

The Hong Kong Early Child Development Scale-3: A Validation Study

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Abstract

The Hong Kong Early Child Development Scale (HKECDS) is a tool for assessing holistic early child development in preschoolers aged from three to six years. The original version of the scale, HKECDS, was updated in 2019 (HKECDS-2) to reflect the contemporary context and local curricular expectations. Children ($n = 144$) from three kindergartens in Hong Kong completed the HKECDS-2 in individual sessions. Rasch model analysis and expert discussions resulted in a short version of the scale (HKECDS-3) with 50 items in nine domains. The domains are Personal and self-care (4 items), Language development (7 items), Pre-academic learning (10 items), Cognitive development (6 items), Gross motor (4 items), Fine motor (2 items), Health and safety (5 items), Moral development (6 items), and Society and environment (6 items). There were significant correlations between findings from the updated version of the tool, HKECDS-3 and the HKECDS-2 (long form), and older children had significantly higher scores than younger children.

Keywords : early childhood development, Hong Kong Early Child Development Scale, holistic development, Chinese

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Introduction

Research has repeatedly demonstrated the importance of investing in the early years, a period that is highly sensitive to experiences promoting lifelong development (Britto et al., 2017). With rising investment in early childhood development (ECD) across countries, there are clear demands for developing contextually appropriate assessments of child development. Assessment of ECD can be undertaken for reasons including population monitoring, programme evaluation, and for diagnostic evaluation of children's eligibility for special educational programs. Regardless of the reasons for assessment, accurate measurement of progress in child development is critical. In the era of evidence-based decision-making, evaluation of the impact of small-scale interventions is a necessary precursor to scaling them up (Banerjee et al., 2019). Further, valid and reliable measurements are also required to inform national policy to enhance child development (Richter et al., 2019).

Measuring Early Child Development

Psychometrically robust tools for direct measurement of ECD provide solid evidence for evaluating the effectiveness of programmes targeting ECD (Britto et al., 2017). However, the tools must be sensitive to socio-economic, educational, cultural and linguistic contexts. Assessment tools, including the means of administration and materials, need to be culturally appropriate and measures should include items that reflect important culturally valued skills (Rao & Mirpuri et al., 2020).

However, we face several challenges in measuring child development. First, ECD itself is dynamic; it is composed of multiple and interdependent domains, and its growth is not linearly predictable. Second, there are challenges to efficiently implementing assessments that have adequate sensitivity to capture differences in ECD, including values and skills unique to the culture of the context. Third, most existing assessments have been normed using western, educated, industrialised, rich, and democratic (WEIRD) populations which may not work the same way in other populations (Rao & Mirpuri et al., 2020). Hence, there is a pressing need to develop contextually appropriate tools for local contexts. In addition, existing assessment tools should be constantly evaluated and updated to ensure they reflect

changes in expectations of what children can do at different ages and revisions of national curriculum guidelines. It is also essential that assessments can be administered within a short period of time and still possess excellent psychometric properties.

To address these challenges, there have been global efforts to develop contextually appropriate child assessment tools that involve adult reports and/or direct child assessments. To provide a population-based tool to monitor ECD across countries, caregiver-report measures have been developed. These include the Early Childhood Development Index 2030 (ECDI2030) (UNICEF, 2021) for children aged 24 to 59 months (that measures health, learning, and psychosocial well-being domains) and the Caregiver Reported Early Development Index (CREDI) (McCoy et al., 2018) for children from birth to 3 years (that measures motor, cognitive, language, social-emotional and mental health skills). There are also teacher-report measures, including the Early Development Instrument (EDI; Janus & Offord, 2007) and the Chinese Early Development Instrument (CEDI) (Ip et al., 2013) that measure preschoolers' school readiness. Adult report measures have the advantage of collecting data on child development efficiently because they often involve inviting caregivers or teachers to respond to a list of survey items through pen-and-paper or interview forms. However, the quality of the data depends greatly on how well the caregivers or teachers know the children assessed and are prone to reporters' bias (Renk, 2005).

Tools that involve direct assessment of holistic child development include the International Development and Early Learning Assessment (IDELA) (Pisani et al., 2018) that measures early literacy, early numeracy, motor, and social-emotional development of children from 3.5 to 6 years and the East Asia-Pacific Early Child Development Scales (EAP-ECDS) (Rao et al., 2014, 2019) for East Asian children aged 3 to 5 years (that measures Cognitive development, Socio-emotional development, Motor development, Language & Emergent literacy, Health, Hygiene and Safety, Cultural Knowledge and Participation, and Approaches to Learning). Recently, a direct assessment measure, the Early Childhood Development Assessment Scale (ECDAS; Rao et al., 2021) was developed for children aged 36 to 71 months to complement UNICEF's ECDI2030 caregiver-report measure. When findings obtained using the adult reported and directly assessed versions of ECDAS were compared, it was found that the two measures of child development were significantly correlated, with the direct assessment showing greater variability by age and providing a more fine-grained

analysis of children's developmental competencies (Rao et al., 2021). These tools have contributed towards our understanding of child development by enabling cross-cultural comparisons. However, since they were developed across different contexts, and focus on children's developmental milestones and global or regional early learning standards, they may not fully capture curricular and cultural expectations in specific contexts.

