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Undernutrition of HEU infants in their first 1000 days of life: A case in the urban-low resource setting of Mukuru Slum, Nairobi, Kenya

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ABSTRACT

Background: According to the Lancet, the successful chemoprophylaxis and the introduction of lifelong antiretroviral therapy programs to eliminate mother to child transmission of HIV has promoted the rise in number of HIV exposed uninfected (HEU) infants. In resource limited settings, these infants are at an increased risk of undernutrition due to risk factors such as low birth weight, food insecurity, household composition, income and improper feeding patterns. As several other studies have suggested, the risk factors vary from one setting to another. This paper delved into reviewing the predisposing undernutrition factors in relation to HIV exposure among infants within the low resource urban setting of Mukuru Slum, in Nairobi, Kenya.

Methods: A retrospective cohort study was performed on 160 mother/guardian-child pairs in Mukuru Slum, Nairobi, Kenya. Growth charts of the HIV exposed uninfected infants were studied against a control group of HIV unexposed uninfected infants (HUU). Interviews to collect information on socio economic status, household composition, HIV exposure, infant feeding practices and food insecurity related challenges were done. Data was analyzed using IBM SPSS version 20 and WHO anthroplus software. Descriptive statistics as well as Chi square, t-tests and multivariate analysis was done.

Results: Stunting among the HIV exposed uninfected infants was the most common form of undernutrition. ***38.9%*** of the HEU infants were severely stunted (LFAZ), while ***5.6%*** of them were severely wasted (WFLZ), while ***24.4%*** of them were severely underweight. The mean birth weights of the HEU infants ***(2.953kg)*** was lower than the HUU ***(3.195kg).*** HIV exposure was associated with lower Weight for Length Z score (WFLZ), Weight for Age Z score (WFAZ), Length for Age Z score (LFAZ), BMI for Age Z score (BAZ) and Middle Upper Arm Circumference Z score (MUACZ) ***($p<0.001$)***. HEU infants were more likely to live in households with lesser number of adults ***($p=0.016$)*** and higher number of children ***($p<0.001$)*** as compared to the HUU. Although exclusive breastfeeding was upheld among all infants, the HEU were more likely to rely on Food by Prescription supplements ***($p<0.001$)*** to meet their daily energy needs. Households with HEU infants were, however, less likely to receive food ***($p=0.041$).*** Overall the largest effect sizes on undernutrition of all infants was found to be affected by the age of children ***($\eta_p^2=0.439$; $p<0.001$)***, sex ***($\eta_p^2=0.135$; $p=0.001$)***, HIV exposure ***($\eta_p^2=0.351$; $p<0.001$)*** and food aid ***($\eta_p^2=0.083$; $p=0.021$).***

Conclusion: This study concluded that, HIV exposed uninfected infants in Mukuru were faced with a high undernutrition risk that was associated with HIV exposure, household composition, food aid and use of food by prescription supplements. These factors provide an insight when managing undernutrition among such infants in other resource limited settings. This study recommends future operational studies to inform HIV programs on exact ways to eliminate undernutrition among the rising number of HEU infants.

1. Introduction

Globally, it was estimated that a total number of 36.9 million people were living with HIV by 2017 (UNAIDS, 2018). A third of these people live in the sub-Saharan Africa, which includes about 90% of children living with HIV. Since the year 1996, the use of antiretroviral therapy (ART) among HIV infected expectant women has markedly resulted to the elimination of mother to child risk of transmission globally (Hofer

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et al., 2016). Subsequently, the number of HIV Exposed Uninfected (HEU) infants continues to increase with the availability of life-long combined antiretroviral therapies to almost all women across the world. Currently, it is estimated that 1.5 million HIV infected women become pregnant annually, which causes the HEU infants to experience numerous exposures during their fetal and early life. Significantly, the discovery of the ART therapy in the elimination of mother to child transmission during pregnancy, delivery and breastfeeding has been the highlight of success in fighting the HIV epidemic globally. In resource-limited settings, the use of ART therapies among women living with HIV has closely led to the achievement of 90% decrease in pediatric infections. By the year 2017, it was estimated that about 80% of the 1.5 million expectant women living with HIV were receiving ART (UNAIDS, 2018). This means that millions of infants born to these women have in-utero ARV exposure for the first 9 months of their life. These infants are also exposed to post-partum ART treatment as a prophylaxis for the first 3 months, and thereafter cotrimoxazole drugs until their HIV status tests negative; and most importantly risk factors that revolve around household and maternal challenges. All this happens within 1000 days of their life. Any health problems that could lead to their undernutrition and increase in number of infections could be associated to the HIV exposure, birth weight, household composition, food insecurity-related challenges, improper feeding techniques, or the income available within the settings they live in. However, there have been limited studies linking the exact challenges that cause the HEU infants to be more undernourished than their HUU counterparts living within similar socio-economic conditions. This is especially after the 2015 WHO directive that specified that all HIV expectant mothers' ought to receive lifelong ART treatment during their conception (AIDSinfo, 2016).

1.1. HEU infants in Kenya

Kenya has got a growing number of HEU newborns across the country due to the effective programs set up to eliminate mother to child transmission of HIV. Per HIV and AIDS estimates report in 2015, about 830,000 women were living with the virus in Kenya (UNAIDS, 2015). This means that if all these women who were aged 15 and over would give birth, their infants would add up to the already growing number of HEU children that are about 660,000 in Kenya currently (UNAIDS, 2015). The infants born to families living in resource limited settings are faced with several challenges that affect their nutrition status and potential growth.

In Mukuru Slum, one of the biggest urban settlements in Kenya, the prevalence of HIV is estimated to be about 12% compared to 5% among non-Slum residents and 6% in the rural settings (UNAIDS, 2015). Women and girls are potentially vulnerable to the increasing rate of new infections in the urban settings, thereby creating a foreseen increase in the number of HEU infants living within this setting. With a population of about 600,000 people, the Mukuru Slum is faced with lack of basic services such as food, housing, sanitation, healthcare, security among others (KNBS, 2015). The efforts of HIV health care services such as the Mater Hospital within the area have led to a considerable elimination of viral transmission up to about 89%. Despite this success, the outcomes of these infants are at stake with the underlying challenges that face them since conception, to birth and throughout their lives. Most crucially, their 1000 first days of life.

