



**INFLUENCE OF DIETARY INTAKES, 'WASH' AND DIARRHEAL  
MORBIDITY ON STUNTING AMONG CHILDREN BELOW  
FIVE YEARS IN NAKURU COUNTY: A CASE STUDY  
OF KAPTEMBWO AND MILIMANI, KENYA**

**Daniel Matoke Ayienda<sup>1,2i</sup>,  
Muthuka J. Kyalo<sup>2</sup>,  
Job O. Mapesa<sup>1</sup>,  
Lawrence Mugambi<sup>1</sup>,  
Eglah J. Kiplagat<sup>2</sup>**

<sup>1</sup>Kenya Methodist University,  
Nairobi, Kenya

<sup>2</sup>Kenya Medical Training College,  
Nairobi, Kenya

**Abstract:**

Stunting is the most prevalent and pervasive form of under nutrition worldwide. In 2019, an estimate of 144 million (21.3%) of children under the age of 5 years are stunted globally. In sub-Saharan Africa, 34% of children fewer than 5 years are stunted and the burden of stunting is most prevalent in the Eastern Africa region with 37% (FAO, 2017). In Kenya, out of a total of 7 million under 5 years, 1.82 million (26%) children are suffering from stunting; out of which 11.4% are severely stunted. Stunting is associated with greater risk of death from infectious diseases in childhood, poorer cognition, poorer educational outcomes and lower adult earnings. The study population was a total of 314 children aged 0-59 months. Data was collected using survey CTO questionnaire. Use of pesticides, hygiene practices and sanitation (human waste disposal), hand washing practices, water sources and means of water treatment were examined and adequately described in relation to EED and stunting. Survey CTO programme was installed in tablets and or smart phones, in which a questionnaire with closed ended questions was programmed and used to collect a no-paper work data. The Survey CTO programmed questionnaire only allowed the researcher to key in a response for one question before moving to the next question. Data was analyzed using SPSS version 22 software. Descriptive analysis was done using SPSS while regression was done using STATA. There was no significant difference in dietary intakes between children in Kaptembwo and Milimani, and that the dietary intakes in both Milimani and Kaptembwo were adequate and balanced. Out of

<sup>i</sup> Correspondence: email [danayienda2026303@gmail.com](mailto:danayienda2026303@gmail.com)

202 children sampled in Kaptebwo, 40.59% had experienced diarrhea in the last four weeks to data collection while out of 112 children sampled in Milimani, only 17% had experienced diarrhea in the last four weeks. In spite of the same dietary intakes in Kaptebwo and Milimani, stunting is high in Kaptebwo than in Milimani. Out of a total of 314 children sampled, 25% were stunted in Kaptebwo, while only 3.33% were stunted in Milimani. Diarrhea increases loss of dietary nutrients thereby making the nutrients required for growth inadequate. High level of stunting in Kaptebwo is associated with poor environmental conditions (poor sanitation and hygiene) which contribute to diarrhea. Diarrhea could be key contributor to Environmental Enteric Dysfunction (EED), which is too a contributor to stunting. It is recommended that residents of Kaptebwo and Milimani are educated on the importance of good sanitation and hygiene in order to curb diarrhea, which is a contributor to the development of EED. In the same spirit, understand the importance of proper use of pesticides. Experimental research was done in the same area involving the use of biological markers for EED.