In developing ECD measures, efforts have focused on evaluating the psychometric properties in terms of scale reliability and validity. According to the literature on ECD measurement (Pushparatnam et al., 2021) and a systematic review of measures of ECD across low- and middle-income countries (Munoz-Chereau et al., 2021), reports of validity include concurrent, face, construct, content and convergent validity, and most of the tool development studies discussed the contextual adaptation of the items. In terms of reliability, internal consistency (Cronbach alpha ranging from .23 to .95), inter-rater and test-retest reliabilities (Kappa co-efficient ranging from .00 [poor] to .99 [very good]) were also reported for measures in low- and middle-income countries (Munoz-Chereau et al., 2021).

Hong Kong Early Child Development Scale

The first version of the Hong Kong Early Child Development Scale (HKECDS; Rao et al., 2013) was developed in 2012. It is a population-based, direct assessment tool for the assessment of holistic child development among 3- to 6-year-olds in Hong Kong. The measure is unique because it was the first to consider both the holistic development of preschool children and Hong Kong's ECD expectations. It is a population-based tool that was developed based on government-issued curriculum guidelines for pre-primary education. The scale was also developed when there was increasing local and global attention directed to early childhood education.

The development of the HKECDS followed an iterative process. The first version relied heavily on the measure developed by Oppen (1992, 1996) for a study of preschool education in Hong Kong. Oppen's (1996) measure covered development in five domains: motor, personal and social, cognitive, language, and pre-academic skills. These items, together with the newly developed items, were adapted to align with the local curriculum guide at the time when the measure was developed – *Guide to the Pre-primary Curriculum* (Curriculum

Development Council, 2006). The *Guide* communicates early learning and developmental expectations for children in Hong Kong. The core of the Pre-primary Curriculum Framework includes developmental objectives in Physical, Cognitive and language, Affective and social, and Aesthetic development. To achieve these developmental objectives, the curriculum includes six learning areas (Physical fitness and health, Language, Self and society, Early mathematics, Science and technology, and Arts) for children to construct their knowledge, and to develop basic skills, values, and attitudes. Hence, the domains of the HKECDS extended the coverage from Oppenheimer's measure (1996), to include specific learning areas listed in the curriculum guide.

We ensured that the items were relevant to the Hong Kong context. An example of contextual alignment was including items tapping knowledge on hygiene practices to prevent viral transmission that was considered essential for children in Hong Kong following the SARS outbreak in 2003. One item asks what the child would do when he/she coughs or sneezes, and the three sub-items were scored for every hygiene measure that the child could name of (e.g., cover the mouth/ nose, cleaning the nose, washing hands, wearing masks). Tasks and instructions were designed for the local context. One example is the task used to assess fine motor development involved the using chopsticks, which are commonly used in Chinese families.

After item analyses and several rounds of review meetings with ECD experts, the final HKECDS consisted of 95 items. Scale development and validation are detailed in Rao et al. (2013). The scale included eight domains: Personal, Social and self-care; Language development; Pre-academic learning; Cognitive development; Gross motor development; Fine motor development; Physical fitness, health and safety; and Self and society. Items have between one and nine dichotomously scored sub-items, resulting in 311 sub-items. The test is administered in Cantonese to children individually by trained assessors and takes around two 30-minute sessions to complete. The scale was normed with 3- to 6-year-old preschoolers in Hong Kong, showing appropriate difficulty and good discrimination to measure children's development outcomes. Children's scores showed a clear developmental trend from K1 (3-year-olds), K2 (4-year-olds), to K3 classes (5-year-olds), with older children achieving higher scores than younger children in all subscales. Children from middle-class families had significantly higher scores than those from working class families in all domains except for

Gross motor and Fine motor. Cronbach's alphas for the domains ranged from .61 to .95.

