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Nutrient Intake, Morbidity and Nutritional Status of Preschool Children are Influenced by Agricultural and Dietary Diversity in Western Kenya

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Abstract: A cross sectional survey was set up to assess the influence of agrobiodiversity and dietary diversity on morbidity, nutrient intake and the nutritional status of preschool children in Western Kenya. About 34.8% preschool children were severely stunted, 21.5% severely underweight and 8.3% were severely wasted. There was a positive and strong relationship between agricultural biodiversity, dietary diversity and caregivers' level of education. Morbidity level and dietary diversity had significant influence on underweight levels and stunting. Consideration of agrobiodiversity in terms of dietary diversity can improve the nutrition and health status of a preschool child.

Key words: Agrobiodiversity, dietary diversity, preschool, nutrition status, western Kenya

INTRODUCTION

Agrobiodiversity encompasses the variety and variability of animals, plant and microorganisms which are necessary to sustain key functions of the agro-ecosystem, its structure and processes for and in support of, food production and security (FAO, 1999). Agro-biodiversity composes biodiversity at the inter and intra-specific level of edible food crops and animals that are used in the production systems for food and agriculture. Different farming systems exist at inter-specific level with different combinations of edible food plants and animals. At the intra-specific level different numbers of varieties or breeds may be cultivated per crop or animal species, thus in low to high genetic variety, depending upon the diversity between and within varieties or breeds. Agrobiodiversity influences safety and security of food and agricultural production and could be more effectively used to improve diets and nutrition (Johns *et al*., 2006). Increasing biodiversity at the farm level can be translated into dietary diversity in households.

Agricultural biodiversity is essential for a sustainable improvement in food and nutrient security and is absolutely essential in coping with predicted impacts of climate change as the underpinnings of more resilient farm ecosystems (Frison *et al*., 2011). The erosion of the ecosystem diversity has affected the availability of some indigenous food crops (Tabuti *et al*., 2004) and wild animals used for food. A change in biodiversity has a direct effect on the change in the variety and diversity of human diets and quality of foods and nutrients intake. Major changes in local systems of production, mostly due to human activities (Walingo *et al*., 2009), with a shift from subsistence agriculture and an increasing orientation to markets both for income and food purchase (Johns and Sthapit, 2004) affect dietary diversity of local population. These changes diminish the opportunities for hunting and gathering (Johns and Eyzaguirre, 2006), an important source of a variety of sources of protein in households.

There is an intricate linkage between agrobiodiversity, dietary diversity and malnutrition, especially dietary quality and health. In tackling malnutrition much can be gained by linking agriculture and ecology to human nutrition (Deckelbaum *et al*., 2006) especially that both biodiversity and hunger hot spots almost overlap (DeClerck *et al*., 2011). Dietary diversity is often defined as the number of foods from all food groups eaten by either an individual (s) or household (s) and is positively correlated with nutrient density and adequacy of diets of people or groups (Kennedy *et al*., 2007; Steyn *et al*., 2006; Mirmiran *et al*., 2004; Foote *et al*., 2004). There is an association between child dietary diversity and nutritional status that is independent of socioeconomic factors (Arimond and Ruel, 2004). Dietary diversity is associated with greater intake of energy and other nutrients (Hatloy *et al*., 1998), so that a very low diverse monotonous diet limits the intake of micronutrients. Low dietary diversity is a predictor of stunting and the inclusion of a variety of food groups is essential to improve child nutritional status (Rah *et al*., 2010). Children with diarrhea reportedly come from low socioeconomic backgrounds and tend to suffer from decreased diversity (Rah *et al*., 2010). Dietary diversity has been associated with wasting (Arimond and Ruel, 2004). Besides improving nutrients intake, a high dietary

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diversity improves dietary adequacy and, child growth and nutrition (Nti, 2011). The objective of this study was to assess the influence of agrobiodiversity and dietary diversity on the nutrient intake and the nutritional status of preschool children in Western Kenya.

