South African Journal for Research in Sport, Physical Education and Recreation, 2008, 30(2): 39-51.
Suid-Afrikaanse Tydskrif vir Navorsing in Sport, Liggaamlike Opvoedkunde en Ontspanning, 2008, 30(2): 39-51.
ISSN: 0379-9069

THE MOTOR DEVELOPMENT OF 2 TO 6-YEAR OLD CHILDREN INFECTED WITH HIV

Jo-Anne E. BOTHA & Anita E. PIENAAR
School of Biokinetics, Recreation and Sport Science, North-West University, Potchefstroom, Republic of South Africa

ABSTRACT

The aim of the study was to determine the motor development of 2 to 6-year old children (53.74 months, sd 12.49) who were infected (Group 1, n = 17) with HIV and to compare their development with an affected (Group 2, n = 13) and unaffected group (Group 3, n = 12). The motor development of the group was determined by the Peabody Developmental Motor Scales (PDMS-2). Variance of analysis (ANOVA) revealed that the developmental level of the HIV-infected group varied between 45 and 51 months, compared to their mean chronological age of 57 months, and that they performed the poorest of the groups in all the variables regarding gross motor, fine motor and total motor ability. Their total motor ability differed significantly from that of the healthy group, while their gross motor skills showed larger deficits compared to their fine motor development. A forward discriminant analysis further indicated that loco-motor skills contributed most to the discrimination between the groups. It is concluded that the infected group exhibits serious motor deficiencies in contrast to healthy children of the same chronological age. These results highlight the necessity of motor intervention for HIV-infected children, focussing on gross motor skills to improve their motor development and quality of life.

Key words: HIV; AIDS; Children; Pediatrics; Development; Motor development; Intervention.

INTRODUCTION

Statistics indicate that worldwide an estimated 38.6 million (33.4 million – 46 million) people were living with the Human Immunodeficiency Virus (HIV) in 2005 (UNAIDS, 2006), an estimated 4.1 million (3.2 million – 6.4 million) became newly infected and 2.8 million (2.4 million – 3.3 million) lost their lives to the Acquired Immune Deficiency Syndrome (AIDS) (UNAIDS, 2006). In South Africa 5 511 751 people are HIV positive according to statistics (Health Systems Trust, 2007) and the estimated HIV prevalence for the total population is 11.4%. In women (age group 20-24 and 25-29) the prevalence increased from 2002 to 2005 respectively from 29.1 – 30.6% and from 34.5 – 39.5% (Department of Health, 2006). This increase in HIV prevalence in woman (child-bearing age) indicates difficulties for the children of South Africa (Wolters *et al*., 1995; Thorne & Newell, 2000; Loening-Voysey, 2002). Statistics regarding children indicate that 2.1 million children under the age of 15 are infected with HIV worldwide (UNAIDS, 2004; Children on the Brink, 2004). By 2003, 510 000 children younger than 15 years had already died as a result of AIDS (UNAIDS, 2004). This growing HIV/AIDS epidemic has far reaching consequences for children who are affected by it (Children on the Brink, 2004). In South Africa, more than 1 201 675 children under the age of 18 are maternal orphans due to this disease (Health Systems Trust, 2007). The number of orphans in Sub-Saharan Africa has increased from 1 million in 1990 to 12 million in 2003, while the projection for 2010 is that this number will increase to 18 million children (Children on the Brink, 2004).

The AIDS-pandemic in Sub-Saharan Africa is the most solemn risk for children's survival and health to date (Bicego *et al*., 2003). In children, HIV is characterised by a variety of developmental deficiencies. Researchers indicate that children with HIV exhibit neuro-developmental, cognitive, motor and nutritional deficiencies (Wolters *et al*., 1995; Msellati *et al*., 1993; Davis-McFarland, 2000; Blanchette *et al*., 2001; Wachsler-Felder & Golden, 2002) as well as changes in their immune and central nervous system (Lindsey *et al*., 2000). The incidence of neurological deficiencies in HIV children is estimated to be between 30–90% (Bode & Rudin, 1995). HIV is also associated with encephalopathy, a condition characterized by a decline in brain growth, resulting in poorer cognitive, neuro and motor development (Epstein, 1986; Mitchell, 2001; Rosenfeldt *et al*., 2000). Research reports that motor deficiencies are already apparent during the first three months of an infected baby's life (Gay *et al*., 1995). This loss of motor developmental milestones is evident in progressive motor deficiencies, which in time worsen, as the children are required to perform increasingly more complex and integrated tasks (Blanchette *et al*., 2001; Gay *et al*., 1995). This can result in deficiencies regarding balance, gait, perceptual-motor skills and muscle functioning (Brouwers *et al*., 1994; Jay & Dalakas, 1994). In this regard research confirms statistically significant differences pertaining to cognitive and motor development of children infected with HIV compared to those of healthy children (Blanchette *et al*., 2001).