A revised version HKECDS (HKECDS-R) was released in 2014 by the research team to enhance the administration process. Revisions mainly involved modifying instructions and tasks, and removing sub-items based on the feedback gathered from the test administration experiences. The revised scale had eight domains with 95 items and 294 sub-items; the domain Self and society was renamed Society and environment. The scale has been used to compare children's development to evaluate programme effectiveness. For example, Lau and Li's (2018) study used it to compare the benefits of whole-day and half-day kindergarten programmes on children in a 2-year longitudinal study. The scale was also used in a study that examined the relation between children's use of digital devices and child development in a 2-year longitudinal study. Zheng and Sun (2021) found that children's use of digital devices and watching cartoons negatively predicted several aspects of child development, with socioeconomic status moderating specific relationships. In a separate study involving 951 preschoolers, Sun and Kang (2020) found that different dimensions of self-regulation were related to domains of child development measured on the HKECDS-R.

Keeping Up with Recent Changes in Early Childhood Education

There have been substantial changes in the local curriculum since the development of the HKECDS and HKECDS-R. The Hong Kong Education Bureau has been promoting a child-centred and play-based curriculum to promote children's balanced development and lifelong learning. The focus was reflected in the curriculum guides that local kindergartens follow. The *Guide to the Pre-Primary Curriculum* was issued in 2006 and the revised version *Kindergarten Education Curriculum Guide* was released in 2017, around the time when the new kindergarten education policy – Free Quality Kindergarten Education Scheme (Education Bureau, 2016) – was implemented to provide free kindergarten education for 15 hours a week for children from three to six years. To achieve the curriculum goals of balanced development, the Guide to the Pre-Primary Curriculum (Curriculum Development Council, 2006), had four developmental objectives at the core of the curriculum framework: Physical development, Cognitive and language development, Affective and social development, and Aesthetic development. Around ten years later, Moral development was added as the fifth

developmental objective in the Kindergarten Education Curriculum Guide (Curriculum Development Council, 2017). This objective includes promoting positive attitudes and values, developing basic understanding of the concept of right and wrong, and roles and responsibilities in the family, school, and society. The 2017 version of the curriculum guide places more emphasis on promoting learning through play and exploration compared to the 2006 version.

With increased use of electronic devices by preschoolers across the world, there has been a corresponding increase in attention to developing children's emergent digital literacy in addition to conventional emergent literacy. This is because children interact with both digital and non-digital tools from an early age in contexts like Hong Kong. Emergent digital literacy includes the skills, knowledge, and attitudes that are precursors to developing proficient digital literacy skills (Neumann et al., 2017). Children are exposed to digital tools (e.g., tablets and smartphones) for learning and social interactions at home, in the community, and school settings. Many children actively engage in games and learning apps, e-learning platforms, reading e-books, and video conferencing at home, at school and in community settings.

Recent research has also highlighted the importance of executive functioning skills in the early years. These skills predict children's school readiness both in academic (Fitzpatrick et al., 2014) and socio-emotional domains (Mann et al., 2016). Longitudinal studies have found that executive functioning skills at preschool predict later school achievement and behavioural outcomes (e.g., Lonigan et al., 2017; McClelland et al., 2013). Results from studies involving Hong Kong preschoolers are also consistent with these findings. For example, Liu et al. (2019) followed children from kindergarten (K3 class) to first grade and they found a significant bidirectional relationship between executive functioning with Chinese and English word reading. Taken together, these studies highlight the importance of executive functioning skills in promoting child development.

The Present Study

In recent years, there have been international efforts in developing cross-cultural measures for ECD (UNICEF, 2021; Rao & Chan et al., 2020) to track progress towards United Nations'

Sustainable Development Goal Target indicator 4.2.1 that focuses explicitly on monitoring child development under 5 years (United Nations, 2019). While these cross-cultural measures are necessary, measures reflecting unique cultural values and skills of different context are also needed (Rao & Mirpuri et al., 2020). We recognise that ECD is dynamic and that there have been changes in the expectations of ECD in Hong Kong compared to around eight years ago when the first version of HKECDS was developed (Rao et al., 2013). To keep up with the changing expectations and environment over the last ten years, it was necessary to review and update the HKECDS (Rao et al., 2013) to ensure its relevance to assessing child development in the current context of Hong Kong and to the latest Kindergarten Education Curriculum Guide (Curriculum Development Council, 2017) and international early childhood education research. It was also important that assessments could be administered in a short time to enhance effectiveness in implementation. Hence, the present study aimed to develop and validate an updated and shortened version of the HKECDS, namely, the Hong Kong Early Child Development Scale-3 (HKECDS-3). The second aim of the study was to examine the psychometric properties of the HKECDS-3. The study has two main objectives:

1. To develop the updated and short form of the scale, HKECDS-3, based on the earlier versions of the HKECDS; and
2. To examine the psychometric properties of the HKECDS-3, including the comparisons of validity and reliability against the long version of the scale (HKECDS-2).

