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Evaluation of the psychometric properties of the parents' proxy MPAQ-C in Chinese population

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Evaluation of the psychometric properties of the parents' proxy MPAQ-C in Chinese population

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(Original article)

1

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Abstract

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We examined psychometric properties of a Modified Physical Activity (PA) Questionnaire for Children (MPAQ-C). Thirty-two parents (study 1), forty primary school students (6-9 yrs) and one of each student's parents (study 2), and 625 parents (study 3) completed the MPAQ-C. The MPAQ-C (6 items) measured children's physical activity (PA) after school, and during evenings and weekends for seven days. Test-retest reliability (study 1) and convergent validity (study 2) were measured. Factor validity of the MPAQ-C (study 3) was examined using confirmatory factor analysis (CFA). A single factor model of the MPAQ-C fit the data well ($\chi^2(9) = 42.78, p < .001$; comparative fit index [CFI] = .977; non-normed fit index [NNFI] = .962; root mean square error of approximation [RMSEA] = .079 [90% CI = .057 to .11]), with good test-retest reliability, composite reliability (.80) and convergent validity. The factor loadings of MPAQ-C were invariant across fathers/mothers ($\Delta X^2(6) = 3.44, p > .05$). The MPAQ-C is a suitable parent proxy for measuring PA in young Chinese children.

Keywords: exercise, children, physical activity, family, questionnaire

1 Introduction

2 The role that Physical Activity (PA) plays in health promotion and prevention of lifestyle-
3 related diseases is well established (United States Department of Health and Human Services,
4 2000). While it is generally accepted that PA improves health, children's participation in PA is
5 lower than it should be in Hong Kong. In 2009, the Leisure and Cultural Services Department
6 (LCSD) analyzed the pattern of PA in a sample of Hong Kong citizens. In young children aged
7 7-12 years old, even including the PA in physical education class, only about 34% of Hong
8 Kong's children met the age-specific PA recommendation (i.e., engaged in moderate-to-vigorous
9 PA for at least 60 minutes, 5 days a week) established by the National Association for Sport and
10 Physical Education (2004). When PA in physical education class was not included, only 21% of
11 young Hong Kong children met the aforementioned PA recommendation.

12 In studying sedentary behaviors in Hong Kong children, Lam, Sit and Cerin (2010)
13 revealed that children were quite sedentary, spending an average of 2.6 hours per day watching
14 TV and playing video or other non-electronic games in a seated position. In addition, researchers
15 have concluded that 30–70% of obese children and adolescents would remain obese adults
16 (Kotani et al., 1997; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Given the prevalence and
17 consequences of physical inactivity and obesity, there is ample rationale for accurately
18 measuring children's PA to facilitate PA promotion. Bauman, Phongsavan, Schoeppe, and Owen
19 (2006) stated that valid and reliable measurement of PA, applicable to children, are needed in
20 health promotion: a) to identify level of PA in and among populations; b) to understand the
21 correlates or determinants of PA, and its relationship to health related outcomes; and c) to
22 measure the impact and effectiveness of PA related programs and interventions.

1 Unlike measuring PA in adults, measuring PA in children is more challenging because
2 children's PA is short-lived and intermittent, and it is often difficult to measure due to children's
3 lack of comprehension of various PA concepts (Baquet, Stratton, Van Praagh, & Berthoin, 2007).
4 When measuring PA in children, most researchers use direct observation, heart rate monitoring,
5 accelerometry, pedometers and/or self-report questionnaires (i.e., interviews, diaries, and proxy
6 reports). Among these measurements, self-report questionnaires are preferable because they are
7 inexpensive, easier to administer, can collect data from large samples, and have the ability to
8 gather different types of activity-related information (e.g., PA type, frequency, duration, and
9 intensity). Conversely, some researchers who measured PA in children contended that using self-
10 administered questionnaires in children might induce measurement errors (Loprinzi & Cardinal,
11 2011; Sallis, Buono, Roby, Carlson, & Nelson, 1990; Trost, 2007). Children younger than 10
12 years of age could not recall their PA, and they had trouble understanding questionnaires. Trost
13 et al. (2000) evaluated 4th grade students' understanding of PA by asking them to evaluate an
14 activity-related checklist. Without video and verbal descriptions, 35.6% of the students could not
15 complete the checklist correctly.