**Keywords:** Environmental Enteric Dysfunction (EED), stunting, diarrheal morbidity

## 1. Introduction

Stunting is the most prevalent and pervasive form of under-nutrition worldwide (Prendergast & Humphrey, 2014). An estimate of 144 million (21.3%) of children under the age of 5 years are stunted globally (UNICEF (2019)). In sub-Saharan Africa, 34% of children fewer than 5 years are stunted and the burden of stunting is most prevalent in the Eastern Africa region with 37% (Nshimyiryo et al., 2015). In Kenya, out of a total of 7 million children under 5 years, 1.82 million (26%) children are stunted, out of which 11.4% are severely stunted (Below -3 Standard deviation) (KNBS, 2015). Stunting is associated with greater risk of death from infectious diseases in childhood, poorer cognition, poorer educational outcomes and lower adult earnings (Caulfield et al. 2004; Alderman et al., 2006; Grantham-McGregor et al., 2007; Maluccio et al., 2009). The causes of stunting are postulated to be multi-factorial and include at least; inadequate prenatal nutrition and inadequate dietary intake early in life (first 1,000 days); chronic and repeated acute infections leading to a catabolic inflammatory state; and the chronic intestinal inflammatory condition known as Environmental Enteric dysfunction (EED). EED is a subclinical syndrome characterized by mucosal inflammation, reduced barrier function, villous blunting and reduced absorptive capacity in the small intestine (Crane et al., 2015). EED is established during infancy and is associated with poor sanitation, certain gut infections, micronutrient deficiencies, all of which may ultimately lead to chronic malnutrition (stunting), wasting and reduced vaccine efficacy among children living in low-resource settings (Crane et al., 2015). EED was first described among adult Corps volunteers returning from deployment to low-and middle-income countries (LMIC) in the 1960s who presented with unexplained, persistent weight loss. Despite non-specific,

clearly identifiable infectious etiology, biopsies of intestinal tissues in these individuals demonstrated morphological changes suggestive of chronic enteric infection (Lindenbaum et al., 1966; Keusch et al., 1972). The symptoms of these volunteers usually resolved within several months of returning to the USA, further supporting the link between these histological changes and recurrent exposure to pathogens in areas of poor sanitation and hygiene (Lindenbaum et al., 1971; Lindenbaum et al., 1973). Studies have observed that EED is absent in some tropical populations of high socioeconomic status, such as Qatar and Singapore. These findings demonstrate that environmental conditions were critical drivers of EED, instead of geographical position (Prendergas and Kelly, 2012).

Many studies done on stunting have, in many cases, focused on poor nutrient intake as the principal cause of stunting, attaching little emphasis on Environmental enteric dysfunction (EED). Poor sanitation and hygiene is a classical environment for development of EED. Studies have also revealed that higher cumulative burden of diarrhea before the age of 2 years is associated with greater odds of being stunted at 2 years (Checkley et al. 2008). This study found that diarrhoeal episodes were high in Kaptebwo (40.59%) than in Milimani (17%). Despite children in Kaptebwo and Milimani taking nutritionally adequate diets, without any significant difference, stunting was higher in Kaptebwo (25%) than in Milimani (3.33%). The high episodes of diarrhea of children in Kaptebwo lead to loss of nutrients from the GIT due to short transient time or due to mal-absorption as a result of villous atrophy, associated with EED. Children taking adequate diets end up being stunted due to the effects of environmental factors. These findings demonstrated that nutritionally adequate diet is necessary but not enough for ensuring optimal linear growth, and that environmental conditions (poor water, sanitation, and hygiene), associated with the development of EED could play a significant role in stunting (Mbuya & Humphrey, 2016).

## 2. Materials and Methods

The present study was conducted in Kaptebwo informal settlement and Milimani estate both located in Nakuru County, Kenya. The study design was a comparative study and adopted descriptive cross-sectional approach which ensured complete description of the situation, making sure that there is minimum bias in the collection of data. The tool was pre-tested by the principal investigator and the research assistants and adjusted accordingly before it was used in the actual data collection.

The study targeted children under the age of five years. The study area is estimated to have a total population of 106,123 (Kaptebwo 43,521 in area of 5.1 km<sup>2</sup> and Milimani 26,643 in area of 20.9 km<sup>2</sup> (KNBS, 2019).

The two study areas (Kaptebwo and Milimani) were clustered accordingly in readiness for data collection. Kaptebwo was clustered into 10 big clusters, each with between 30-35 dwellings or plots. Systematic random sampling was used to sample 10

dwelling from each cluster. Purposive sampling method was used to select at least 2 households with a child 0-59 months from each dwelling or plot; thereby making the final sample 202 children.

In Milimani, households were clustered into 14 clusters of between 15-20 households per cluster. Purposive sampling method was used to select at least 8 households with a child 0-59 months, per cluster, making the total sample for Milimani 112 children. The study population was a total of 314 children aged 0-59 months. Data was collected using survey CTO questionnaire. The study variables; for example dietary intakes, the use of pesticides, hygiene practices and sanitation (human waste disposal), hand washing practices, water sources and means of water treatment were examined and adequately described in relation to EED and stunting.