Method

Participants

A total of 144 Chinese children from three kindergartens in Hong Kong participated in the study. The sample included children ranging in age from 3.09 to 6.67 years (Mean age = 4.28; 68 3-year-olds, 44 4-year-olds, 27 5-year-olds, and 5 6-year-olds), and included 86 boys (59.7%) and 58 girls (40.3%). Purposive sampling was employed to sample two kindergartens from a low-income district in Kowloon ($n = 81$) and one kindergarten from a high-income district in Hong Kong Island ($n = 63$).

Instrument

As a first step, the HKECDS-2 was developed based on the earlier versions: HKECDS and HKECDS-R. The two versions were reviewed by our research team composed of university researchers in the field of early childhood education, developmental psychology, and child assessments. The expert panel included six members who were university researchers in early childhood education and/or experienced early childhood educators. The goal of the review was to revise the scale to capture the changes in expectations of the local curriculum and global emphasis of early child development, but the expert panel also wished to retain as many items as appropriate to ensure comparability across time. Discussions included developing new items to align with the current expectations of Hong Kong preschoolers by incorporating the developmental objectives listed in the Kindergarten Education Curriculum Guide (Curriculum Development Council, 2017) into the measure. The newly added domain, Moral development, includes five new items (saying thank you, sharing, showing concern, offering help, and doing the right thing) and an existing item (returning lost toy). Since the curriculum guide also included expectations on developing children's English and Putonghua, an existing item was modified to invite children to name objects in English and Putonghua in addition to Cantonese.

We also evaluated whether the scale covered the global expectations of child development by referring to the United Nations' Sustainable Development Goal Target indicator 4.2.1 that focuses explicitly on monitoring the proportion of children under 5 years (United Nations, 2019). Indicator 4.2.1 is concerned with the percentages of children under 5 years of age who are developmentally on track in health, learning, and psychosocial well-being and health is primarily measured by the motor domain in the ECDI2030, a caregiver-report measure, developed by UNICEF (2021), to assess children's on-track status. We added a hopscotch task taken from the Developmentally on Track Assessment Scale and Caregiver Survey (Rao & Chan et al., 2020) to get a more comprehensive picture of Hong Kong children's motor development.

As described in the introduction, recent research identified the important role of executive functioning skills in children's school readiness. Hence, in addition to existing items on verbal fluency (i.e., naming objects of a given category) and visual working memory (i.e.,

memorising the order of appearance of coloured cards), two items tapping executive functioning skills were added. One item was a Backward Digit Span task to assess children's auditory working memory: children repeated a set of two to three numbers in reverse order. The other item measured cognitive flexibility: children sorted nine cards using three different ways of grouping (the cards had three attributes, colour, shape, and size, and could be sorted by each attribute). After grouping in one way, children would need to shift to a different rule to group in another way successfully. Both tasks have been used with children from three to five years (Rao & Chan et al., 2020).

Several items were updated to match the current context. We replaced the picture of playing computer games with playing games on a tablet to represent playing digital games. The instructions and pictures of the item related to watching television were also replaced with stimuli relevant to watching videos online. On identifying the appropriate Octopus card¹ under the Society and environment domain, updated designs of the cards were used as the picture stimuli. Another new item was on using smartphones: children were asked to enlarge and reduce sizes of images and to swipe to a different image. Based on the experience of administering the HKECDS and HKECDS-R, minor changes were made to the instructions and to the order of some items and sub-items to enhance children's comprehension and the administration flow. The team removed some easy items that were achieved by nearly all children.

The resulting HKECDS-2 has 92 items (283 sub-items) under nine domains: Personal and self-care (7 items; 16 sub-items), Language development (11 items; 37 sub-items), Pre-academic learning (24 items; 80 sub-items), Cognitive development (11 items, 40 sub-items), Gross motor (9 items; 31 sub-items), Fine motor (7 items; 20 sub-items), Health and safety (8 items; 24 sub-items), Moral development (6 items; 7 sub-items), and Society and environment (9 items; 28 sub-items). Each sub-item was rated dichotomously with "1" for correct responses and "0" for incorrect responses. Table 1 presents sample items from each domain.

¹ Octopus cards are stored value cards used for transport and electronic payments in Hong Kong.

