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## Establishing normative data for the Functional Dexterity Test in typically developing children aged 3–5 years

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### A B S T R A C T

*Study Design:* Cross-sectional.

*Introduction:* The Functional Dexterity Test (FDT) is a timed pegboard hand dexterity test. Normative data have been developed primarily in adults with some studies in the pediatric population. The present study will complement the existing pediatric data and make the FDT a stronger assessment for use in this population.

*Purpose of the Study:* The primary aim of this study was to collect normative data in typically developing children aged 3–5 years in the Greater Montreal area; the secondary aim was to evaluate the intrarater and interrater reliabilities of the FDT.

*Methods:* The FDT was administered to typically developing children aged 3–5 years, who were recruited from various geographical locations and socioeconomic status levels across the Greater Montreal area. Descriptive statistics, *t*-tests, and analysis of variance were used to compare age-gender groups. The intraclass correlation coefficient (ICC) was calculated to determine intrarater and interrater reliabilities. *Results:* Normative data were collected from 267 children (137 females) from 18 daycares. Statistically significant differences in FDT scores were found across all age bands ( $P < .01$ ). Total time decreased with increasing age ( $P < .01$ ). No significant differences were found between genders. The FDT showed excellent interrater (ICC = 0.89–0.98) and intrarater (ICC = 0.83–0.99) reliabilities.

*Conclusions:* The clear and standardized pediatric instructions, scoring sheet, and normative data table developed in this study provide health care professionals with quick and easy tools to facilitate scoring and clinical interpretation of hand dexterity in preschool-aged children. Future studies should include school-aged children and adolescents from a larger geographic area.

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### Introduction

Skilled hand use involves: the ability for one to have individual control over their fingers, a somatosensory system that can guide hand movements and the ability to react with an appropriate hand configuration from sensory information.<sup>1</sup> When children experience difficulties with any one of these skills, challenges can permeate in simple daily tasks involving picking up small objects between the thumb and index fingers,<sup>1</sup> such as when playing with small toys, and manipulating buttons and zippers during dressing tasks. As children

develop and continue to experience difficulties with fine motor tasks, their overall independence and ability to participate in the activities of daily living and school become further limited.

Several dexterity tests in pediatrics exist, including the Jebsen-Taylor Test, Purdue Pegboard Test, Box and Blocks Test, 9-Hole Peg Test, Grooved Pegboard Test, Sollerman Hand Function Test, and the Moberg Pickup Test. The Functional Dexterity Test (FDT) is an assessment for hand dexterity in both pediatric and adult populations. It is a timed pegboard test, which quickly allows clinicians to evaluate a patient's functional hand dexterity.<sup>2</sup> Standardized equipment for the FDT includes a square wooden pegboard (20.6 × 20.6 × 3.7 cm) with 16 peg holes (diameter = 2.5 cm; depth = 3 cm) that are organized in 4 rows of 4 with 2 cm of space between each row. Each peg hole contains a wooden peg (diameter = 2.2 cm; length = 4 cm) with a black- and white-colored face on each end. Patients are instructed to turn all the pegs over as quickly as

The authors Sabrina Curatolo, Marine Leblanc, Cristina Patulli, Tiffany Tang, and Joanie Tremblay provided equal contribution to this study.

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possible, completing each row in a zigzag fashion.<sup>2</sup> This is administered first with the patient's dominant hand, followed by their nondominant hand.

The FDT has several advantages over the aforementioned hand dexterity evaluations. First, the FDT has the strongest psychometric properties in the adult population when compared to other existing dexterity tests.<sup>3</sup> Yet, this remains to be established in the pediatric population. More specifically, the FDT discriminated "intrinsic manipulative movements" better than the Jebsen-Taylor Test.<sup>4</sup> Second, the FDT is well-suited for pediatric assessment because the pegs (4 × 2.2 cm) are a good size for even young children to manipulate. The testing apparatus is straightforward and engaging, and the test itself takes little time to administer, accommodating both a child's attention span and a busy clinic setting.<sup>5</sup>

The FDT has been successfully norm-referenced for adults.<sup>6</sup> Considering the benefits the FDT provides for the pediatric population, researchers have shown interest in developing pediatric norms for this evaluation. Preliminary norms have been developed with small sample sizes affecting generalizability.<sup>5,7</sup> Additionally, the previous studies did not consider socioeconomic status (SES). Indeed, research has demonstrated that SES is associated with a wide array of outcomes in children, including overall health, cognitive, language, and motor development.<sup>8,9</sup> These effects begin prior to birth and continue into adulthood.<sup>8</sup> Therefore, sampling children from diverse SESs is important to construct valid FDT norms. Due to the quick administration time ideal for younger patients, and the convenient and easily reproducible testing equipment, the FDT is a useful tool for occupational therapists (OTs) in pediatric settings.