16 Because of the aforementioned difficulties measuring children's PA, many researchers have
17 asked parents and teachers to watch their children's PA and record it. This type of measure of PA
18 is also known as proxy reporting of PA. Conflicting evidence exists relative to the accuracy of
19 proxy-reports for children's PA. Sirard and Pate (2001) reviewed the accuracy of proxy-reports
20 for PA of children aged 6 years old or below and concluded that evidence of their validity was
21 limited due to proxy bias such as social desirability (i.e., parents want researchers to believe that
22 their children are more active than they truly are). Importantly, the accuracy of the proxy report
23 is subject to the amount of time that proxy respondents are next to the children. As a result,

1 parents reported that they had difficulties reporting children's PA when their children were at
2 school (Telford, Salmon, Jolley, & Crawford, 2004). In addition to validity, there are also
3 concerns related to the reliability of some parents' proxy report on children's PA because intra-
4 class-correlation coefficients (ICCs) were only low to moderate (ICCs ranged .20 - .70) for some
5 proxy measures (Janz, Broffitt, & Levy, 2005; Purslow, Jaarsveld, Semmler, & Wardle, 2009;
6 Sithole & Veugelers, 2008).

7 However, some studies concluded that agreement was fair-to-moderate among children's
8 PA and their parents' proxy-reports of their child's PA (Sithole & Veugelers, 2008), with most
9 of the information being accurate (Dowda et al., 2007). For example, Sithole and Veugelers
10 (2008) compared children's reports on their PA with those of their parents; the kappa score
11 between children's and parents' reports of organized sport participation was fair (.41). Similarly,
12 Chow and Louie (2010) compared the parent proxy report of children's PA with pedometry and
13 accelerometry. Acceptable convergent validity of parent proxy report of children's PA was found
14 when compared with pedometer steps ($r = .73$).

15 Therefore, it appears that parental proxy reports achieved a certain degree of accurate
16 estimates about their children's PA output. However, additional research efforts are warranted to
17 confirm if parent proxy reports are valid and reliable in measuring children's PA, especially for
18 children's PA outside of school because the after-school period is considered to be a predictive
19 and critical period for assessing children's overall PA (Welk, Corbin, & Dale, 2000).

20 Therefore, given the need to continue to examine ways in which parent proxy can be
21 improved to accurately report children's PA, the objective of this study was to examine the
22 psychometric properties of a Modified Physical Activity Questionnaire for Children (MPAQ-C)

1 that was used by Chinese parents to report their young children's PA participation outside school
2 time. Three studies were done to accomplish the above objective. Study 1 assessed the test-retest
3 reliability of MPAQ-C across respondents twice in a 2-week interval. Study 2 assessed the
4 convergent validity of the MPAQ-C, comparing the relationship between the child's PA level
5 reported by parents (i.e., MPAQ-C) and actual level of PA measured by pedometer-recorded step
6 counts. Study 3 examined the factor validity (i.e., how well the questionnaire items measure the
7 construct) of MPAQ-C in a large sample of parents.

8 It is worth noting that only primary school students aged 6 to 9 years old were invited to
9 participate in this study. This age group was selected for several reasons. First, it follows
10 recommendations issued in a meta-analysis that investigated the relationship between parental
11 behavior, and children and adolescent PA levels (Pugliese & Tinsley, 2007). This meta-analysis,
12 which included children between the ages of 2 and 15 years, and demonstrated a moderate positive
13 relationship between parental behavior and child PA levels, issued a call for a more focused
14 examination of PA measurement in children (Pugliese & Tinsley, 2007). Given the need to
15 further examine valid and reliable measures of PA in children, we elected to include 6 – 9 year
16 old children in this study. Secondly, Partridge, Brustad, and Babkes Stellino (2008) suggest that
17 parental influence is at its peak in the earliest stages of their children's lives and diminishes
18 through adolescence. Given the strong level of influence of parents on children at this younger
19 age, it is important to accurately measure PA and facilitate PA participation during this
20 developmental stage of a child's life. A third reason that this age group was studied is that during
21 their early developmental phase (under the age of 13 y), children spend large amounts of free
22 time with parents, outside of school (Hofferth & Sandberg, 2001). Finally, previous researchers
23 have suggested that using parental proxy to monitor children's PA, especially when they can