Survey CTO programme was installed in tablets and or smart phones and used in the collection of a no-paper work data. A questionnaire with closed ended questions was programmed using Survey CTO into the tablets and or smart phones. The programme required that each research assistant log in using his personal details before accessing the questionnaire.

The Survey CTO programmed questionnaire only allowed the researcher to key in a response for one question before moving to the next question. In cases where for example the answer to a question was 'No', the programme skipped all other questions which could only be responded to if the answer was 'Yes'. This helped a lot in saving time and allowed the researcher to collect the available data within a short period of time.

Three hundred and fourteen children aged between 00 months and 58 months were sampled. Survey CTO platform was used to collect data on diarrheal morbidity, socio-economic and socio-demographic factors, dietary intake patterns, hygiene and sanitation, use of pesticides and water treatment and anthropometry. Data was analyzed using SPSS version 22 software. Descriptive analysis was done using SPSS while regression was done using STATA. Excel was used to do descriptive analysis and in the generation of appropriate graphs.

### **3. Results and Discussion**

#### **3.1 Socio-demographic characteristics of children aged 0-59 months at Kaptembwo and Milimani**

A total of 314 children aged between 0-59 months were sampled and consisted of 162 (51.59 %) male and 152 (48%) female children with an average age of 24.5 months and the mean height of 81.82 centimeters, as shown in Table 1 below.

**Table 1:** The demographic characteristics of children

Target child characteristics	Kaptembwo		Milimani		Overall
	Male	Female	Male	Female	All children
	Mean	Mean	Mean	Mean	Mean child characteristics
Age in months	26.00	24.00	25.00	23.00	24.5
Height in cm	82.54	80.01	83.84	80.90	81.82

### 3.2 Dietary practices

There was no significant difference of food eaten by reference child between Milimani and Kaptembwo for all food types; p values (Carbohydrates 0.79, Lipids 0.847, Proteins 0.0294, and Vitamins 0.905).

**Table 2:** Food group eaten by reference child in the last 24 hours

Food group eaten by reference child in the last 24 hours	Kaptembwo	Milimani			Overall
	n=202	n=112	ch2	P-value	n=314
Carbohydrates	91.1	90.2	0.0713	0.79	90.8
Lipids	89.1	88.4	0.0373	0.847	88.9
Proteins	87.1	91.1	1.1034	0.294	88.5
Vitamins	90.6	90.2	0.0144	0.905	90.4

Table 3 below shows that children in Kaptembwo recorded high episodes of diarrhea (40.59%) in the last four weeks compared to (12.86%) who had diarrhea in the last four weeks in Milimani. The overall diarrhea episodes for Milimani and Kaptembwo were 29.23%. 70.73% of the children who had diarrhea in Kaptembwo got treatment while 75% of the children who had diarrhea in Milimani got treatment. An average of 71.57% children who had diarrhea in Kaptembwo and Milimani got treatment.

**Table 3:** Episodes of diarrhea in the last 4 weeks and treatment for Kaptembwo and Milimani

Area	Diarrhea percent (%)	Area	Treatment (%)
Kaptembwo (n=202)	40.59	Kaptembwo (n=82)	70.73
Milimani (n=112)	17.86	Milimani (n=20)	75
Overall (n=314)	29.23	Overall (n=102)	71.57

### 3.3 Contributors for diarrhea

Through regression analysis, various dependent factors (x) were tested using *probit* model against the independent variable (Diarrhea) (y), to establish the factors that significantly contributes to diarrhea in Kaptembwo and Milimani. Using *probit* model to assess the factors that contribute to diarrhea in Kaptembwo and Milimani at household level, the result show that buying Githeri and nuts from vendors, treatment with ORS, hand hygiene before eating, after eating, after defecation/urination, after changing a child's nappy, availability of water at the site of washing hands, use of ventilated pit latrine and de-worming in every three months were key factors (p<0.05).

