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Yi-nam Suen

*School of Nursing, The University of Hong Kong*

Ester Cerin

*Institute for Health and Ageing, Australian Catholic University, Melbourne, Australia*

Anthony Barnett

*Institute for Health and Ageing, Australian Catholic University, Melbourne, Australia*

Wendy Y. J. Huang

*Department of Sport and Physical Education, Hong Kong Baptist University*

Robin R. Mellecker

*Department of Sports Science and Physical Education, The Chinese University of Hong Kong*

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## Development of physical activity-related parenting practices scales for urban Chinese parents of preschoolers: confirmatory factor analysis and reliability

Yi-nam Suen, Ester Cerin, Anthony Barnett, Wendy Y.J. Huang, and Robin R. Mellecker

Suen is with the School of Nursing, The University of Hong Kong, Hong Kong, China. Cerin and Barnett are with the Institute for Health and Ageing, Australian Catholic University, Melbourne, Australia. Cerin is also with the School of Public Health, The University of Hong Kong, Hong Kong, China. Huang is with Department of Physical Education, Hong Kong Baptist University, Hong Kong, China. Mellecker is with Department of Sports Science and Physical Education, The Chinese University of Hong Kong, Hong Kong, China.

Cerin ([Ester.Cerin@acu.edu.au](mailto:Ester.Cerin@acu.edu.au)) is corresponding author.

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## Abstract

**Background:** Valid instruments of parenting practices related to children’s physical activity (PA) are essential to understand how parents affect preschoolers’ PA. This study developed and validated a questionnaire of PA-related parenting practices for Chinese-speaking parents of preschoolers in Hong Kong. **Methods:** Parents (n=394) completed a questionnaire developed using findings from formative qualitative research and literature searches. Test-retest reliability was determined on a sub-sample (n=61). Factorial validity was assessed using confirmatory factor analysis. Subscale internal consistency was determined. **Results:** The scale of parenting practices encouraging PA comprised two latent factors: Modelling, structure and participatory engagement in PA (23 items), and Provision of appropriate places for child’s PA (4 items). The scale of parenting practices discouraging PA scale encompassed four latent factors: Safety concern/overprotection (6 items), Psychological/behavioral control (5 items), Promoting inactivity (4 items) and Promoting screen time (2 items). Test-retest reliabilities were moderate to excellent (0.58-0.82), and internal subscale reliabilities were acceptable (0.63 to 0.89). **Conclusion:** We developed a theory-based questionnaire for assessing PA-related parenting practices among Chinese-speaking parents of Hong Kong preschoolers. While some items were context and culture specific, many were similar to those previously found in other populations, indicating a degree of construct generalizability *across cultures*.

**Key words:** role model, young children, encouragement, exercise, screen time

## Introduction

Engagement in regular physical activity (PA) is associated with numerous health benefits for children.<sup>1</sup> Since PA behavior tracks from childhood to adulthood,<sup>2</sup> the establishment of healthy behaviors including regular engagement in PA as early as in the preschool age (3-5 year old) is highly desirable in terms of health. Studies have found that preschoolers' compliance with the recommended PA guidelines varies across geographical regions. For example, adequate levels of PA have been reported in Canada<sup>3</sup> and the UK<sup>4</sup>. However, low prevalence levels have been found in other regions, such as Hong Kong<sup>5</sup> and Australia<sup>6</sup>. It is, thus, important to identify modifiable factors that affect preschoolers' PA.

As children, especially preschool-aged, spend most of their time with their parents or primary caregivers (thereafter, 'parents'), an increasing number of studies have focused on how parents influence children's PA behavior.<sup>7-9</sup> Parents influence children's PA behavior through their parenting practices, defined as parental behaviors or actual actions that are goal oriented and aimed at attaining desired outcomes.<sup>10</sup> These practices are influenced by culture and are likely to differ across geographical regions and ethnic groups.<sup>11-13</sup>

Hong Kong is a mix of British and Chinese cultures as it was a British colony and is now part of the Peoples Republic of China. Parenting in Hong Kong is unique in the way that parents are influenced by both Western culture and Confucianism, the cornerstone of traditional Chinese culture. Confucian principles place Hong Kong children and youth in a subordinate position, whereby they are considered to be their parents' private property and are expected to show a strong sense of filial piety and to be obedient.<sup>14</sup> In addition, as Confucianism considers achieving an education as a family business,<sup>15</sup> Hong Kong children's daily activities are typically education-oriented and significantly controlled by their parents. Ha and colleagues<sup>14</sup> explained the relationship between Confucianism, Hong Kong parenting style and children's PA through two concepts: hierarchical relationships and emphasis on education. Hong Kong parents do not only emphasize the importance of education of their children in which parents prioritize their children's academic performance over extra-curriculum activities, such as PA, they also demand themselves to be well-educated and hard-working. Such a belief not only limits

the time and resources parents provide to their children related to PA, but also causes themselves to be highly focused on their career rather than participating in PA and providing a good role model to their children.<sup>14</sup>

Although PA parenting practices are likely to play a major role in shaping Chinese preschoolers' PA behavior and habits, no validated instruments were available to assess parenting practices related to PA in a Chinese context. Also, as of mid-2016, only three instruments of parenting practices related to preschoolers' PA had been developed for other cultures - specifically, for Dutch,<sup>16</sup> Latino,<sup>11</sup> and US<sup>17</sup> parents of preschool-aged children. Only the latter two were validated using exploratory or confirmatory factor analysis,<sup>11,17</sup> and only the instrument developed for Latino parents was based on qualitative formative research,<sup>11</sup> as recommended by a recent review of PA parenting questionnaires.<sup>18</sup>

All extant instruments of PA-related parenting practices for preschool children included items measuring practices that promote PA through the restriction of sedentary behaviors and stimulation of PA participation by providing relevant instrumental, emotional and conditional support (e.g., the provision of play equipment, psychological support such as encouragement, modeling and monitoring).<sup>11,16,17</sup> In addition, the instruments developed for Latino and US parents included items gauging practices inhibiting PA, including the promotion of screen time and/or other sedentary behaviors, restriction and/or rules about PA related to safety or other concerns, and other behavior controlling practices.<sup>11,17</sup>

In line with the three above-mentioned studies, our recent qualitative study<sup>12</sup> found that instrumental (e.g., bringing the children to play in a park), motivational (e.g., encourage children to walk instead of using motorized transport), and conditional support (e.g., parental participatory engagement in different types of PA) were commonly used by Hong Kong Chinese parents to promote their preschool-aged children's engagement in PA, while parental safety concerns, excessive focus on academic achievement, lack of time and resources, and the promotion of sedentary behaviors were parenting practices considered to discourage children's PA. Using the findings of this formative qualitative investigation of PA-related parenting practices in Hong Kong Chinese parents,<sup>10</sup> and other

instruments of PA-related parenting practices,<sup>11,16,17</sup> this study aimed to develop and validate (assess test-retest reliability and factorial validity) a PA-related parenting practice questionnaire appropriate for Hong Kong Chinese parents of preschool-age children. As Hong Kong represents a South-East Asian multi-cultural urban environment which is influenced by Western and Chinese cultures, the content of this instrument is also likely applicable to parents of preschool-age children living in other South-East Asian cosmopolitan cities and other Chinese urban areas.

