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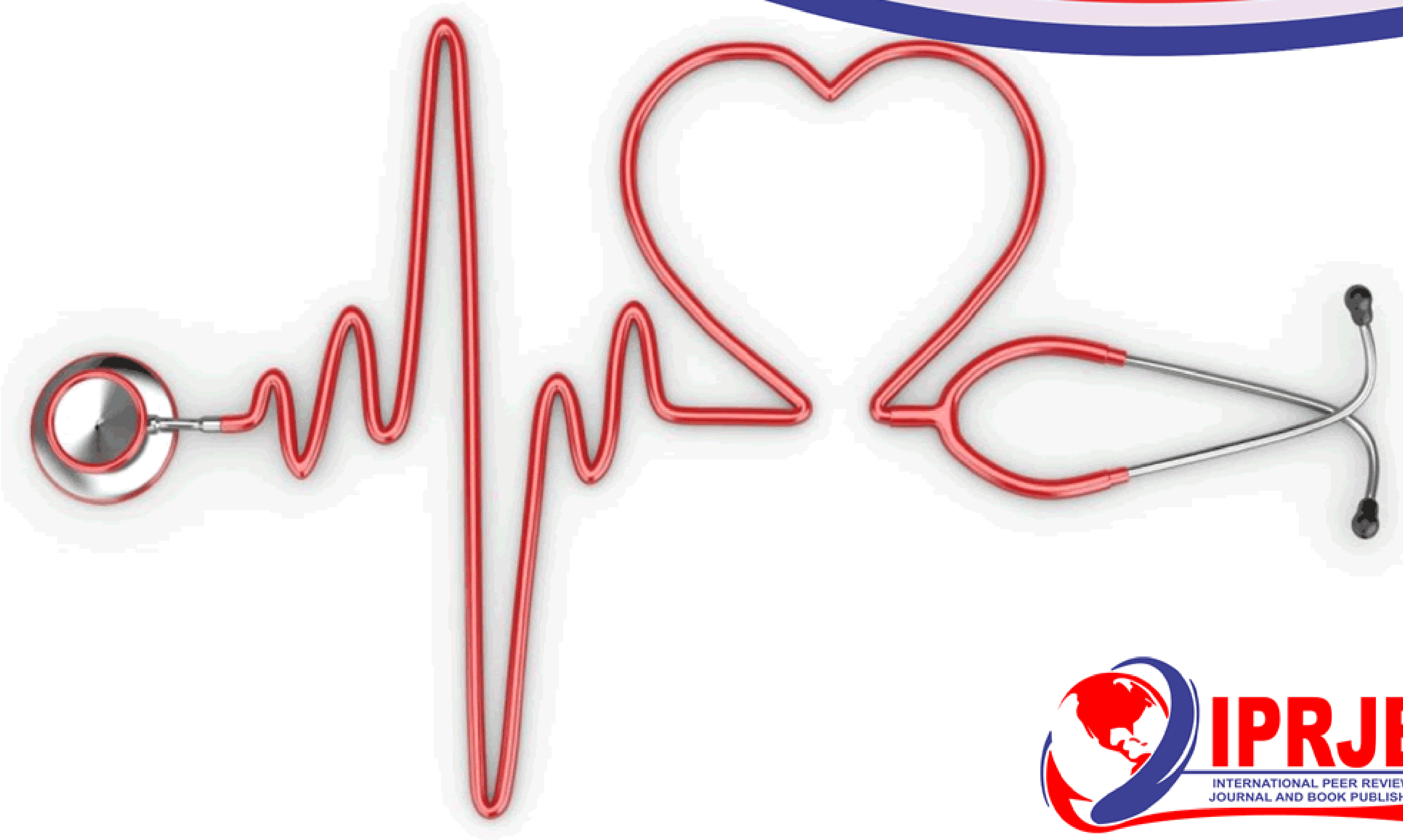

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EFFECTS OF NUTRITION SUPPORT ON ATTAINMENT OF MOTOR SKILLS MILESTONES IN CHILDREN RECEIVING ANTIRETROVIRAL THERAPY (ART) IN SELECTED SLUMS OF NAIROBI, KENYA

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Abstract

Purpose: To assess effect of nutrition support on achievement of motor developmental milestones in HIV-infected children on ART in urban resource-poor settings of Nairobi, Kenya.

Methodology: Quasi experimental study design, carried out in eight slum areas of Nairobi. Two hundred and sixty (260) HIV-infected children (aged 6-59 months) on ART were randomly selected from eight comprehensive care centres (CCCs) and followed for a period of up to six months.

Findings: Nutritional support did not significantly contribute to attainment of neither gross motor (AOR=2.45; 95% CI: 0.81-7.46; P=0.114) nor fine motor skills milestones (AOR=1.08; 95% CI: 0.33-3.51; P=0.904) in HIV-infcted children.

Unique contribution to theory, practice and policy: The study provides insights that are critical in enabling programmes providing support to HIV-infected children consider additional factors such as environmental, treatment and educational interventions to their nutrition interventions. The findings of study can also be used to inform policy with regard to effectiveness of interventions in concretely addressing care and management of HIV and AIDS among young children in general and in resource poor settings in particular.

