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ORIGINAL ARTICLE

A developmental screening tool for toddlers with multiple domains based on Rasch analysis

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Background/purpose: Using multidomain developmental screening tools is a feasible method for pediatric health care professionals to identify children at risk of developmental problems in multiple domains simultaneously. The purpose of this study was to develop a Rasch-based tool for Multidimensional Screening in Child Development (MuSiC) for children aged 0–3 years.

Methods: The MuSic was developed by constructing items bank based on three commonly used screening tools, validating with developmental status (at risk for delay or not) on five developmental domains. Parents of a convenient sample of 632 children (aged 3–35.5 months) with and without developmental delays responded to items from the three screening tools funded by health authorities in Taiwan. Item bank was determined by item fit of Rasch analysis for each of the five developmental domains (cognitive skills, language skills, gross motor skills, fine motor skills, and socioadaptive skills). Children's performance scores in logits derived in Rasch analysis were validated with developmental status for each domain using the area under receiver operating characteristic curves.

Conflicts of interest: The authors have no conflicts of interest relevant to this article.

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Results: MuSiC, a 75-item developmental screening tool for five domains, was derived. The diagnostic validity of all five domains was acceptable for all stages of development, except for the infant stage (≤11 months and 15 days).
Conclusion: MuSiC can be applied simultaneously to well-child care visits as a universal screening tool for children aged 1—3 years on multiple domains. Items with sound validity for infants need to be further developed.
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Introduction

Standardized developmental screening tools are critical to the process of screening children for the risk of developmental problems at an early stage. This is especially the case for children aged 0—3 years, which is the critical period for early intervention.[1—3] Screening tools are also one of the strategies used by pediatric practitioners to detect childhood developmental problems at an early stage.[2,3] Because of the utility of such screening tools for childhood development, the American Academy of Pediatrics (AAP) recommended in 2001 that all children receive standardized developmental screening as part of their well-child care.[1]

Previous surveys have indicated that screening tests were infrequently used (23—30%) by pediatricians between 1994 and 2002.[2,4] A consistent use of screening tools in pediatric practices rose to 48% in the United States in 2009,[5] and exceeded 90% in 2011[6,7] after enhanced research and educational programs began recommending such tools. What prevented pediatricians from implementing screening tools may have been a lack of personnel, time, or effective screening tools that provided sound validity.[5] Therefore, developing a concise and reliable screening tool is critical for a quick and efficient screening process.

Children in Taiwan receive five free developmental screenings during their scheduled vaccinations (ages 0—2 months, 2—4 months, 4—10 months, 10—18 months, and 2—3 years), under the policy of the Ministry of Health and Welfare.[8] Physicians collect health information and conduct screening tests and physical examinations to detect developmental delays in specific developmental domains. If potential multidomain delays are identified, the child undergoes further examination in a Joint Evaluation Center for Child Development (which has a team of pediatric medical specialists, including pediatric neurologists, pediatric psychiatrists, physiatrists, clinical psychologists, physical therapists, occupational therapists, speech pathologists, audiologists, social workers). There are three screening tools that have been developed under the funding of the health authorities and frequently used in well-childcare visits in Taiwan. They are the "Taipei City Developmental Screening Checklist for Preschoolers, 2nd Version" (Taipei II),[9,10] the "Simplified Child Developmental Screening Test" (SiCDeST),[11] and the developmental items in the "Child Health Pamphlet" (DICHP).[12] These tests are designed to detect possible global developmental problems, rather than multidomain developmental problems. All of these screening tests have various checklists for different age groups. The Taipei II provides checklists for 13 age groups <6 years of age: ages 4 months, 6 months, 9 months, 12 months, 15 months, 18 months, 24 months, 30 months, 36 months, 42 months, 48 months, 60 months, and 72 months.[9,10] The DICHP provides checklists for nine age groups <6 years old: 1 month, 2—3 months, 6—7 months, and 9—10 months, and 1—1.5 years, 1.5—2 years, 2—3 years, 3—4 years, and 4—7 years of age.[11] The SiCDeST provides checklists for six age groups <3 years: ages 4 months, 6 months, 9 months, 12 months, 18 months, and 24 months.[12] The distinct decision validity of the checklists across age levels has been reported.[9—13] Choosing an appropriate and age-matched checklist for parents to fill out and providing further clinical decisions based on test results of different checklists may be an added burden on the heavy workload of pediatric practitioners. Therefore, a parent-administered developmental screening tool covering multiple domains with fewer items tailored for an individual child is necessary for enhancing developmental surveillance and screening in clinical settings. One advantage of these three screening tests is that the checklist for a specific age level and its adjacent age level in the same screening tool may share one or two common items.[9—12] Such an advantage is a huge factor in designing a multidomain developmental screening tool using Rasch analysis and multidimensional Rasch analysis.[14]

Rasch analysis and multidimensional Rasch analysis[14] derived from the item response theory are powerful statistical models for selecting items with good fits to the model and estimating personal ability and item difficulty on a common logit scale. Furthermore, Rasch-based analysis is the first step in creating computerized adaptive testing (CAT) formats for simple clinical screening tests, wherein fewer items are required for estimating a child's developmental level.

The main purpose of this study was to develop a tool for Multidimensional Screening in Child Development (MuSiC), a concise developmental screening tool for young children, by item bank construction and validation of the item bank with developmental status.

Methods

Data collection

This study was a secondary analysis of a convenient sample of 632 children between the ages of 3.0 months and

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