leq 0.004$) differences for cognitive, physical and psychological impairment severity were found for all CASE scores except for the CASE Physical Design/Access factor score in relation to cognitive and psychological impairment (Table V). An overall pattern of significant ($p \leq 0.05$) *post hoc* differences were found for most CASE scores with youth with less severe impairment having lower CASE scores than youth with more severe impairment. As expected, significant score differences were found between the youth grouped in nonadjacent impairment severity categories (i.e. “no problem” and “big problem”).

Mean score differences between these two groups ranged between 5 and 7 points for CASE total scores and between 1 to 4 points for CASE factor scores. Significant ($p \leq 0.05$) score differences were also found in many of the *post hoc* comparisons between youth grouped in adjacent impairment severity categories with mean CASE score differences ranging from 1 to 4 points.

Discussion

The purpose of this research was to further validate the CASE with a large sample of Canadian youth with a range of chronic conditions. There was an accumulation of validity evidence reported. Similar to prior research, the internal consistency of the CASE was high [2, 11, 13]. Results from factor analyses demonstrated an interpretable three-factor structure that contributed a large proportion of variance explained. Additionally, the three-factor subscales had moderate-to-high internal consistency, suggesting that they have the potential to be good estimates of three dimensions of the environment measured by the CASE.

The factor structure found in this study was similar to the four-factor structure found in prior research that included a large proportion of children with acquired brain injuries [11, 13, 14]. The key difference is that the first factor in this study, “Community/Home Resources” included three of the four items included in the fourth factor from the prior study, “Other family/neighborhood problems”. Interestingly, these three items (family stress, finances and neighborhood crime/violence) were developed specifically for the CASE to represent broader familial and societal problems that might affect participation of children and youth with and without chronic conditions. It is unclear which of the factor solutions would be more useful in research and practice. An advantage to the prior four-factor solution is that it keeps these three items separate from the other community/home resources items. Whereas, an advantage to the three-factor solution is that it might be more efficient for use in studies that do not require this level of specificity or that can only examine a reduced set of variables/scores due to statistical power constraints. Future research with a larger and more representative sample of youth with chronic conditions using confirmatory factor analysis and other methods such as

Table IV. Differences in CASE scores: Primary chronic condition group.

CASE scores	N	F Omnibus (p)	**Scheffés <i>post hoc</i> comparisons (p)
CASE total	396	5.96 (0.001)*	Cleft lip/palate compared with cerebral palsy (0.003), autism spectrum disorder (0.002) & spina bifida (0.012) Amputation compared with autism spectrum disorder (0.056) & cerebral palsy (0.079)
CASE factor: community/home resources	403	7.081 (0.001)*	Cleft lip/palate compared with cerebral palsy (0.003), autism spectrum disorder (0.001), spina bifida (0.033) & developmental delay (0.072) Amputation compared with autism spectrum disorder (0.001) & cerebral palsy (0.061)
CASE factor: school resources	418	2.075 (0.037)	F test not significant
CASE factor: physical design/access	420	10.077 (0.001)*	Cerebral palsy compared with cleft lip/palate (0.001), acquired brain injury (0.007), autism spectrum disorder (0.016), developmental delay (0.030) Spina bifida compared with cleft lip/palate (0.001), acquired brain injury (0.004), autism spectrum disorder (0.005), developmental delay (0.008), amputation (0.04)

*ANOVA results, F omnibus, that were statistically significant ($p \leq 0.0125$).

***Post hoc* comparisons that were statistically significant ($p \leq 0.05$) or approached significance ($p = 0.051$ to 0.08).

Table V. Differences in CASE scores: Impairment severity category.