The central nervous system of HIV children is influenced to a larger extent than the peripheral nervous system, which is influenced more in adults (Davis-McFarland, 2000). This causes the virus to be more prominent in the developing nervous system of a child, which, in turn, results in the deficiencies in developmental milestones (Davis-McFarland, 2000; Blanchette *et al*., 2001; Wachsler-Felder & Golden, 2002). Motor developmental deficiencies are mainly the result of gross motor deficiencies rather than of fine motor deficiencies (Msellati *et al*., 1993; Parks & Danoff, 1999). This conclusion is attributed to the fact that gross motor skills require the use of large-muscle groups and physical effort, whereas fine motor skills require less strength (Parks & Danoff, 1999). HIV is associated with exhaustion and a decline in physical functioning, which restrict the person in performing life-sustaining activities (Crystal *et al*., 2000; Keyser *et al*., 2000; Cade *et al*., 2004; Storm *et al*., 2005). Research reveals that 50% of HIV infected children's physical functioning is restricted and that 58% have one or more restriction concerning school activities (Storm *et al*., 2005). A loss of muscle mass contributing to a decrease in strength and functionality is also reported (Grinspoon & Mulligan, 2003).

Although South Africa is one of the countries in the world with the highest HIV/AIDS prevalence, access to antiretroviral treatment is limited (Abdool, 2004). Research is therefore essential for the development of alternative intervention methods to enhance the quality of life of children with HIV. The aim of this study was firstly to determine the level of gross motor and fine motor development of 2 to 6-year old children affected by and infected with HIV, and to compare it with children not affected by this disease. Secondly the researchers wanted to determine which of the variables (stationary, loco-motor skills, object manipulation skills, grasping and visual motor integration) contribute most to the overall motor development profile of the child as this can be valuable information when compiling motor intervention programmes for such children.

METHODOLOGY

Research design

A three-group cross-sectional research design was used to analyse the results of a convenient sample of 42 children classified as infected with HIV, affected and unaffected by HIV.

Participants

The HIV-infected group (Group 1) and HIV-affected group (Group 2) were selected at a Hospice day care centre for HIV-infected and affected children in Potchefstroom (South Africa) according to availability. Children are only allowed entrance to this day care centre if proof of their HIV status can be furnished, while medical clinics also refer HIV positive children to this day care facility. The affected children (HIV negative status, Group 2), are allowed access to the day care centre solely on the proviso that a death certificate of one of or both the parents is provided which states that the death was as a result of an AIDS-related disease such as tuberculosis, pneumonia and cardiac failure. A control group (Group 3) of children who were not infected with or affected by HIV was compiled from the Klerksdorp area near Potchefstroom. The control groups (Groups 2 and 3) were also selected on the basis of their age, sex, race and socio-economic status being similar to those of the experimental group. The HIV-status of the children was determined using the FIRST RESPONSE HIV CARD TEST 1-2.O. The test is an immunochromatographic (rapid) test for the qualitative detection of all isotypes (IgG, IgM, IgA) spesific to HIV-1 including subtype O and HIV-1 in human serum, plasma or whole blood. In a comparison of the FIRST RESPONSE HIV CARD TEST 1-2.O test versus a leading commercial anti-HIV1&2 ELISA and Rapid test, results gave a sensitivity of 100% (120/120), a specificity of 99.18% (121/122) and a total agreement of 99.59% (241/242). Due to only three laboratories processing PCR testing in South Africa, 22% of the total capacity required, rapid tests are used (Meyers *et al.*, 2006). The total group consisted of 42 children with a mean age of 53.74 months (sd 12.49). The HIV-infected group (Group 1) consisted of 17 children with a mean age of 57.41 months (sd 10.57), of which 12 were boys (60.58 months, sd 9.05) and five were girls (49.80 months, sd 10.89). The affected group (Group 2) consisted of 13 children with a mean age of 49.39 months (sd 12.96), of which eight were boys (51 months; sd 13.71) and five were girls (46.80 months; sd 12.70). The children from both these groups were transported to and from the school with a bus belonging to the school on a daily basis. The socio-economic circumstances of the group was considered low, because their living conditions were characterised by poor sanitary conditions and housing. Although a dietician did not compile the diet, they were part of a feeding scheme. This consisted of maize porridge, morvite or soya porridge for breakfast and a fruit for a snack during the course of the morning. Cooked lunches consisted of meat, rice and vegetables with a peanut butter or jam sandwich and at 15:00 and a cold drink before going home. The children were also supplied with morvite over the weekends when the school is closed. The unaffected (Group 3) consisted of 12 children with a mean age of 53.25 (sd 13.86) of which six were boys (59 months; sd 13.73) and six were girls (47.50; sd 12.44). This group consisted of children from similar socio-economic circumstances who where not infected with or affected by HIV. These children were all enrolled in a day care centre, although no feeding scheme was available at the centre. The method of pairing was used to even the groups regarding age, sex and race.

