Original Article

Mandarin parents’ evaluation of developmental status in the detection of delays

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Abstract

Background: We examined the parental perception and accuracy of the Mandarin translation of the Parents’ Evaluation of Developmental Status, a screening questionnaire for parent concerns about children’s various developmental skills.

Methods: The questionnaire was translated into Mandarin. Upon enrollment, caregivers completed the Mandarin PEDS and answered four questions about its acceptability and usefulness, and its ease of understanding and completion. The Mandarin PEDS was independently evaluated by a pediatrician and a community nurse, and classified as high risk (≥ two predictive concerns), medium risk (one predictive concern), low risk (any non-predictive concerns) or no risk (if no concern) for developmental delays. The caregivers repeated Mandarin PEDS at a 2 week interval for test–retest reliability, while the children underwent testing for accuracy using a developmental assessment test.

Results: The majority (≥85%) of the 73 caregivers perceived the Mandarin PEDS as acceptable and useful, as well as easy to understand and complete. Fifteen (20.5%) and 24 responses (33.9%) were classified as high and moderate risk, respectively. The test–retest and inter-rater reliabilities were excellent, with an intra-class correlation coefficient of 0.812 (95% CI: 0.701–0.881, P < 0.001) and a kappa value of 0.870 (P < 0.001), respectively. Mandarin PEDS was 80.0% sensitive and 83.8% specific for those in the high-risk category (adjusted OR, 64.68; 95% CI: 1.33–139.72; P = 0.035).

Conclusion: Mandarin PEDS was well received by the caregivers, and was reliable and accurate in detecting developmental delays in the Mandarin-speaking subjects. We recommend it for early detection of children with developmental and behavioral problems.

Key words developmental delay, developmental screening, parent concern, sensitivity, specificity, translation.

Developmental disabilities affect one in six children aged 3–17 years, and the rate increased from 12.84% to 15.04% between 1997 and 2008 in the USA. They should be detected early and receive intervention to improve the management outcomes and prevent future problems. Nevertheless, differentiating children with and without developmental–behavioral problems in practice is difficult. Despite the many initiatives aimed at detecting children at risk (e.g. during health-care visits), the majority are not discovered until school age, and gaps exist in available services and referral processes.

Parents can accurately assess their children’s developmental status when asked the right questions, enabling a practical approach to early detection. One such developmental screening tool, Parents’ Evaluation of Developmental Status (PEDS), allows parents to report concerns about their child’s development, behavior and social skills by answering “yes”, “no”, or “a little” to 10 questions. Risk for developmental delays is stratified based on the child’s age and the number of predictive concerns: ≥ two for high risk, one for medium risk, and any non-predictive concerns for low risk, or no risk if no concern. PEDS has good content validity, sensitivity (86%) and specificity (74%), with a positive predictive value (PPV) and negative predictive value (NPV) of 37% and 93% respectively. It has been used in the USA as a clinic-based or national survey tool to evaluate children at risk of developmental, behavioral or social delays. It is a useful measurement tool addressing psychosocial risk profiles and is sensitive to changes in parenting intervention. The applicability and validity of PEDS in other languages and cultures, however, have not been well studied.

Mandarin has been the official language in China since the Yuan period (1260–1368), and is now the modern standard. It is an official language used in the United Nations and in some Asian nations such as China, Hong Kong, Macau, Taiwan, Malaysia and Singapore. In the USA alone, more than

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60 million people speak another language at home, with 41.7% speaking English less than “very well” and Mandarin being the second commonest spoken language. Although PEDS is a feasible developmental screening tool, it is not commonly used in these Asian countries, and undoubtedly there is a need for good-quality translations of screening tools in Mandarin.

To examine the potential of PEDS as a screening tool in Chinese subjects, an initial study of a Mandarin translation of PEDS in Singapore noted a 90% rate of high- or moderate-risk results. This was far higher than the reported prevalence rates for disabilities, and was due to inadequate translation of the word “concern” used prominently in PEDS, given that it is a synonym for “care” in Mandarin as in “do you care about . . . . “. Hence, there is an urgent need to validate the Mandarin version of PEDS before it is used in the Mandarin-speaking population.

The aim of this study was therefore to describe the translation process and validation of the Mandarin version of PEDS with regard to (i) parent perception; (ii) diagnostic accuracy (i.e. PPV, NPV, sensitivity and specificity) in screening for developmental delays; and (iii) inter-rater and test–retest reliabilities.