Impairment	No problem mean (SD)	Little problem mean (SD)	Big problem mean (SD)	F omnibus (<i>p</i>)	Scheffé's <i>post hoc</i> comparisons (<i>p</i>)
Cognitive (<i>problem solving</i>)					
	<i>n</i> = 150	<i>n</i> = 140	<i>n</i> = 106		Severity category differences
CASE: Total	23.34 (5.89)	25.84 (6.13)	28.66 (6.98)	22.37 (0.001)*	No to Little (0.003)** No to Big (0.001)** Little to Big (0.003)**
CASE: Community/Home Resources	11.93 (3.35)	13.69 (3.66)	15.70 (4.26)	32.61 (0.001)*	No to Little (0.001)** No to Big (0.001)** Little to Big (0.001)**
CASE: School Resources	5.11 (1.62)	5.81 (2.10)	6.35 (2.33)	13.00 (0.001)*	No to Little (0.009)** No to Big (0.001)** Little to Big (0.101)
CASE: Physical Design/Access	6.34 (1.93)	6.42 (1.83)	6.79 (2.07)	1.88 (0.153)	F test not significant
Physical (<i>movement</i>)					
	<i>n</i> = 99	<i>n</i> = 156	<i>n</i> = 140		Severity category differences
CASE: Total	22.47 (5.25)	24.56 (5.82)	29.15 (6.78)	39.60 (0.001)*	No to Little (0.028)** No to Big (0.001)** Little to Big (0.001)**
CASE: Community/Home Resources	11.96 (3.56)	13.10 (3.68)	15.27 (4.06)	24.75 (0.001)*	No to Little (0.061) No to Big (0.001)** Little to Big (0.001)**
CASE: School Resources	5.13 (1.68)	5.59 (2.01)	6.20 (2.23)	9.03 (0.001)*	No to Little (0.196) No to Big (0.001)** Little to Big (0.028)**
CASE: Physical Design/Access	5.45 (0.87)	5.96 (1.48)	7.78 (2.19)	73.57 (0.001)*	No to Little (0.056) No to Big (0.001)** Little to Big (0.001)**
Psychological (<i>anxiety/depression</i>)					
	<i>n</i> = 219	<i>n</i> = 124	<i>n</i> = 52		Severity category differences
CASE: Total	23.92 (5.89)	27.19 (7.09)	29.15 (6.13)	19.91 (0.001)*	No to Little (0.001)** No to Big (0.001)** Little to Big (0.173)
CASE: Community/Home Resources	12.48 (3.51)	14.29 (4.12)	16.48 (3.98)	27.16 (0.001)*	No to Little (0.001)** No to Big (0.001)** Little to Big (0.002)**
CASE: School Resources	5.30 (1.82)	6.05 (2.18)	6.39 (2.30)	9.84 (0.001)*	No to Little (0.003)** No to Big (0.001)** Little to Big (0.556)
CASE: Physical Design/Access	6.27 (1.83)	6.87 (2.04)	6.50 (2.03)	3.98 (0.019)	F test not significant

*ANOVA results, F omnibus, that were significant ($p \leq 0.004$).

***Post hoc* comparisons that were significant ($p \leq 0.05$).

structural equation modeling might offer additional insights here [22].

The pattern of associations found between the CASE scores and scores from the CASP and CAFI provided evidence of convergent validity. Similar to others studies, youth with higher CASE scores (more problematic environment) had lower CASP scores (less extent or more restricted participation) and higher CAFI scores (more severe impairment) [2, 11–14, 17, 18]. Additionally, the magnitude of the correlations among CASE scores and other scores provided further validity evidence. For example, it is likely that the CASE total score and CASE Community/Home Resources factor score had stronger (i.e. moderate) associations with the other scores because these two CASE scores had more items and thus greater coverage of environmental factors. Moreover, the similar moderate association found between the CASE Physical Design/Access factor score and the CASP Basic Daily Living/Mobility factor score was

validating given that youth who experience physical design/access problems would likely have more restricted participation in activities that require greater physical functioning [1, 5, 6].

This was the first study to comprehensively examine discriminant validity of the CASE in children or youth with a range of chronic conditions. Significant differences in CASE scores existed for condition and impairment severity, but not for age or gender. In one study, Bedell [11] found significant CASE total score differences in between children and youth with chronic conditions (the majority had an ABI) and children without conditions, but did not examine age, gender or impairment. Chen and Bedell [23] also found CASE total score differences according to type and severity of impairment in children and youth with ABI with children with no or less severe physical, cognitive and psychological impairments having lower CASE scores than children with more severe and multiple impairments.

The *post hoc* comparison tests provided further discriminant validity evidence. Youth with conditions who were expected to have greater physical and social environmental problems due to greater physical and social impairment (e.g. cerebral palsy, autism spectrum disorder, spina bifida), had higher CASE scores than youth who were expected to have less environmental problems (e.g. cleft lip/palate, amputation). The 5- to 7-point difference found in mean scores between these groups reflects a potentially clinically important difference (i.e. a difference in impact on at least three environmental problems) given that each CASE item is rated on a 3-point scale. However, these results should be viewed with caution given the unequal representation of chronic conditions in the sample.