## Methods

This study consisted of a qualitative, scale-developing stage; and a quantitative, test-retest reliability and factorial validity stage. The study was approved by the ethics committees of the local tertiary institution and Department of Health.

### *Participants*

Two convenience samples of Chinese-speaking parents of Hong Kong preschool-age children were recruited from kindergartens, preschool playgroup centers and Maternal Care and Health Clinics of the Department of Health located in pre-selected neighborhoods stratified by Census-based area-level socioeconomic status (SES) (areas with monthly domestic household income  $\geq$ HK\$ 24,500 and  $<$ HK\$ 24,500 were classified respectively as medium-to-high and low-to-medium SES) and population density (areas with  $\geq$ 9,000 and  $<$ 9,000 residents/km<sup>2</sup> were classified respectively as high and low density).<sup>11,12</sup>

Eligible participants were Chinese-speaking parents of at least one 3-5 year-old Chinese-speaking child (physically and cognitively fit for PA) living in Hong Kong. Eligible participants provided written informed consent and completed a socio-demographic survey before participating in the study. Twenty participants (50% women; 40% from low-to-medium SES area) participated in the qualitative stage of the study (cognitive interviews), while 394 participants took part in the quantitative study which aimed at assessing the factorial validity of the questionnaire. The total sample size of ~400 participants was based on the commonly-used rule of thumb for confirmatory factor analyses (CFA) of at least 5 participants per parameter,<sup>19</sup> assuming a CFA measurement model with ~30 questionnaire

items to be estimated. A sub-sample of 61 (~15%) participants were also involved in the test-retest reliability quantitative component. Table 1 shows participants' socio-demographic characteristics in the qualitative stage.

### *Procedure and instruments*

#### *Qualitative stage – questionnaire development*

Statements collected in a formative, qualitative study of parents of Chinese Hong Kong preschoolers,<sup>12</sup> which aimed to identify PA-related parenting practices encouraging and discouraging children's participation in PA, were used to compile a list of items for a questionnaire of PA-related parenting practices relevant to Hong Kong preschoolers. Additional items were also generated by the panel of experts based on extant published<sup>11,17</sup> and unpublished studies known to the panel members. The questionnaire was developed in English, translated into Chinese by two bilingual staff members, and independently back-translated into English by a third bilingual researcher. Differences in the original and back-translated versions were reviewed and resolved by the panel, emphasizing conceptual and cultural rather than linguistic equivalence. The resulting questionnaire was named Physical Activity Parenting Practices for Preschoolers - Hong Kong (PAPPP - HK) and consisted of 57 items describing PA-related parenting practices. The PAPPP-HK asked the respondents to rate the items on a 5-point frequency scale ranging from 'never' to 'always' according to how often they employed the practices with their 3-5 year old child. The initial version of the PAPPP-HK was administered and tested for comprehensiveness and clarity via cognitive interviews on a sample of 20 Chinese-speaking parents of Hong Kong preschoolers. None of the items required amendments based on the findings from the cognitive interviews.

#### *Quantitative stage*

Eligible participants (n=394) were provided with the initial version of the PAPPP-HK and a socio-demographic questionnaire in a pre-paid envelope and asked to mail the completed questionnaire to the research team. A sub-sample of 61 participants (~15%) were required to complete the PAPPP-

HK twice, two weeks apart, to examine test-retest reliability. They were provided a separate pre-paid envelope for the second survey.

### *Data analysis*

Means and standard deviations were computed for each item and the subscales of the PAPPP-HK. We tested the significance of the difference between the means obtained from the first and second assessments for each item and subscale (subscales resulting from the final measurement models of the PAPPP-HK based on CFAs). Test-retest reliability of each item and subscale were estimated by computing absolute-agreement, two-way mixed effects intra-class correlation coefficients (ICC). ICC values below 0.40 were classified as poor, 0.41–0.60 as moderate, 0.61–0.80 as substantial and >0.80 as excellent reliability.<sup>20</sup> Items with poor reliability (ICC<0.40) were not included in the CFAs of the PAPPP-HK and were, hence, excluded from the final working version of the PAPPP-HK.

A priori measurement models of the PAPPP-HK were constructed and their validity was tested using CFAs. CFA rather than exploratory factor analysis methods were used because many PAPPP-HK items were similar to those of an instrument of PA-related parenting practices developed for a Latino population.<sup>11</sup> Also, CFA methods made it easier to compare the factorial structures of the two instruments. Based on previous studies and theoretical considerations,<sup>11,17,18</sup> we hypothesized that responses to items assessing parenting practices encouraging preschoolers' PA would be explained by three correlated latent factors: participatory engagement (i.e., conditional support), structure (instrumental support) and modeling (motivational support including modeling through self-participation of PA) (Supplementary Figure 1). Items with poor test-retest reliability were excluded from the model. We hypothesized that responses to items assessing parenting practices discouraging preschoolers' PA would be explained by four correlated factors: promoting screen time, promoting inactivity, psychological/ behavioral control and safety concerns/overprotection<sup>11</sup> (Supplementary Figure 2).

CFAs based on the Maximum Likelihood Estimation method were used to assess the fit of the data to *a priori* measurement models of the PAPPP-HK. Analyses were conducted on the within-neighborhood variance-covariance matrix to address the presence of clustering effects at the

neighborhood level.<sup>21</sup> Jöreskog and Sörbom’s iterative model-generating approach was used to re-specify the models, including an inspection of standardized factor loadings, standardized residual covariances, univariate Lagrange multiplier tests, Wald tests, multivariate outliers, and theoretical considerations.<sup>22</sup> The comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean squared residual (SRMR) were used to test the global model fit. Values indicative of good model fit are  $\geq 0.95$  for CFI,  $\leq 0.06$  for RMSEA, and  $\leq 0.08$  for SRMR.<sup>23</sup> As CFI is strongly influenced by the magnitude of correlations between variables, we treated CFI values  $\geq 0.90$  as indicative of acceptable levels of model fit if the other two fit indices met Hu and Bentler’s stricter criteria, as done in O’Connor et al.’s study.<sup>11</sup> We reported the Satorra-Bentler scaled  $\chi^2$  test because several questionnaire items were not normally distributed.<sup>24</sup> EQS 6.2 (Multivariate Software Inc.) was used to conduct the CFA. Cronbach’s alpha coefficients and mean inter-item correlation were computed to establish the internal consistency of the subscales in the total sample. Mean inter-item correlations with values ranging from 0.15-0.50 indicate an adequate level of internal consistency.<sup>25</sup>

## Results

The descriptive statistics and test-retest reliability indices for each item of the PAPPP-HK are shown in Supplementary Table 1. Twelve items showed poor test-retest reliability ( $ICC < 0.40$ ) and were omitted from the version of the PAPPP-HK that was factor analyzed. The test-retest reliability of the remaining items ( $n=45$ ) was from moderate to substantial ( $ICC: 0.40-0.80$ ).

