Motor Performance Changes in Children Testing Positive for HIV Over 2 Years

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Key Words: gross and fine motor skills • pediatrics

Objective. To determine the effect of HIV infection on the motor performance of children and preadolescents, the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) was administered to see whether performance scores (raw and standard) would change with duration of the disease.

Method. Thirty-four children and preadolescents were tested on the BOTMP at initial diagnosis of HIV positive and again at 6-month intervals over a 2-year period for a total of five test sessions. The participants’ scores on the Gross, Fine, and Battery Composites, as well as eight individual subtests, were compared with those of children who were developing typically.

Results. Gross Composite and Battery Composite percentile scores were consistently 1 to 2 standard deviations below the means for the normal reference populations over the 2-year period. Fine Composite scores were closer than +.5 standard deviation to the mean for the normal reference population.

Conclusion. Gross motor function was more impaired than fine motor function in this sample of children and preadolescents who were HIV positive, and this pattern was unchanged after 2 years of infection. The BOTMP can be useful both to identify specific areas of motor deficits and to monitor changes in motor function over time after application of interventions.

Because of treatment and lifestyle improvements in maternal care (Diamond, 1989; Flanigan et al., 1996; Weiss & Louria, 1994; Wilfert, 1996), an increasing number of HIV-positive children are surviving into adolescence and beyond, many in relatively good health. Treatment advances for the children have included pharmaceutical interventions such as zidovudine (AZT), gamma globulin, combination drug treatments, and other chemotherapeutic modalities (Hirschfeld, 1996). Additional intervention strategies have included improved nutrition (Czarnecki, 1996; Hamilton, 1996; Heller, 1997; Oleske, Rothpletz-Puglia, & Winter, 1996) and exercise programs. These approaches have been shown to increase the lifespan and enhance the quality of life of children who are HIV positive (i.e., these children survive longer and retain greater levels of functional abilities compared to children who have not been treated) (Brady, 1994; Stein, Tsai, & Singh, 1995).

HIV disease in children has been characterized by a variety of neurodevelopmental impairments, beginning with developmental delay and continuing to progressive encephalopathy (O’Hara & D’Orlando, 1996). A loss of developmental milestones is often observed, resulting in
progressive motor deficits and intellectual and behavioral deterioration (Chamberlain, 1993). Investigators who had used neuropsychological assessments to study HIV-related central nervous system disease in children (Wolters, Brouwers, Moss, & Pizzo, 1994) stated that daily living skills (an important aspect of functioning affected by HIV disease and antiretroviral treatment) are not measured by cognitive tests. The investigators believed that behavioral and motor skills may have important implications for the planning of medical, educational, and rehabilitative interventions.

Maintenance of motor skills is an important goal in pediatric occupational therapy because motor function allows children to engage in experiences that directly contribute to their cognitive growth and social maturation. The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP; Bruininks, 1978), a 46-item, 8-subtest measure of gross motor and fine motor skills, is an instrument widely used by occupational therapists to measure motor skills in school-age children, specifically those skills important to their ability to perform activities of daily living. Our belief was that the BOTMP might be useful in describing the progression of motor skill development in children and preadolescents who were HIV positive. BOTMP results could aid in guiding treatment with this population by characterizing where motor deficits are present and where motor skills have improved after therapeutic interventions.

Using the BOTMP, our purpose was to monitor the motor performance of a group of children and preadolescents who were HIV positive over a period of 2 years in order to compare individual subtest performance. We also compared these children to a normal reference population.

Method

Participants

More than 200 children were enrolled in antiretroviral research protocols at the Pediatric Branch of the National Cancer Institute (NCI) in Bethesda, Maryland, from 1987 to 1996. Their followup regimen included returning at 6-month intervals for reexamination. Through blood testing, these children were confirmed to have HIV infection. Modes of infection included vertical transmission (mother to child, 54%), transfusion of blood or blood products (44%), sexual (.4%), and unknown (.4%). By symptom definition established at the Centers for Disease Control and Prevention, these children could be said to be HIV positive but had not yet developed AIDS.