One plausible explanation for why the *post hoc* comparison tests for the CASE School Resources factor score were not significant for condition is that schools often provide a range of environmental accommodations and services to support all students' participation in the least restrictive environment regardless of type of primary condition. Another explanation is that the School Resources factor score had the fewest number of items and may not have been sensitive enough to detect significant condition group differences.

Overall, significant ($p \leq 0.004$) differences in CASE scores were found in relation to severity of cognitive, physical and psychological impairment. The only exception here was that there were no significant differences found on the CASE Physical Design/Access factor score for youth with cognitive (problem solving/judgment) and psychological (e.g. anxiety and depression) impairment. This result was validating because physical design/access is not often identified as a problem affecting youth with cognitive or psychological impairment [2, 13, 14, 17, 18]. *Post hoc* differences were found for all other CASE scores with youth with less severe impairment generally having lower CASE scores than youth with more severe impairment. As anticipated, except for the prior noted exception, youth with no cognitive, physical or psychological impairment consistently had significantly lower CASE scores than youth with the most severe impairments in these three areas. Mean differences in CASE scores between these two groups ranged between 1 and 5 points, with a greater magnitude of difference found in scales with the most items (CASE Total and CASE Community/Home Resources).

Limitations and future research directions

Although the results are promising, there were study design features that limited their generalizability and definitive conclusions that could be made about them. For example, there were unequal numbers of youth represented in each of the nine chronic conditions, reduced power to potentially detect significant *post hoc* differences among these nine groups of youth, and lack of data on race, ethnicity and socioeconomic status. Also, the majority of the youth had cerebral palsy and was mainly from English-speaking families living in Ontario, Canada. Thus, further testing with more diverse and representative samples is needed.

Additionally, the study did not examine the test-retest reliability of the CASE in this study given that this was not the

focus of the larger study. In previous research, the CASE total score was shown to have moderately good test-retest reliability [11–13]. However, more research is still needed to assess the relative stability of all CASE scores in children and youth with disabilities to have greater confidence that changes in scores over time or after intervention are a reflection of actual changes in the physical, social and attitudinal environment (i.e. responsiveness). Another potential limitation in this study is that the correlations among the CASE, CASP and CAFI scores (i.e. evidence of convergent validity) might have been inflated due to shared method variance given that they were completed as part of a single assessment schedule. Thus, future research is needed to assess correlations between CASE scores and scores from other environmental measures (i.e. concurrent validity evidence).

The CASE only provides quantitative ratings that reflect environmental barriers and even though the CASE includes open-ended questions asking families to report on environmental supports and strategies, ratings for environmental supports are not provided. Therefore, stakeholders interested in obtaining quantitative ratings on environmental supports would need to consider other promising measures that assess environmental supports or both supports and barriers [1, 9, 10, 24, 25].

Finally, because the CASE is completed by parents or primary guardians, the scores reported in this study only reflect parent perspectives. It is likely that the perspectives of youth would differ somewhat from their parents [4, 16]. Even though it is recommended that parents consider their youth's perspectives, parents probably differed in the extent to which they did this in this study. Future research with the CASE might include providing more explicit guidelines to parents for inclusion of the youth's perspective and/or developing a youth-report version of the CASE similar to what was done with the CASP [16]. Having the perspectives of the parent and youth, as well as other key people involved in the youth's life, would likely result in a more consistent and collaborative approach for addressing environmental factors to support the participation of youth with chronic conditions and disabilities [4, 16].

Conclusions

The accumulation of validity evidence found in this study as well as prior research findings [2, 11–14, 16–18] suggests that the CASE is a promising measure for youth with a range of chronic conditions. Further psychometric testing is suggested to confirm the three-solution factor structure found in the study, assess test-retest reliability and examine the responsiveness of the scores over time. Also, future testing is needed to show whether the CASE total and CASE factor scores are useful across more diverse and representative samples in terms of chronic condition/disability, race, ethnicity, socioeconomic status and geographic location.

Clinicians and researchers will need to consider which CASE scores (total, subscale or item-level) to use based on the level of specificity and statistical power needed for their clinical and research needs. In addition to the three-factor subscale scores described, stakeholders might consider creating other subscale or composite scores guided by their

own information goals, for example, combining items that are specific to a setting or one of the five ICF environmental domains [13, 14, 23, 26]. Finally, and importantly, future research is needed to understand how scores from the CASE (and other measures) inform decisions to support meaningful participation of youth with chronic conditions and disabilities and to know whether these scores are responsive to interventions or policies that target the physical, social and attitudinal environment [1, 4, 9, 10].

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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