1 watch the types of PA in which they engage, can be as accurate (or more accurate) than other
2 types of PA measurement (Chow & Louie, 2010; Sithole & Veugelers, 2008). Since this type of
3 research has not been previously done in Chinese children, and since there is a need for more
4 valid and reliable ways to measure PA in younger children, we believe that studying the potential
5 usage of parent proxy to report children's PA when they are 6-9 years of age may significantly
6 enhance our knowledge about PA in this population, and it may help researchers design more
7 effective PA interventions in the future.

8 Methods

9 Participants

10 Study 1. A total of 32 parents of primary school students (Mean = 7.13, SD = 1.00 yrs)
11 completed the MPAQ-C twice in 2 weeks during the spring of 2010. Response rate was 80%.
12 Most parent respondents were 31 -50 years old (93.3%) and mothers (70%), who had attained at
13 least a secondary or primary school education (73.3%). About 30% of the parent participants
14 were housewives or retired.

15 Study 2, conducted also in the spring of 2010, used a convenience sample of 40 students
16 (Mean age = 6.75, SD = .44 yrs) from a primary school in Hong Kong, and one of each student's
17 parents. Fifty student-parent pairs were invited to participate in the study, and forty pairs agreed
18 to participate. Eighty percent of the proxy reports from the MPAQ-C were completed by mothers.
19 Only 22.6% of parents had attained an undergraduate education level or above. Children's mean
20 body mass index (BMI) was 16.56 ± 3.00 kg/m², and children were average in size (height:
21 132.42 ± 5.46 cm and weight: 29.03 ± 6.42 kg).

1 Study 3. A total of 625 parents of students (6-9 yrs) in 8 primary schools were invited to
2 participate in Study 3. Using convenience sampling, parents of students from 8 primary Schools
3 located in Kowloon, Hong Kong Island and New Territories of Hong Kong participated in the
4 study. Parents were surveyed between March and April of 2011. This sample size met Bentler
5 and Chou's (1987) sample size recommendation of a ratio of at least 10:1 (participants to
6 estimated parameters) for a Confirmatory Factor Analysis (CFA). After conducting data
7 management (see "Data analysis"), data from 595 parents (95%) were included in further data
8 analysis. Most of the parents were mothers (75.4%) and most children were from two-parent
9 families (93.9%). About 30% of parents had attained undergraduate or postgraduate education
10 level. Informed consent from parents was obtained by returning the signed consent forms and
11 completed questionnaires for the aforementioned studies.

12 Measures

13 MPAQ-C. The Modified Physical Activity Questionnaire for children (MPAQ-C) was
14 completed by parents who assessed childrens' participation in PA outside school time during the
15 past seven days (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997). This instrument,
16 which has previously been utilized with children ages of 9 to 14 years, originally consisted of 9
17 items measuring the frequency with which children do PA in various situations and times (e.g.,
18 school, recess, after school, evening, etc.). Three items were removed for this study because
19 parents could not observe children's PA in some circumstances (e.g., during school recess, in PE
20 classes, during lunch time at school). The removed items were "In the last 7 days, what did you
21 do most of the time *at recess*?", " In the last 7 days, *during your physical education (PE) classes*,
22 how often were you very active (playing hard, running, jumping, throwing)?" and "In the last 7
23 days, what did you normally do *at lunch* (besides eating lunch)?" An example of a remaining

1 question in this MPAQ-C was “In the last 7 days, on how many days right after school, did your
2 child do sports, dance, or play physical related games in which s/he was very active?” A five-
3 point Likert-type scale ranging from 1 = “none” to 5 = “6 or 7 times last week” was used.

4 We did not feel it was necessary to modify the questionnaire for use with younger children
5 because younger children were not reading and interpreting the questionnaire—parents were
6 answering the questions. Further, even though children’s physical developmental abilities are
7 different as they age and mature, their capacity for movement, and a parent’s capacity to
8 determine whether a child was “very active” are likely consistent across the age spectrum of
9 growing children.