Methods

Study design and participants

This was a cross-sectional study that followed Standards for the Reporting of Diagnostic Accuracy. Between March and July 2012, we visited two local mother-and-child health (MCH) clinics and the largest kindergarten in Sibu town: Fu Yuan Kindergarten. We invited eligible Mandarin-speaking Chinese parents or caregivers with the ability to write to voluntarily take part in the study. We included those who (i) had children between 1 and 6 years of age; (ii) spent at least 5 h/day with their children; (iii) were caring for the children’s daily needs (e.g. preparing meals and bedtime, supervising playtime and bathing); and (iv) stayed with their children on average 6 days/week. Babysitters, maids or other salaried staff were excluded, as were those with known developmental disabilities (e.g. autism, Down syndrome, cerebral palsy, sensory impairment etc.). Families were recruited based on the child’s gender and age to ensure equal distribution across five age categories: 1–<2 years; 2–<3 years; 3–<4 years; 4–<5 years; and 5–<6 years).

Translation of PEDS into Mandarin

We obtained written permission from the author of PEDS and referred to the American Association of Orthopedic Surgeons Guidelines for the process of cross-cultural adaptation and self-report measures. We changed the key word “concerns” used in PEDS to another word closer in meaning to “a little worried”. A linguist from the National Institute of Translation and the first author (T.H.T.) who is bilingual, conducted forward translation into Mandarin independently, and harmonized everything into one draft after considering the Singaporean translation. Back translation was completed by another pair of linguists and a pediatrician not previously exposed to PEDS.

A consensus on the pilot Mandarin PEDS was reached by comparing the English PEDS with all the translations and back-translations. Content, meaning and sentence structure of the PEDS were preserved through the evaluation of the clarity, naturalness and adequacy of phrasing of the translation. The pilot Mandarin PEDS was then tested on four eligible bilingual non-medical Chinese parents who answered the Mandarin PEDS before the English version. With the responses and feedback, a focus-group discussion was conducted in order to further refine the suitability and comprehension of wording and sentences before finalizing the Mandarin PEDS.

Parent perception of the Mandarin PEDS

Caregivers were asked to complete the Mandarin PEDS in writing at the MCH clinics or kindergarten. In order to ensure the accuracy of responses by the caregivers, their children were either in the class or in the clinic supervised by another staff member or accompanied by relatives (if any) so that they could complete the questionnaire. They answered two study-designed questions about Mandarin PEDS on (i) its acceptability as a developmental screening tool in Malaysia (acceptable, not acceptable, no comment); and (ii) the ease of understanding and completion of the questions (very easy, easy, difficult, very difficult). The total time taken by caregivers to complete Mandarin PEDS was recorded.

Reliability of the Mandarin PEDS

The completed Mandarin PEDS was interpreted and scored by the second author (B.C.L.) to determine the risk categories for developmental delays using a score form. A trained community nurse interpreted and scored the same Mandarin PEDS for inter-rater reliability using another score form. The caregivers were then given an appointment (set 2–3 weeks later) in a child development clinic (CDC) situated at another location in Sibu. During this appointment, caregivers re-did the Mandarin PEDS for test–retest reliability.

Diagnostic accuracy of the Mandarin PEDS

On the second visit, or at a time convenient to the families in between the first and second visits, two trained nurses assessed the children using the Griffiths Mental Development Scales from Birth to Two Years (GMDS), or the Extended Revision (GMDS-ER) at the CDC or the kindergarten for diagnostic accuracy of the Mandarin PEDS. The assessment was supervised by T.H.T., who is a certified user of the Griffiths test. The test measures critical developmental trends that indicate the functional mental growth of young children, namely gross motor, personal–social, language, eye–hand coordination,
performance (visual–perception and test of speed of working and precision) and practical reasoning (ability to reason and solve practical problems). The test has an overall reliability coefficient of 0.993 and good content validity.\(^{18}\) The Griffiths test was conducted in Mandarin and the children responded to the verbal tasks in Mandarin. The Griffiths examiners were blinded to the first Mandarin PEDS results. The parents or caregivers were not informed of the Griffiths results until after the second Mandarin PEDS.

**Griffiths definition of developmental delays**

A mean score of 100±16 on the GMDS from birth to 2 years,\(^{18}\) and an adjusted score of 100±15 on the GMDS-ER, are considered normal.\(^{19}\) We applied the following criteria to the Griffiths results: mild developmental delay was defined as total score 1–2 SD below the mean; and severe developmental delay was defined as total score ≥2 SD below the mean.\(^{19}\) After completion of the study, children with any reported concern on the Mandarin PEDS or developmental delays from the Griffiths test were offered a free further assessment by the first two authors in the same clinic. Children with no reported concern and normal developmental assessment were asked to continue with their routine developmental surveillance program at their MCH clinics.