### 3.4 Levels of stunting

#### 3.4.1 Height-for-age by gender Kaptebwo, Milimani

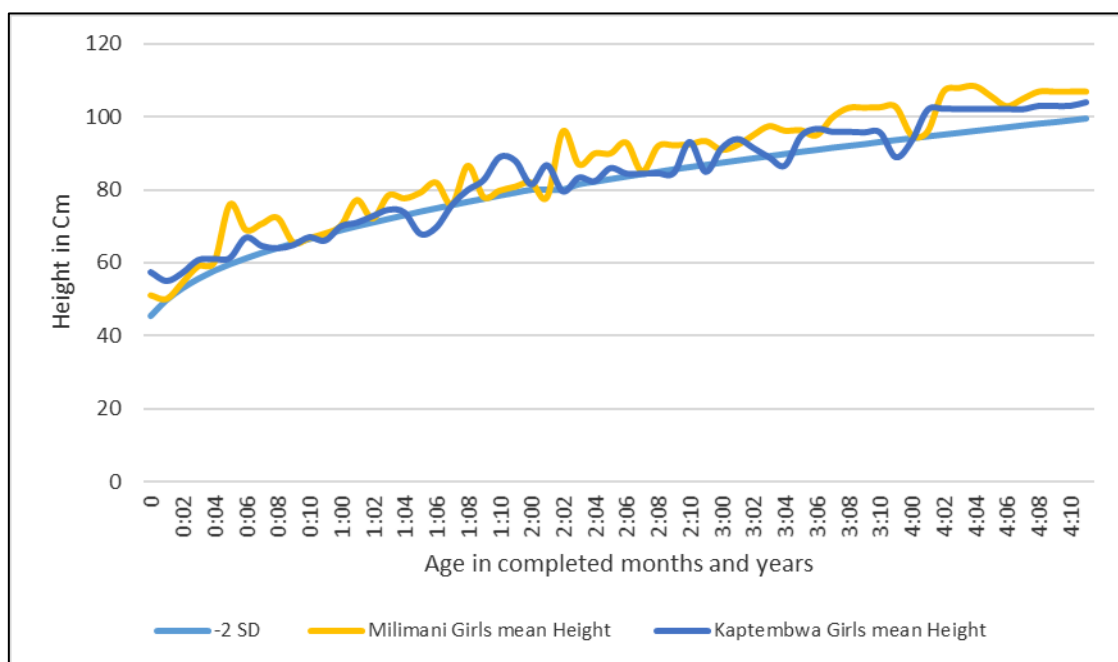
Table 4 below shows the level of stunting for Kaptebwo is 25% while that of Milimani is 3.33%. It was found that boys were more stunted than girls in both Kaptebwo (boys 15%, girls 10%) and Milimani (boys 2.50%, girls 0.83%). From this table, boys contributed more to the stunting percentages than girls in both cases (75% boys Milimani, 60% boys Kaptebwo; 25% girls Milimani, 40% girls Kaptebwo).

**Table 4:** Height-for-age by gender in Kaptebwo and Milimani

Description	Percentage for Stunting (%)	Gender	Contribution to Stunting per gender (%)
Milimani (n=112)	3.33	Boys 2.50%	75
		Girls 0.83%	25
Kaptebwo (n=202)	25	Boys (15%)	60
		Girls (10%)	40