Keywords: *Nutrition, motor skills, children, HIV*

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1.0 INTRODUCTION

Globally, the most efficient and cost-effective way to tackle paediatric HIV is to reduce mother-to-child transmission (MTCT) (WHO, 2012). However, every day there are nearly 1500 new infections in children under five years of age where more than 90% of them occur in developing world, majority being associated with MTCT (WHO, 2014b). In Kenya, there are about 11,000 new child infections annually according to the National HIV estimates (National AIDS Control Council & National AIDS & STI Control Programme, 2014)). HIV-infected infants frequently present with clinical symptoms in the first year of life (Kellerman *et al.*, 2013; Brahmbhatt, *et al.*, 2006). This consequently affects their overall growth and development, including their physical and motor skills. Growth and development of HIV-infected children are further complicated by lack of nutritious foods necessary to boost normal growth and development, especially in limited resource settings (Magadi, 2011).

HIV-infected infants often present with chronic diarrhoea, oral candidiasis and failure to thrive. Early central nervous system findings include loss or delay in motor skills, irritability and poor head growth (Arpadi, 2005). Significant motor deficits have been shown to occur with increased frequency among HIV-infected children, beginning in infancy (Hamadani *et al.*, 2013; Ferguson, and Jelsma, 2009). These abnormalities cannot be accounted for by other biological or environmental risk factors. Evidence has however shown that with early interventions which include treatment, growth monitoring and proper nutrition, HIV-infected children can lead a relatively healthy life (WHO, 2014b).

Although data is often taken in the course of a child's treatment, there has been no systematic analysis to show possible effect of nutrition on infants and children on ART. In part, this study worked to fill the systematic gap of linking growth and development of HIV-infected children to ART and nutrition. Studies examining the benefits of macronutrient interventions for HIV-infected adults exist. However, there is a lack of substantial data on infants and children regarding effects of food-based supplementation in HIV care and treatment programmes in the developing world. Limited published information, abstracts and unpublished work are emerging regarding HIV-related outcomes such as viral load, CD4 counts (Mahlungulu *et al.*, 2007; Kadiyala and Rawat, 2014), clinical symptoms, coinfections, and hospitalizations (Hughes *et al.*, 2013; Manary *et al.*, 2007) even among the available adult studies. These studies indicate a correlation between nutrition and HIV. In children however, such data is limited. The gaps in information on the effects of nutrition support for children infected by HIV indicate a need for detailed systematic review of effect of food support that focus mainly on macronutrients and locally available foods on growth and development. This study in part provides some critical data that will alleviate the aforementioned shortcomings regarding effects of nutritional support, especially for young children.

2.0 LITERATURE REVIEW

2.1 Motor Skills Development and HIV in Children

There is a growing body of knowledge from child development literature indicating that multiple factors contribute to developmental delay in chilren. Many of these factors are common within families affected by HIV and AIDS (Mda, 2015). Children with HIV infection are at increased risk of developmental and behavioural challenges. HIV-infected children are at risk of potential impact from the virus, of antiretro-viral treatment (ART) and environmental factors that are known to affect cognitive development. Reduced stimulation is a predictor of poor cognitive performance. In households where poverty and illness occur, parental responsiveness and environmental richness may be reduced (Ashton et al., 2010). Several risk factors of HIV infection have been documented as risks for reduced cognition delayed child developmental. Risk factors such as alcoholism, drug use, mental health disorders, chronic family illness and multiple stresses have been shown to exercebate HIV infecton (Sherr *et al.,* 2014).

Research indicates that children with HIV display a variety of neuro-developmental, cognitive, motor and nutritional deficiencies (Bagenda *et al.,* 2013; Hamadani *et al.,* 2013). HIV infects the developing Central Nervous System (CNS) of children and the virus is known to enter the CNS early in the course of the disease (Chang *et al.,* 2010; Fergusson *et al.,* 2009). Since the first reports of pediatric AIDS in the 1980s, delayed neurodevelopment has been a well-recognized complication of HIV disease (Kulkarni *et al.*, 2012). Both motor and cognitive development are affected and delay may present despite the initiation of anti-retroviral therapy (ART). Even without the influence of opportunistic infections, motor performance has been found to be about 75% of the level of typical development of children (Ferguson and Jelsma, 2009). Observational evidence suggests a robust positive association between linear growth during the first 2 years of life with cognitive and motor development (Christopher *et al.,* 2015).

Based on a review of related literature, cognitive challenges in HIV-infected children was evident albeit that most of these studies were conducted in developed world (Hamadin *et al.,* 2013). Although there is increased focus in SSA, no studies focused on the effects of nutrition support (a key predictor of treatment outcomes in SSA resource poor setting) and on a control group that was on ART. Majority of the studies focused on ‘normal’ (non-infected controls) and indicated a gap in scope to cover significant insight on the role of nutrition support for interventions in resource poor setting (Lachman, *et al.,* 2014).

Despite the shortcomings of the data, the challenge to synthesize results of the studies and broad umbrella of cognitive and behavioural performance, the recent updates of the topic show clear on-going evidence that children with HIV may well have special educational needs and face prospect of cognitive delay in some domains of functioning (Hamadani, *et al.*, 2013). The results from these further suggest that routine cognitive monitoring for such children from an early age and on a regular basis with appropriate interventions can ameliorate or cater for the cognitive function needs of infected children. Early child development and stimulation may particularly be relevant for young children, despite the paucity of data of young age groups (Higgins & Green, 2011).

Skovdal *et al.* (2013) advocated for the need to develop interventions that address various aspects of SDH including integration of psychosocial support programmes into clinical care and/or establishment of partnership and health referral systems to allow health facility providing nutrition and treatment sign up poor HIV-infected children to child development programmes. In a systematic review of cognitive performance studies by Sherr *et al.* (2014) among children living with HIV, it was confirmed that children living with HIV are at increased risk of cognitive delay compared to their HIV- negative peers. This disposition was attributed to children's biological responses to the virus and treatment as well as social factors, such as parental responsiveness and environmental richness, and cements the need for early childhood development programmes and more targeted health service to cater for better cognitive development of the children (Saaka & Shaibu, 2013).