2. Methodology

This study was a retrospective cohort study of HEU infants participating in past perinatal HIV studies. The growth and development of these infants was monitored from the time they were born through to 2 years of age and compared to their counterpart group of HIV unexposed uninfected (HUU) infants using growth records from the Mater hospital. Anthropometric measurements were conducted, and determination of feeding habits was done within the households of infants in the study to determine their current nutrition status.

2.1. Study location

The study was carried out within Mukuru Slums in Nairobi. Mukuru Slum is characterized by a population of about 1 million people and is reported to be the leading region with the highest poverty levels in Nairobi. It is an informal settlement and a fast-growing Slum that is located about 5 kilometers from the city center. The Mater comprehensive care clinic serves to provide care and treatment for the households affected by HIV.

2.2. Target population

The target population of this study consisted of 2917 households in the Slum who live within a ten-kilometer radius of the Mater hospital, from which sampling was conducted. The study targeted households with infants 2 years and below who lived with at least one adult within the household, either directly or indirectly affected with HIV for the HEU group or living within the Slum and unaffected by the virus for the HUU group.

2.3. Sampling procedures

Mukuru location was randomly selected among other resource-limited settings of Nairobi. In specific, the region of Hazina that consisted of six villages had a random selection of 3 villages. Multistage sampling technique was used to select the study sample. The technique was useful because there was no adequate list of individuals in the population since the study was set in an urban settlement, with nomadic residents. A list of households in the area was obtained from the area chief during the first stage. Households with children below the age of 2 years were identified using snowball sampling technique. Through this sampling, the first subjects in the HUU group were identified, who then helped in naming others who also had households with infants 2 years and below until the number of cases needed was reached. The HEU sample was also randomly selected from the hospital records, matching the entry characteristics of mother/guardian-infant matches. Records from a food aid program running within the area were also used to identify households at risk of food insecurity.

A sample size of 10% of the accessible population was used it was expected that a total of 1604 children lived within the study area.

The households that were targeted were strictly those with infants aged 2 years and below whose mother/guardian-infant pairs were enrolled in the facility at the time of birth for the HEU group. Infants in the HUU category were recruited from health care and food security programs within the area. Infants were excluded if they died or were termed as lost to follow-up. The sample size was distributed as follows (see Tables 1 and 2):

2.4. Data collection instruments

2.4.1. Interviews

The interviews were administered to mothers and care givers in cases where the mother was unavailable. The interviews were done orally and

Table 1
Sample size.

Villages	Households with children 2 years and below	Children 2 years and below		
		HEU	HUU	Total
Kisii	653	33	32	65
Maasai	521	41	11	52
Hazina	430	16	27	43
Total	**1604**	**90**	**70**	**160**

Table 2
WHO cutoff points for undernutrition.

Indicator	Weight for Length (Wasting)	Weight for Age (Underweight)	Length for Age (Stunting)	MUAC
Severe	<-3 SD	<-3 SD	<-3 SD	<11.5cm
Moderate	<-3 SD to < -2 SD	<-3 SD to < -2 SD	<-3 SD to < -2 SD	≥11.5cm to <12.5 cm
Low	<-2 SD to < -1SD	<-2 SD to < -1SD	<-2 SD to < -1SD	12.5 cm
Normal	<-1 SD to <2 SD	<-1 SD to <2 SD	<-1 SD to <2 SD	>12.5 cm
Overweight	>2 SD	>2 SD	>2 SD	

included: review of demographic information, growth monitoring charts of the infants, household dietary practices, morbidity of children under 2 years, nutrition knowledge, food security related aspects, feeding practices since birth and the time of introduction of complementary foods.

2.5. Observation

Through observation, the researcher gathered information of what the household members practiced regarding their nutrition and not just what they reported during the study. This formed a crucial basis of evaluating the nutrition adequacy and status of the infants since their time of birth.

2.6. Pre-testing of the research instrument

Pre-testing of the interview was conducted among 10 respondents before the research. These were obtained from a different urban settlement in Kibera Slum. The sample tested acted as a guide to any improvements of the interview. Pre-testing helped to improve on the validity, reliability and clarity of the research instrument.

2.7. Data collection procedures

Data was collected using growth chart records obtained from the Mater Hospital, anthropometric measurements were also done using equipment from the hospital facility. These included collecting data about:

- ➢ Weight of the infants- A salter scale was used, and the weight of the infants taken with as little clothing as possible. The readings were taken to the nearest 0.1kg.
- ➢ Height of the infants-a height board was used, and the length of infants taken with the back of their head leaning on the board, and feet touching the board since they could not stand up steadily. The reading was taken to the nearest 0.1 cm
- ➢ Age was obtained from the growth card given to the child at the time of birth to ensure accuracy.
- ➢ Birth weight was also collected from the growth card issued at the time of birth
- ➢ Middle upper arm circumference- Arm circumference measurements were taken using a MUAC tape and recorded to the nearest 0.1cm

A questionnaire was used to inquire information about:

- Income-to identify whether the amount of income influenced the availability and accessibility of food within the households. The respondents were asked to answer questions that regarded to their income by answering whether their average income in a month fit within a certain range.
- Number of meals per day-to enumerate the number of meals taken by the infants in a typical day after their introduction into complementary food. This was specifically to infants who were six months of age and above.
- Household size- The respondents were asked to enumerate the number of adults who live within the household within a typical month. This was to assess whether this influenced the food security of the households due to the amount of income generated. As well, the study inquired about the total number of children living within the household in a typical month to assess how food was distributed and utilized among the infants.
- Food insecurity related variables-the study utilized some food security parameters to assess variables such as food availability, food utilization and food aid within households which would directly affect the quality, amount and feeding practices that could be adopted for infants within the study.
- Number of infants either breastfed or formula fed- The mothers or caregivers were asked whether they chose to breastfeed, or formula feed their infants since birth. This was to quantify the number of infants breastfed or formula fed, for both the HEU and HUU infants, to compare and correlate any relationships with their nutrition outcomes.
- The number of hospital visits of each child- The number of hospital visits was recorded to find out if it correlated with nutrition status or not. The study did not consider the reasons for hospital visits or admittance.
- Complementary food introduction- The mothers and the care givers were asked to respond about the time within which they chose to introduce solid foods to their infants. The data would allow for a better understanding of feeding practice preferences for the infants within the study.
- Mother/guardian knowledge about the interaction of (Anti-retroviral drugs) ARVs and food intake- The study recorded whether the mothers or guardians of the infants in the study attended classes on the knowledge of ARV and food intake interaction of both the infants and the mothers. These classes were mostly carried out within the hospital settings and other programs within the Slum area.
- ARV Exposure- Even though the Infant ARV exposure corresponded with Mother's exposure to ART treatment for the HIV Exposed Uninfected (HEU) group of infants, this information was useful to find out if this ARV exposure affected the infants in any way, regarding their birth weight and growth faltering regarding stunting, wasting or underweight.