Thirty-four of these children and preadolescents, 15 girls and 19 boys, met the criterion for this study of missing no more than one follow-up appointment over 2 years. Their ages at initial testing ranged from 4 years 11 months to 13 years 2 months, with an average age of 8 years 6 months. Average ages of participants at each evaluation interval are indicated in Table 1.

While in the Clinical Center and subject to these protocols, participants were treated with a number of drugs in various doses and combinations including AZT, gamma globulin, and others. They also received basic instruction on exercise and functional activities from occupational therapists and physical therapists.

Each visit to the Clinical Center required the participant to remain as an inpatient for 4 or 5 days, during which all testing took place. Regular visits to occupational therapy and physical therapy were part of their daily regimen. The children were given instruction on academic skills and exercises to aid strengthening, range of motion, and balance. There was often, but not always, time for practice by the participant while supervised by the therapist.

Instrument

The BOTMP (Bruininks, 1978; see Table 2) was administered to all participants at the baseline evaluation. Scores on the four gross motor subtests are combined to obtain the Gross Motor Composite score. Scores on the three fine motor subtests are combined to obtain the Fine Motor Composite score. The score on the eighth subtest, Upper-Limb Coordination, is combined with the Gross Motor Composite score and the Fine Motor Composite score to obtain the Battery Composite score.

The raw score from each test is converted to a standard score on the basis of previously established age-dependent normal distributions. Each subtest has a mean score of 15 and a standard deviation of 5, whereas each composite distribution has a mean of 50 and a standard deviation of 10.

The BOTMP has been established as a reliable tool for the assessment of motor performance in children. Beitel and Mead (1982), Harrington (1985), Moore, Reeve, and Boan (1986), and Palisano (1989) evaluated test–retest reliability and found correlations ranging from .68 to .98. Reliability for individual subtests has ranged from .29 to .89, with most subtests in the .70 to .80 range. Moore et al. (1986) also calculated an intraclass

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<td><strong>Gross Motor Composite</strong></td>
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<td><strong>Battery Composite</strong></td>
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correlation coefficient for the total test scores over four administrations and obtained .87.

In addressing reliability and validity of the BOTMP, Wilson, Polatajko, Kaplan, and Faris (1995) concluded that the instrument is an appropriate descriptive measurement tool of the motor abilities of children according to reported interrater reliabilities in limited subtests. Bruininks, the developer of this instrument, maintains that the subtests are all adequately reliable (personal communication, February 1998). Standard scores are believed to result in better reliability than raw scores (Harrington, 1985; Moore et al., 1986; Wilson, et al., 1995).

**Procedure**

The BOTMP was administered by three occupational therapists who had been trained in its use. Initial testing was 1 to 2 weeks after the participant had been confirmed to be HIV positive, and repeat testings were at 6-month intervals over a 2-year period. Most of the initial testings and all of the follow-up testings were given by the primary occupational therapist. Approximately one third of the initial testings were administered by two supporting therapists who had been trained with the primary therapist to ensure consistency in technique. Interrater comparisons were not made because of the brevity of time with the participants.

**Data Analysis**

Raw scores were grouped together to obtain sample means and standard deviations for each of the eight subtests. Raw scores were also converted to standard scores for each participant on the basis of the participant’s age, and these individual standard scores were then grouped and averaged to determine sample standard scores for each of the eight subtests and for Gross Motor Composite, Fine Motor Composite, and Battery Composite scores as defined in the BOTMP manual (Bruininks, 1978).

**Results**

Participants’ average raw scores for the four gross motor subtests are shown in Figure 1, and those for the three fine motor subtests are in Figure 2. Participants’ standardized scores for the seven subtests are in Figures 3 and 4, and standardized scores for Upper Limb Coordination and Battery Composite scores are in Figure 5. Means and standard deviations for the BOTMP reference (normal) population are indicated in Figures 3, 4, and 5 for comparison with the standardized scores of our sample.