Further, Skeen *et al*. (2014) compared developmental outcomes of children living with and without HIV at community and reported that child-based organizations. As most studies are confined to clinical studies, children living with HIV were more likely to have developmental difficulties and had greater likelihood to be living with a sick family member and not regularly attending school. Despite being in greater need, they also found children living with HIV were comparatively less likely to participate in early child development and educational support programmes offered by community organizations. Based on the findings the review by Sherr *et al*. (2014) suggested that for better outcomes health services, including community-based programmes, needed to be sensitive to the individual developmental requirements especially to children living with HIV.

Early studies in United States and Europe indicate that there is possibility that HIV-CNS involvement prior to setting of significant immunosuppression and the condition for the first AIDS-defining illness in as many as 18% of pediatric patients (European Collaborative Study, 1992). HIV-related encephalopathy can present as static or progressive HIV encephalopathy, with microcephaly, delay or loss of developmental milestones (motor, mental and language), and pyramidal tract symptoms (Belman, 1988). Prior to introducing HAART, encephalopathy was reported in 35% to 50% of children who consequently progressed to AIDS status in the United States (Rossit, 2007). HAART has beeen reported to prevent and reverse encephalopathy and with the introduction in the United States incidence of encephalopathy reduced to <2% (*ibid*). However more studies were recomended to cushion for differences in populations especially in Africa where there are differences in environmental and resource settings, coupled with high prevalences of malnutrition, malaria, tuberculosis and opportunistic infections, and substantially different child-rearing environments.

Relatedly, a study of Rwandan children of 6 months to 2 year, observed that about 40% of HIV-infected children had an abnormal neurodevelopmental examination at 18 months compared to only 5% of HIV-exposed but uninfected children. The gross motor scores were reported significantly lower at all measurement points for HIV-infected children (Peter, 2008). In another study in the Democratic Republic of Congo (DRC), it was reported developmental impairment occured in both asymptomatic HIV-infected children and HIV-exposed, but uninfected children compared to control children. The findings supported the idea that possibly there may be a compounding effect by environmental components to delay developmental indicators when HIV is in the CNS (Callens, 2009). The theory was further supported in a study of Ugandan children from birth to 2 years found that HIV-infected infants not only scored lower in mental and motor development but also demonstrated greater deceleration in their rate of motor development compared with HIV-exposed, uninfected infants and a control group (Drotar *et al.,* 1999). The phenomenon was also documented in Tanzania that developmental scores decreased with increasing age, and suggested a cumulative risk for poor neurodevelopment arising from HIV, poverty, and stress in families which care for HIV-infected individuals (McGrath *et al.,* 2006).

Van Rie *et al.* (2009) studied pre-school children the Democratic Republic of Congo (DRC) and showed that the HIV-positive children had lower mean scores for both motor and mental developemnt compared to unaffected children. Comparatively, studies of cognitive effects of HIV in adults to those in children similarly reflect the need for regular assessment of neurocognitive functioning in HIV patients, especially if there is evidence of deterioration or change in clinical status (Bagenda *et al.*, 2013).

3.0 METHODOLOGY

The study employed a quasi-experimental design with two parallel groups. One group comprised HIV-infected children on ART and receiving food support, and the other group consisted of HIV-infected children on ART and not receiving food support. A total of 260 study participants aged 6-59 months were enrolled into the study together with their mothers or guardians. The children were enrolled from eight CCCs managed by the Lea Toto Programme. All the recruited study children were required to attend the CCCs once a month to undergo routine assessment by the CCC staff. Those in the food support group were given supplies to last them until the next visit. For purposes of the study, assessment of motor skills developmental milestones through observation was conducted at mid and end point, namely the third and sixth month after enrolment.

Data collection tools were developed to gather primary data through interviews and Focus Group Discussions (FGDs) with mothers/guardians of the study children and health workers. Data sheets were also developed to guide collection of data on observable fine and gross motor skills. The tools were pretested to check their reliability and validity for data collection. Information from questionnaires was entered into excel or Epi-info data sheets and analysed using the statistical package for social science (SPSS). Ethical Approval and scientific clearance was sought from the KEMRI Scientific Steering Committee (SSC) and the National Ethical Research Committee (ERC).

4.0 FINDINGS AND DISCUSSIONS

A total of 260 participants were studied. They comprised 151 (58.1%) and 109 (41.9%) participants in the experimental and control group respectively. The study children's demographic characteristics are shown in Table 1.

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Table 1: Distribution of Study Children's Demographic Characteristics at Baseline

	Study pop. (n=260) n (%)	ART only (n=109) n (%)	ART + Food (n=151) n (%)	χ^2 value	p value
Age of child in months					
6 -11	31 (11.9)	15 (13.8)	16 (10.6)	8.573	0.380
12-17	23 (8.8	10 (9.2)	13 (8.6)		
18- 23	20 (7.7)	10 (9.2)	10 (6.6)		
24-29	20 (7.7)	7 (6.4)	13 (8.6)		
30-35	18 (6.9)	11(10.1)	7 (4.6)		
36-41	28 (10.8)	11 (10.1)	17 (11.3)		
42-47	23 (8.8)	10 (9.2)	13 (8.6)		
48-53	44 (16.9)	20 (18.3)	24 (15.9)		
54-59	53 (20.4)	15 (13.8)	38 (25.2)		
Sex of child					
Male	126 (48.5)	53 (48.6)	73 (48.3)	0.002	0.965
Female	134 (51.5)	56 (51.4)	78 (51.7)		

The ages of the study children at baseline ranged from 6 to 59 months with a mean age of 35.7 months (SD=17.2). The males were 126 (48.5%) and the females were 134 (51.5%). There was no statistical difference in the demographic characteristics of the children by study group (P>0.05).