2.8. Data analysis

Anthropometric measurements were analyzed using the WHO anthroplus software version 3.2.2 to obtain the Z scores of the infants. The Z-scores were used to determine nutritional status of children and categorized as either normal, stunted, wasted or underweight. The Nutrition status of the infants was analyzed and was compared to the WHO cut off points that were defined using the following criteria:

Data obtained was analyzed using the IBM SPSS statistics Version 20 software. This included analysis of the frequencies (percentages, means and standard deviation of the study population), t-tests, and correlation tests and multivariate tests. Pearson correlation was used to determine the degree of relationship between pairs of continuous variables.

Multivariate analysis of variance (MANOVA) was performed using a general linear model (GLM). The model was used to analyze the simultaneous effects of the predisposing factors on undernutrition represented by the Z scores. The factors that were analyzed in the model included: sex, exposure to HIV, Income, use of supplements, food aid, food utilization, food accessibility, food affordability, birthweight, age of infants, number of children in the household, number of adults in the household, and the number of meals. It was assumed that each dependent variable presented a normal distribution, and all observations were independent of all other observations. The tests also assumed the homogeneity of the covariances between the dependent and independent variables. The study also evaluated the effect size using the values of Pillai's trace partial eta squared (η^2). Variables without significant effect were removed

through a backward procedure. Cohen's effect size index was computed to summarize the qualitative effects between the variables (Cohen, 1977). This evaluation served as a reference to identify the overall effect size of the analyzed variables. As such, an indication of a large effect size meant that the evaluated variable had a great influence on the under-nutrition status of the infants. P-values for the study were considered statistically significant at 95% confidence levels ***(p=0.05)***.

The effect sizes were classified as follows:

- small ($\eta_p^2 < 0.030$),
- medium ($0.030 \leq \eta_p^2 < 0.100$) and
- large ($\eta_p^2 \geq 0.100$).

2.9. Ethical considerations

Permission to undertake the research was obtained from the Ministry of Health through the Project manager of the Comprehensive Care Clinic of the Mater Hospital. Informed consent to the mothers and care providers was provided both in English and Swahili. Confidentiality of all those who chose to participate was maintained. Information collected was also within discretion parameters. In return, caregivers of participating infants in the study received information about the nutritional status and referrals made for follow up about their status where necessary.

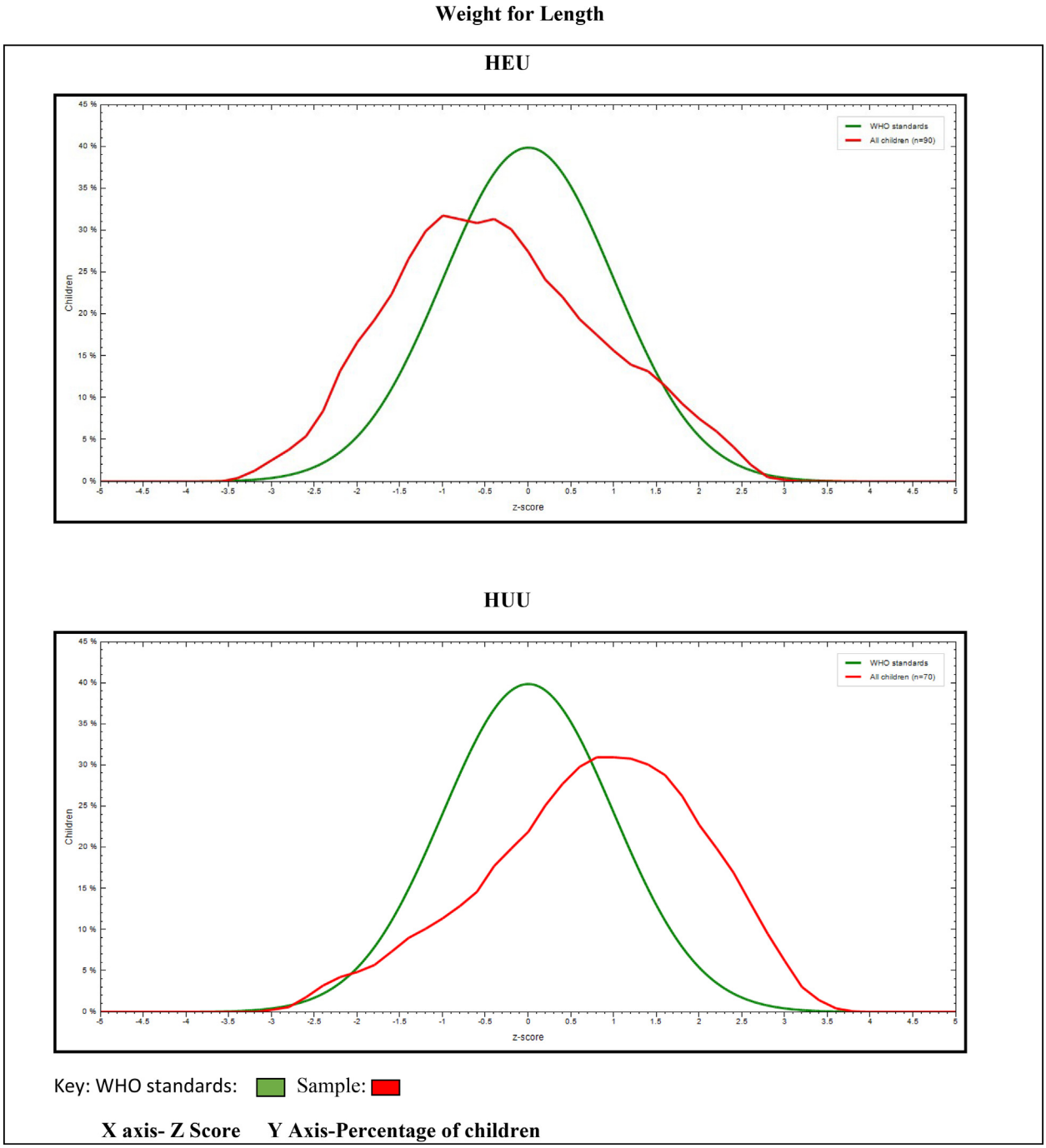

Fig. 1. Distribution of the Study population according to the Weight for length indices.