The a priori factor structure of the PAPPP scales for Encouragement and Discouragement of PA demonstrated poor fit to the data, with only the SRMR fit indices meeting the pre-established criteria ( $\leq 0.08$ ; Table 2). The measurement model for PAPPP – Encouragement was re-specified (Supplementary Figure 3) by first excluding an item with low variability (item 12: 80% of participants reported never “going skiing with child”). As the latent factors Participatory Engagement of PA, Structure and Modelling were highly correlated ( $r > 0.85$ ), they were combined into a single latent factor, named Participatory Engagement in PA, Modelling and Structure, representing parenting practices encouraging PA. Four items (items 52, 53, 55 and 56) did not substantially load on a common factor ( $|standardized\ loadings| < |0.30|$ ) but showed substantial inter-correlations. These were modeled as a

separate latent factor allowed to be correlated with the other latent factor. This factor represented the Provision of Appropriate Places for Child’s PA (4 items; Supplementary Figure 3). The final measurement model for PAPPP – Encouragement, consisting of two latent factors, demonstrated acceptable fit to the data with two indices meeting Hu and Bentler’s<sup>23</sup> stricter criteria of model fit, and the other index (CFI) meeting the less stringent criterion (Table 2). Table 3 reports the descriptive statistics and item standardized loadings for the final measurement model of the PAPPP – Encouragement with two correlated latent factors.

The measurement model of the PAPPP-Discouragement was modified by deleting item 31, since it significantly loaded on all latent factors except Safety Concerns/Overprotection, and, hence, did not measure a single construct (Table 4 and Supplementary Figure 2). The final model demonstrated acceptable fit to the data with two indices meeting Hu and Bentler’s stricter criteria of model fit and the CFI meeting the less stringent criterion (Table 2), and consisted of four latent factors matching the a priori model (Supplementary Figure 2). They were Safety Concern/ Overprotection (6 items), Psychological/Behavioral Control (5 items), Promoting Inactivity (3 items, item 31 was dropped) and Promoting Screen Time (2 items). The latent factors showed low to substantial inter-correlations. Table 4 reports the descriptive statistics and item standardized loadings for the final measurement model of the PAPPP – Discouragement.

The ICCs of the scales based on the results of the CFAs using data from the test-retest sample (n=61) showed moderate to excellent test-retest reliabilities ranging from 0.58 for Promoting Screen Time to 0.82 for Promoting Inactivity. The internal reliabilities (Cronbach’s alphas) of the subscales for the total sample ranged from 0.63 to 0.89. The inter-item correlations of the two PAPPP-Encouragement subscales and four PAPPP-Discouragement subscales were all greater than 0.25 and ranged between 0.26 and 0.55, demonstrating an acceptable level of consistency (Table 5).

## Discussion

The purpose of this study was to develop and validate (i.e., assess the test-retest reliability and factorial validity) a questionnaire of PA-related parenting practices appropriate for Hong Kong Chinese parents of preschool-age children. As Hong Kong children (including preschoolers) have been shown

to engage in low levels of PA,<sup>26,27</sup> which may be due to family influences,<sup>9</sup> culturally-specific, reliable and valid measures of PA-related parenting practices are needed to gain a better understanding of how Hong Kong Chinese parents influence their children’s PA.

The Physical Activity Parenting Practices for Preschoolers – Hong Kong (PAPPP-HK) questionnaire developed and validated in this study showed good factorial validity, acceptable levels of internal consistency, and moderate-to-excellent test-retest reliability. The PAPPP-HK was developed as a set of independent scales of practices encouraging and discouraging PA for several reasons. As children at preschool age tend to be spontaneously active, parenting practices that discourage PA may be more influential than those that encourage PA.<sup>28</sup> Also, previous studies found it more useful and informative to separate parenting practices into encouraging and discouraging for educational reasons and to increase the predictive validity of the scales.<sup>11,29</sup>

Studies on PA-related parenting practices for preschoolers in US and Latino populations have shown that capturing both positive and negative aspects of parenting is important. For example, O’Connor and colleagues reported negative associations of objectively-assessed PA and practices promoting inactivity and screen time,<sup>11</sup> while Vaughn et al. found parental instrumental support (a practice encouraging PA) and restriction of PA for safety concerns as predictors of higher levels of PA.<sup>17</sup> These findings were also supported by our qualitative study on Hong Kong parents of preschool-age children who identified sets of practices encouraging (logistic support, verbal encouragement, supervision, and participatory engagement) and discouraging children’s PA (safety concerns, promotion of sedentary behavior, academic achievement, and lack of time and personal resources).<sup>12</sup>

The final version of the PAPPP-HK scale gauging parenting practices encouraging PA included 27 items describing parental behaviors identified in our earlier qualitative work and other instruments. Similar to what was found in a Latino sample,<sup>11</sup> responses on items measuring modeling, structure, and participatory engagement were best explained by a single rather than three a priori-defined correlated latent factors (Supplementary Figures 1 and 3). Overall, these findings suggest that these parenting practices tend to co-occur in both Chinese and Latino cultures. Also, 17 of the 27 items of the PAPPP-HK Encouragement scale were nearly identical to those included in O’Connor et al.’s instrument for

Latina, revealing cross-cultural similarities in parenting practices. Differences between the two samples of parents were found in the (greater) number of activities encouraging PA identified by the Chinese sample, which also included transport-related walking (e.g., walking up the stairs instead of using the lift). As the pedestrian-oriented urban form of Hong Kong encourages walking for transport in all age groups,<sup>21,30</sup> this finding is not surprising. Parenting practices related to active transportation (i.e., walking and stair climbing) are likely to be more important in an urban setting such as Hong Kong, which facilitates engagement in transport-related walking, than in car-dependent sprawling cities such as Houston, where O'Connor et al.'s instrument was developed.

The measurement model of the PAPP-HK Encouragement scale differed from its Latino counterpart also in relation to the number of latent factors, with the former having the 'provision of appropriate places for child's PA' as an additional factor underlying the responses of four items hypothesized to measure the provision of 'structure' for PA. While the aspect of providing support (places) for preschoolers' play may be somewhat related to other PA-encouraging practices, external parameters, such as the living environment, may also affect parents' ability to find suitable places for active play. As a result, the provision of appropriate places for PA may represent a mixture of parenting practices and perceived environmental factors that influence parents' ability to give such support.<sup>11</sup> This would explain why items gauging the provision of places for PA formed a separate latent factor which was only moderately positively correlated with modeling, structure, and participatory engagement. The issue of having appropriate places for children's engagement in PA is particularly important in Hong Kong where there is insufficient open space for children's play and where high traffic volumes and levels of air pollution may act as deterrents.<sup>31,32</sup>