Measuring instruments

Peabody Developmental Motor Scales - second edition (PDMS-2)

The PDMS-2 (Folio & Fewell, 2000) consists of six subtests, which measure interdependent abilities during early motor development. It was developed to measure gross and fine motor skills in children from birth to 71 months of age. The subtests consist of reflexes, stationary, loco-motor skills, object manipulation skills, grasping and visual motor integration. The totals of the subtests are presented in a raw score, a percentile, age equivalents, as well as a standard score. The test developers (Folio & Fewell, 2000) contend that the standard score gives the best indication of an individual's progress in the subtests, and suggest that this score be used to compare the subtests with one another. These subtests contribute to a gross motor total [reflex (only 0-12 months), stationary, loco-motor skills and object manipulation skills], a fine motor total (grasping and visual motor integration) and an overall motor total. The gross motor total, the fine motor total as well as the motor total are expressed in percentiles as well as quotients. The quotients are seen as the most reliable values for the PDMS-2 (Folio & Fewell, 2000), because they integrate the various subtests, are not reliant on a single subtest and display the child's abilities with regard to gross motor, fine motor as well as total motor abilities. The grading of motor development is represented as follows: (1) Very poor; (2) Poor; (3) Below average; (4) Average; (5) Above average; (6) Excellent; (7) Superior. The PDMS-2 has been tested as a reliable and valid measuring instrument (Folio & Fewell, 2000). The test-retest-reliability coefficient is >0.90, while the internal validity varies between 0.90 and 0.96. The content validity of the PDMS-2 is determined by the skills, which are measured and is corroborated by knowledge of motor development, which is already available. Folio and Fewell (2000) indicated that the test battery is suitable for use with any race, sex or ethnicity.

Procedure

The North-West University provided ethical approval for conducting the study (nr. 06M02). The director of the Hospice Day Care Centre gave permission and the parents/guardians had to complete informed consent forms before the child was included in the study. The HIV status of each child was determined by the clinics responsible for their health. The research was done at the day care centres during school hours. Trained translators were used to ensure that the children understood the instructions.

Statistical procedure

The data was analysed using Statistica for Windows (Statsoft, 2006) as well as SAS software (SAS, 2000-2003). Descriptive statistics were used to determine means (M), standard deviations (sd) and maximum and minimum values. A One-way variance of analysis was used to analyse the differences between the groups. A statistical equation [$n=(1.96)^2(6.52)^2/(3.75)^2$] (Steyn *et al*., 1998), based on relevant results (Ernst, 2004), determined that each of the groups should consist of at least 11.6 (n=12) children in order for the results to have statistical power. Practical significance of differences (ES) between groups was calculated by dividing the mean difference (M) by the largest standard deviation (sd) (Cohen, 1988; Steyn, 1999). The following guidelines for interpreting the practically significance were set, namely ES=0.2

(small effect), ES=0.5 (medium effect) and ES=0.8 (large effect) (Cohen, 1988). Due to the number of subjects for this study, it was considered practically significant if the effect size indicated a medium or large effect. A histogram analysis was done to analyse the normality distribution of the different groups. A forward stepwise discriminant analysis was performed by way of SAS to determine which variables (subtests) could best discriminate between the groups, and a classification matrix was compiled from the same data to evaluate the accuracy of the prediction. Subsequently the SAS programme was used to analyse the cross validity of the discriminant function by making use of the Jack-knife method. The striking rate of the discriminant analysis was also analysed (Huberty, 1994), according to which the practical significance of the method was calculated, and a value of 0.2 indicated a large practical effect.

RESULTS

Table 1 displays a comparison between the mean chronological and developmental ages of the three groups, while Table 2 provides descriptive information of the groups with regard to their mean values of the PDMS-2. Table 3 represents significant intergroup differences regarding the PDMS-2 variables.

TABLE 1. **THE CHRONOLOGICAL AGE OF THE GROUPS IN RELATION TO THEIR DEVELOPMENTAL AGE IN VARIOUS SUBTESTS**

	Group 1 (n=17)			**Group 2 (n=13)**			**Group 3 (n=12)**		
	ChronA	**DevA**	**Diff**	**ChronA**	**DevA**	**Diff**	**ChronA**	**DevA**	**Diff**
Gross motor	M	M		M	M		M	M	
Stationary	57	45	-12	49	45	-4	53	56	+3
Loco-motor	57	46	-11	49	46	-3	53	56	+3
Object manipulation	57	51	-6	49	49	0	53	58	+5
Fine motor									
Grasping	57	48	-9	49	53	+4	53	53	0
Visual motor integration	57	50	-7	49	43	-6	53	55	+2

ChronA = Chronological age; DevA = Developmental age, Diff = Difference between chronological and developmental age; M= mean; n = number of subjects

Table 1 indicates that the infected group (Group 1) had the highest mean chronological age (57 months) of the three groups, although the age differences between the groups were not statistically significant. They exhibited the lowest developmental level (45-51 months) of the three groups in the various subtests. It is apparent that Group 1 fared the worse of the three groups in all the subtests compared to their chronological age [stationary (12 months), grasping (9 months) and loco-motor skills (11 months)]. Table 1 further indicates that the chronological age of Group 2 (49 months) is lower than their developmental age in three of the five subtests, one was similar and one was higher. Visual motor integration is the lowest in the group (6 months), although they fared better than their chronological age in grasping. Object manipulation was at the same level as their chronological age. Table 1 also reveals that the developmental age of Group 3 exceeds their chronological age (53 months) in all the subtests (0-5 months).