Participants’ standardized gross motor subtest scores were generally lower than fine motor subtest scores. Average scores on all gross motor subtests were below the normal (reference) population mean of 15. Most were between .5 to 1 standard deviation lower, but the scores for Running Speed and Agility (15) and the Gross Composite (50) were more than 2 standard deviations below the means for the normal population. Participants’ average standardized fine motor scores were very close to the normal population mean (15) and within ± .5 standard deviation. The Fine Composite scores and Upper Limb Coordination scores also were very close to their respective population means (within .5 standard deviation). Their overall Battery Composite scores were between .5 and 1 standard deviation below the normal population mean.

The low standard scores on Running Speed and Agility appear to account for much of the suppression of the Gross Composite scores (see Figure 3). Similarly, the low scores on standardized Gross Composite appear to account for much of the suppression of standardized Battery Composite scores (see Figure 5).

**Discussion**

In this study, we have demonstrated how the motor performance of a group of children and preadolescents who are HIV positive changes over time and how the performance of these children compares with that of children of
similar age who have not been affected. Absolute (i.e., raw score) improvements in motor performance may not be adequate if a child is falling behind his or her peer group because the peer group may be improving at an even faster rate. Over the 2 to 3 years that we followed this sample, the performance level of the participants’ motor skills generally increased. However, children in the 4-year-old to 13-year-old range (such as the children in our sample) are expected to show improvement in motor skills as they mature, and the gross motor skills of our sample remained clearly below the normal population.

Contrasting with gross motor performance, the participants’ fine motor performance remained equal to that of similar children who were developing typically. A possible explanation for this finding is that gross movements require large muscle groups and some degree of physical effort, whereas fine movements are associated with more precise outputs but lower force. Therefore, gross motor performance deficits in children with HIV might be related to an overall loss of strength.

The data displayed in Figures 1 through 5 cannot be used to predict motor performance changes for specific ages because the participants were distributed across a range of ages. The time intervals represent the length of time the children were known to be HIV positive. For example, the "6-month interval" contains data for children who had been diagnosed 6 months earlier; the "1-year interval," contains data for children diagnosed 1 year earlier, and so forth. At each successive interval, the sample was 6 months older, but the distribution did not change (see Table 1). Any inferences from our data should be restricted to the effect of being HIV positive for a length of time up to 2 years after diagnosis.

Our findings suggest that the maintenance of strength and other components of gross motor skills is important in children with HIV to allow them to engage in chosen occupations. Of specific concern are occupations related to Running Speed and Agility because deficits are apparent in this area. Without specific attention to gross motor performance, children with HIV may be unable to engage in age-appropriate occupations, like physical games, sports, team competitions, cycling, and in-line skating, as well as self-care tasks requiring gross skill, such as showering independently. Fine motor performance appears to be unaffected by the illness; therefore, occupational therapy as well as other therapeutic interventions should emphasize gross motor skills rather than fine motor skills.

Reassessment with the BOTMP at regular intervals and comparison with standardized scores will aid the clinician in determining whether motor skills are improving. The BOTMP could be useful for general monitoring of motor performance in this population.

Figure 3. Gross motor subtests and Gross Motor Composite, average standardized scores at 6-month intervals. Means and standard deviations of the normal population references by Bruininks are indicated.

Figure 4. Fine motor subtests and Fine Motor Composite, average standardized scores at 6-month intervals. Means and standard deviations of the normal population referenced by Bruininks are indicated.

Figure 5. Standardized Battery Composite, average scores at 6-month intervals. Means and standard deviations of the normal population referenced by Bruininks are indicated.
Conclusion

These children and preadolescents with HIV infection showed improvement in gross and fine motor skills over 2 years of living with the disease. However, their gross motor function was below that of age-matched norms. Whereas all gross motor subtest scores were below the norm, Running Speed and Agility was most deficient, falling 2 standard deviations below the norm. Performance of fine motor skills was in the average range of age-matched norms.

In the same way that it is used with other disease populations, the BOTMP can be used to identify specific motor deficits and monitor changes in motor function over time for children with HIV infection. After periodically reassessing these children, clinicians would be able to judge whether intervention plans were achieving goals or whether modification in plans would be advisable.

References