The Discouragement scale of the PAPP-HK consisted of four latent factors, as initially hypothesized. These were: safety concerns/overprotection, psychological/behavioral control, promoting inactivity, and promoting screen time. Previous studies found that directive, restrictive, and punitive parenting practices that force children to behave in a particular way have a negative impact on children's PA.<sup>33</sup> Discouragement of children from being physically active can be achieved in two main ways: control over PA and promotion of behaviors that substitute PA. Control over PA (e.g., restriction

of PA) is associated with parents' safety concerns<sup>34</sup> and parents' behaviors that influence children's PA psychologically or behaviorally.<sup>35</sup> Parents' regulations or allowance over screening time are associated with children's risk of obesity and PA levels.<sup>36</sup> The promotion of inactivity is defined as a set of parenting practices that encourage sedentary behavior, which is sometimes inversely related to the accumulation of PA.<sup>17</sup>

Eleven of 16 items in the PAPPP-HK Discouragement scale were nearly identical to those of O'Connor et al.'s corresponding scale,<sup>11</sup> again giving support for cross-cultural similarities in PA-related parenting practices for preschool-aged children. Three Hong Kong specific items that originated from our formative qualitative study related to safety concerns or parental overprotective tendencies, possibly due to parents' perceptions of the neighborhood environment in Hong Kong as being unsafe<sup>21</sup> and not suitable for children to play. Two additional items related to academic performance were prioritized by Chinese parents over spending time on participation in PA. This provides further support for the hypothesis that Confucius' beliefs are common in Chinese families<sup>14,15</sup> and that these beliefs influence PA-related parenting practices.

### *Strengths and limitations*

A strength of this study refers to the fact that the PAPPP-HK scales were developed based on an established theoretical framework relevant to parenting and a formative, qualitative study with relevant input from the target population. We conducted extensive psychometric analyses of the newly-developed instrument. However, the validation work should be extended to an examination of criterion validity with respect to objectively-measured preschoolers' PA. Also, the findings from this study may be affected by reporting biases as “discouraging PA” could be perceived as an undesirable behavior. Parents may be less likely to report parenting practices they used to discourage their children from being active. However, validating the instrument by direct observation in a sufficiently large sample would be costly and possibly impractical. As this study was conducted in a sample of Chinese parents in Hong Kong only, the instrument would need to be cross-validated in another Chinese sample. There may be substantial cultural differences across different regions of China and among Chinese living overseas

that may impact on the relevance, factorial structure, and validity of the newly-developed PAPPP-HK.

Future work needs to address these issues.

## **Conclusion**

We have developed and validated scales of PA-related parenting practices encouraging and discouraging preschoolers' participation in PA, which are appropriate for Hong Kong Chinese parents. Although further cross-validation work is needed, the current study suggests that the PAPPP-HK scales are sufficiently reliable and valid to be used in the target population. Several latent factors identified in this study were similar to those found in other cultures, suggesting that certain PA-related parenting practices (e.g., encouragement, modelling, structure, safety concerns, promotion of inactivity and screen time) may be universally important. Yet, the content of several questionnaire items was context and culture specific (e.g., transport-related PA; the provision of places for child's PA; and the emphasis on academic achievement). Further investigations into the cultural and geographic idiosyncrasies and universality of parenting practices related to preschoolers' PA are warranted.

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**Table 1.** Participants’ characteristics in the quantitative study.

Characteristics: Mean (SD) or frequency (%)	Reliability sub-sample (n=61)	Total sample (n=394)
<i>Child’s characteristics</i>		
Female	23 (38%)	168 (42.5%)
Age in years	4.5 (0.7)	4.2 (0.7)
<i>Parent’s characteristics</i>		
Age in years	37.3 (5.6)	37.2 (6.0)
Female	56 (92%)	314 (79.7%)
Relationship with child		
Mother	54 (88%)	306 (77.7%)
Father	4 (7%)	79 (20.1%)
Others (female or male relative)	3 (5%)	9 (2.2%)
Educational attainment		
Up to lower secondary school	37 (61%)	157 (39.8%)
Upper secondary school	8 (13%)	47 (11.9%)
Associate degree or higher diploma	4 (7%)	42 (10.7%)
Undergraduate degree	10 (16%)	116 (29.4%)
Postgraduate degree	2 (3%)	32 (8.2%)
Employment status		
Unemployed	38 (62%)	150 (38.1%)
Employed , part-time	3 (5%)	32 (8.1%)
Employed, full-time	20 (33%)	212 (53.8%)
Language spoken*		
Cantonese	58 (95%)	369 (92.9%)
Mandarin	12 (20%)	91 (23.1%)
English	3 (5%)	38 (9.6%)
<i>Household characteristics</i>		
No. of adults (19+ years)		
1	9 (15%)	38 (9.6%)
2	31 (51%)	183 (46.4%)
3 or above	21 (34%)	173 (44.0%)
No. of children (up to 18 years)		
1	30 (49%)	157 (39.8%)
2	26 (43%)	207 (52.5%)
3 or above	5 (8%)	30 (7.7%)
Average monthly income (HK\$)		
<15,000	23 (33%)	73 (18.5%)
15,000 - 25,000	17 (28%)	90 (22.8%)
25,000 - 40,000	16 (26%)	75 (19.1%)
>40,000	8 (13%)	156 (39.6%)
Unit/house/apartment size, in sqf.		
<600	15 (25%)	182 (46.2%)
600-899	32 (52%)	154 (39.1%)
900-1199	5 (8%)	37 (9.4%)
≥1200	9 (15%)	21 (5.3%)

*Note:* \* Multiple responses allowed; sqf = squared feet.

**Table 2.** Goodness-of-fit of a priori and final measurement models of the Physical Activity Parenting Practices for Preschoolers - Hong Kong (PAPPP – HK) scales.

Models	Satorra-Bentler scaled $\chi^2$ (df)	CFI	RMSEA (95% CI)	SRMR
A priori				
Encouraging PA	1080 (347); p<.001	0.710	0.071 (0.069, 0.078)	0.075
Discouraging PA	237 (113); p<.001	0.881	0.062 (0.051, 0.070)	0.058
Final				
Encouraging PA	610 (318); p<.001	0.911	0.049 (0.043, 0.055)	0.058
Discouraging PA	231 (98); p<.001	0.923	0.060 (0.050, 0.070)	0.056

*Notes.* df = degrees of freedom; PA = physical activity; CFI = comparative fit index; RMSEA = root mean square error of approximation; 95% CI = 95% confidence interval; SRMR = standardized root mean squared residuals.

**Table 3.** Final measurement model of the Physical Activity Parenting Practices for Preschoolers - Hong Kong (PAPPP – HK): parenting practices *encouraging* physical activity (N=394).