The study was approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR-12-16-10787). Written informed consent was obtained from all parents or caregivers; and the study was conducted according to the Declaration of Helsinki. The parents or caregivers were reimbursed for transportation costs once for completing study.

**Statistical analysis**

Descriptive analysis was used to describe the Mandarin PEDS assessment and the Griffiths test. Sensitivity, specificity, PPV, NPV were used to determine the accuracy of Mandarin PEDS compared the Griffiths test in detecting developmental delays, OR with 95% CI was used to quantify uncertainty of the analysis. Logistic regression was used to determine the extent of the association between the Mandarin PEDS and the Griffiths when confounders (i.e. children’s gender and age, caregiver relationship to the children and family income, as well as their age and highest education level) were considered in the analysis. Kappa agreement and intra-class correlation coefficients (ICC) were used to determine the reliability. Analysis was done using spss for Windows (version 20.0; IBM, Armonk, NY, USA).

**Results**

Mandarin PEDS was developed per the study protocol and American Association of Orthopedic Surgeons Guidelines.\(^{17}\) A total of 367 families were screened for eligibility over six visits to the MCH clinics and two visits to the kindergarten, with 65.9% \((n = 242)\) of them fulfilling the eligibility criteria. A substantial number of these caregivers \((n = 145, 59.9\%)\) were not able to commit to the second part of the study, that is, to attend the developmental assessment and complete the second Mandarin PEDS at CDC located 5 km away for various personal reasons and lack of family transport. Sixteen (6.6%) families refused to consent while 81 (33.5%) eligible Chinese families were willing and consented to the study as well as completed the first Mandarin PEDS (Fig. 1). Subsequently, eight families (9.9%) did not attend the Griffiths assessment and complete the second Mandarin PEDS for logistical reasons. Table 1 lists the demographic data of the final 73 families. There was no significant difference in demographics or Mandarin PEDS results between those who did and did not complete the Griffiths assessment and second Mandarin PEDS \((P > 0.05)\).

The majority of the 73 caregivers who completed the study were married mothers \((n = 62, 84.9\%)\), who had attended either high school \((n = 42, 57.5\%)\), or college/university \((n = 28, 38.4\%)\). Their mean age was 34.5±7.8 years. The monthly family income for 12 caregivers (16.4%) was below poverty line (<RM1,000), whereas 58.9% \((n = 43)\) had below-average income (RM1,001–3,000).\(^{20}\) The socioeconomic background of the sample did mirror that of Malaysia’s general Chinese population. The children were equally distributed by age and gender, with a male: female ratio of 1.03 to 1 (Table 1).

The time taken by the caregivers to complete the first Mandarin PEDS ranged from 1 to 15 min (mean, 5.30±3.0 min). Sixty-two caregivers (84.9%) reported that the Mandarin PEDS was acceptable as a developmental–behavioral screening tool, with only one caregiver not accepting and 10 (13.7%) not commenting. The caregivers rated the Mandarin

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**Fig. 1** Flow diagram of subject recruitment. Griffiths assessment, Griffiths Mental Development Scales–Extended Revised and Griffiths Mental Development Scales from Birth to Two Years; PEDS-M, Mandarin Parents’ Evaluation of Developmental Status.
Table 1 Subject characteristics

| n (%) or mean ± SD |
|-------------------|
| Caregivers        |
| Gender            |
| Male              |
| Female            |
| Age group (years) |
| 1≤2               |
| 2≤3               |
| 3≤4               |
| 4≤5               |
| 5≤6               |
| Age at Griffiths assessment (years)† |
| 3.33 ± 1.4        |
| Birth order       |
| First             |
| Second            |
| Third             |
| Fourth and beyond |
| 7.8               |

†Griffiths Mental Development Scales—Extended Revised and Griffiths Mental Development Scales from Birth to Two Years.

Table 2 Mandarin PEDS vs Griffiths‡ results

| Mandarin PEDS                  | Griffiths‡ results | Total‡ n (%) |
|--------------------------------|--------------------|--------------|
|                                | Severe developmental delay (≤ −2 SD) n (%) | Mild developmental delay (> −2 SD to ≤ −1 SD) n (%) | Normal (> −1 SD) n (%) |
| Two or more predictive concerns (high risk) | 4 (26.7) | 4 (26.7) | 7 (46.7) | 15 (20.5) |
| One predictive concern (moderate risk)     | 1 (4.2) | 1 (4.2) | 22 (91.7) | 24 (33.9) |
| Any non-predictive concern (low risk)       | 0 | 0 | 20 (100) | 20 (27.4) |
| No concern (no risk)                      | 0 | 3 (21.4) | 11 (78.6) | 14 (19.2) |
| Total                                       | 5 (6.8) | 8 (11.0) | 60 (82.2) | 73 (100) |

‡Griffiths Mental Development Scales—Extended Revised and Griffiths Mental Development Scales from Birth to Two Years.