TABLE 2. **DESCRIPTIVE STATISTICS OF THE MOTOR AND PHYSICAL DEVELOPMENT OF THE GROUPS**

	Group 1					Group 2					Group 3				
Variables	**n**	**M**	**sd**	**Min**	**Max**	**n**	**M**	**sd**	**Min**	**Max**	**n**	**M**	**sd**	**Min**	**Max**
Age	17	57.41	10.57	35	71	13	49.38	12.96	32	68	12	53.25	13.86	33	69
Gross motor															
Stationary SC	17	7.76	2.82	3	15	13	9.23	2.35	5	14	12	10.75	1.86	8	15
Stationary percentile	17	27.53	24.02	1	95	13	41.31	25.30	5	91	12	58.08	20.04	25	95
Stationary grading	17	3.47	1.18	1	6	13	3.92	0.76	2	5	12	4.17	0.58	4	6
Loco-motor SC	17	7.41	2.69	3	11	13	9.08	2.69	6	16	12	11.25	1.96	8	14
Loco-motor percentile	17	26.47	24.90	1	63	13	38.38	25.59	9	98	12	63.67	22.33	25	91
Loco-motor grading	17	3.12	0.93	1	4	13	3.92	0.76	3	6	12	4.42	0.51	4	5
Object manipulation SC	17	8.76	1.95	6	12	13	10.08	1.75	8	13	12	11.08	1.31	9	13
Object manipulation percentile	17	36.41	22.16	9	75	13	50.38	21.05	25	84	12	63.00	15.57	37	84
Object manipulation grading	17	3.65	0.49	3	4	13	4.23	0.44	4	5	12	4.17	0.39	4	5
Fine motor															
Grasping SC	17	8.59	2.74	1	13	13	11.00	2.42	6	15	12	10.25	2.83	6	16
Grasping percentile	17	43.53	25.34	5	102	13	61.00	25.31	9	95	12	51.67	29.03	9	98
Grasping grading	17	3.71	0.99	1	5	13	4.31	0.75	3	6	12	4.42	0.67	4	6
Visual motor SC	17	8.47	3.02	5	13	13	8.08	2.56	5	13	12	11.83	3.10	8	17
Visual motor percentile	17	35.59	31.57	5	84	13	30.77	26.39	5	84	12	65.50	29.55	25	99
Visual motor-grading	17	3.47	1.01	2	5	13	3.46	0.88	2	5	12	4.83	1.03	4	7
Gross motor percentile	17	25.06	22.43	1	84	13	41.77	21.32	10	84	12	65.33	18.99	23	90
Gross motor quotient	17	86.94	12.87	1	84	13	96.54	9.18	81	115	12	106.58	8.24	89	119
Gross motor grading	17	3.18	1.07	1	5	13	3.85	0.55	3	5	12	4.25	0.62	3	5
Fine motor percentile	17	42.29	31.44	8	102	13	44.23	28.66	5	95	12	60.83	31.86	16	97
Fine motor quotient	17	91.18	13.35	61	112	13	97.23	13.66	76	124	12	106.25	15.59	85	127
Fine motor grading	17	3.41	1.06	1	5	13	3.77	1.01	2	6	12	4.58	1.08	3	6
Total motor percentile	17	27.94	25.54	2	84	13	42.23	23.97	6	91	12	64.83	19.99	35	93
Total motor quotient	17	87.47	12.92	70	115	13	96.46	11.14	77	120	12	106.83	9.45	94	122
Total motor grading	17	3.23	1.03	2	5	13	3.69	0.75	2	5	12	4.50	0.79	4	6

n = subjects; M = mean; sd = standard deviation; Min = minimum value, Max = maximum value SC= standard score

An analysis of the standard scores obtained by Group 1 for all the subtests in the PDMS-2, as displayed in Table 2, indicates that the skills affected most in this group are stationary and loco-motor skills. The table further indicates that the norm percentiles of all the subtests of the group vary between 26 and 37.58. Gross motor, fine motor and total motor development falls respectively on the 25th, 36th and 27th percentile. The grading in the various subtests, as well as the gross motor, fine motor and total motor development indicates a below average development according to the chronological age of the group. The fine motor quotient grading indicates an average development (between 90 and 110 standard score), while the gross motor and total motor quotient indicate a below average (between 80 and 89) development.

Group 2 fared poorest in the visual motor integration, loco-motor and stationary skills when comparing the various groups. This group tested below average in the above-mentioned skills, while grasping and object manipulation tested average. Percentiles varied between 30 and 61 for the various subtests; while gross motor skills were on the 41st percentile, fine motor on the 44th percentile and the total motor development on the 42nd percentile. The grading of the motor quotient indicate that the development of this group was average (between 90 and 110) in gross motor, fine motor and total motor skills.