Items No.	Item description	M (SD)	Skew	CISC	Participatory engagement in PA, modeling & structure	Provision of appropriate places for child’s PA
					Standardized loading	Standardized loading
	How often do you ...					
1	...allow your child to help you with outdoor chores?	2.57 (1.30)	0.21	0.39	0.39	-
2	...allow your child to pick an active game to do together?	3.97 (0.89)	-0.66	0.46	0.46	-
3	...ask what your child would like to play and play with them?	4.04 (0.84)	-0.56	0.48	0.50	-
4	...bring your child to play on the beach?	3.23 (1.05)	-0.10	0.49	0.49	-
5	...dance with your child?	3.11 (1.07)	-0.13	0.41	0.45	-
6	...encourage your child to walk rather than use motorized transport?	3.60 (0.97)	-0.21	0.34	0.33	-
7	...encourage your child to walk up the stairs instead of using the lift?	3.14 (1.15)	-0.04	0.33	0.30	-
10	...go hiking with your child?	2.57 (1.30)	0.19	0.46	0.47	-
11	...go on a walk with your child?	3.66 (1.02)	-0.48	0.46	0.48	-
13	...go swimming with your child?	3.16 (1.19)	-0.13	0.44	0.46	-
14	...have outdoor toys available for your child?	3.44 (1.13)	-0.40	0.57	0.60	-
15	...let your child go outside to play around your home?	3.34 (1.32)	-0.43	0.35	0.40	-
16	...play a sport or active game together as a family?	3.56 (0.99)	-0.41	0.64	0.68	-
17	...play sports games with your child (such as soccer or baseball)?	3.23 (1.11)	-0.31	0.56	0.59	-
19	...ride the bicycle with your child?	3.17 (1.23)	-0.25	0.50	0.53	-
20	...say positive things to motivate your child to be more active?	3.78 (0.97)	-0.74	0.52	0.59	-
21	...schedule active play time?	3.72 (0.96)	-0.54	0.55	0.63	-

Items					Participatory engagement in PA, modeling & structure	Provision of appropriate places for child's PA
No.	Item description					
22	...set an example for your child by exercising in front of him/her?	3.19 (1.11)	-0.15	0.55	0.58	-
23	...sign your child up to take part in sports?	3.22 (1.25)	-0.38	0.37	0.41	-
24	...compete with your child in various active games/ active play?	3.03 (1.10)	-0.23	0.54	0.57	-
25	...suggest your child plays outside?	3.69 (0.99)	-0.58	0.60	0.65	-
26	...take your child to the park?	4.12 (0.83)	-0.56	0.47	0.54	-
27	...teach your child new and different ways to be active?	3.47 (0.97)	-0.39	0.61	0.67	-
52	...choose a park with areas designated for 3-5 year-old children?	3.26 (1.31)	-0.25	0.33	-	0.38
53	...avoid allowing your child to play in over-crowded parks.	3.20 (1.20)	-0.19	0.36	-	0.39
55	...choose a well-maintained and regularly cleaned park for your child?	4.01 (1.00)	-1.07	0.56	-	0.84
56	...choose a place with low crime for your child?	4.05 (1.04)	-1.17	0.58	-	0.82

*Notes:* M = mean; SD = standard deviation; Skew = skewness; CISC = corrected item-scale correlation. Correlation between latent factors = 0.34. Correlations between error terms: Items 2 and 3 = 0.53(items measuring ‘freedom of activity choice’); Items 4 and 13 = 0.28; Items 6 and 7 = 0.36; Items 6 and 11 = 0.28; Items 7 and 11 = 0.14 (items 6, 7 and 11 measuring practices related to walking). All factor loadings were statistically significant at  $p < .001$ .

**Table 4.** Final measurement model of the Physical Activity Parenting Practices for Preschoolers - Hong Kong (PAPPP – HK): parenting practices *discouraging* physical activity (N=394).

Items					Safety concerns	Psychological /	Promoting	Promoting screen
No.	Item description				/ overprotection	behavioral control	inactivity	time
	How often do you ...	M (SD)	Skew	CISC	Standardized loading	Standardized loading	Standardized loading	Standardized loading
32	...take your child with you shopping instead of leaving them to play outside (under supervision) with other children in the neighborhood?	2.97 (1.21)	0.09	0.27	0.32	-	-	-
39	...not let your child play outside because of lack of child friendly places to play?	2.16 (1.09)	0.66	0.56	0.63	-	-	-
40	...not let your child play outside because you are worried about crime?	1.89 (1.02)	1.04	0.55	0.78	-	-	-
42	...not let your child play actively for fear of him/her getting dirty?	1.65 (0.87)	1.35	0.64	0.68	-	-	-
44	...not let your child play outside because you are worried about traffic?	1.94 (1.04)	1.07	0.66	0.77	-	-	-
45	...not let your child play outside because the weather is too hot?	2.34 (1.05)	0.40	0.53	0.59	-	-	-
37	...not play with your child because you have to help his/her siblings with school work?	2.54 (1.35)	0.24	0.29	-	0.34	-	-
43	...not let your child play by asking them to do academic work / study?	2.52 (1.15)	0.36	0.34	-	0.50	-	-

Items					Safety concerns / overprotection	Psychological / behavioral control	Promoting inactivity	Promoting screen time
No.	Item description	M (SD)	Skew	CISC	Standardized loading	Standardized loading	Standardized loading	Standardized loading
46	...not register your child for sports or dance due to lack of money?	1.87 (1.07)	1.17	0.35	-	0.53	-	-
50	...tell your child he/she is not good enough at sports or active games?	1.65 (0.92)	1.29	0.37	-	0.50	-	-
51	...tell your child he/she will get hurt if he/she plays actively?	1.63 (0.89)	1.41	0.45	-	0.61	-	-
33	...carry your child because he/she does not want to walk?	2.51 (1.17)	0.36	0.45	-	-	0.62	-
34	...drive your child, when walking was an easy option?	1.81 (1.00)	1.10	0.41	-	-	0.59	-
49	...push your child in a stroller because he/she does not want to walk?	1.66 (0.97)	1.29	0.45	-	-	0.59	-
29	...allow your child to play a lot of videogames?	2.21 (0.94)	0.49	0.55	-	-	-	0.73
30	...allow your child to watch TV for long periods of time?	2.14 (0.92)	0.36	0.55	-	-	-	0.75