3. Results

Out of 160 infants, 90 were HEU and 70 HUU:
HEU (n = 90) Female: n = 48; Male: n = 42
HUU (n = 70) Female: n = 39; Male:n = 31
After computation of the Z scores, the study recorded differences in curve distribution between the study subjects and the WHO growth curves.

3.1. Weight for Length

Fig. 1 above shows that the HEU distribution curve shifted to the left

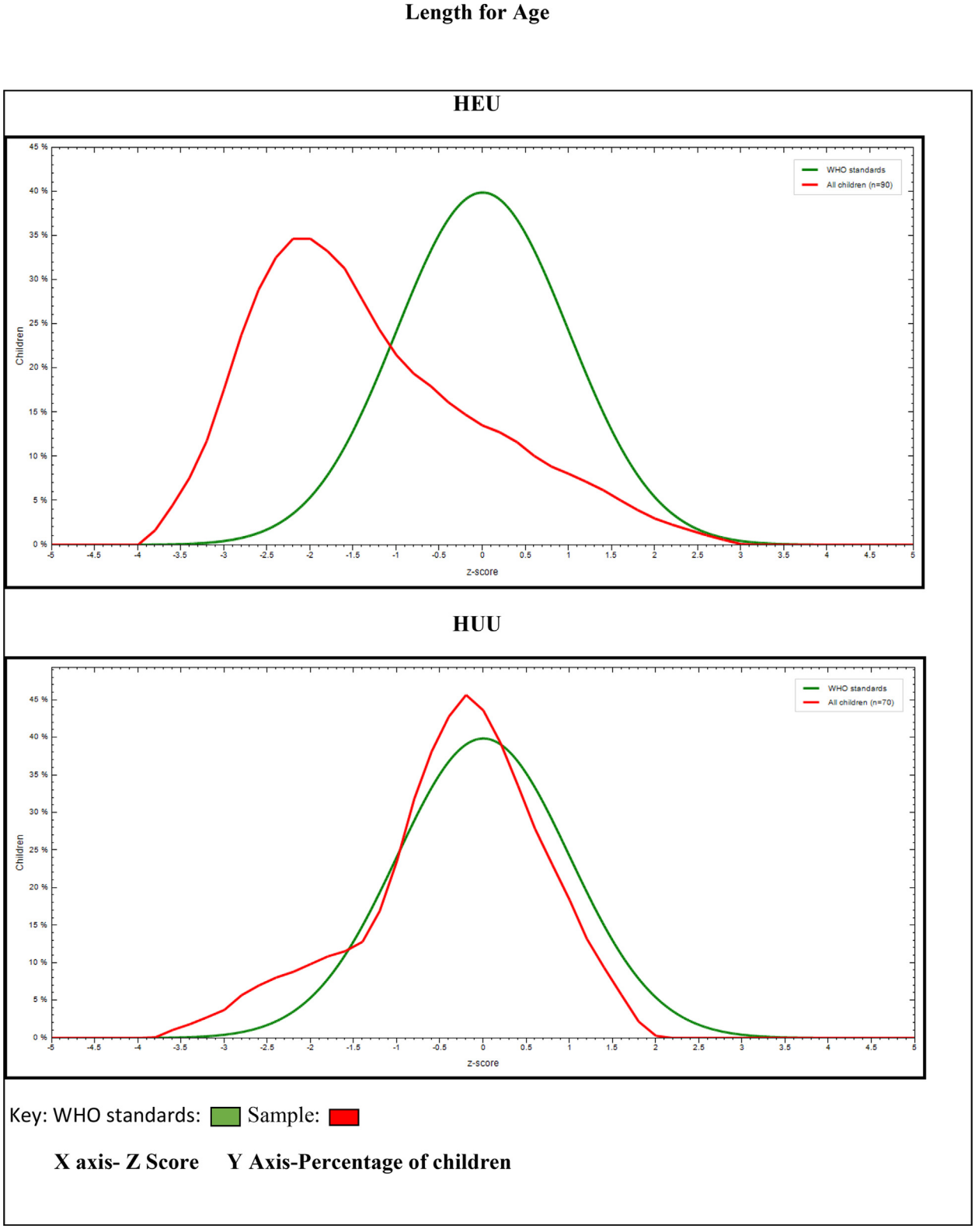

Fig. 2. Distribution of the study population according to the Length for Age.

when compared to the WHO standards. The HUU distribution curve shifted to the right when compared to the WHO reference curves. Thus, the median of the two groups, HEU and HUU was lower than that of the WHO standard.

3.2. Length for Age

Fig. 2 above shows that the length for age curve of the HEU infants was shifted towards the left and had a lower median as compared to the WHO reference curve. However, there was an almost coincidence on the sides of the curve of the HUU study group with that of the WHO reference curve, but with a shift in the curve of the study population towards the