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Table 1. *Sample Items from the Nine Domains of the HKECDS-2*

Domain	Sample Items
Personal and self-care	Tells his/her name Uses chopsticks to pick up styrofoam pieces
Language development	Tells the uses of common objects Tells a story based on four pictures
Pre-academic learning	Writes his/ her name Tells the time from a digital clock
Cognitive development	Tells the meaning represented by common signs Predicts patterns
Gross motor	Walks from heel to toe on a straight line Stands on one foot
Fine motor	Cuts a square using a pair of scissors Ties a knot using threads
Health and safety	Understands methods to prevent germ transmission Understands the meaning represented by the traffic light colours
Moral development	Says thank you Shows concern to others
Society and environment	Distinguishes between recyclable and non-recyclable Uses the smartphone

Procedure

All assessors participated in a three-hour training session that focused on administration and scoring of the HKECDS-2 and building rapport with children. Before data collection, assessors had to achieve at least 85% reliability with the master trainer – designated as the “gold standard”. The trained assessors administered the long form of the measure with children individually in a quiet room within the kindergartens. The test lasted for around two 30-minute sessions. All assessors followed a Chinese instructional manual and used the same tool kit with standardised objects and a Picture Book with full-colour picture stimuli to administer the tasks. For each child there was a separate scoring sheet and a set of consumables to complete tasks such as writing and cutting. To evaluate test-retest reliability, the assessment was administered to the same child by the same assessor over two separate days (mean follow-up period = 20 days) for 15 randomly selected children from the participating children.

Analytic Plan

Our analyses corresponded to our two research objectives. First, to develop the short form of the HKECDS, item response theory (DeMars, 2010) guided the item selection process from the long form (HKECDS-2) to the shortened version, HKECDS-3. Since the scale is a measure of an overall domain of holistic child development, a Standard Rasch model analysis on binary items was applied to the 283 sub-items of the HKECDS-2 to evaluate item difficulty. We administered an iterative process in selecting items based on two inclusion criteria: (a) misfit p -values should be at least .05, and (b) infit and outfit values should be within the range between .5 and 1.5 (DeMars, 2010). These criteria were chosen to ensure items are consistent with each other and can reliably discriminate children by their underlying ability. Items with suboptimal fitting statistics may be retained if they are theoretically sound and to ensure a sufficient number of items for each subscale, particularly when misfit p -values were close to .05 and infit and outfit values were close to .5. While this may lower the reliability of the resultant scale, it ensures good validity with a sound theoretical basis. The above process was iterated until the fitting statistics had stabilised.

The second research objective was to evaluate the psychometric properties of the resultant short form (HKECDS-3). Analyses of reliability and validity were conducted, and findings were compared against the corresponding findings of the long form (HKECDS-2). First, scale reliabilities were computed using the Person Separation Reliability index, a metric from the standard Rasch model. The index generated is similar to the Kuder-Richardson 20 (KR-20) statistic for binary items and Cronbach's alpha for Likert-style items. This was used because it was highly relevant in our case of distinguishing children by developmental stages. Second, inter-class correlation (ICC) coefficients were calculated using two-way random-effect models to evaluate inter-rater reliability and test-retest reliability of both scales. For inter-rater reliability, a subset of children was double rated by two independent raters. Criterion-based validity of the HKECDS-3 was also tested against the HKECDS-2 using Pearson's correlation. Finally, the convergent validity of the HKECDS-2 and the HKECDS-3 were tested against the biological age of the child using the Pearson's correlation coefficient and socioeconomic status (based on the kindergarten district as a proxy) using ANOVA analysis controlling for age and gender. Since we had a small sample of 6-year-olds, we combined

aged 5 and aged 6 into one group in the analysis involving the age variable.

Results

Item Selection

The original 283 sub-items in the HKECDS-2 were subjected to the iterative Rasch model analysis procedure. The fitting statistics have been established after four iterations of item selection, resulting in 99 sub-items that fit the inclusion criteria. An additional 43 sub-items were also retained despite not meeting the inclusion criteria. This is because they either were important aspects of early development of preschoolers in the local context or were considered closely connected with other sub-items by the expert panel. For example, two items (including eight sub-items) on children's knowledge of recycling were retained because there were no other items on recycling in the scale, which is an important concept on children's role and responsibilities in the society. Since the item analysis was conducted at a sub-item level, in many cases some sub-items within an item met the inclusion criteria, but others did not. In a verbal fluency task in which children named objects within categories, first in Cantonese, followed by English and Putonghua; only the sub-items involving English and Putonghua met the criteria. However, it was necessary to keep the Cantonese sub-items prior to the English and Putonghua sub-items to facilitate children's understanding. In a language item involving understanding instructions, children were asked to put a block on top, below, behind, in front of, and next to a chair. Although only two sub-items "in front of" and "next to" were satisfactory statistically, we also kept the easier sub-items in the sequence to enhance the logical flow of the task. We found it necessary to keep some of the easier sub-items to engage children in the tasks.