The primary purpose of this study was to develop normative data for the FDT in typically developing children aged 3–5 years in the Greater Montreal area. It was hypothesized that the time required to complete the FDT would decrease with increasing age: specifically, 3-year-olds would score slower than 4- and 5-year-olds, and 5-year-olds would score the fastest FDT times. It was also hypothesized that girls would score better than boys in this age group, as described in the study by Taylor et al.<sup>10</sup> The secondary purpose of this study was to measure intrarater and interrater reliabilities of the FDT. It was hypothesized that the ICC will be moderate to high, denoting acceptable agreement between raters and within the same rater.

## Methods

### Participants

When developing norms, a sample of 50–75 participants per group is recommended.<sup>11</sup> In a pediatric population, it is essential to have normative data for each age group due to the functional changes occurring in child development. A power analysis was conducted, indicating that a sample size of 64 children per age band (3, 4, and 5 years) is appropriate in order to detect a moderate effect size (0.25) at 80% power with an alpha of 0.05. This can further be divided by gender (32 females and 32 males) creating a total of 6 groups and  $n = 192$ . Portney and Watkins<sup>12</sup> indicate that this number of participants is appropriate to detect significant differences in scores between age and gender groups in typically developing children. The present study used 1-year age bands as previous research conducted by Lee-Valkov et al.<sup>7</sup> indicated that the mean performance between each year band (3, 4, and 5 years) was significantly different ( $P < .01$ ).

The study received approval from the McGill Institutional Review Board. Children were recruited from a list of daycare facilities randomly selected from the Greater Montreal area using a public online directory, as well as a map with their postal codes and

associated incomes. Income was divided into 6 levels, where neighborhoods defined as level 1 have a median family income over \$90,000, level 2 from \$80,000–90,000, level 3 from \$70,000–80,000, level 4 from \$60,000–70,000, level 5 from \$50,000–60,000 and level 6 under \$50,000.<sup>13</sup> Postal codes were used as a proxy for SES in order to ensure a representative sample. Daycares representing various boroughs of Montreal generated from the list were randomly selected and contacted by telephone to participate in the study. Once authorization was received from the daycare director, the investigators coordinated an initial visit to the facility to distribute packages to parents. Each package included (1) 1 information flyer, (2) 1 consent form, and (3) 1 short medical questionnaire. Signed consent, as well as completed medical questionnaire by the parent, was mandatory prior to determining eligibility of participants. Documents were provided in both English and French.

### Eligibility

Three- to 5-year-old typically developing children were eligible to participate in the study. "Typically developing" was defined in this study as a child who is not under investigation nor has any confirmed diagnosis of an intellectual impairment, developmental disability, significant behavioral problems, motor impairment, or a congenital or acquired malformation of the upper extremities. All inclusion/exclusion criteria were gathered from the medical questionnaires, which were reviewed by the research team. Exclusion criteria included diagnosis or current investigation for aforementioned issues, receiving active occupational therapy (OT), speech and/or physical therapy services, and additional assistance in/outside of their daycare setting. Potential participants previously under investigation for delay in any sphere of development but with negative results or those who previously consulted specialized services and were discharged were included in the study. These selection criteria were sufficiently inclusive to ensure that all range of typical development was captured within the sample.

### Testing procedures

English and French versions of the FDT assessment instructions were standardized through a forward-backward translation process prior to administration to maximize consistency and to reduce sources of measurement error.<sup>14</sup> Grammar was verified by a French-speaking experienced occupational therapist (Appendix 1). A scoring sheet was also developed to facilitate the recording of participant performance during administration of the FDT (Appendix 2).

Each participant was evaluated by an OT master student with the FDT. Anglophone examiners evaluated the English-speaking 3- to 5-year-old children, and Francophone examiners led the assessment for French-speaking 3- to 5-year-old children. Each participant's FDT performance was videotaped to facilitate scoring. The FDT was conducted using a square wooden pegboard with 15 pegs. Chairs and desks that were available at the daycares were used by the evaluators, where children were asked to be seated so that at least 3 quarters of their thighs were on the seat pan, with the elbows at approximately a 90-degree angle to the desk and no more than 10 cm away. Children were given the opportunity to adjust their chair's position. Testing occurred in a safe and non-threatening environment (a small classroom or office within the daycare), with minimal distractions, good lighting, and with input from the daycare educator for scheduling a time where the children were most receptive to participate (eg, before/after snack time and after nap time). In order to ensure optimal interaction between the evaluators and the participants, initial contact with the participants was done through daycare educators. Time was granted prior to

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