Table 2 indicates that Group 3 scored an average in the various subtests with percentiles ranging between 51 and 65 for the various subtests. They obtained almost the same standard scores in all the subtests (10.25-11.83) and as a result, fared average in all subtests. Gross motor skills of the group were on the 65th percentile, fine motor skills on the 60th percentile and total motor skills on the 64th percentile. The grading of the group for the various skills was average. This group exhibited average development (between 90 and 110) with regard to gross motor, fine motor as well as total motor quotient grading.

Table 3 displays significant intergroup differences in the different variables that were assessed. Statistically significant differences are indicated in the standard scores ($p<0.05$) for stationary, loco-motor skills as well as object manipulation between Groups 1 and 3. These differences are also of high practical significance (ES of 1.06; 1.06 and 1.19 respectively). Similar statistically and practically significant differences were also found in the percentiles of the various subtests.

In the visual motor standard score, the differences between Groups 1 and 3 as well as 2 and 3 are statistically significant ($p<0.05$), and the ES of both indicate a large practical significance. The visual motor standard score of Group 2 was the poorest of the three groups. Statistically significant differences are indicated between the gross motor percentile of Groups 1 and 3 as well as Groups 2 and 3. The ES between Groups 1 and 3 (1.80) indicates the largest practical significant difference in all the subtests. There is also a statistically significant difference in the total motor percentile between Groups 1 and 3 and it indicates a large practical significance (ES=1.44). A statistically significant difference also occurred between the gross motor and total motor quotients of Groups 1 and 3 ($p<0.05$), while, likewise, a significant difference ($p<0.01$) was found in the fine motor quotient.

A stepwise discriminant analysis was performed on the standard scores of the five subtests to determine which exhibited the largest discriminatory value between the three groups. A summary of this analysis is reported in Table 4, while Table 5 shows the classification matrix, which indicates whether the subjects are classified into the correct groups on the basis of the variables (subtests), which discriminate between the groups.

TABLE 3. **SIGNIFICANT INTERGROUP DIFFERENCES WITH REGARD TO PDMS-2 VARIABLES**

	Group 1	Group 2	Group 3	Group 1 and 2	ES	Group 1 and 3	ES	Group 2 and 3	ES
Gross motor	***M***	***M***	***M***	**P**		**P**		**P**	
Stationary SC	7.76	9.23	10.75	-	-	0.0128*	1.06	-	-
Stationary percentile	27.53	41.31	58.08	-	-	0.0076*	1.27	-	-
Loco-motor SC	7.41	9.08	11.25	-	-	0.0017*	1.42	-	-
Loco-motor percentile	26.47	38.39	63.67	-	-	0.0018*	1.49	0.0399*	0.99
Object manipulation SC	8.76	10.08	11.08	-	-	0.0062*	1.19	-	-
Object manipulation percentile	36.41	50.39	63			0.007*	1.2	-	-
Fine motor									
Grasping SC	8.59	11	10.25	0.05*	0.87	-	-	-	-
Grasping percentile	43.53	61	51.67	0.04*	0.68	-	-	-	-
Visual motor SC	8.47	8.08	11.83	-	-	0.0198*	1.08	0.0085*	1.21
Visual motor percentile	35.59	30.77	65.5	-	-	0.0448*	0.95	0.0171*	1.18
Gross motor percentile	25.06	41.77	65.33	-	-	0.0022*	1.80	0.0254*	1.11
Gross motor quotient	86.94	96.54	106.58	-	-	0.0003*	1.52	-	-
Fine motor percentile	42.29	44.23	60.83	-	-	-	-	-	-
Fine motor quotient	91.18	97.23	106.25	-	-	0.033*	0.97	-	-
Total motor percentile	27.94	42.23	64.83	-	-	0.0014*	1.44	-	-
Total motor quotient	87.47	96.46	106.83	-	-	0.0006*	1.48	-	-

*$p<0.05$; M = mean; ES = effect size; SC= standard score

According to Table 4, three subtests entered into the model, of which loco-motor skills discriminated most between the groups and was also the only subtest making a statistically significant ($p<0.05$) contribution. Visual motor integration and grasping also contributed to the discrimination between the groups, while stationary and object manipulation was omitted from the model.

TABLE 4. **FORWARD STEPWISE DISCRIMINANT ANALYSIS**

Variable	F-value	Wilks' Lambda
Loco-motor standard score	8.24	0.7029
Visual motor standard score	2.81	0.6125
Grasping standard score	4.26	0.4977

Table 5 indicates the number of children who are correctly placed in their group after the reclassification on the grounds of the discriminant analysis. This percentage varies between 50% and 79%, and Group 1 was reclassified best. The prior probabilities, which were chosen as the proportion of the groups due to the groups not being of equal size, were (Group 1: 17/42 = 0.4048; Group 2: 13/42 = 0.3095; Group 3: 12/42 = 0.2857) respectively.

TABLE 5. **RECLASSIFICATION OF SUBJECTS IN THE VARIOUS GROUPS**

Group	**1 (N = 17)**	**2 (N = 13)**	**3 (N = 12)**
1	12 (70.59%)	3	2
2	2	9 (69.23%)	2
3	4	2	6 (50%)
Total	**18**	**14**	**10**

Table 6 represents the results of the cross validity which was determined by reclassifying the groups.