Table 2 presents the changes in the number of items and sub-items from the HKECDS-2, the version after Rasch model analysis, to the shortened version (HKECDS-3). The resultant HKECDS-3 scale has 142 sub-items: 12 for Personal and self-care, 21 for Language development, 28 for Pre-academic learning, 17 for Cognitive development, 15 for Gross motor, 9 for Fine motor, 13 for Health and safety, 7 for Moral development, and 20 for

Society and environment. Examples of items that had been removed from HKECDS-2 (long form) following the item selection process are shown in Table 2. As reflected in the item and sub-item numbers after the Rasch model analysis procedures and the final scale of HKECDS-3, the total number of items was similar, but we retained more sub-items that were necessary in maintaining the logic flow and establishing the incremental difficulties, especially for the domain of Pre-academic learning.

Table 2. *Number of Items at Different Stages of the Scale Development*

Domain	HKECDS-R	HKECDS-2 (Long form)	After Rasch Model Analysis Procedures	HKECDS-3 (Final Scale)	Example of items removed in HKECDS-3
Personal and self-care	7 (16)	7 (16)	4 (7)	4 (12)	Knows his/her name, knows parents' phone number, puts on vest by himself/herself
Language development	13 (47)	11 (37)	7 (12)	7 (21)	Knows the uses of common objects, knows the uses of body parts, understands action completion
Pre-academic learning	27 (89)	24 (80)	9 (12)	10 (28)	Points to the middle object in pictures, identifies the lightest and heaviest objects, identifies the monetary value of coins, addition and subtraction
Cognitive development	10 (39)	11 (40)	6 (13)	6 (17)	Matches objects, names colours, understands the attributes of objects
Gross motor	12 (30)	9 (31)	4 (12)	4 (15)	Hopping, standing long jump, catches and throws the ball
Fine motor	9 (23)	7 (20)	2 (8)	2 (9)	Block stacking, ties a knot, coils a thread, uses a paper clip
Health and safety	8 (24)	8 (24)	5 (13)	5 (13)	Distinguishes healthy and unhealthy food, understands the meaning represented by the traffic light colours
Moral development	0 (0)	6 (7)	6 (7)	6 (7)	No items removed
Society and environment	9 (26)	9 (28)	5 (15)	6 (20)	Identifies the child Octopus card, matches the recyclable with the coloured recyclable bins, uses recyclable materials
Total	95 (294)	92 (283)	48 (99)	50 (142)	

Notes. Number of sub-items in parentheses. HKECDS-R was developed based on the expectations of the Guide to the Pre-primary Curriculum (Curriculum Development Council, 2006); the version was updated as HKECDS-2 following the revised guide, the Kindergarten Education Curriculum Guide (Curriculum Development Council, 2017); HKECDS-3 is the shortened version of HKECDS-2 following Rasch model analysis procedures and expert evaluation.

Reliability and Validity Analysis of the HKECDS-3

The second research objective examined the psychometric properties of the resultant short form, HKECDS-3. We also made reference to the long version, HKECDS-2. Overall, the HKECDS-3 has similarly high person separation reliability (.98) compared with the HKECDS-2 (.99). At the domain level, the corresponding reliability figures of the HKECDS-3 (.73 - .94) were comparable to the HKECDS-2 (.73 - .97). Within the HKECDS-3, Fine motor (.92) and Gross motor (.92) had higher reliabilities, and the reliability indices were relatively lower for Moral Development (.73) and Personal and self-care (.84).

Using two-way random-effect models, intra-class correlation (ICC) analyses were conducted between independent raters and over time separately, to evaluate inter-rater and test-retest reliability. Both HKECDS-2 and the HKECDS-3 attained high ICC coefficients for most domains ($> .95, ps < .01$), with an exception for the domain Society and environment that had a relatively higher coefficient for the HKECDS-2 (.94) than the HKECDS-3 (.89). In terms of consistency of scores across time, the HKECDS-3 has high test-retest reliabilities (.84 - .98). For Society and environment, the ICC coefficient of the HKECDS-3 (.84) was higher than HKECDS-2 (.78).

To assess criterion validity of the shortened scale, the scores of the HKECDS-3 were compared against those of the HKECDS-2, using Pearson's correlation. Both the domain ($r = .97$ to $1.00, ps < .001$) and total scores ($r = .99, p < .001$) were found to be highly correlated. We explored the HKECDS-3's convergent validity with a focus on its ability to differentiate children of different age and socioeconomic status. Comparing scores among children aged 3, 4, and 5 years, the effects of age on scores were significant for all domains and the overall score (see Table 3, $ps < .001$). The domains also had medium to large effect sizes with children's age ($rs = .53$ - $.76$), which are similar to the effect sizes of the longer version HKECDS-2 ($rs = .54$ - $.81$).