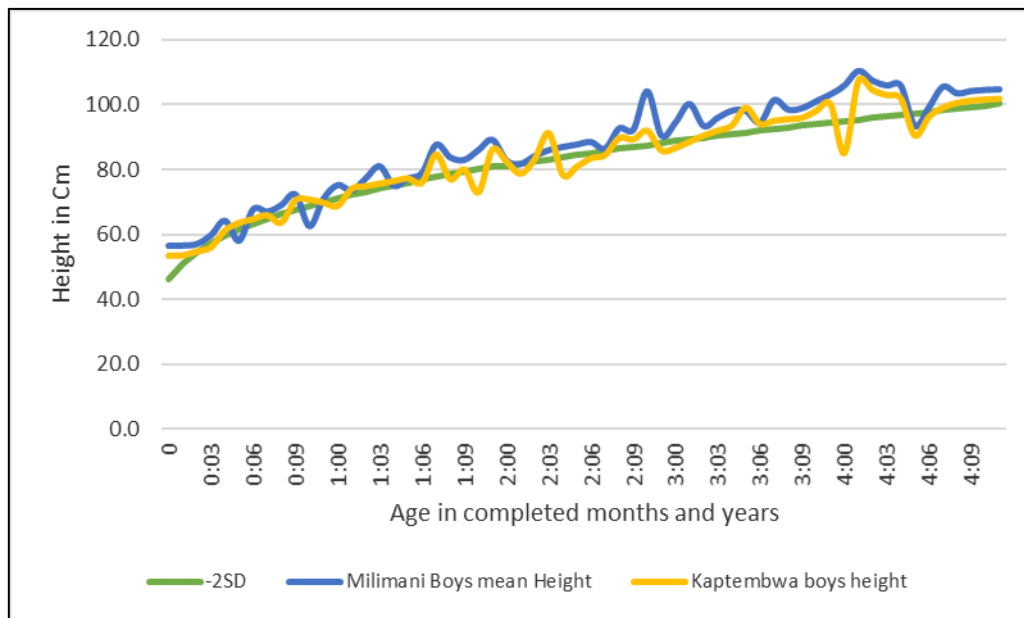
#### 3.4.2 Relationship of dietary intake and stunting in Kaptebwo and Milimani

Figure 1 below shows that the Height-for-age values for many girls in Kaptebwo trails the height –for –age values for many girls in Milimani. The graph shows that there is high fluctuation in the nutritional status for children between 18-30 months and between 46-54 months.



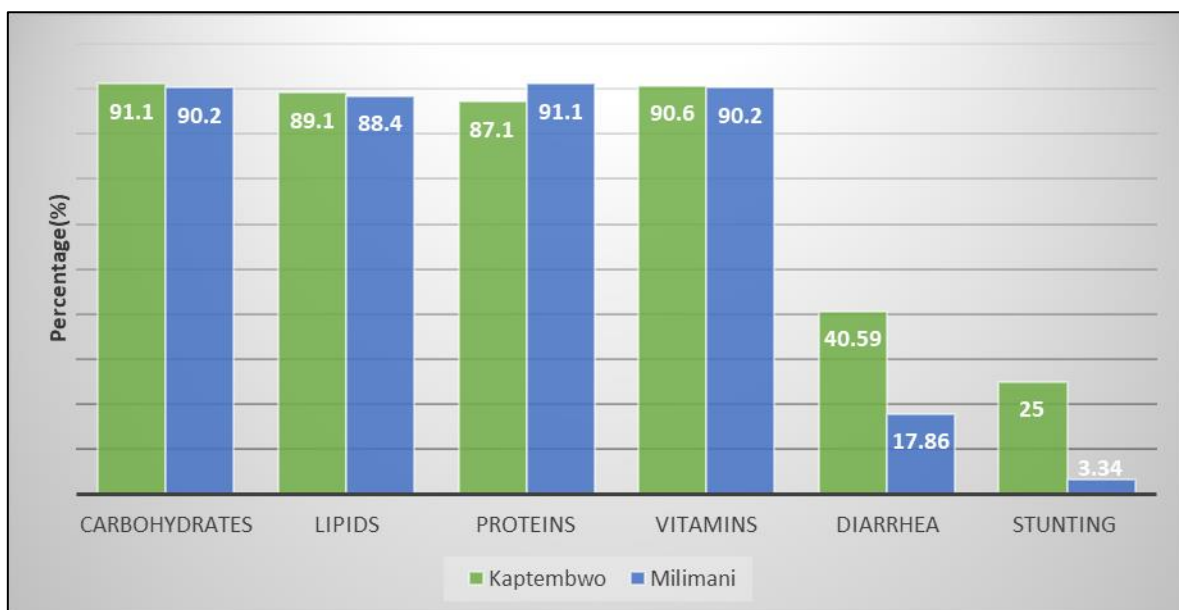
**Figure 1:** Height-for-age for girls in Kaptebwo and Milimani, Comparison of Actual Height with -2SD

Figure 2 below shows that when the Height-for-age for boys in Kaptebwo and Milimani is compared, it is noted that the heights of many boys in Kaptebwo trails the heights of boys in Milimani.