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subscale scores to the true-negative group (those with ≤ one significant concern and Griffiths results better than $-1$ SD).

The 11 children in the false-positive group had lower Griffiths scores (mean, $95.9 \pm 18.39$) compared with the true-negative group (mean, $108.2 \pm 14.61$), with a significant mean difference in the score of 12.3 (95% CI: 2.28–22.32, $P = 0.017$). For the language subscale, the false-positive group also had a lower Griffiths score (mean, $82.0 \pm 16.6$) compared with the true-negative group (mean, $95.6 \pm 14.1$), with a mean difference in the score of 13.6 (95% CI: 4.05–23.11, $P = 0.006$).

Among the 13 children who had mild or severe developmental delays on the Griffiths results, 11 responded to the invitation for further pediatric assessment in the clinic (seven with ≥ two predictive concerns on the first Mandarin PEDS; and two each with one significant concern and no concern, respectively). These 11 children were aged between 4.47 and 8.30 years (mean, $6.2 \pm 1.31$ years) and their diagnoses are summarized in Table 4.

**Discussion**

To the best of our knowledge, this is the first validation study of the Mandarin PEDS. A well-translated and validated screening tool in Mandarin to detect developmental delays is much needed using the language that is familiar to the Chinese population, which in turn should improve early detection of children at risk of these problems. Children with delayed early childhood development are often associated with psychosocial risk profiles such as low maternal education. Designing a developmental screening tool that is acceptable and easy to understand and complete, such as reported by present caregivers, is vital to ensure the validity and usefulness of the tool. Given that the majority of the present caregivers had only high school education and middle-lower income, the Mandarin PEDS is a feasible tool to implement in most Chinese populations, without many logistical issues. Attending to and eliciting information on developmental concerns from parents in this manner improves the collaborative relationship and increases the likelihood of parents following through with professional recommendations.

Most of the development screening tools are normed and standardized against developmental milestones in a selected population, and hence the scores may reflect differences in social and cultural experiences. PEDS, however, addresses parental concerns about their children’s development and behaviors using the simple open-ended question “do you have any concern...?” This is more likely to retain accuracy during the translation of the original English tool. This is an important component of the translation of an English scientific tool, in order to achieve “equivalence” such that the translated items remain consistent, valid and meaningful in a new language for use in different cultural and language settings.

A well-translated tool is also an important factor to consider when a developmental screening tool is used for future studies to screen populations at risk or as a measurement tool in non-English culture.
In this study, the word “concern”, which in Mandarin meant more or less “care” as in “do you care about . . .” was replaced by another word that was closer in meaning to “a little worried”. Not surprisingly, the use of the word “worries” produced high risk rates (i.e. 20.5%) that were far more reflective of the prevalence and commensurate with the incidence of developmental disabilities.1,7,26 If we considered those caregivers who reported one predictive concern (n = 24, 33.9%) on the Mandarin PEDS, these figures were higher than those reported in population surveys (9–11% for ≥two predictive concerns, and 15–19% for one predictive concern).8,9 We believe this is because the recruitment from the kindergarten and clinics was voluntary, and hence potentially meant that we recruited caregivers who already had some concerns about the development and/or behaviors of their children because they were more willing to participate in this study. In the same way, the high rejection rate of 67.9% (n = 161, Fig. 1) may have been indicative of lack of concern in those caregivers who chose not to take part. Nevertheless, despite the concerned caregivers, this study identified some form of developmental delay in 17.8% of the sample (n = 13), similar to the expected prevalence of developmental disabilities (i.e. one in six children),1,9 supporting Mandarin PEDS as an accurate screening tool.