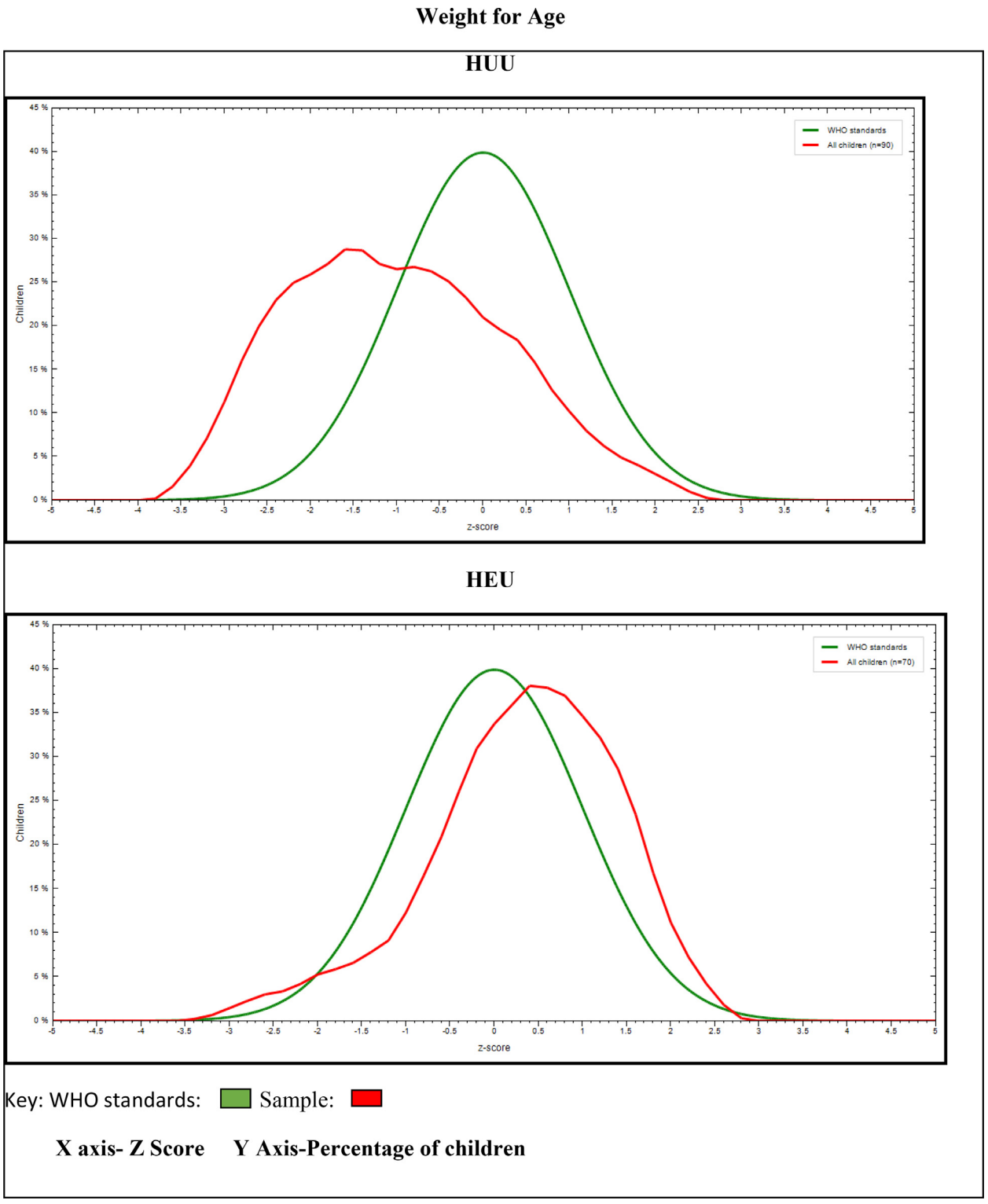

Fig. 3. Distribution of the study population according to weight for Age.

top.

3.3. Weight for Age

From Fig. 3 above, the Weight for Age curve of the HUU infants shifted towards the left and had lower medians as compared to the WHO reference curves. The HEU curve however, had a minor shift towards the right as compared to the WHO reference curve.

3.4. BMI For Age

From Fig. 4 above, the BMI for Age curve for the HUU shifted towards

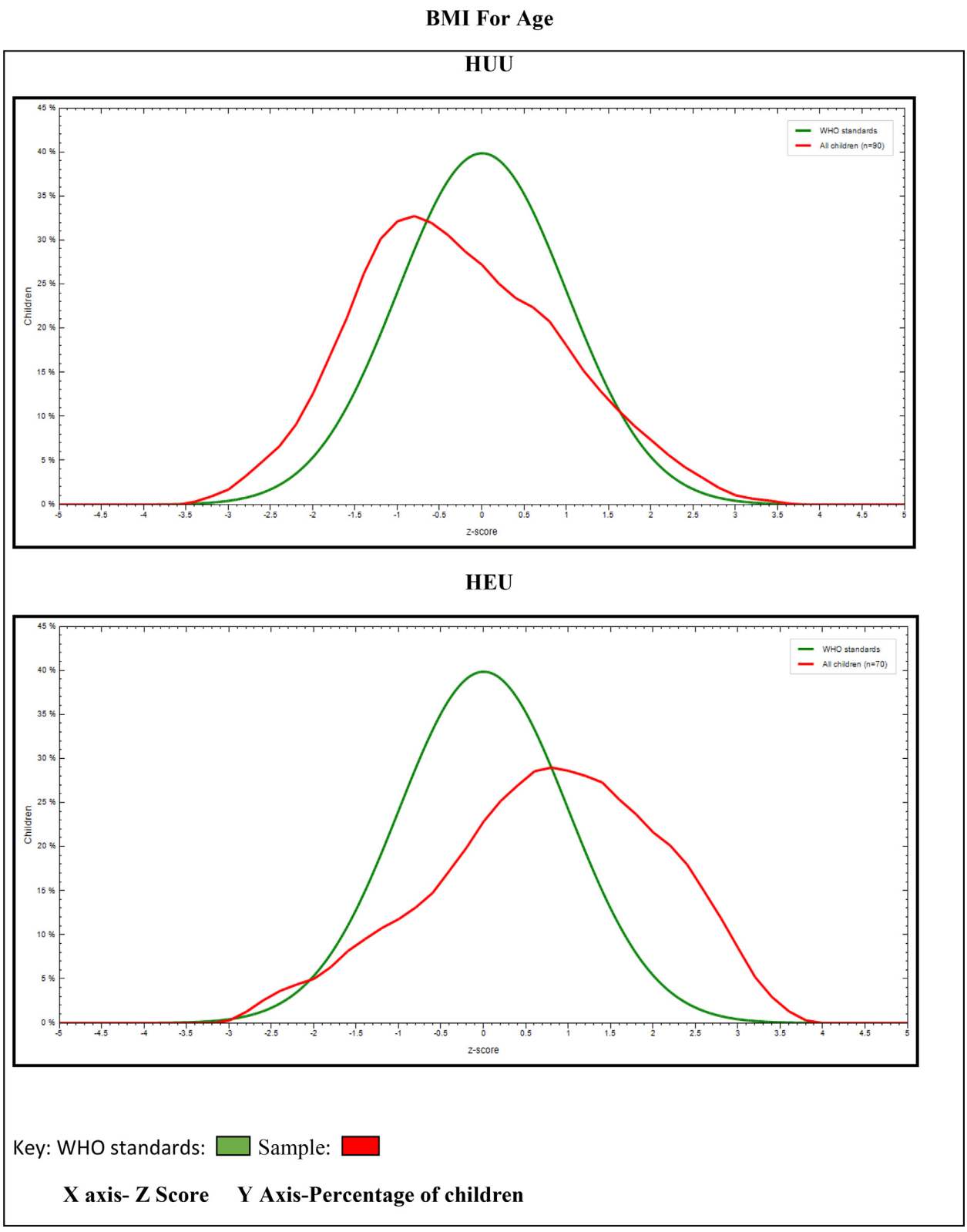

Fig. 4. Distribution of the Study Population According to their BMI for Age.