**Figure 2:** Height-for-age for boys in Kaptebwo and Milimani, Comparison of Actual Height with -2SD

The number of boys stunted in Milimani is low (5%) compared to the number of boys stunted in Kaptebwo (30%). The low number of stunting in Milimani is also recorded for girls (1.67%) compared to the number of girls stunted in Kaptebwo (20%).



**Figure 3:** Comparison of Dietary Intakes, Diarrhoeal Episodes, Stunting levels in both Kaptebwo and Milimani

#### **4. Discussions**

The study sought to evaluate the role of environmental enteric dysfunction in stunting of fewer than five. Consent was sought from mothers or caregivers, as the test subjects were minors. Results showed that dietary intakes for Kaptebwo and Milimani are not significantly different ( $P>0.05$ ), but the levels of stunting in Kaptebwo are higher (25%) than the stunting levels in Milimani (3.335%). These results are usually unexpected, especially when the dietary intakes are the same. Under normal circumstances, it is expected that children who take almost the same dietary intakes exhibit close growth patterns. Therefore, Environmental Enteric dysfunction has a positive role in stunting of children under five.

The study revealed that in both Kaptebwo and Milimani, boys are more stunted than girls. These findings concurs with findings of the study by Grace A. K. Etyang and Caroline J. Sawe, (2016), on factors associated with stunting in children under 2 years in the Cambodia and Kenya, which found higher risk of stunting in males than in females. The results of this study showed that stunting in both males and females started in the second year of life. This finding differs with a study by Adair and Guilkey (1997), which show that males are more likely to become stunted in the first year of life.

Episodes of diarrhea were high in Kaptebwo (40.59%) than in Milimani (12.86%) episodes environmental factors which contribute to diarrhoea took centre stage in manipulating the desired effects of adequate dietary intakes and thereby causing stunting. This finding agrees with Mbuya & Humphrey, (2016), who suggest that a nutritionally adequate diet for child is necessary but not enough for ensuring optimal linear growth. This means that children in Kaptebwo loss more nutrients through diarrhea than children in Milimani. Episodes of diarrhoea significantly reduce the absorptive capacity of the small intestine; hence fewer nutrients are available for utilization in the body. This characteristic was strongly associated with stunting.

The high episodes of diarrhea in Kaptebwo are attributed to poor environmental conditions such as unsafe drinking water, lack of sanitation and poor hygiene. This agrees with Prus-Ustun and Corvalan, (2006), who found that an estimated 94% of the diarrheal burden of disease is attributed to the environment, and associated with risk factors such as unsafe drinking water, lack of sanitation and poor hygiene.

#### **Conflict of Interest**

Authors declare no conflict of interest.

#### **About the Author(s)**

##### **Daniel Matoke**

MSc-[C], BSc –Biomedical sciences, PGD-Nutrition and Dietetics, Lecturer, Kenya Medical Training College, Kenya.



### **Muthuka John Kyalo**

PhD Fellow & Lecturer, College of Health Sciences, Jomo Kenyatta University of Agriculture & Technology, Kenya (BSc, MPH, PGD-Biotech, Pharm-D, D. Nutr-Medicine, and PhD-Fellow) is health specialist in diverse areas. John has his interest in HIV/AIDS, maternal, child and neonatal (MCNH), reproductive and adolescent health as well as neglected tropical diseases.

### **Job O. Mapesa (PhD)**

Chairman of the Department, Kenya Methodist University, Nairobi, Kenya.

### **Eglah Jerotich Kiplagat**

Deputy Registrar & Lecturer at Kenya Medical Training College, Nairobi, Kenya. She is a nutrition specialist and health educator with over 20 years experience in academia and other health settings. Her key interests are on nutrition interventions, livelihoods and MCH.

### **MSc Lawrence Mugambi**

Lecturer, Kenya Methodist University, Nairobi, Kenya, His interest are public health, human nutrition and dietetics.

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