The study has shown that the translation possesses good sensitivity and excellent specificity depending on the degree of delays considered, similar to the English-language PEDS.7,8 In addition, the present PPV and NPV were similar to those reported in the original PEDS studies.7,8 The present high level of sensitivity and specificity support the effectiveness of Mandarin PEDS in differentiating children with developmental delays and those at risk from those with typical development. The sensitivity is better when only severe developmental delay is considered, but it is lower if mild developmental delay is included, because this is not as easy to identify. Although the sensitivity in this study improved when one predictive concern was used to detect mild developmental delay (P > 0.05), the specificity and PPV of Mandarin PEDS were much lower. Therefore, repeated screening at a later age for children with one predictive concern on Mandarin PEDS, as suggested by the PEDS authors, is necessary.7

On further analysis, the false-positive group (i.e. those with ≥two predictive concerns but normal Griffiths test) had lower total mean score and language subscore than the true-negative group, with a mean score difference of 12.3 and 13.6, respectively. This is not surprising because over-referrals (false positives) on PEDS reflect psychosocial risk factors (e.g. poverty, housing instability, parent mental health problems, limited education and parenting skills etc.) and/or mild developmental delay.10,22 Therefore, children of these parents who expressed concern shall be provided with such services as parent training or quality pre- or after school programs to enhance the children’s early developmental experience.

This study has also established the Mandarin PEDS as a reliable screening tool due to its good test–retest reliability with regard to the number of significant concerns in the first and second Mandarin PEDS, as well as risk categorization by the pediatrician. The high inter-rater reliability established in this study means that the test can also be scored and interpreted by trained community nurses. This shows also that with training, allied health personnel can reliably administer and interpret the Mandarin PEDS. This is important because in regions such as Malaysia and some of the Mandarin-speaking areas, community nurses are tasked to monitor children’s developmental progress in the primary care setting. Providing these nurses with an accurate and reliable developmental–behavioral screening tool will result in earlier identification of at-risk children.

There were several limitations to the present study. This was a small cross-sectional study of children recruited voluntarily from the community. The families who consented and participated in this study were subject to recruitment and sampling biases, resulting in higher rates of high and moderate risk concerns as aforementioned. We recognize that although the Griffiths tests are a validated and accurate diagnostic tool, they have not been translated and validated in any Mandarin-speaking population.18,19 They are, however, the only comprehensive and commonly used developmental assessment available at the study site. Although the present findings are unlikely to differ greatly in performance from the other Mandarin-speaking populations, challenges may exist when applying these results to different Chinese populations, for example in China where Mandarin is the dominant language, or in the USA where Mandarin is generally used as a second language. It is recommended that a norming or duplicate study be conducted in these countries or regions. The present findings might not be generalizable to children and families of other ethnic backgrounds who can read and write Mandarin, or to Chinese people who are illiterate.

In conclusion, this study on the Mandarin PEDS supports its acceptability, accuracy and reliability for use in the Mandarin-speaking Chinese population as a screening tool for

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Table 4 Diagnosis of children with abnormal Griffiths results (as last reviewed in June 2016)

| Diagnosis                              | n = 11 (100%) | No. significant concerns on the first Mandarin PEDS assessment |
|----------------------------------------|--------------|---------------------------------------------------------------|
| Autism spectrum disorder               | 4 (36.4)     | ≥Two predictive concerns, n = 3; one predictive concern, n = 1|
| Language-based disorder or dyslexia    | 4 (36.4)     | ≥Two predictive concerns, n = 1; one predictive concern, n = 1; no concern, n = 2 |
| Language-based disorder and ADHD       | 2 (18.2)     | ≥Two predictive concerns, n = 2 |
| Intellectual disability                | 1 (9.1)      | ≥Two predictive concerns, n = 1 |

1Griffiths Mental Development Scales—Extended Revised and Griffiths Mental Development Scales from Birth to Two Years. ADHD, attention deficit–hyperactivity disorder; PEDS, Parents’ Evaluation of Developmental Status.
developmental–behavioral problems. We therefore recommend it for use by the relevant professionals and authorities, with its relatively low training requirement, for early detection of these problems. Prior, however, to its widespread adoption for screening purposes in any setting, the availability and adequacy of referral, diagnostic assessment and early intervention programs should be addressed. Given a validated developmental screening tool in Mandarin, a study on the prevalence of risk of developmental delays in children in the Mandarin-speaking population is recommended.

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Disclosure

The authors declare no conflict of interest.

Author contributions

T.H.T. conceptualized and designed the study, collected, analyzed and interpreted the data. T.H.T. also wrote the first draft of the manuscript and critically revised the manuscript as submitted; and there was no honorarium, grant, or other form of payment given to anyone to produce the manuscript. B.C.L. assisted in the conceptualization and design of the study, contributed to collection, analysis and interpretation of data as well as manuscript preparation. J.H., M.R.A. and S.C.W. contributed to the study design. M.A.B.B. assisted in the analysis and interpretation of the data. All authors critically revised, read and approved the final manuscript.

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