10 The original 9-item Physical Activity Questionnaire for Children (PAQ-C) has moderate to
11 high test-retest reliability in children aged 9 to 14 years ($r = 0.75$ for males and $r = 0.82$ for
12 females). Also, convergent validity was supported in children aged 8 to 13 years, given the
13 strong relationship of the PAQ-C score to activity rating ($r = 0.63$) and the moderate correlation
14 between the PAQ-C score and the week summation of 24-hr moderate-to-vigorous activity
15 recalls ($r = 0.53$) (Kowalski, Crocker, & Faulkner, 1997). The reliability and validity of the
16 PAQ-C with children under the age of nine has not been established, but this study will provide
17 that information, in addition to information about the appropriateness of using the MPAQ-C with
18 Chinese children.

19 Pedometer. Children’s PA was also measured using a pedometer (Yamax Digiwalker SW-
20 200). Student walking steps were recorded by wearing pedometers every day for seven days.
21 Parents assisted with recording their children’s step count on a step record sheet at the end of

1 these seven days. From pedometers, the average step count per day was calculated by adding the
2 step count over seven days and dividing by seven days.

3 Procedures

4 Study 1. A cover letter stating the purpose of study was sent to school principals. Once the
5 principal agreed to participate in the study, a site visit was arranged. On the site visit, instructions
6 about the study were given in classes, and questionnaires were distributed to students during the
7 site visit. After school on the same day, students brought the questionnaires to one of their
8 parents and asked them to complete it twice during a 2-week interval.

9 Study 2. Similar to study 1, once school principals' consent to participate in the study was
10 confirmed, a site visit was arranged. During the site visit, students were instructed to clip the
11 pedometer to a waist band or belt at the waist and placed it parallel to the ground according to
12 the manufacturer's recommendations. Students were required to put the pedometer on their waist
13 the whole day, except during bathing, swimming and sleeping, from Monday to Sunday
14 consecutively during a week. Before the study began, students were given one day to practice
15 using the pedometer. Any Pedometer that was tested and had technical difficulties was replaced
16 by another pedometer in good condition. On the following seven days, students measured their
17 walking steps by wearing pedometers. Parents assisted children with recording their step count
18 on a step record sheet every day for seven days. On the seventh day, parents were asked to
19 complete a modified PA Questionnaire for Older Children (MPAQ-C). This questionnaire took
20 approximately 5 minutes to complete. A small gift was given to students who participated in
21 studies 1 and 2 to recognize their contribution to the study.

1 Study 3. The procedures for this study were very similar to that of study 2, except that
2 students were not required to put the pedometer on during the study period. After obtaining the
3 school principals' consent, with instruction, students brought the questionnaires to one of their
4 parents and asked them to complete it. On average, parents finished the entire questionnaire in 5
5 minutes.

6 Data analysis

7 Data collected for the three studies were analyzed using both maximum-likelihood
8 estimation in *LISREL* 9.1 (Jöreskog & Sörbom, 1993) and Statistical Package for the Social
9 Sciences (SPSS) (Version 21.0) with a significance level set at $p < .05$.

10 Study 1. To determine test-retest reliability of the MPAQ-C, intra-class correlation
11 coefficients (ICCs) were used to assess the repeatability of answers across respondents twice in a
12 2-week interval. ICCs higher than .70 are classified as acceptable (Nunnally & Bernstein, 1994).
13 Cronbach's alpha coefficients were examined to evaluate the internal consistency of the
14 questions. In general, the higher the Cronbach's alpha coefficient (i.e., closer to 1) the more
15 likely it is that items in a scale measured the same construct. A widely-accepted cut-off value
16 of .70 was utilized, based on current practice (Nunnally, 1978).

17 Study 2. To assess the convergent validity of the MPAQ-C, a monotrait-heteromethod was
18 used to assess the relationship between children's PA level reported by parents (i.e., MPAQ-C)
19 and actual level of PA measured by pedometer-recorded step count. Pearson Correlation was
20 thus acquired to measure this relationship. Correlation coefficients less than .45 indicate a small
21 relationship, .50-.75 indicate a moderate to good relationship, and equal to or greater than .8 is
22 considered a strong relationship (Field, 2009).