MATERIALS AND METHODS

Study site: The study was conducted in Matungu, Butere-Mumias region of western Kenya. The study area consisted of scattered homesteads spanning an area of 259.6 km^2. The population density was 417 persons per square kilometer with a total of 820 households. About 60% of the population in this area was below the poverty line. The mean annual rainfall is 2051 mm. The major cash crop grown was sugarcane. Most of the people leased their land to middlemen who grew sugarcane while the poor landowners were the labor providers on the sugarcane farms.

Study design and sampling: The study was conducted using a cross-sectional survey design. Households with preschool children were identified from a list developed by the Local Administrative Office that comprised 820 households. Using systematic random sampling every 5th household listed was included in the sample forming a total of 164 households was identified from this list to form the unit of analysis. In this area households are separated from each other by an average distance of about half a kilometer. Only the youngest preschool child aged 12-60 months was selected from each household to form a sample of 164 preschool children for anthropometric and dietary assessment. The caregivers of the preschool children were the respondents who provided information on the selected variables for study.

Dietary and agricultural diversity: Food consumption for preschool children was assessed by a qualitative twenty-four-hour dietary recall survey. A child caretaker was asked to recall, list and estimate the amount of food consumed by her preschool child. A detailed list of all the ingredients of dishes, snacks and other foods eaten was recorded, including the method of preparation. Dietary diversity was assessed by estimating the dietary diversity score, based on only the first twenty three healthy foods consumed over a period of two months using food checklists. Dietary diversity score, defined as the number of foods consumed in the last twenty four hours preceding the recall was calculated. The score varied from 0-23 and was categorized into; high diversity = >22 foods: moderate diversity = 18-22 foods: low diversity = 13-17 foods: and very low diversity = <13 foods (FANTA, 2004). Nutrient intake was estimated form the amounts of foods consumed using Kenyan Food Composition tables (Sehmi, 1993) and included energy, protein, fats, iron, calcium, zinc, vitamin A and vitamin C. Food and nutrient intake of preschool children was compared to the recommended daily allowances for children of the same age. Food checklists and food frequency questionnaire were used to collect information on food and dietary diversity in households. A market survey was conducted in three markets to understand the diversity of foods available to households in the market.

Agricultural diversity was measured by assessing the variety of food plants grown and animals reared by households. Using key informants and Focus Groups, foods acquired from the natural habitats were also assessed. This information was used to develop a food checklist for the community. Species diversity was quantified using the Shannon-Wiener index (Kent and Cocker, 1992):

$$H' = \sum(pi \log pi)$$

where, pi = relative abundance of the occurrence of the ith species in the family land as the proportion of the number of individuals of the ith species to the total number of individuals. The role of socio-economic and cultural factors that influenced dietary diversity was assessed through focus group discussions.

Anthropometric and morbidity measurements: Anthropometric measurements were done using standardized procedures recommended by WHO (2006). The age of a preschool child was recorded from the child's birth certificate. Weight was measured using a weighing scale that was calibrated to the nearest 0.1 kg. Height was measured using a height meter or a length board for a child below two years. These measurements were used to estimate the nutritional status of a child in terms of stunting, wasting and under nutrition. Morbidity level among the preschool children was assessed by estimating the number of episodes of infections a child had experienced in the last two months prior to the survey and included diarrhea, malaria and acute respiratory infections.

Socio-demographic and agro-economic data: Socio-demographic and agro-economic information was collected at the household level using a detailed interview schedule. Focus Group Discussions was used to gather information on factors that influenced agricultural biodiversity and dietary intake. Beliefs and taboos held about certain foods, education level of caregivers and household income per month, community-based food security systems and the local farming systems was collected.

Data analysis: Descriptive statistics were used to summarize data on agro-biodiversity, dietary intake and nutrition status of preschool children. Pearson correlation was used to quantify the relationship between agro-biodiversity and socio-cultural and agro-economic factors; show effect of dietary intake on selected variables and also to establish associations between nutrition status and selected variables. Stepwise regression was used to determine the variables with most effect on nutrition status.