TABLE 6. **SUMMARY OF THE CROSS VALIDITY OF THE JACK-KNIFE METHOD**

	Group 1	**Group 2**	**Group 3**	**Total**
Group 1	10	3	4	17
Percentage correct	58.82	17.65	23.53	100
Group 2	4	6	3	14
Percentage correct	30.77	46.15	23.08	100
Group 3	4	2	6	12
Percentage correct	33.33	16.67	50.00	100
Total	18	11	13	42
Percentage correct	42.86	26.19	30.95	100

The results of the cross validity of the discriminant analysis, which were determined by way of the Jack-knife method, are displayed in Table 6. According to this, the percentage of correct classifications of the different groups varies between 58.82, 46.15 and 50.0%. The better-than-chance index is also calculated, because the cross validity exhibited low values and the practical significance of the discriminant analysis therefore also needed to be analysed. The following formula which was used [($I = (Ho\text{-}He)/(1\text{-}He)$, where Ho is the observed hitrate (10+6+6)/42 = 0.524) and He is the expected hitrate (0.4048)(17)+(0.3095)(13)+(0.2857)(12) = 0.341 thus I = (0.524-0.341)/1-0.341)] exhibited a practical significance of 0.28, which is an indication of large practical validity (Huberty & Lowman, 2000).

DISCUSSION

The results of the study regarding the percentiles obtained for total motor skills of the infected group (28th percentile), the affected group (42nd percentile) and the unaffected group (65th percentile), showed that the infected group differed significantly from the unaffected group. A comparison with the findings of a study on 5 to 6 year old (66.1 months) South African children from poor socio-economic circumstances indicated that the HIV-infected children's loco-motor skills were much poorer (26th percentile compared to 48th percentile), while their total motor quotient was also lower (87.47) compared to 90.84 in the low SES group (Pienaar *et al.*, 2007). This clearly indicates that the infected group already exhibits serious motor deficits compared to other children of the same chronological age, especially the unaffected children. According to the grading scale of the PDMS-2, their development is already below average in comparison to the other two groups, who exhibited average development. Researchers point out that such deficiencies are already noticeable in the first three months of an infected baby's life (Blanchette *et al*., 2001), while these results are also confirmed by researchers who studied 28 infected and 98 uninfected children (Gay *et al*., 1995). These researchers also found that motor deficiencies were already evident during the first three months of the baby's life and that it deteriorates in time.

The gross, fine and total motor quotients indicated that the infected group performed below average with regard to the gross motor and total motor skills, while their performance was average in the fine motor skills. Groups 2 and 3 fared average in the gross motor, fine motor and total motor quotients. Furthermore, the infected group performed worst with regard to their gross motor skills (25th percentile), against the 41st and 65th percentiles of Group 2 and 3. A reasonable difference was also recorded between the fine motor and gross motor skills development of Group 1 in comparison to the other two groups that obtained more or less the same percentile values for fine motor and gross motor development. These differences between the groups exhibited the largest practical significance (EG=1.80). It can be concluded that the gross motor skill development of the HIV infected group is influenced to a greater degree than their fine motor skills development, although their total development was also below average. These results are in agreement with other literature findings, indicating that the gross motor skills of infected children are affected most by the virus (Msellati *et al*., 1993; Parks & Danoff, 1999).

The discriminant analysis indicated that loco-motor skills can best distinguish the groups from one another ($p<0.05$). This can possibly be attributed to the fact that large muscle groups underlie the performance of gross motor skills and require physical exertion, whereas fine motor skills require less strength (Parks & Danoff, 1999). This result therefore confirms also that gross motor development of infected children is affected most. The discriminant analysis also provides valuable information regarding the content when compiling motor intervention programmes for such children.

CONCLUSION

A clear tendency of poorer motor development is apparent in young children infected by HIV. The necessity of motor intervention for children with HIV to promote their development and quality of life is therefore emphasized. Literature has also confirmed that additional intervention strategies, improved nutrition and exercise programmes can improve the life expectancy and quality of life of children with HIV (Brady, 1994; Stein *et al*., 1995). In this regard, a researcher alleges that when handicaps are identified at an early stage and intervention is applied timeously, a significant difference in the growth and development of a child can occur (Lerner, 1993). The results confirm that the emphasis of motor intervention programmes for young children with HIV must be on gross motor skills, especially on loco-motor skills.

These results of the study should be evaluated against the fact that the study had limitations. The progression of the children's HIV status could not be determined due to ethical constraints, and could possibly have played a role in the performance of motor skills, where exhaustion would be apparent earlier in children who have advanced HIV. Further shortcomings are the small research group and the fact that the study was based on an availability sample that made it difficult to generalize the findings to larger populations.

ACKNOWLEDGEMENTS

The National Research Foundation of South Africa is thanked for the financial support of this project as well as the Focus Area of the Faculty of Health Sciences (North-West University) and the personnel of the day care centre for their co-operation during this study.