1 Study 3. Before data analysis, data screening, including listwise case deletion, univariate
2 and multivariate outlier detection, univariate and multivariate normality, multivariate collinearity
3 and homoscedasticity, were identified and checked.

4 Confirmatory factor analyses (CFA) were conducted to establish the factor validity and
5 reliability of a single factor model of the MPAQ-C, and assess how well the data fit this
6 measurement model. In line with the recommendations of Kline (2005), multiple fit indices were
7 used to assess the model fit: relative chi-square (chi square / df), root-mean-square error of
8 approximation (RMSEA), standardized root mean residual (SRMR), Non-normed fit index
9 (NNFI) and comparative fit index (CFI). NNFI and CFI ranging between 0 and 1, with values
10 above 0.90, indicate a good fit to the data. Values of SRMR and RMSEA, which are less than .08,
11 are generally regarded as an acceptable fit (Hu & Bentler, 1999). Values of relative chi-square,
12 which range from 2.0 to 5.0, are considered desirable (Tabachnick & Fidell, 1989).

13 Equally important, reliability that refers the precision or consistency of measurement was
14 examined using standardized factor loadings (SFL), composite reliability (CR) and average
15 variance extracted (AVE). Squared multiple correlation shows the proportion of variance that is
16 explained by the observed variable. An item is considered to be reliable if its squared multiple
17 correlation is 0.50 or above (Chin & Todd, 1995). Composite reliability examines the extent to
18 which items in the construct relate to the studied construct, while average variance extracted
19 shows the amount of total variance that is due to the latent variable and measurement error. In
20 general, a scale is considered to be reliable if composite reliability is 0.7 or higher and AVE is
21 0.5 or above (Hair, Anderson, Tatham, & Black, 1998).

1 Study 2. Table 1 presents the correlations between parent proxy report of children's PA (i.e.,
2 MPAQ-C) and step count data from the pedometers. Overall, the children's daily step count was
3 6223.78 (SD= 3324.33) and mean MPAQ-C was 2.14 (SD = .61). Mean score of the MPAQ-C
4 was positively correlated with total step count in a week ($r = .63, p = .01$), and total step count on
5 weekdays ($r = .57, p = .006$), and total step count on the weekend ($r = .59, p = .06$).
6 Interestingly, mean score of the MPAQ-C was not significantly associated to
7 students' BMI ($r = -.27, p = .42$). Convergent validity of the MPAQ-C was moderate to good,
8 suggesting that the MPAQ-C satisfactorily measured children's PA outside school time.

9 [INSERT TABLE 1 ABOUT HERE]

10 Study 3. Figure 1 shows the graphic measurement model of the MPAQ-C and Table 2
11 shows the results of the CFA. The model fit the data well ($\chi^2 (9) = 42.78, p < .001; \chi^2 /df = 4.753$;
12 CFI = .977; NNFI = .962; SRMR = .036; RMSEA= .079 [90% CI = .057 to .104]). Validity of
13 the MPAQ-C was further supported by the Standardized Factor Loadings (SFL), standardized
14 loading estimates of items. The SFL of all items were above .50 as recommended (Hair et al.,
15 1998). The 6 items in the MPAQ-C combined to measure a construct (i.e., children's PA), and
16 the MPAQ-C had satisfactory factor validity. Table 3 presents the standardized parameter
17 estimates, squared multiple correlation, composited reliability, and average variance extracted
18 (AVE) for the measurement model of the MPAQ-C. Researchers (Fornell & Larcker, 1981; Hair
19 et al., 1998) have suggested that acceptable composite reliability is 0.70, and that of the MPAQ-
20 C was 0.80. Next, squared multiple correlations ranged from 0.28 (item 3) to 0.46 (item 6) while
21 the AVE was .40, which was lower than the recommended value (i.e., 0.5 or above) (Hair et al.,
22 1998). Despite the lower squared multiple correlations for some items (e.g., item 3, 4 and 1) that
23 resulted in lower AVE, inclusion of these items did not negatively affect the overall model fit, so

1 these items were retained in the model. In sum, satisfactory factor validity and fair reliability of
2 MPAQ-C were found.