the left as compared to the WHO reference curve. There was however a shift towards the right for the HEU group as compared to the WHO reference curve.

3.5. Food insecurity-related variables

3.5.1. Food affordability

Regarding Food affordability, the study found out the following as shown on Table 3:

There was no significant relationship between HIV exposure and food affordability. Households that were exposed to HIV recorded slightly lower numbers of food affordability (82.2%) as opposed to the unexposed homesteads (85.7%).

3.5.2. Food accessibility

From the data collected, the respondents indicated that:

Table 4 shows no significant statistical relationships between HIV exposure and food accessibility. There was a higher number of HIV exposed households (58.3%) that indicated ease of food accessibility as opposed to the unexposed households (41.7%). But this difference was non-significant.

3.6. Food utilization

This was classified into:

- Slow- Food was considered to stay longer after purchase among the HIV exposed subjects
- Normal- Food stayed for periods considered normal in the households exposed to HIV
- Fast- Food was used faster than normal in the HIV exposed households

According to Table 5, there was no statistically significant relationship between food utilization and HIV exposure among the households evaluated in the study.

3.7. Food aid

As shown on Table 6, there was a statistically significant relationship between food aid or donations and HIV exposure in the households. Households that were exposed to HIV were less likely to receive food donations **(30.0%)** than those that were not exposed.

3.8. Household composition

3.8.1. Number of adults

This was classified as per the number of adults living within the households in the study sample. This was presented as shown on Table 7 below:

There was a significant relationship between the number of adults in a household and HIV exposure. Households that were exposed to HIV and had HEU infants, were most likely to have lesser number of adults as compared to those who were not affected by the virus. Most of the HEU infants lived with either 1 or 2 adults in their homes as opposed to HUU infants who lived with either 2 or 3 adults.

Table 3
Relationship between food availability with HIV exposure.

	Exposed		P values
	No % (n)	Yes % (n)	
Could afford Food	85.7% (60)	82.2% (74)	**0.553**
Could not afford Food	14.3% (10)	17.8% (16)	

Table 4
Relationship between food accessibility and HIV exposure.

	Exposed		P values
	No % (n)	Yes % (n)	
Can access food	41.7% (48)	58.3% (67)	**0.412**
Cannot access food	31.4% (22)	25.6% (23)	

Table 5
Relationship between food utilization and HIV exposure.

	Exposed		P values
	No % (n)	Yes % (n)	
Slow	24.3% (17)	30.0% (27)	**0.728**
Normal	47.1% (33)	52.2% (36)	
Fast	28.6% (20)	30.0% (27)	

Table 6
Relationship between food aid and HIV exposure.

	Exposed		P values
	No % (n)	Yes % (n)	
Receive food	45.7% (32)	30.0% (27)	**0.041**
Do not Receive food	54.3% (38)	70.0% (63)	

Table 7
Relationship between number of adults and HIV exposure.

Number of Adults	Exposed		P values
	No % (n)	Yes % (n)	
1	8.6% (6)	24.4% (22)	**0.016**
2	42.9% (30)	45.6% (41)	
3	40.0% (28)	16.7% (15)	
4 and above	8.6% (6)	13.3% (12)	

3.8.2. Number of children

As shown on Table 8 above, there was a significant relationship between the number of children in a household and HIV exposure. Households with a higher number of children were most likely to be affected by HIV and vice versa. HEU infants, therefore, were more likely to live with a higher number of siblings or infants either ≥ 2 as compared to the HUU group who were more likely to live with just one other infant (see Table 9).

3.9. Income

The study predefined the levels of income within the study population as follows:

$</=$ 10,000 Kenya shillings per month- Low Income

10,001 to 20,000 Kenya shillings per month- Normal Income

Table 8
Relationship between number of children and HIV exposure.

Number of Children	Exposed		P values
	No % (n)	Yes % (n)	
1	51.4% (36)	23.3% (21)	**<0.001**
2	24.3% (17)	33.3% (30)	
3	18.6% (13)	31.1% (28)	
4 and above	5.7% (4)	12.2% (11)	

Table 9
Relationship between income and HIV exposure.

Income Range	Exposed		P Values
	No % (n)	Yes % (n)	
<=10000	50.0% (35)	43.3% (39)	**0.222**
]10000; 20000	32.9% (23)	25.6% (23)	
>20000	17.1% (12)	30.0% (27)	

>20,000 Kenya shillings per month- High income

There was no significant relationship between HIV exposure and the income levels within the households. Most of the households with HEU infants had either normal or high income as compared to the households with HUU infants.

3.10. Infant feeding practices

3.10.1. Age of complementary food introduction

This was classified into the number of months that the infants in the study population were introduced to solid foods. The study predefined the age of complementary food introduction as follows according to Kenyan national guidelines on nutrition and HIV among infants (Kenya, 2014)**:0-5 months- Unacceptable**; **6 months and above-Acceptable.** This is illustrated in Table 10 below:

As shown on Table 10 above, there was no significant relationship between HIV exposure and the age of food introduction. Being that most of the sample size was collected from the hospital records, the acceptable age (6 months) of introduction of solid foods was adhered to by most of the mothers/guardians. However, the study noted that there were still some HEU infants who were began on solid foods at very young ages of 0, 2,3, 4 and 5th months.

3.10.2. Formula or breastfeeding

As illustrated on Table 11 above, there was no significant relationship between HIV exposure and Breastfeeding. Notably, both groups had higher number of infants who were Breastfed as compared to those who were formula fed.