4.1 Socio-Demographic Characteristics of Study Children's Caregivers

The caregivers' ages at baseline ranged from 16 to 45 years with a mean age of 28.2 years. The majority of the caregivers, 254 (97.7%), were female. One hundred and seventy nine (68.8%) had primary education and 175 (67.3%) were married. Christianity was the dominant region comprising 95.8% of respondents. One hundred and thirty three (59.9%) of the caregivers had lived in the study areas for a period ranging between 4 to 6 years with only 14 (6.4%) having resided in the study areas for a period exceeding 10 years. Results of the socio-demographic characteristics of the guardians are shown in Table 2.

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Table 2: Distribution of Respondents by Socio-Demographic Characteristics

	Study Pop. (n=260) n (%)	ART only (n=109) n (%)	ART + Food (n=151) n (%)	χ^2 value	p value
Age in years					
16-25	54 (20.8)	25 (22.9)	29 (19.2)	1.274	0.529
26-35	158 (60.8)	67 (61.5)	91 (60.3		
36-45	48 (18.5)	17 (15.6)	31 (20.5)		
Sex					
Male	6 (2.3)	3 (2.8)	3 (2.0)	0.165	0.685
Female	254 (97.7)	106 (97.2)	148 (98.0)		
Education attainment					
No formal education	19 (7.3)	12 (11.0)	7 (4.6)	4.575	0.102
Primary	179 (68.8)	75 (68.8)	104 (68.9)		
Secondary	62 (23.8)	22 (20.2)	40 (26.5)		
Marital status					
Single	35 (13.5)	15(13.8)	20 (13.2)	1.799	0.407
Married	175 (67.3)	69 (63.3)	106 (70.2)		
Separated/ Divorced	50 (**19.2)**	25 (22.9)	25 (16.6		
Religious affiliation					
Christian	249 (95.8)	105 (96.3)	144 (95.4)	0.146	0.703
Other	11 (4.2)	4 (3.7)	7 (4.6)		
Duration of stay in study area					
1-3 years	72 (31.1)	35 (28.1)	77 (26.2)	8.290	**0.040**
4-6 years	133 (59.9)	53 (45.6)	80 (61.8)		
7-9 years	41 (18.6)	23 (22.8)	18 (15.1)		
>10 years	14 (6.4)	10 (9.9)	4 (3.4)		

With the exception of the duration of residence in the study area ($\chi2$=8.290, df=3, P=0.040), there were no significant differences ($P<0.05$) in the socio-demographic characteristics of respondents between the two study groups. A higher proportion of respondents in the experimental group had lived in the study area for longer durations of time compared to those in the control group.

4.2 Respondents' Household Characteristics

The average household size was 4 members, with a majority of households (65.4%), consisting of 4 to 6 members. Results of the respondent's characteristics are as presented in Table 3.

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Table 3: Socio-Economic Characteristics of Respondents' Households

	Study pop. (n=260)		**ART only (n=109)**		**ART + Food (n=151)**		**χ^2 value**	**df**	**p value**
	n	**%**	**n**	**%**	**n**	**%**			
Household size									
1-3	44	16.9	20	18.3	24	15.9	1.261	2	0.532
4-6	170	65.4	73	67.0	97	64.2			
7-9	46	17.7	16	4.7	30	19.9			
Number of adults in the household									
1-3	231	88.8	94	86.2	137	90.7	1.288	1	0.256
4 or more	29	11.2	15	13.8	14	9.3			
Number of children 6-17 years									
1-3	210	80.8	88	80.7	122	80.8	<0.001	1	0.99
4 or more	50	19.2	21	19.3	29	19.2			
Number of children below 5 years									
1-3	256	98.5	109	100.0	147	97.4	2.933	1	0.087
4 or more	4	1.5	0		4	2.6			
Source of income in the last month									
None	13	5.0	5	4.6	8	5.3	0.227	3	0.973
Small scale business	26	10.0	11	10.1	15	9.9			
Casual labour	215	82.7	90	82.6	125	82.8			
Regular employment	6	2.3	3	2.8	3	2.0			
Average monthly income									
<1000	59	22.7	11	10.1	48	31.8	17.011	2	**<0.001**
1001-3000	157	60.4	77	70.6	80	53.0			
3001-5000	44	16.9	21	19.3	23	15.2			

Results of household composition shows that 88.8% of the households had between 1and 3 adult members, 80.8% of the households had children aged 6-17 years and only 1.5% of households had more than 3 children below the age of 5. There were no significant differences in the household size and composition between the study groups (P<0.05). Most of the caregivers (82.7%) engaged in casual labour to earn an income in the month preceding the survey. The experimental group had significantly lower incomes (χ^2=17.011, df=2, P<0.001) than the control group.

4.3 Respondents' Household Food Availability

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Nearly all (97.7%) respondents purchased their food with no significant difference (P=>0.05) in the proportion of those who purchase food between study groups. However, a significantly higher proportion of respondents (P=<0.001) in the experimental group received food from well-wishers compared to those in the control group. Results of respondents' household food availability are summarized in Table 4.