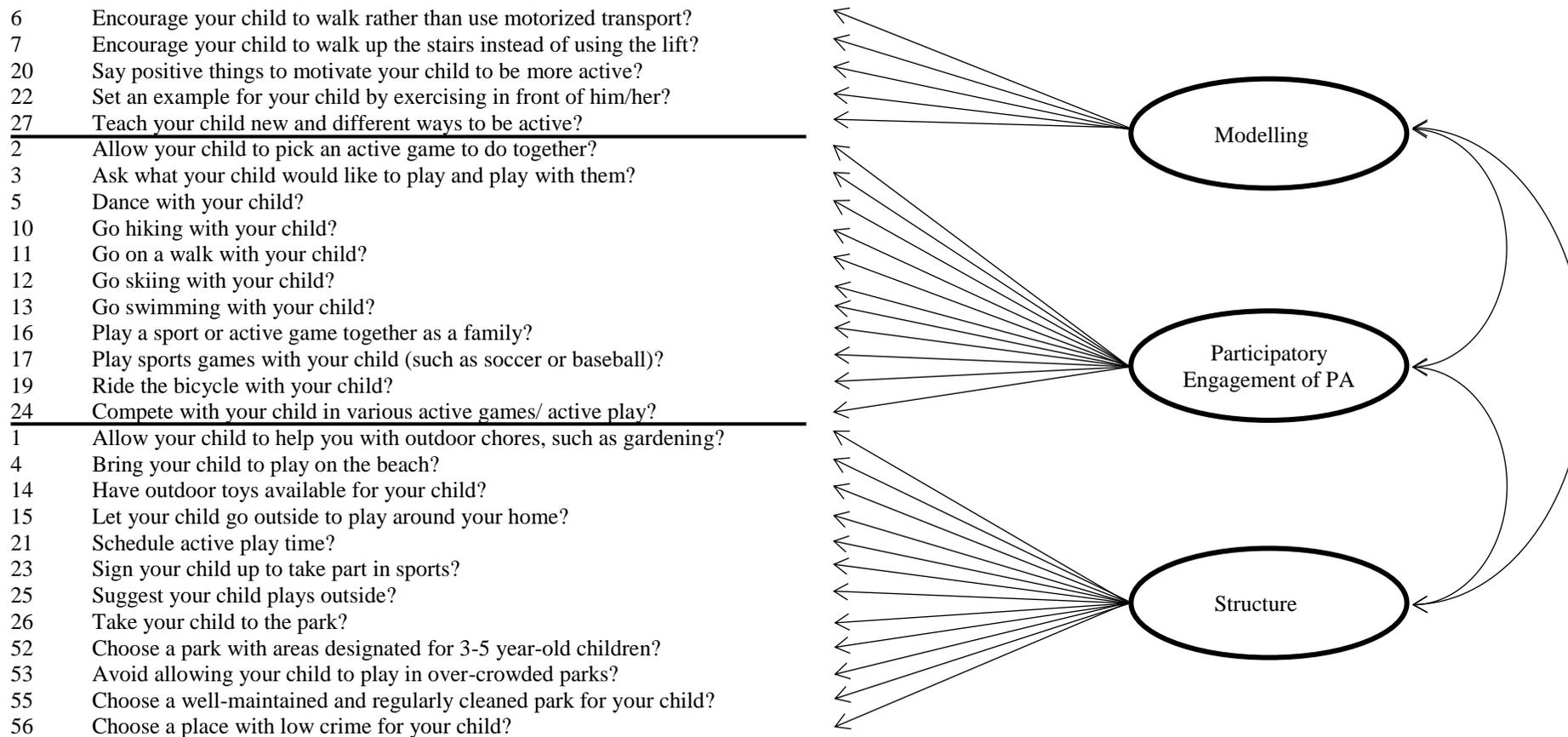
*Notes:* M = mean; SD = standard deviation; Skew = skewness; CISC = corrected item-scale correlation. Correlation between latent factors: Safety concerns / overprotection and Psychological / behavioral control = 0.73; Safety concerns / overprotection and Promoting inactivity = 0.50; Safety concerns / overprotection and Promoting screen time = 0.41; Psychological / behavioral control and Promoting inactivity = 0.46; Psychological / behavioral control and Promoting screen time = 0.35; Promoting inactivity and Promoting screen time = 0.39. All factor loadings statistically significant at  $p < .001$ .

**Table 5:** Test-retest and internal reliabilities of the Physical Activity Parenting Practices for Preschoolers - Hong Kong (PAPPP – HK)

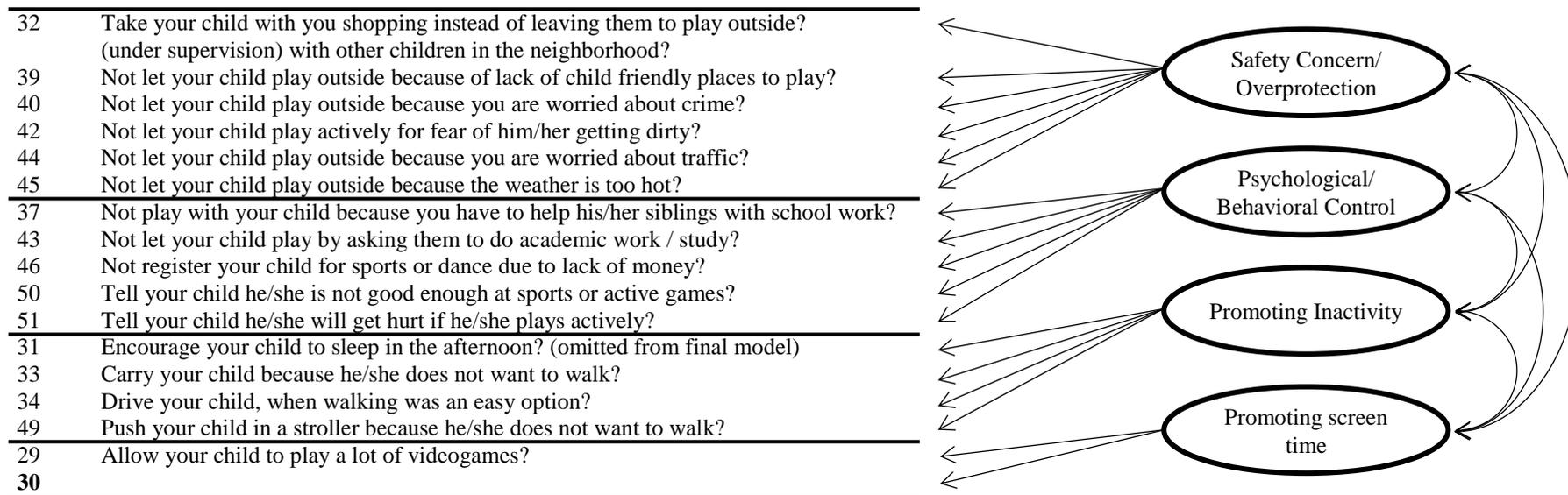
Subscale	Test-retest reliability (n = 61)			Internal reliability (n = 394)	
	ICC (95% CI)	Mean (SD)		Average inter-item correlation	Cronbach's alpha
		Assessment 1	Assessment 2		
<b>Practices that encourage child's PA</b>					
Structure, modeling and engagement (23 items)	0.77 (0.64, 0.85)	3.27 (0.63)	3.28 (0.61)	0.26	0.89
Provision of appropriate places for child's PA (4 items)	0.65 (0.47, 0.77)	3.66 (0.82)	3.69 (0.77)	0.35	0.68
<b>Practices that discourage child's PA</b>					
Safety concerns / overprotection (6 items)	0.66 (0.49, 0.78)	2.20 (0.76)	2.33 (0.75)	0.38	0.79
Psychological / behavioral control (5 items)	0.63 (0.46, 0.76)	2.04 (0.65)	2.06 (0.55)	0.26	0.64
Promoting inactivity (3 items)	0.82 (0.72, 0.89)	1.80 (0.82)	1.78 (0.78)	0.36	0.63
Promoting screen time (2 items)	0.58 (0.39, 0.73)	2.16 (0.80)	1.99 (0.75)	0.55	0.71

*Notes:* ICC = intra-class correlation; 95% CI = 95% confidence interval; SD = standard deviation.