REFERENCES

ABDOOL, K.Q. (2004). HIV treatment in South Africa: overcoming impediments to get started. *The Lancet*; 363: 1394, April 24.

BICEGO, G.; RUTSTEIN, S. & JOHNSON, K. (2003). Dimensions of the emerging orphan crisis in Sub-Saharan Africa. *Social Science and Medicine*, 56: 1235-1247.

BLANCHETTE, N.; SMITH, M.L.; FERNANDES-PENNEY, A.; KING, S. & READ, S. (2001). Cognitive and motor development in children with vertically transmitted HIV infection. *Brain and Cognition*, 46(1-2): 50-53, June-July.

BODE, H. & RUDIN, C. (1995). Calcifying arteriopathy in the basal ganglia in human immunodeficiency virus infection. *Pediatric Radiology*, 25: 72-73.

BRADY, M. (1994). Treatment of human immunodeficiency virus infection and its associated complications in children. *Journal of Clinical Pharmacology*, 34: 17-29.

BROUWERS, P.; BELMAN, A. & EPSTEIN, L. (1994). Organ-specific complications: Central nervous system involvement: Manifestations, evaluation and pathogenesis. In P.A. Pizzo & C.M. Wilfert (Eds.), *Pediatric AIDS: the challenge of HIV infection in infants, children, and adolescents* (433-455). Philadelphia, PA: Williams & Wilkens.

CADE, W.T.; PERALTA, L. & KEYSER, R.E. (2004). Aerobic exercise dysfunction in human immunodeficiency virus: a potential link to disability, *Physical Therapy*; 84(7): 655-664.

CHILDREN ON THE BRINK (2004). "A joint report of new orphan estimates and framework for action". Hyperlink [http://www.unicef.org/publications/index_22212.html]. Retrieved 19 February 2005.

COHEN, J. (1988). *Statistical power analysis for the behavioral science*. New York, NY: Erlbaim.

CRYSTAL, S.; FLEISHMAN, J.A.; HAYS, R.D.; SHAPIRO, M.F. & BOZZETTE, S.A. (2000). Physical and role functioning among persons with HIV: results from a nationally representative survey. *Medical Care*, 38: 1210-1223.

DAVIS-McFARLAND, E. (2000). Language and oral-motor development and disorders in infants and young toddlers with human immunodeficiency virus. *Seminars in Speech and Language*, 21(1): 19-34.

DEPARTMENT OF HEALTH (2006). *National HIV and syphilis antenatal sero-prevalence survey in South Africa*: 2002-2005. [Pretoria: Department of Health].

EPSTEIN, L.G.; SHARER, L.R.; OLESKE, J.M.; CONNOR, E.M.; GOUDSMIT, J.; BAGDON, L.; ROBERT-GUROFF, M. & KOENINGSBERGER, M.R. (1986). Neurological manifestations of human immounodeficiency virus infection in children. *Pediatrics*, 78: 678-687.

ERNST, J.E. (2004). The influence of an intervention programme on 9-12 year old farmworker children with developmental coordination disorder, based on an integrated approach. Unpublished Master's thesis. Potchefstroom: North-West University.

FOLIO, M.R. & FEWELL, R.R. (2000). *Peabody Developmental Motor Scales (2nd ed.)*. Austin, TX: PRO-ED.

GAY, C.L.; ARMSTRONG, D.; COHEN, D.; LAI, S.; HARDY, M.D.; SWALES, T.P.; MORROW, C.J. & SCOTT, G.B. (1995). The effects of HIV on cognitive and motor development in children born to HIV-seropositive woman with no reported drug use: birth to 24 months. *Pediatrics*, 96(6): 1078-1082.

GRINSPOON, S. & MULLIGAN, K. (2003). Weight loss and wasting in patients infected with human immunodeficiency virus. *Clinical Infectious Diseases*, 36(suppl 2): S69-78.

HEALTH SYSTEMS TRUST. (2007). "*Health Statistics*". Hyperlink [http://www.hst.org.za/healthstats]. Retrieved 11 June 2007.

HUBERTY, C.J. (1994). *Applied discriminant analysis*. New York, NY: John Wiley & Sons.

HUBERTY, C.J. & LOWMAN, L.L. (2000). Group overlap as a basis for effect size. *Educational and Psychological Measurement*, 60: 543-563.

JAY, C. & DALAKAS, C. (1994). Myopathies and neuropathies in HIV-infected adults and children. In P.A. Pizzo & C.M. Wilfert (Eds.), *Pediatric AIDS: the challenge of HIV infection in infants, children, and adolescents* (433-455). Philadelphia, PA: Williams & Wilkens.

KEYSER, R.E.; PERALTA, L.; CADE, W.T.; MILLER, S. & ANIXT, J. (2000). Functional aerobic impairment in adolescents seropositive for HIV: a quasiexperimental analysis. *Archive of Physical and Medical Rehabilitation*, 81: 1479-1484, November.

LERNER, J. (1993). *Learning disabilities: theories, diagnosis & teaching strategies* (6th ed.) Boston, MA: Houghton Mifflin.