Table 4: Distribution of Food Availability among Respondents

	Study pop. (n=26(		ART only (n=10		ART + Food (:				
	n	**%**	**n**	**%**	**n**	**%**	**χ valu(**	**df**	**p valu(**
Source of food for the household									
Purchase	254	97.7	106	97.2	148	98.0	0.165	1	0.685
Well-wishers	64	24.6	13	11.9	51	33.8	16.284	1	**<0.001**
Daily expenditure on food									
<100	172	66.2	70	64.2	102	67.5	0.853	2	0.653
101-300	77	29.6	33	30.3	44	29.1			
>300	11	4.2	6	5.5	5	3.3			
Meals study child consumes per day									
More than three	89	34.2	32	29.4	57	37.7	2.537	2	0.281
Breakfast, lunch and	148	56.9	65	59.6	83	55.0			
Two	23	8.8	12	11.0	11	7.3			
Do other household members eat similar number of meals as study child?									
Yes	182	70.0	82	75.2	100	66.2	2.444	1	0.118
No	78	30.0	27	24.8	51	33.8			

Most of the respondents' (66.2%) daily expenditure on food was less than one hundred shillings with no significant difference between the study groups. Over half of the respondents (56.9%) indicated that the study child consumed three main meals in a day with no significant differences in number of meals consumed by the study children between the study groups. A majority (70.0%) of the respondents' household members consumed similar number of meals as the study child.

4.4 Assessment of Dietary Pattern among Study Children

Table 5 details weekly consumption of various food types by children in the two study groups during the three study phases.

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Table 5: Weekly Consumption of Food Groups among Study Children by Study Group

	Baseline			**Midpoint**			**Endpoint**		
	ART only (n=109)	**ART + Food (n=151)**	**p value**	**ART only (n=109)**	**ART + Food (n=151)**	**p value**	**ART only (n=109)**	**ART + Food (n=151)**	**p value**
	n(%)	**n(%)**		**n(%)**	**n(%)**		**n(%)**	**n(%)**	
Cereals	95 (87.2)	134 (88.7)	0.697	101 (92.7)	138 (91.4)	0.711	104 (95.4)	144 (95.4)	0.985
Roots/tubers	100 (91.7)	139 (92.1)	0.928	99 (90.8)	141 (93.4)	0.446	94 (86.2)	139 (92.1)	0.129
Meat	104 (95.4)	142 (94.0)	0.628	103 (94.5)	144 (95.4)	0.751	100 (91.7)	137 (90.7)	0.776
Vegetables	96 (88.1)	143 (94.7)	**0.053**	100 (91.7)	145 (96.0)	0.144	103 (94.5)	148 (98.0)	0.126
Pulses	85 (78.0)	115 (76.2)	0.731	83 (76.1)	118 (78.1)	0.704	86 (78.9)	121 (80.1)	0.808
Fruits	107 (98.2)	145 (96.0)	0.324	107 (98.2)	148 (98.0)	0.930	108 (99.1)	147 (97.4)	0.316
Dietary diversity score									
Low (1-3)	12 (11.0)	12 (7.9)	0.331	7 (6.4)	6 (4.0)	0.643	5 (4.6)	2 (1.3)	0.260
Moderate (4-5)	21(19.3)	40 (26.5)		32 (29.4)	43 (28.5)		35 (32.1)	47 (31.1)	
High (>5)	76 (69.7)	99 (65.6)		70 (64.2)	102 (67.5)		69 (63.3)	102 (67.5)	

At baseline, the proportions of children consuming different food groups in ART only arm compared favorably to those in the ART and food group. Different food types including cereals (87.2% vs. 88.7%; P=0.697), root tubers (91.7% vs. 92.1%; P=0.928), meat (95.4% vs. 94.0%; P=0.628) were consumed in almost equal proportions between the study groups at baseline survey except for vegetables, which were consumed by a higher proportion of those in the experimental group (88.1%vs.94.7% P=0.053).

At midpoint evaluation, there were no significant differences in the proportion of children consuming different food types between the control and experimental arms (P<0.05). Cereals were used in almost equal proportions between the two groups (92.7% vs. 91.4%; P=0.711). Similarly, of consumption of other food groups show that root tubers (90.8% vs. 93.4%; P=0.446), meat (94.5% vs. 95.4%; P=0.751), vegetables (91.7% vs. 96.0%; P=0.144), pulses (76.1% vs. 78.1%; P=0.704, and fruits (98.2% vs. 98.0%; P=0.930) were consumed in almost equal proportions between the control and experimental arms respectively.

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At end point, proportion of children consuming different food groups in ART only compared to ART + food arm was not significantly different: cereals (95.4% vs. 95.4%; P=0.985), root tubers (86.2% vs. 92.1%; P=0.129), animal products (91.7% vs. 90.7%; P=0.776), vegetables (94.5% vs. 98.0%; P=0.126), pulses (78.9% vs. 80.1%; P=0.808), and fruits (99.1% vs. 97.4%; P=0.316).

The dietary diversity patterns were comparable between the study arms during the three study phases (P=0.331 at baseline; P=0.643 midpoint and P=0.260 end point, respectively).

4.5 24 Hour Recall on Consumption of Three Main Meals among Study Children

Results of 24 hour recall on consumption of three main meals and an analysis of whether the food consumed was balanced is as shown in Table 6.