RESULTS

Agrobiodiversity: The food crops grown and animals reared in the households are detailed in Table 1. The level of crop and livestock diversity in the area was very low. On average there were only three types of every crop category studied growing in the area. The crops grown by most households was maize (97.2%) and cassava (59%), while the African zebu (49.3%) and chicken (70.1%) were the common livestock reared in households. The foods grown included sorghum and finger millet, sesame seeds, bambare nuts, soya beans and green grams, bananas, tomatoes, were grown by less than 30% of the households. Indigenous vegetables like *Cleome gynandra, Brassica carinata, Solanum scabrum*, though not grown in any of the households and served in households' meals were purchased from the markets. Most of the households 73.6% grew 3-5 types food crops while 17.4% grew more than six types, 8.3% grew less than two types and 0.7% did not grow any food crops. About 5.6% did not keep any livestock, 65.2% kept less than two types, 27.8% kept 3-5 types while only 1.4% kept more than five types of livestock. Lack of household gardens can compromise the food security of individuals.

Plant and animal foods form the natural habitat: Foods harvested from the natural habitat included guavas (97.1%), mushrooms (43.1%), white ants (termites 30.1%), wild birds (11.1%), wild fruits (*masaye*) 6.3%, *Rhus natalensis* (*usangula*), *Tamarindus indica* (*mikhwa*), *Ximenia Americana* (*tsinduri*), hare, big grasshoppers (1.4%) and honey. Households obtained averagely two types of food items from the natural habitat. Respondents attributed the reduction in hunting and gathering to modern agriculture and modern ways of living. While 29.9% of the households did not obtain food from the natural habitat, 58.3% got less than two types, 10.4% got 3-5 types and 1.4% obtained more than five types of food from the natural habitat. However only 65.2% obtained 1-2 animals for food from the natural habitat and 58.3% obtained 1-2 plant foods from the natural habitat.

Foods from the markets: A market survey of the common food products sold (Table 2) revealed reduced variety and diversity of food products sold in the market. The commodities commonly purchased at the market included whole maize, cassava flour, sorghum, wheat flour, finger millet, dry beans, groundnuts, sweet potatoes, cow pea leaves and kales. Of these products only one variety was recorded present in the markets. The respondents mentioned food products and varieties that were not currently sold in the market stating the disappearance.

Table 1: Types of food crop and livestock in households

Type of food and livestock	Households Growing (%) or Keeping Livestock
Food crops	
Cereals	
Maize	97.2
Sorghum	27.1
Finger Millets	6
Legumes and pulses	
Beans	47.9
Green Grams	1.4
Soya Beans	1.4
Roots and tubers	
Cassava	59
Sweet Potato	44.4
Yams	12.5
Vegetables	
Indigenous Vegetables	11.8
Exotic Vegetables	12.5
Tomatoes	0.7
Fruits	
Bananas	15.3
Mangoes	4.9
Pineapples	4.2
Paw Paws	1.4
Oranges	0.7
Nuts and oilseeds	
Groundnuts	20.8
Bambara nuts	4.2
Sesame seeds	0.7
Livestock reared	
Chicken	70.1
Cattle	49.3
Sheep	18.1
Ducks	9.7
Goats	7.6
Pigs	7.6
Turkey	6.3
Birds	5.6
Fish	0.7

Dietary variety and diversity: Foods consumed in the area were classified into the following categories; cereals, roots/tubers, pulses/nuts, vegetables, fruits/vegetables, meat/meat products (included fish), milk/milk products and fats/oils. The consumption of meat/meat products, milk/milk products, roots/tubers, fruits/vegetables, pulses/nuts and fats/oils was generally poor, while the intake of breads/cereals and fruits/vegetables was good with all preschool children consuming at least one food item from these groups. Only 3.5 and 0.7% preschool children consumed more than five varieties of cereals and of fruits/vegetables respectively, while consumption of four varieties was observed for cereals 12.5%, roots/tubers 0.7% and