LINDSEY, J.C.; HUGHES, M.D.; McKINNEY, R.E.; COWLES, M.K.; ENGLUND, J.A.; BAKER, C.J.; BURCHETT, S.K.; KLINE, M.W.; KOVACS, A. & MOYE, J. (2000). Treatment-mediated changes in human immunodeficiency virus (HIV) Type 1 RNA and CD4 cell counts as predictors of weight growth failure, cognitive decline, and survival in HIV-infected children. *The Journal of Infectious Disease*, 182: 1385-1393.

LOENING-VOYSEY, H. (2002). HIV/AIDS in South Africa: caring for vulnerable children. *African Journal of AIDS Research*, 1: 103-110.

MEYERS, T.; MOULTRIE, H.; SHERMAN, G.; COTTON, M. & ELEY, B. (2006). Management of HIV-infected children. In P. Ijumba & A. Padarath (Eds.), *South African Health Review*, 14: 235-256.

MITCHELL, W. (2001). Neurological and developmental effects of HIV and AIDS in children and adolescents. *Mental Retardation and Developmental Disabilities Research Reviews,* 7: 211-216.

MSELLATI, P.; LEPAGE, P.; HITIMANA, D.; VAN GOETHEM, C.; VAN DE PERRE, P. & DABIS, F. (1993). Neurodevelopmental testing of children born to human immunodeficiency virus type 1 seropositive and seronegative mothers: a prospective cohort study in Kigali, Rwanda. *Pediatrics*, 92(6): 843-848.

PARKS, R.A. & DANOFF, J.V. (1999). Motor performance changes in children testing positive for HIV over 2 years. *American Journal of Occupational Therapy*, 53: 524-528.

PIENAAR, A.E.; LABUSCHAGNE, G.M. & PEENS, A. (2007). Motor and sensory development of 5-6 year old children in poor socio-economic circumstances: Thusano-study. *African Journal for Physical, Health Education, Recreation and Dance*, Special Edition: 304-320, September (Supplement).

ROSENFELDT, V.; VALERIUS, N.H. & PAERREGAARD, A. (2000). Regression of HIV-associated progressive encephalopathy of childhood during HAART. *Scandinawian Journal of Infectious Diseases,* 32: 571-574.

SAS INSTITUTE INC. (2002-2003). *The SAS System for Windows*. Release 9.1 TS Level 1MO. Cary, NC: SAS Institute.

STATSOFT (2006). *Statistica for Windows*. Release 5.5: general conversions and statistics. Tulsa, OK: StatSoft.

STEIN, Z.A.; TSAI, R.T.; SINGH, T.; TSAI, W.Y.; KUHN, L. & WILLIAMS, R. (1995). Changes over time in survival of children after AIDS diagnosis in New York City. *American Journal of Preventative Medicine*, 11(3): 30-33 Supplement.

STEYN, S.; SMIT, C.; DU TOIT, J. & STRASHARM, C. (1998). *Moderne statistiek in praktyk*. Pretoria: Strasharm.

STEYN, H.S. (1999). *Praktiese beduidendheid. Die gebruik van effekgroottes. Wetenskaplike Bydraes, Reeks B: Natuurwetenskappe nr. 117*. Potchefstroom: PU vir CHO, Publikasiebeheer-komitee.

STORM, D.S.; BOLAND, M.G.; GORTMAKER, S.L.; HE, Y.; SKURNICK, J.; HOWLAND, L. & OLESKE, J.M. (2005). Protease inhibitor combination therapy, severity of illness and quality of life among children with perinatally acquired HIV-1 infection. *Pediatrics*, 115(2): e173-e182.

THORNE, C. & NEWELL, M. (2000). Epidemiology of HIV infection in the newborn. *Early Human Development*; 58: 1-16.

UNAIDS. (2004). "*AIDS epidemic update*." Hyperlink [http://www.unaids.org/wad2004/EPI_1204_pdf_en/EpiUpdate04_en.pdf]. Retrieved 19 February 2005.

UNAIDS. (2006). "*Overview of the global AIDS epidemic*". Hyperlink [http://data.unaids.org/pub/GlobalReport/2006/2006_GR_CH02_en.pdf]. Retrieved 20 June 2007.

WACHSLER-FELDER, J.L. & GOLDEN, C.J. (2002). Neuropsychological consequences of HIV in children: a review of current literature. *Clinical Psychology Review*, 22: 441-462.

WOLTERS P.L.; BROUWERS, P. & MOSS, H.A. (1995). Pediatric HIV disease: effects on cognition, learning and behavior. *School Psychology Quarterly*, 10:305-328.

Prof. Anita Pienaar: School of Biokinetics, Recreation and Sport Science, North-West University (Potchefstroom Campus), Private Bag X6001, Internal Box 616, Potchefstroom 2520, Republic of South Africa. Tel.: +27 (0)18 299 1796, Fax.: +27 (0)18 299 1796, E-mail: anitapienaar@nwu.ac.za

(Subject editor: Dr. G.K. Longhurst)