Table 6: 24 Hour Recall and Consumption of Balanced Diet by Study Group

Baseline			Midpoint			End point		
ART only (n=109)	**ART + Food (n=151)**	**p value**	**ART only (n=109)**	**ART + Food (n=151)**	**p value**	**ART only (n=109)**	**ART + Food (n=151)**	**p value**
n(%)	**n(%)**		**n(%)**	**n(%)**		**n(%)**	**n(%)**	
Child ate all the three main meals								
96 (88.1)	137 (90.7)	0.489	90 (82.6)	129 (85.4)	0.532	89 (81.7)	129 (85.4)	0.414
Child ate a balanced diet for breakfast								
9 (8.3)	3 (2.0)	**0.017**	4 (3.7)	1 (0.7)	0.081	6 (5.5)	1 (0.7)	**0.017**
Child ate a balanced diet for lunch								
16 (14.7)	6 (4.0)	**0.002**	6 (5.5)	4 (2.6)	0.237	4 (3.7)	3 (2.0)	0.408
The child ate a balanced diet for supper								
18 (16.5)	6 (4.0)	**0.001**	7 (6.4)	5 (3.3)	0.238	9 (8.3)	3 (2.0)	**0.017**

At baseline, consumption of the three main meals (breakfast, lunch, and supper) was not significantly different between the ART only and ART + food study arms (88.1% vs. 90.7%; P=0.489). However, a significantly lower proportion of children in the ART + food arm consumed a balanced diet on the three main meals compared to the ART only arm; breakfast (8.3% vs. 2.0%; P=0.017), lunch (14.7% vs. 4.0%; P=0.002), supper (16.5% vs. 4.0%; P=0.001) at baseline.

Like at baseline survey, there was no significant difference in the proportion of children consuming three main meals (breakfast, lunch, and supper) between the ART only and ART + food group (82.6% vs. 85.4%; P=0.532). Likewise, there were no significant differences in the proportion of children consuming a balanced diet on the three main meals in the ART only compared to ART + Food (breakfast 3.7% vs. 0.7%; P=0.081, Lunch 5.5% vs. 2.6%; P=0.237 and supper (6.4% vs. 3.3%; P=0.238) during midpoint evaluation.

Consumption of three main meals among children by study groups at end point evaluation was not significantly different between ART only and ART + food group (81.7% vs. 85.4%; P=0.414). However, the proportion of children consuming a balanced diet on two of the three main meals - breakfast (5.5% vs. 0.7%; P=0.017) and supper (8.3% vs. 2.0%; P=0.017) - was significantly different between the two study groups. A higher proportion of children in the ART only group ate balanced meal for breakfast and supper compared to those in the ART + food group.

4.6 Attainment of Gross Motor Skills Milestones

Table 7 shows results of the attainment of gross motor skills milestones between and within study arms.

Table 7: Attainment of Gross Motor Skills between and within Study Arms

	ART only (n=109)		**ART + Food (n=151)**		**χ^2 value**	**df**	**p value**
	n	**%**	**n**	**%**			
Attainment of gross motor skills: Baseline							
	84	77.1	125	82.8	1.312	1	0.252
Attainment of gross motor skills: Midpoint							
	103	94.5	141	93.4	0.137	1	0.711
% change: Midpoint – Baseline		17.4		10.6			
χ^2 value		13.576		8.074			
p value		**<0.001**		**0.004**			
Attainment of gross motor skills: End point							
	104	95.4	136	90.1	2.549	1	0.11
% change: End point – Baseline		18.3		7.3			
χ^2 value		15.461		3.415			
p value		**<0.001**		**0.065**			

The analysis showed no significant differences in attainment of gross motor skills milestones between the two study arms during the three study phases (P>0.05). At baseline, the two study arms showed no statistically significant differences (P=0.252) in the proportion of children attaining gross motor skills milestones, with 77.1 % of children in the ART only arm compared to 82.8% in the ART and food arm having attained the gross motor skills in their age category. Similarly, at midpoint evaluation, there were no significant differences (P=0.711) in the proportion of children who had attained their motor skills: 94.5% vs 93.4% in the ART arm only and ART and food arm. At end point evaluation, 95.4% of children in the ART only arm compared to 90.1% in the ART and food arm had attained their gross motor skills. The differences in the two study arm were not statistically significant (P=0.110).

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Within the ART only arm, the proportion of children who attained gross motor skills milestones for their age increased significantly (P<0.001) from 77.1% at baseline to 94.5%% at midpoint evaluation. Within the ART and food arm for the same duration, the change from 82.8% at baseline to 93.4% at midpoint was also significant, (P=0.004). After six months intervention, there were significant changes (P<0.001) within the ART only arm with the proportion of children attaining gross motor skills milestones increasing from 77.1% at baseline to 95.4% at end point evaluation. Within ART and food arm for the same duration, the change from 82.8% at baseline to 90.1%.at end point evaluation was also statistically significant (P=0.065).

An analysis of the effect of food support on attainment of gross motor skills milestones among children at end point adjusting for baseline and midpoint attainment is presented in Table 8.

Table 8: Effect of food support on attainment of gross motor skills milestones among children at end point adjusting for baseline attainment, midline attainment, and consumption of balanced diet for the three main meals (Breakfast, Lunch, and Supper)

Variables	AOR	95% CI		p value
		Lower	**Upper**	
Study arm				
ART only	1.00			
ART + Food	2.45	0.81	7.46	0.114
Child attainment of the gross motor skills: Baseline				
Yes	1.61	0.53	4.94	0.403
No	1.00			
Child attainment of the gross motor skills: Midpoint				
Yes	12.22	3.66	40.79	**<0.001**
No	1.00			

An analysis of the effect of food support on attainment of gross motor skills milestones among children at end point adjusting for baseline and midpoint attainment showed that food support did not significantly contribute to attainment of gross motor skills milestones (AOR=2.45; 95% CI: 0.81-7.46; P=0.114) (Table 8).