3.10.3. Use of food supplements

Food supplements in this case relate to the administration of Food by Prescription (FBP) supplements to the infants in the study population (see Table 12).

There was statistical significance between the use of food supplements and HIV exposure within the households. Almost all households with HEU infants received the FBP (94.4%) as opposed to 32.9% who were within the unexposed group.

3.11. Multi variate analysis

Table 13 below shows the contribution of the variables to undernutrition. The variables that significantly affected undernutrition (WFLZ, LFAZ, WFAZ, BAZ, MUACZ) included sex, exposure to HIV and food aid. Large effect sizes were found in:

- The contribution of Sex on WFLZ, WFAZ and BAZ.
- The contribution of exposure to HIV on LFAZ, WFAZ, MUACZ.

Medium effect sizes were found for:

- The contribution of Sex on LFAZ and MUACZ
- The contribution of exposure to HIV on WFLZ, BAZ
- The contribution of food aid on MUACZ.

Table 13 below represents this contribution:

From Table 13 above, the contribution of age was only statistically

Table 10
Relationship between age of complementary food introduction and HIV exposure.

Number of months	Exposed		P values
	No % (n)	Yes % (n)	
0	0.0% (0)	1.1% (1)	**0.544**
2	0.0% (0)	1.1% (1)	
3	0.0% (0)	3.3% (3)	
4	4.3% (3)	4.4% (4)	
5	5.7% (4)	3.3% (3)	
6	87.1% (61)	83.3% (75)	
7 months and above	2.9% (2)	3.3% (3)	

Table 11
Relationship between formula of breast feeding and HIV exposure.

	Exposed		P values
	No % (n)	Yes % (n)	
Breast Milk	75.7% (53)	86.7% (78)	**0.074**
Formula Milk	24.3% (17)	13.3% (12)	

Table 12
Relationship between use of food supplements and HIV exposure.

	Exposed		P values
	No % (n)	Yes % (n)	
Consume Supplements	32.9% (23)	94.4% (85)	**<0.001**
Do not Consume Supplements	67.1% (47)	5.6% (5)	

significant in WFLZ ***(p=0.006)*** and BAZ ***(p<0.001)***. The older subjects in the study were likely to have low weight for length and BMI for age and vice versa.

Exposure to HIV was statistically significant to all the anthropometric measurements, meaning that all exposed subjects were subject to malnourishment.

The contribution of sex was statistically significant ***(p<0.001)*** in WFLZ, WFAZ, BAZ and MUACZ. The study found out that the male subjects had lower measurements as compared to their female counterparts.

Food aid on the other hand, was only statistically significant in MUACZ ***(p=0.003)***. The subjects who received food aid were less likely to have a lower MUAC measurement and vice versa.

4. Discussion

According to the current Lancet report, successful interventions for elimination of pediatric HIV infection have led to concerns in the health outcomes of HEU infants (Evans et al., 2016). Among these concerns include the increased reported impaired growth among these infants when compared to the HUU infants. Nutrition, being the hallmark of this growth, therefore, plays a key role in the future interventions to accelerate growth of this increasing number of infants in the past decade. The data collected from this study was from infants with an average age of 12 months which was crucial to determine the feeding methods of the infants because at this age, they would already have begun complementary foods according to Kenyan nutrition guidelines (Kenya, 2014). The data demonstrated that the HEU infants had lower Z scores than HUU infants. Some of the infants in the study had a considerably lower mean Z scores compared to the WHO reference curves. Although this was related to HIV exposure, the WHO growth standards that have previously been recommended as growth key standards for infants globally, do not consider the ethnicity, socio-economic status and the mode of feeding used (Group,

Table 13
Overall effect size of the variables on undernutrition.

	Age		Exposed		Sex		Food Aid	
	η_P^2	P Values	η_p^2	P Values	η_p^2	P Values	η_p^2	P Values
Overall Effect Size	0.439	<0.001	0.351	<0.001	0.135	0.001	0.083	0.021
WFLZ	0.048	0.006	0.200	<0.001	0.110	<0.001	0.004	0.442
LFAZ	0.017	0.107	0.161	<0.001	0.019	0.083	0.024	0.052
WFAZ	0.024	0.051	0.280	<0.001	0.107	<0.001	0.001	0.668
BAZ	0.099	<0.001	0.171	<0.001	0.105	<0.001	0.007	0.289
MUACZ	0.009	0.249	0.225	<0.001	0.055	0.003	0.057	0.003

2006). In Kenya, this is one of the crucial elements of undernutrition that is constantly reported in hospitals (Kenya, 2014). The results collected were congruent with studies that have formerly concluded that HEU infants are at an increased risk of stunting compared to their HUU peers (Sudfeld et al., 2016).

38.9% of the HEU infants were mildly stunted (LFAZ), while 5.6% of them were moderately wasted (WFLZ), and 24.4% of them were moderately underweight. The study owed moderate and mild wasting and stunting to reports that have been documented in Kenya in the past (Chege et al., 2016). According to the reports, undernutrition presented by either wasting, stunting or underweight was as a result of predisposition to conditions such as HIV exposure, food insecurity that could be due to poor socio-economic backgrounds or geographical location in the country (Keino et al., 2014). Infants living in urban settlements also have poor accessibility to safe water and high quality of food to meet their energy needs (Maxwell et al., 2000).

On reviewing the birth weight of the infants, the study found that the HEU infants were born with lower weights than the HUU infants. The mean birth weight of the HEU infants was 2953 grams as compared to 3195 grams of the HUU infants. While 54% HEU infants reviewed in the study had birth weight of 2500 grams and above as compared to 87.1% of the HUU infants, the study noted that 20% of the infants were born with weight 2500 grams or below as compared to only 12.9% of the HUU infants. Studies revolving around pre-term and low birth weights among HEU infants record that low birth weights among these infants could result either from the lifelong ART exposure, low maternal weight due to the viral burden that could lead to reduction of the number of meals taken by the mother (Ramokolo et al., 2014). Although this study documented the ARV exposure of infants, it was not able to record the maternal state of the mothers that could predispose the HEU infants to low birth weights (Muhangi et al., 2013). This was because data collected was done at one static point and some infants were living with guardians rather than their biological mothers. Moreover, the study noted that although the birth weight of the HUU infants correlated with their WFLZ ($P = 0.02$), WFAZ ($P = 0.008$), and BAZ ($P = 0.017$), this was not the case among the HEU infants. Although a previous study (Oddo et al., 2016) linked small for gestational age with stunting among the HEU infants, this study did not find any relationship because the number of infants who had low birth weights in the study was only 20%.