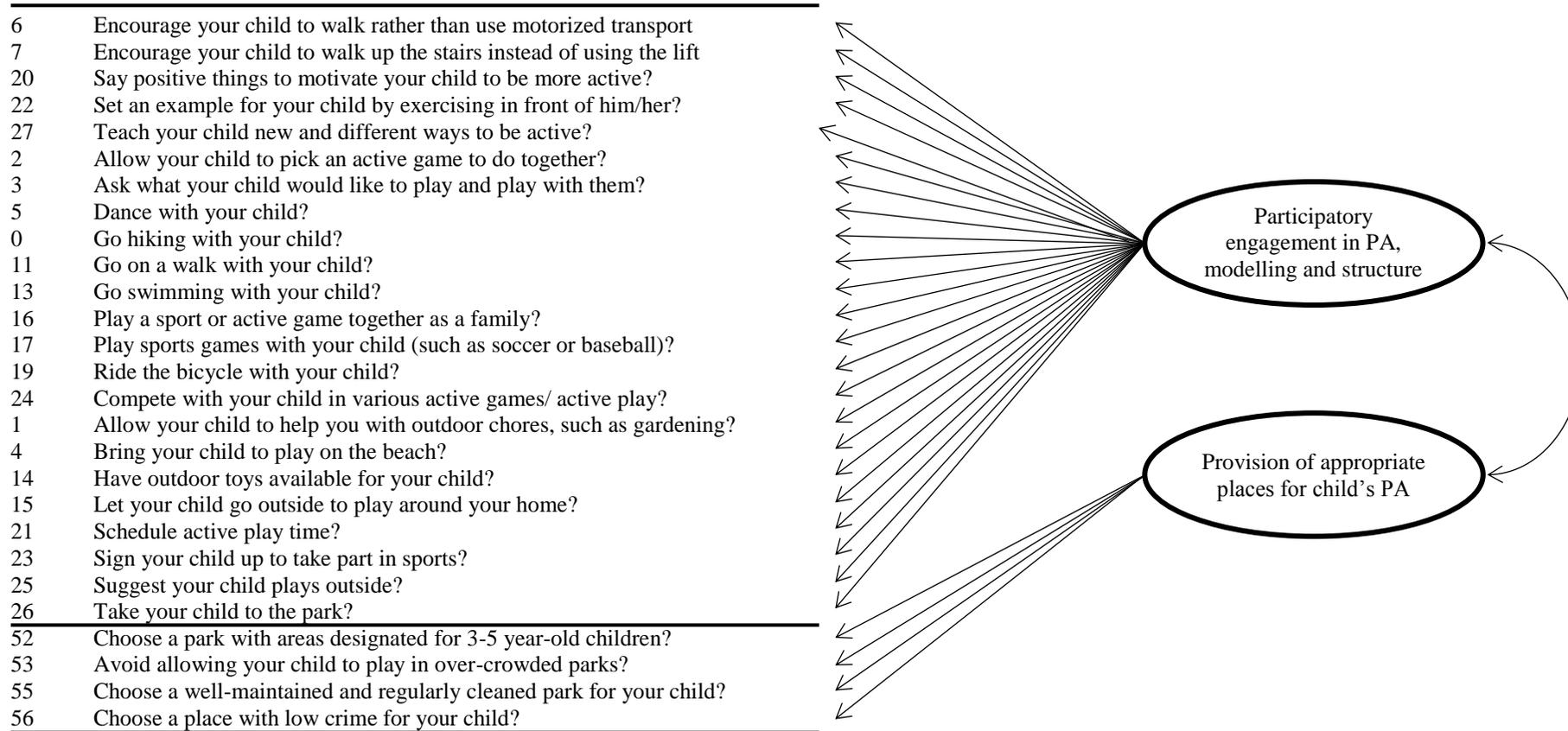
**Supplementary Figure 1.** Proposed (a priori) model for parenting practices that encourage Hong Kong preschoolers’ physical activity.



**Supplementary Figure 2.** Proposed (a priori) and final model for parenting practices that *discourage* Hong Kong preschoolers’ physical activity.



**Supplementary Figure 3.** Final model for parenting practices that *encourage* Hong Kong preschooler’s physical activity.



**Supplementary Table 1.** Descriptive statistics and test-retest reliability of the Physical Activity Parenting Practices for Preschoolers – Hong Kong (PAPPP-HK) questionnaire.

	How often do you ...	ICC	95% CI	p-value	T1	T2	t(60)	p-value
					Mean(SD)	Mean(SD)		
1	...allow your child to help you with outdoor chores, such as gardening?	0.60	0.41 - 0.74	<.001	2.82 (1.30)	3.00 (1.25)	-1.24	0.22
2	...allow your child to pick an active game to do together?	0.55	0.35 - 0.71	<.001	4.08 (0.92)	3.84 (0.78)	2.44	0.02
3	...ask what your child would like to play and play with them?	0.48	0.26 - 0.65	<.001	3.95 (0.94)	3.82 (0.79)	1.16	0.25
4	...bring your child to play on the beach?	0.69	0.53 - 0.80	<.001	2.85 (1.20)	3.00 (1.13)	-1.27	0.21
5	...dance with your child?	0.42	0.19 - 0.61	<.001	2.85 (1.11)	2.80 (0.98)	0.34	0.74
6	...encourage your child to walk rather than use motorized transport?	0.48	0.26 - 0.65	<.001	3.49 (1.12)	3.70 (1.04)	-1.52	0.13
7	...encourage your child to walk up the stairs instead of using the lift?	0.51	0.30 - 0.67	<.001	3.52 (1.23)	3.36 (1.29)	1.02	0.31
8 <sup>D</sup>	...find age appropriate games that get your child moving?	0.37	0.13 - 0.57	.002	3.64 (1.05)	3.62 (0.84)	0.12	0.91
9 <sup>D</sup>	...give your child choices of what physical activities to do?	0.32	0.07 - 0.53	.007	3.75 (0.99)	3.72 (0.84)	0.24	0.81
10	...go hiking with your child?	0.66	0.50 - 0.78	<.001	2.11 (1.02)	2.25 (1.14)	-1.16	0.25
11	...go on a walk with your child?	0.40	0.15 - 0.58	.001	3.59 (1.07)	3.56 (1.01)	0.22	0.83
12	...go skiing with your child?	0.76	0.63 - 0.85	<.001	1.51 (0.87)	1.67 (1.00)	-2.01	0.05
13	...go swimming with your child?	0.72	0.57 - 0.82	<.001	3.28 (1.16)	3.26 (1.14)	0.15	0.88
14	...have outdoor toys available for your child?	0.47	0.26 - 0.65	<.001	3.30 (1.19)	3.46 (0.94)	-1.17	0.25
15	...let your child go outside to play around your home?	0.64	0.46 - 0.77	<.001	3.30 (1.37)	2.93 (1.42)	2.44	0.02
16	...play a sport or active game together as a family?	0.40	0.15 - 0.58	.001	3.30 (1.85)	3.36 (1.02)	-0.44	0.66
17	...play sports games with your child (such as soccer or baseball)?	0.65	0.47 - 0.77	<.001	3.07 (1.15)	3.08 (1.02)	-0.14	0.89
18 <sup>D</sup>	...reward your child for being still?	0.35	0.11 - 0.55	.003	2.87 (1.12)	2.87 (1.20)	0.00	1.00
19	...ride the bicycle with your child?	0.80	0.69 - 0.88	<.001	3.21 (1.25)	3.25 (1.25)	-0.32	0.75
20	...say positive things to motivate your child to be more active?	0.63	0.45 - 0.76	<.001	3.61 (1.20)	3.46 (1.03)	1.20	0.24
21	...schedule active play time?	0.49	0.27 - 0.66	<.001	3.28 (1.07)	3.64 (1.11)	-2.61	0.01
22	...set an example for your child by exercising in front of him/her?	0.63	0.45 - 0.76	<.001	2.95 (1.13)	3.07 (1.08)	-0.94	0.35
23	...sign your child up to take part in sports?	0.61	0.42 - 0.74	<.001	3.13 (1.48)	3.18 (1.31)	-0.31	0.76
24	...compete' with your child in various active games/ active play?	0.47	0.24 - 0.64	<.001	2.89 (1.24)	2.82 (1.06)	0.43	0.67
25	...suggest your child plays outside?	0.58	0.39 - 0.73	<.001	3.41 (0.99)	3.59 (1.12)	-1.47	0.15
26	...take your child to the park?	0.40	0.16 - 0.59	.001	3.87 (0.90)	3.80 (0.96)	0.50	0.62
27	...teach your child new and different ways to be active?	0.46	0.24 - 0.64	<.001	3.39 (0.90)	3.21 (0.99)	1.44	0.15
28 <sup>D</sup>	...teach your child that being active is good for his/her health?	0.30	0.05 - 0.51	.010	3.46 (1.18)	3.61 (0.99)	-0.89	0.37
29	...allow your child to play a lot of videogames?	0.51	0.30 - 0.68	<.001	2.10 (0.85)	1.98 (0.76)	1.12	0.27
30	...allow your child to watch TV for long periods of time?	0.52	0.32 - 0.68	<.001	2.23 (0.99)	2.00 (0.91)	1.95	0.06
31	...encourage your child to sleep in the afternoon?	0.78	0.66 - 0.86	<.001	3.21 (1.45)	3.20 (1.35)	0.14	0.89