3 Table 4 depicted the fit indices for each step of the measurement invariance analysis. Prior
4 to invariance analysis, a one-factor model was acceptable for both fathers ($\chi^2 (14) = 39.93$, p
5 $< .001$; CFI = .957) and mothers ($\chi^2 (14) = 17.49$, $p > .05$; CFI = .996). Also, the multi-group
6 analysis in the unconstrained model (i.e., Model 1) showed an acceptable baseline model for
7 fathers and mothers ($\chi^2 (28) = 93.313$, $p < .05$; CFI = 1.000). Next, in Model 2, all factor
8 loadings were constrained to be equal among fathers and mothers ($\chi^2 (34) = 96.765$, $p < .05$; CFI
9 = 1.000). As this level of invariance was nested within Model 1, a chi-square difference test was
10 conducted to compare which model fits the data better ($\Delta\chi^2 (6) = 3.44$, $p > .05$) and the
11 result was not significant. Also, there was no change to the CFA between Models 1 and 2, which
12 supported that the factor loadings were invariant across fathers and mothers. In summary, the
13 six-item MPAQ-C was deemed reliable and valid as a measure of parent proxy reported PA.

14 [INSERT FIGURE 1, and TABLES 2, 3 and 4 ABOUT HERE]

15 Discussion

16 The Modified Physical Activity Questionnaire for Children (MPAQ-C) was developed to
17 overcome the dearth of published and psychometrically validated parent proxy questionnaires
18 that can be used to measure Chinese children's PA. This study sought to examine the
19 psychometric properties of the MPAQ-C used by Chinese parents to report their young
20 children's PA participation outside school time. The most important findings of the study were
21 that: (a) test-retest reliability and internal consistency of the MPAQ-C were high; (b) the
22 comparison between parent proxy report of children's PA and step data from pedometers

1 revealed acceptable convergent validity of the MPAQ-C for measuring children's PA outside
2 school time; and (c) CFA indicated a good fit of data in a single factor model of the MPAQ-C.
3 Composite reliability, individual items' squared multiple correlations, and measurement
4 invariance provided additional evidence that the MPAQ-C is acceptable for use with young
5 Chinese children.

6 To date, existing literature on the validity of parent proxy of children's PA is incomplete.
7 Some researchers attempted to develop validated parent proxy measures (e.g. questionnaires,
8 electronic activity diaries) of children's PA, but failed (Bender, Brownson, Elliott, & Haire-
9 Joshu, 2005; Lau, Engelen, & Bunday, 2013; Telford, Salmon, Jolley, & Crawford, 2004).
10 Researchers explained that parents might not totally understand how to complete the diaries or
11 questionnaires, and that estimating and differentiating various activity levels may result in
12 misreporting their children's PA. Additionally, some questionnaires used in these studies asked
13 parents to report their children's PA all times during weekdays and weekends. The validity of the
14 questionnaires was lower because parents could not always be with their children in school.
15 Therefore, out of social desirability or lack of information and observation, some parents might
16 under- or overestimate their child's PA. In this study, parents only reported their children's PA
17 during specified times when they were likely to observe their young children's PA (i.e., before
18 and after school times in weekdays and weekends); this adjustment may have increased the
19 validity of the MPAQ-C in this study. In fact, this questionnaire was similar to that of Manios,
20 Kafatos and Markakis (1998), who asked parents to assess their children's 3-day leisure time PA.
21 Leisure time in that study was considered time away from school, and it included afternoons,
22 evenings and weekends, travel to and from school meal times, and sleeping habits. Taken
23 together, these findings suggest that the validity of parent proxy report may be increased if the

1 reported times of children's PA were specified, and if parents were more likely to be with their
2 children.

3 Compared to the previous reliability studies of parents' proxy report on children's PA (Janz,
4 et al., 2005; Manios et al., 1998; Purslow et al., 2009; Sithole & Veugelers, 2008), MPAQ-C's
5 intra-class reliability correlation coefficient was higher (ICC ranged .20 - .70). Possibly, this is
6 related to the longer length of the data collection period (i.e., 7 days). Manios et al. (1998)
7 pointed out that parents' proxy-reports of children PA would be more reliable if data were
8 obtained over a period of 3 days or more, compared to the data obtained from 2 separate days of
9 observation used in the study by Sallis, Buono, Roby, Carlson and Nelson (1990). It is also
10 possible that narrowing the period of data collection (i.e., before and after school), and focusing
11 on specific periods of time when children's PA is more likely observed by their parents, can
12 further enhance reported reliability and validity.