5.7 Effect of Food Support on Attainment of Fine Motor Skills Milestones among Children

Table 9 shows the results of child attainment of the fine motor skills between and within study arms. There were no statistically significant differences in the children's attainment of gross motor skills milestones between the two study arms during the three phases of the study. At baseline, the proportion of children who attained their age-related fine motor skills milestones in the ART only arm (78.9%) was not significantly different from the one in ART and food arm (82.8%), (P=0.430). At midpoint evaluation, the proportion of children who attained their age-related fine motor skills milestones in ART only arm (93.6%) was not significantly different from the one in ART and food arm (87.4%), (P=0.102). Similarly, after six months of intervention, the proportion of children who attained the gross motor skills milestones in ART only arm (94.5%) was not significantly different from the one on ART + food arm (92.1%.9%), (P=0.444).

Table 9: Attainment of fine motor skills milestones between and within study arms

	ART only (n=109)		ART + Food (n=151)		χ^2 value	df	p value
	n	**%**	**n**	**%**			
Attainment of fine motor: Baseline							
	86	78.9	125	82.8	0.624	1	0.430
Attainment of fine motor: Midpoint							
	102	93.6	132	87.4	2.67	1	0.102
% change: Mid-Baseline		14.7		4.60%			
χ^2 value		9.895		1.28			
p value		**0.002**		0.258			
Attainment of fine motor: End point							
	103	94.5	139	92.1	0.586	1	0.444
% change: End-Baseline		15.6		9.3			
χ^2 value		11.495		5.9			
p value		**<0.001**		**0.015**			

Analysis of the attainment of gross motor skills milestones in within the ART only arm, showed a significant increase, (P=0.002), in the proportion of children attaining their age-related milestones from baseline to midline (78.9% vs. 93.6%) respectively. Within ART and food arm for the same duration, the change from 82.8% of the study children at baseline to 87.4% % at midpoint was not significant (P=0.258).

After six months of intervention, there were significant changes in the proportion of children attaining gross motor skills milestones in both arms. Within the ART only arm, the proportion of children who attained their age-related milestones increased significantly from 78.9% at baseline to 94.5% at end point (P<0.001). Within ART + food arm for the same duration, the change from 82.8% of children at baseline to 92.1% at end point evaluation was significant, (P=0.015).

The effect of food support on attainment of fine motor skills milestones among children at end point evaluation adjusting for baseline attainment, midpoint attainment, and consumption of balanced diet for the three main meals (Breakfast, Lunch, and Supper) is as shown in Table 10.

Table 10: Effect of food support on attainment of fine motor skills milestones among children at end line adjusting for baseline attainment, midline attainment, and consumption of balanced diet for the three main meals (Breakfast, Lunch, and Supper)

Variables	AOR	95% CI Lower	95% CI Upper	p value
Study arm				
ART only	1.00			
ART + Food	1.08	0.33	3.51	0.904
Child attainment of the fine motor skills: Baseline				
Yes	6.14	1.94	19.46	**0.002**
No	1.00			
Child attainment of the fine motor skills: Midpoint				
Yes	6.35	1.84	21.92	**0.003**
No	1.00			
The child ate a balanced diet for breakfast in the last 24 hours				
Yes	3.58	0.11	113.37	0.470
No	1.00			
The child ate a balanced diet for lunch in the last 24 hours				
Yes	0.82	0.04	16.75	0.898
No	1.00			
The child ate a balanced diet for supper in the last 24 hours				
Yes	0.68	0.03	15.72	0.811
No	1.00			

The analysis shows that food support was not significantly contributory to children's attainment of gross motor skills milestones (AOR=1.08; 95% CI: 0.33-3.51; P=0.904).

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The objective of this study was to assess the effect of a six month nutrition care and support intervention on growth and development of HIV-infected children, aged 6-59 months, on ART in a resource poor setting. The growth and development indicators measured were nutritional status and motor skills. To control for significant confounding factors, the study also assessed and analyzed the dietary and morbidity patterns of the study children in recognition that these may have a direct influence on the children‘s overall growth and development.

5.2 Discussion

The results of this study showed that attainment of gross and fine motor skills among children in the two study arms was not statistically different at baseline and end point (P=0.110 for gross motor skills and P=0.444 for fine motor skills). There was however a significant increase in the proportion of children who attained gross motor skills milestones for their age at midpoint evaluation within both study arms (P=0.001 vs. P=0.004, control vs. experimental respectively).

This significant improvement in gross motor developmental milestone of the study children in both study arms is corroborated by a meta-analysis of linear growth and child development in low and middle income countries (Sherr and Richter, 2013).) that indicated effective integrated interventions, such as those provided by the Lea Toto program, when coupled with integration with environmental and educational interventions, can produce larger positive effects and improve developmental outcomes even for immunosuppressed children.

The findings of this study however conflict with findings of a South African study on the prevalence of motor delay among HIV infected children living in Cape Town (Fergusson *et al.*, 2009). The South African study found that despite the initiation of ART and even without the influence of opportunistic infections, both motor and cognitive development of children below five were affected and delay in attainment of the related age-specific milestones occurred. Similarly, the results of this study differ from those in a study to determine how gross and fine motor skills were affected by HIV infection in children aged five years and younger (Smith *et al.*, 2002). The study showed that children who were HIV-positive performed below the 50th percentile of the normal reference population as a group.

While several studies have been carried out to assess attainment of developmental milestones in children with HIV (Sherr *et al.*, 2014; Ferguson and Jelsma, 2009; Van Rie *et al.*, 2008; Baillieu and Potterton, 2008; Blanchette *et al.*, 2001; Davis-Mcfarland, *et al.*, 2000; Epstein, 1986), these studies have mainly compared HIV-infected children with uninfected ones making it difficult to directly compare the results of this study with such findings. However, a majority of these studies have shown that development of HIV-infected children is generally compromised.