On the differentiation power of district-level socioeconomic status of the HKECDS-3, the scale had a small significant effect size (Cohen's $d = .26, p < .001$), which was slightly higher than that of the HKECDS-2 (Cohen's $d = .22, p = .03$). Controlling for age and gender, children from the high-income district scored significantly higher than from the low-income district on Personal and self-care, Language development, Pre-academic learning,

Table 3. *Analysis of Variance (ANOVA) of the HKECDS-3*

Domain	Number of sub-items (Total score)	M (SD)			ANOVA F statistic
		K1 (3 year)	K2 (4 years)	K3 (Above 5 years)	
Personal and self-care	12	3.00 (1.86)	5.29 (2.69)	7.21 (2.79)	83.42***
Language development	21	8.03 (4.20)	11.04 (4.59)	15.29 (3.16)	78.14***
Pre-academic learning	28	4.10 (3.73)	12.15 (7.29)	18.87 (5.19)	199.58***
Cognitive development	17	4.88 (3.33)	9.33 (4.00)	13.39 (2.51)	166.19***
Gross motor	15	3.47 (3.44)	6.92 (4.50)	9.29 (3.85)	60.47***
Fine motor	9	1.01 (2.14)	5.58 (2.99)	7.29 (1.59)	192.04***
Health and safety	13	4.68 (2.96)	7.42 (3.38)	9.03 (2.99)	53.37***
Moral development	7	3.33 (2.01)	5.17 (1.85)	6.24 (1.28)	70.03***
Society and environment	20	5.86 (3.03)	8.42 (3.39)	12.61 (2.70)	117.39***
Overall	142	38.36 (17.77)	71.31 (25.90)	99.21 (18.31)	228.37***

Notes. *** $p < .001$.

Table 4. *Validity and Reliability of the HKECDS-2 and HKECDS-3*

Domain	Number of sub-items	HKECDS-2				HKECDS-3				
		Scale reliability	Inter-Rater reliability	Test-Retest reliability	Correlation with age	Scale reliability	Inter-Rater reliability	Test-Retest reliability	Correlation with age	Correlation With HKECDS -2
Personal and self-care	12	.88	.99***	.91*	.61***	.84	1.00***	.87*	.58***	.98***
Language development	21	.94	.99***	.99***	.61***	.90	.99***	.98***	.62***	.97***
Pre-academic learning	28	.97	1.00***	.99***	.81***	.94	1.00***	.99***	.78***	.97***
Cognitive development	17	.94	1.00***	.99***	.72***	.90	.99***	.98***	.75***	.96***
Gross motor	15	.95	.97***	.97***	.62***	.92	.92**	.94**	.57***	.91***
Fine motor	9	.94	.98***	.95***	.77***	.92	.94***	.91*	.76***	.94***
Health and safety	13	.91	.99***	.96***	.54***	.87	.97***	.91*	.53***	.94***
Moral development	7	.73	.98***	.96**	.58***	.73	.98***	.96**	.58***	1.00***
Society and environment	20	.87	.89**	.78	.70***	.84	.94***	.84	.70***	.97***
Overall	142	.99	1.00***	.99***	.80***	.98	1.00***	.99***	.80***	.99***

Notes. Scale reliability is represented in person separation reliability. Inter-rater reliability and test-retest reliability are intra-class correlation coefficients on the agreement and consistency of rating using two-way random-effect models respectively. ICCs were tested against .70, a pre-specified benchmark for satisfactory reliability. Correlations in Pearson's correlation coefficients (r).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Cognitive development, Gross motor, Moral development, and the overall score ($ps < .04$). We compared the effect of the district on children's scores across class levels (K1, K2, and K3), which reflects the children's age (K1 for 3-year-olds, K2 for 4-year-olds, and K3 for 5-year-olds) and their length of exposure to the curriculum. We found interaction effects between district and kindergarten class levels for Personal and self-care ($p = .05$) and Gross motor ($p = .03$), showing the gaps between two groups were largest for the oldest age group.

Table 4 presents a summary of the indices and coefficients of the validity and reliability analysis by domains of the HKECDS-2 and HKECDS-3.

Discussion

In this study, we developed the 50-item HKECDS-3 (142 sub-items), an updated and shortened holistic measure of child development for Hong Kong preschool children aged from 3 to 6 years. The scale possesses excellent psychometric properties, suggesting that the assessment can provide reliable and valid data on ECD in Hong Kong.

In developing the measure, our study addresses the three challenges in measuring child development (Rao & Mirpuri et al., 2020) raised in the introduction. First, we recognise that ECD is dynamic, has multiple domains, and that there have been changes in the expectations of ECD in the context of Hong Kong compared to around ten years ago when the first version of HKECDS was developed (Rao et al., 2013). As a result, we have updated the HKECDS measure with reference to the latest Kindergarten Education Curriculum Guide (Curriculum Development Council, 2017) and international early childhood education research. The major changes we have made to the measure were the inclusion of an additional domain of the Moral development domain to align with the changes in the local curriculum guide, as well as adding items on executive function and skills included in cross-cultural measures of ECD.