13 The findings of the study provide additional information for researchers who want to use the
14 MPAQ-C to measure young Chinese children's PA in the future. Since most of children's PA
15 measurements (i.e., the PAQ-C) were developed in western countries (Crocker et al., 1997), to
16 date, there have been limited measurements for examining PA in different cultures (i.e., Chinese
17 children in Hong Kong.)

18 Although this study reported many novel findings that should advance PA measurement in
19 young Chinese children, it is not without methodological limitations. First, the questionnaires
20 were self-administered, which might lead to social desirability bias and lessen validity. In
21 addition, this study mostly utilized a cross-sectional design in that all of the questionnaire data

1 were collected at one time. Children's PA may change over time or from day to day; as a result,
2 addressing children's PA characteristics over time in future measurement research is important.

3 This study also sets the stage for numerous future research studies. First, it is important to
4 fully understand how children's PA is determined, so other socializing agents, such as siblings,
5 peers, and teachers should be examined for their viability for serving as children's proxy report
6 of their PA in future studies. In addition, a longitudinal study should investigate changes in
7 children's PA at multiple times throughout multiple years. Finally, future studies should ask both
8 parents to complete the MPAQ-C, especially since most of the respondents in this study were
9 mothers. To conclude, this study confirmed that the validity and reliability of using the MPAQ-C
10 with parent proxy to assess young Chinese children's PA. The MPAQ-C showed promise as a
11 measurement for future related study in Chinese populations. Future work in this area should
12 help improve the accuracy of measuring younger children's PA.

13 End notes

14 Acknowledgments

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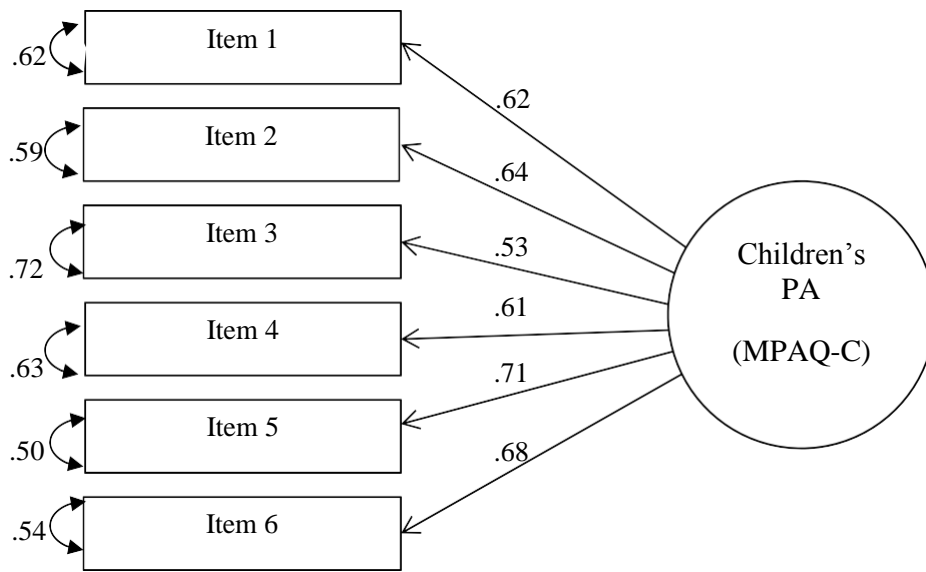
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13 Figure captions

- 14 Figure 1. Measurement Model for the Modified Physical Activity Questionnaires for Children
15 (MPAQ-C)



1

2 The values next to each double-head arrow were Standardized Error (SE). SE tells how precisely
 3 the value of parameter has been measured. Better estimation is found with smaller SE.

4 The values next to each single-headed arrow were Completely Standardized Factor Loadings,
 5 standardized loading estimates of items.