Adjusting for food support on attainment of gross motor skills at end point for baseline and midpoint, and consumption of balanced diet the results of this study showed that food support did not significantly contribute to attainment of gross motor skills milestones (AOR=2.45; 95% CI: 0.81-7.46; P=0.114). Similarly, adjusting for food support on attainment of fine motor skills at end point for baseline and midpoint, and consumption of balanced diet the results of this study showed that food support did not significantly contribute to attainment of gross motor skills milestones (AOR=1.08; 95% CI: 0.33-3.51; P=0.904). These finding reflects conclusions of a study of HIV-infected children that showed improvement in cognitive and motor development by children on HAART (Van Rie *et al.*, 2009). Similar to this study, it is unclear which component of the intervention in this study can be linked to the improvements seen over time, as children were provided with treatment for opportunistic infections, access to nutritional programmes and highly active antiretroviral treatment as appropriate. As noted by Van Rie, this is not entirely a problem of the current study because HIV is complex and requires all possible interventions to control for many of the variables that may contribute to the presence and cause of delay over time. In the current study like in other studies that were meta analyzed (Sherr *et al.*, 2014), the use of group mean scores makes it difficult to know if all the children are performing under a certain level, or if a small subgroup of children are performing particularly poorly and affecting the total mean.

Given that this study did not find nutrition support to significantly influence motor skills outcomes, this finding does not tally with researches that substantiate a need for additional intervention strategies such as improved nutrition and exercise programmes to improve the

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quality of life including development of motor skills for HIV-infected children (Parks and Danoff, 1999; Stein *et al.*, 1995; Brady, 1994). A probable explanation for the discrepancies is the fact that the above mentioned researches worked with children receiving nutritional support over a longer period of time than the current study. Additionally, the aforementioned researches intentionally focused on exercises that were targeted at motor skills as opposed to interventions in this study that were more generalised and broader in terms of type of care and support provided to children enrolled in the Lea Toto Program. This argument can further be interpreted and supported by conclusions drawn by Van Rie *et al.*, 2009). In their study of the effects of the HIV epidemic on the cognitive, motor, and language development of pre-school children in Kinshasa they found developmental impairment in both asymptomatic HIV-infected children and HIV-exposed, uninfected children compared with control children, supporting the idea that there may be an environmental component compounding the delay as a result of the presence of HIV. Based on findings of the current study, that indicate that food is not a contributor, and comparing it with Van Rie's conclusions, it can be argued that motor development skills are more likely to be influenced by environmental factors (including stimulation, response to medication), than by nutrition alone. A possible explanation for the significant improvement within each of the study arms could be that the study participants and programme staff were conscious of the fact that these aspects were being measured. Consequently, there might have been subconscious efforts in addressing motor skills development in the study children. This argument is in line with a study of American children that found HIV-positive children, under specific interventions and involved in research program, were more likely to receive greater attention and care compared other HIV-positive children or uninfected ones consequently influencing better outcomes (of the parameters under study) which they attributed to comprehensive multidisciplinary services and support (Chernoff *et al.*, 2009).

Various other studies measuring motor development in HIV-infected pre-school aged children have found mixed result, some which agree and others contrast findings of this study. A study by Baillieu and Potterton found no fine motor delay in 87.5% of their sample, compared to 71.9% in the current study (Baillieu and Potterton, 2008)). A study of Ugandan children from birth to 2 years found that HIV-infected infants not only scored lower in motor development but also demonstrated greater deceleration in their rate of motor development (Bagenda *et al.*, 2013), a finding contradicting findings of the current study that found deceleration or reduction in proportion of children with delays in motor development. This is in contrast to what was reported by South African and DRC studies (Lowick *et al.*, 2012; Fergusson, *et al.*, 2009) which found greater proportion of HIV-infected children to have delays in motor skills development compared to the current study. Ferguson and Jelsma's (2009) study found that only 9.8% of the HIV positive children from South Africa had motor performances within the normal limit, and only 8.8% of the children who had received antiretroviral treatment had a motor performance within the normal limit Lowick *et al.* (2012) also found that only 10% of the study children were in the total normal range using the Griffiths Mental Development Scales (GMDS) (Griffiths, 1970).). Van Rie *et al.* (2008) study of HIV-infected preschool aged children from the DRC found only 9% had no motor developmental delay.

The above citations however, as earlier indicated, compared HIV-infected children and those affected but not positive for HIV, and the study did not have a nutrition component. None the less, they provide critical data on HIV and aspects of cognitive development (motor skills) in children from resource- poor settings.

Based on results of this study, it is unclear whether nutritional support is not significantly linked to motor skills development of HIV-infected children on ART. This finding contradicts conclusions of an earlier study whose conclusion was that motor deficiencies of HIV infected children can be addressed by nutrition programmes (Petzer, 2008) Partly however, the same study's conclusion suggests intervention strategies, such as motor intervention, seem more relevant than nutrition interventions. This argument is supported by other studies of development in HIV infected children (Serchuck, *et al.*, 2010; Fergusson, *et al.*,2009) that gave nutrition as a factor to be considered indirectly in view that height and weight measures interact with performance (Isaranurug and Chompikul, 2009).

5.3 Conclusions

From the foregoing, food support did not contribute significantly to attainment of motor skills development. Despite this however, there was comparable status in terms of attainment of motor skills in the two study arms at end point. This can be deducted to mean that should the experimental arm children, due to their compromised household food security, not have had the support, there might have been a likelihood of poorer outcomes at end point.

5.4 Recommendations

The study recommends further research focussing on additional factors such as environmental factors response to medication, and programatic interventions that are likely to influence developemnt of motor skills.

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