Another challenge concerns implementing the measures efficiently but also being able to capture differences in ECD. Direct child assessments, while often considered as more reliable than adult reports of child development, have often been more time consuming and labour intensive to administer. The study has successfully reduced the number of items in the

measure while maintaining its sensitivity, so that it can be completed in half of the amount of time, from two 30-minute sessions to one 30-minute session. Taking a shorter time to complete the assessment is ideal for reducing fatigue for the participating children considering children's limited attention span.

The third challenge reminds us of the importance of ensuring the local relevance of measures, with the caution not to directly implement existing assessments normed in other populations (Rao & Mirpuri et al., 2020). Similar to the development process of the original scale (Rao et al., 2013), the instructions and tasks were developed with the local context and culture in mind (e.g., naming local landmarks, using chopsticks). After the Rasch model analysis, the team engaged in the process of reviewing items that did not satisfy the inclusion criteria to ensure that items tapping abilities essential for the local context were still retained. Hence, the development and validation process described in this study calls for the need to review measures used in different contexts and determine whether the scales are measuring the developmentally appropriate skills and knowledge considered to be important by the existing local and global community. Through Rasch modelling, 99 sub-items were selected from the 283 sub-items of the longer measure (HKECDS-2) based on their statistical properties in terms of the misfit and infit/outfit values. In the process of item selection, 43 sub-items were also kept because they were deemed important skills for child development or important for the flow of the assessment. The total number of items after the Rasch model analysis (48 items) and of the HKECDS-3 (50 items) were similar. This means that retaining the 43 sub-items did not significantly affect the length of the test, as most of them were sub-items of items that were already included. This also supports the content validity of the scale established through discussions by experts in the field.

Findings from reliability and validity analyses showed that the HKECDS-3 displayed excellent psychometric properties, with most properties comparable to the longer version, HKECDS-2. Regarding reliability, both the HKECDS-2 and HKECDS-3 had good person separation reliability, inter-rater reliability and test-retest reliability, which are aspects of psychometric properties reported in ECD measures (Munoz-Chereau et al., 2021; Pushparatnam et al., 2021). In fact, the short form (HKECDS-3) had better inter-rater and test-retest reliabilities for the domain Society and environment than the long form (HKECDS-2). The high correlations ($r_s > .89$) between the domains of the two versions of

the scale indicated that the HKECDS-3 achieved good to excellent criterion validity against the longer scale. Like the original HKECDS scale (Rao et al., 2013), children showed a clear developmental trend with scores increasing across age for all domains. The scale also had good differentiating power against district-level socioeconomic status. Altogether, these findings provided the evidence that the shorter version (HKECDS-3) had comparable reliability and validity despite having half of the number of sub-items.

Children from the high-income district performed better than those from the low-income districts in six domains, namely, Personal and self-care, Language development, Pre-academic learning, Cognitive development, Gross motor, Moral development; and the total score. Among these domains, the size of the gap widened across class levels (K1, K2, and K3) to the advantage of children from the high-income district controlling for children's age and gender. This finding is consistent with Ip et al.'s (2016) study that found higher teacher-rated school readiness among children from families with higher income than those from with lower income families. This suggests that children from low-income districts may need more support in these aspects.

We acknowledge that there are several limitations to the study. First, our sample size was small for the validation study, especially for the 6-year-old group. The sample was also purposively selected to include children from both low- and high-income districts and may not reflect the family's socioeconomic status include parental education, income and occupation at individual level. However, we recruited kindergartens from different districts as a proxy for socioeconomic status. Second, HKECDS-3 was implemented with the same group of children as the HKECDS-2, which means it was not empirically tested separately. Third, we have not taken into account the effect of other factors that may affect children's child development when looking at developmental trends. Future studies should (i) use large, representative samples in Hong Kong to establish norms to determine whether children in kindergartens are on-track in their development; (ii) examine the correlation between the HKECDS and other tests of developmental functioning; (iii) deploy longitudinal studies which will permit an understanding of children's developmental trajectories; and (iv) compare cohorts of children as time lag comparisons will permit an understanding of how changes in the environment, for example extended kindergarten closures because of the COVID-19 pandemic, have affected the school readiness of children born in different years.

As noted earlier, the HKECDS is one of the very few early childhood measurement tools that is based on government-issued kindergarten curriculum guidelines. With the development and validation of the HKECDS-3, the short form of the scale, this study demonstrates the importance of updating child assessment measures with changes in the local curriculum and global initiatives to better capture child development. The significant reduction in the number of items allows children to complete the assessment in a shorter time and enables future studies to measure child development more efficiently.

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