	How often do you ...	ICC	95% CI	p-value	T1	T2	t(60)	p-value
					Mean(SD)	Mean(SD)		
32	...take your child with you shopping instead of leaving them to play outside (under supervision) with other children in the neighborhood?	0.41	0.18 - 0.60	<.001	2.70 (0.97)	2.80 (0.98)	-0.72	0.47
33	...carry your child because he/she does not want to walk?	0.72	0.57 - 0.82	<.001	2.13 (1.16)	2.10 (1.11)	0.30	0.77
34	...drive your child, when walking was an easy option?	0.69	0.53 - 0.80	<.001	1.77 (1.06)	1.72 (0.92)	0.49	0.63
35 <sup>D</sup>	...keep your child at home to play with toys?	0.34	0.09 - 0.54	.004	3.16 (1.02)	3.11 (0.92)	0.34	0.73
36 <sup>D</sup>	...keep your child occupied with quiet activities (such as board games and reading)?	0.37	0.14 - 0.57	.001	3.25 (0.93)	3.15 (0.91)	0.75	0.46
37	...not play with your child because you have to help his/her siblings with school work?	0.70	0.54 - 0.81	<.001	2.26 (1.24)	2.38 (1.24)	-0.93	0.36
38 <sup>D</sup>	...have no time to play outdoors with your child?	0.36	0.11 - 0.56	.003	2.77 (1.10)	2.75 (1.01)	0.11	0.92
39	...not let your child play outside because of lack of child friendly places to play?	0.54	0.34 - 0.69	<.001	2.31 (1.15)	2.51 (1.11)	-1.43	0.16
40	...not let your child play outside because you are worried about crime?	0.48	0.26 - 0.65	<.001	1.93 (1.14)	2.07 (1.14)	-0.88	0.38
41 <sup>D</sup>	...not let your child play outside because you are worried about strangers?	0.39	0.15 - 0.57	.001	2.03 (1.24)	1.98 (1.04)	0.30	0.76
42	...not let your child play actively for fear of him/her getting dirty?	0.44	0.22 - 0.62	<.001	1.70 (0.99)	1.87 (1.01)	-1.22	0.23
43	...not let your child play by asking them to do academic work / study?	0.54	0.33 - 0.69	<.001	2.66 (1.25)	2.69 (1.10)	-0.22	0.82
44	...not let your child play outside because you are worried about traffic?	0.44	0.21 - 0.62	<.001	2.00 (1.20)	2.18 (1.04)	-1.18	0.24
45	...not let your child play outside because the weather is too hot?	0.53	0.32 - 0.69	<.001	2.57 (1.23)	2.57 (1.04)	0.00	1.00
46	...not register your child for sports or dance due to lack of money?	0.63	0.46 - 0.76	<.001	2.05 (1.35)	2.05 (1.12)	0.00	1.00
47 <sup>D</sup>	...provide your child with VCDs/DVDs appropriate for children?	0.39	0.16 - 0.57	.001	3.84 (1.02)	3.61 (1.04)	1.58	0.12
48 <sup>D</sup>	...punish your child for being too active?	0.36	0.12 - 0.56	.002	2.69 (1.15)	2.64 (1.16)	0.29	0.77
49	...push your child in a stroller because he/she does not want to walk?	0.67	0.50 - 0.79	<.001	1.51 (0.96)	1.51 (0.98)	0.00	1.00
50	...tell your child he/she is not good enough at sports or active games?	0.46	0.23 - 0.63	<.001	1.52 (0.87)	1.61 (0.78)	-0.74	0.46
51	...tell your child he/she will get hurt if he/she plays actively?	0.43	0.20 - 0.61	<.001	1.72 (0.95)	1.56 (0.67)	1.46	0.15
52	...choose a park with areas designated for 3-5 year-old children.	0.62	0.44 - 0.75	<.001	3.30 (1.43)	3.18 (1.31)	0.75	0.46
53	...avoid allowing your child to play in over-crowded parks.	0.58	0.39 - 0.73	<.001	3.18 (1.32)	3.30 (1.16)	-0.79	0.44
54 <sup>D</sup>	...choose a park with good facilities for your child.	0.35	0.11 - 0.55	.002	4.07 (0.93)	3.93 (0.93)	0.97	0.34
55	...choose a well-maintained and regularly cleaned park for your child.	0.55	0.34 - 0.70	<.001	4.08 (0.86)	4.13 (0.90)	-0.45	0.65
56	...choose a place with low crime for your child.	0.52	0.31 - 0.68	<.001	4.07 (1.03)	4.15 (0.95)	-0.66	0.51
57 <sup>D</sup>	...avoid allowing your child to play with other rude children.	0.32	0.09 - 0.53	.004	3.64 (1.24)	3.98 (0.96)	-2.11	0.04

Notes: T1 = first assessment; T2 = second assessment; ICC = one-way random effects intra-class correlation coefficients with absolute agreement; 95% CI = 95% confidence intervals; SD = standard deviation; t (60) = t-value (60 degrees of freedom). D = item omitted from the confirmatory factor analyses models as displaying low test-retest reliability (ICC<0.40).