Furthermore, the study reviewed food insecurity related variables in relation to HIV exposure that led to undernutrition of the HEU infants. Of importance was to evaluate the food affordability, food accessibility, food utilization and food aid (Pinstrup-Andersen, 2009; Weiser et al., 2012). The study found out that food aid was the most crucial element of food insecurity among the study population (Fielden et al., 2014). Households that were exposed were less likely to receive food ***(p=0.041)***. This was because of the several income-generating programs open to the households within the study location. Although this was not the main aim of this study, respondents that were affected by HIV indicated that they had access to an income generating program that improved the affordability of food therefore, they were not reliant on food aid. This finding was consistent with a study done on the coping mechanisms of households affected by HIV (Bukusuba et al., 2007). Despite the recorded affordability of food, the HEU infants did not record better nutrition status than their HUU counterparts.

To understand food insecurity variables in the households, the study evaluated household composition regarding the number of adults and number of children living with both HEU and HUU infants. The study added up to other studies that demonstrated that HEU infants are categorized as orphans and vulnerable children (Goldberg and Short, 2016). In a study carried out in Ghana, infants born to HIV positive mothers are most likely to be abandoned by their biological mothers or left under the care of their relatives due to the burden of disease (Laar et al., 2015). In this study, HEU infants were most likely to be found in households with one or two adults ***(p=0.016)***, while living with either 2,3 or 4 more children ***(p<0.001)*** in the household. Similarly, the study did not find any significant relationship between income earned in the households and HIV exposure. This is because the respondents could not voluntarily give the exact amounts they earned and instead gave wide ranges of their income. Households of both HUU and HEU infants had an almost similar response in the amount of income earned.

The study also evaluated the infant feeding practices in relation to the HIV exposure. In relation to these practices, the study reviewed the age within which the infants were introduced to solid foods, the mode of infant feeding whether infant or breastfeeding as well as the extent to which infants used Food by prescription supplements (Nagata et al., 2014; Rossouw et al., 2016). Both the HEU and HUU infants recorded high percentages of exclusive breastfeeding. In fact, a slightly higher number of HEU infants breastfed as compared to the HUU infants. this was congruent with the WHO and Kenyan guidelines on infant and young child feeding in the context of HIV (Kenya, 2014; WHO, 2007). The study also noted that there was a small number of HEU infants who were began on solid foods as early as by the time of birth, 2,3,4 and 5 months. Some previous studies had shown that some HEU infants were introduced to solid foods early because their mothers did not have enough breast milk (Sint et al., 2013). Exclusive breastfeeding for HEU infants is recommended for the first six months and thereafter an introduction of solid foods only if they are Acceptable, Feasible, Affordable, Sustainable and Safe (AFASS) (Victora et al., 2016).

This study sought to know the magnitude of effect that each of the variables had on undernutrition among the HEU infants. Overall, sex, HIV exposure and food aid had the most notable effect size on undernutrition of the infants. HIV exposure significantly affected the undernutrition status of the infants which was depicted by WFLZ, LFAZ, WFAZ, BAZ and MUACZ. HEU infants had lower Z scores as compared to the HUU infants because they were exposed to the virus. Previously, research has shown that HEU infants are prone to linear growth faltering as well as stunting when compared to the HUU infants (Sudfeld et al., 2016).

The study also focused on the sex of the infants. Female infants had higher Z scores when compared to the male infants in terms of weight and MUAC measurements. Female infants tended to receive a better health attention in general as compared to the male infants. This was also concluded in a study in Guatemala that reported that nutritional interventions tend to favor female infants more than the male infants (Tumilowicz et al., 2015).

The scope of this study did not lodge on this finding although future studies would evaluate such a gender perception to favor equality in growth among all infants regardless of HIV exposure or socio-economic

conditions.

The overall effect of food aid was significantly correlated with thinness depicted by MUACZ score ***(p=0.003)***. In general, those households that received food were not necessarily well nourished. While food aid interventions eliminated immediate food insecurity, some households rationed or hoarded the food in lieu of future days when they would not have enough food (Rawat et al., 2010). As well, since HEU infants rarely received food, they would be more likely to end up purchasing less expensive food that may be of low quality, which does not meet their energy needs, therefore, resulting to Food by prescription supplements (Nagata et al., 2014). Food aid was directly related to food affordability and accessibility in the study population. This meant that those who responded that they received food donations, could not access or afford it and vice versa.

5. Conclusion

This Study concluded that HIV exposure to infants significantly predisposed them to undernutrition during their first 1000 days of life. HEU infants were likely to be either stunted, wasted, underweight and thin despite the socio-economic conditions. The fact that these infants lived in susceptible situations either in children's homes or with their guardians caused their vulnerability that in turn predisposed them to undernutrition. Although HEU infants are exclusively breastfed, as they grow up, it is crucial to evaluate their living conditions to ensure that their daily energy needs are met. Offering food donations does not necessarily mean that the infants nutrition status will improve. In any case, blanket education on the types of the right quality of food for the HEU infants should be scaled up to eliminate undernutrition. Since most of the HEU infants do not meet their energy needs, they rely on supplements such as Food by Prescription to complement their daily meals.

5.1. Recommendations

The study recommends closer monitoring of infants living in the low socio-economic settings to ensure that undernutrition is eliminated simultaneously with HIV mother to child transmission. As well, food aid programs ought to constantly re-evaluate the utilization of food in vulnerable households to achieve optimum nutrition among targeted infants.

HIV programs ought to be more vigilant to ensure that affected households are not over-reliant on Food by prescription supplements to meet the energy needs at the expense of utilizing food as a source of their energy to eliminate undernutrition.

The study also proposes further research to develop growth charts tethered to infants living in harsh conditions such as developing countries like Kenya. This would enhance national growth monitoring of the HEU infants when compared to their HUU counterparts. A further investigation on factors that cause undernutrition among the HEU infants in low socio-economic urban settings on a larger scale is recommended.

Declarations

Author contribution statement

Jane Wambura: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Brigid Marnane: Contributed reagents, materials, analysis tools or data.

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