Table 2: Variety of plant and animal foods local market

Food type and variety	Stalls stocking product of (%)
Cereals	
Whole maize	67.1
Finger millet	15.3
Sorghum	22.4
Wheat flour	34.1
Polished Rice	3.5
Legumes/pulses/Nuts	
Dry beans	27.1
Green grams	6.8
Cowpeas	5.5
Groundnuts	30.6
Sesame seeds	7.1
Roots and tubers	
Fresh Cassava	0
Cassava flour	24.7
Irish potato	8.2
Sweet potato	16.5
Yams	0
Vegetables	
White cabbage	12.9
Leaf amaranths	7.1
Slenderleaf	3.5
Vigna unguiculata	15.3
Solanum scabrum	8.2
Cleome gynandra	4.7
Brassica carinata	18.8
Pumpkin leaves	3.5
Tomatoes	16.4
Onions	9.6
Fruits	
Avocado	10.9
Oranges	16.4
Fenensi	10.9
Pawpaws	13.7

fruits/vegetables 12.5%. Three varieties of food were consumed by preschool children as follows: 33.3% (cereals), 5.6% roots/tubers, 8.3% (pulses/legumes/ nuts), 73.6% (fruits/vegetables and 6.9% (meat/meat products). Two food varieties were consumed by 45.1% (cereals), 38.9% roots/tubers, 25% (pulses/legumes/ nuts), 77.7% (fruits/vegetables, 43.1% (meat/meat products), 6.3% (milk/milk products) and 4.2% (fats/oils). These foods were not consumed at all by 9% roots/tubers, 21.5% pulses/legumes/nuts, 1.4% fruits/vegetables, 11.8% meat/meat products, 30.6% milk/milk products and 6.3% fats/oils preschool children. Diversity of meals consumed by preschool children within the past week preceding the study revealed that 3% of the children consumed high diversity category (more than 23 types of foods), 6% were in the moderate diversity category (between 18-22 types of foods), 46% in the low diversity category (between 13-17 types of foods) and 45% in the very low diversity category (less than 12 types of foods). The nutrients that were assessed were energy, proteins, fats, vitamin A, vitamin C, iron, calcium and zinc. Most preschool children were not meeting half of the RDA for energy (21%), vitamin A (23%), calcium (44%), zinc (14%) and none met the RDA for fat. However, 97%, 79% and 69% of the preschool children met more than 100% of the daily RDAs for iron, vitamin C and proteins respectively. There was a positive and strong relationship between agricultural biodiversity and dietary diversity (r^2 = 0.496).

Morbidity of preschool children: Two months preceding the study 57.6% of the children had no diarrhea and no acute respiratory infections and only 32.6% had no malaria. When the number of episodes of diarrhea was considered, 29.2% had one episode, 12.5% had two episodes and 0.7% had three episodes. All (42.4%) of the preschool children with diarrhea also had infections. About 31.9% of the preschool children had one episode of acute respiratory infections and 10.4% had two episodes. There was no preschool child with three episodes of acute respiratory infections. Malaria was more prevalent than the previous two infections affecting 67.4% of the preschool children. About 41% of the preschool children had one episode of malaria, 24.3% had two episodes and 2.1% had three episodes of malaria. The major determinants of morbidity were caregivers' level of education (r^2 = 0.346) and nutrition status of the child (r^2 = 0.28). The most affected age category was that of children aged 49-60 months, with 54% of them stunted and 46% severely stunted.

Nutrition status of the preschool children: Prevalence of stunting was 12%, with more males (40%) than females (29%) stunted. The most affected age category was that of children aged 49s-60 months, where 54% of them were stunted with 46% severely stunted. There was a positive relationship between stunting and dietary diversity (r^2 = 0.036). The overall prevalence of severe wasting among the preschool children was (8.3%) with more children in the age range of 24-36 months being wasted. Wasting was significantly associated with morbidity (r^2 = 0.134) and dietary diversity (r^2 = 0.081). About 27.1% preschoolers were underweight. The most affected age category was that of children 24-36 months, where 28% of them were severely under weight. Morbidity level and dietary diversity had significant influence on underweight levels and contributed 11.6% and 7.0% respectively. Stunting was the most prevalent form of malnutrition. Of all the preschool children, about 34.8% severely, 33.3% moderately and 27.1% mildly stunted. The second prevalent form of malnutrition was underweight with 21.5% severely, 27.1% moderately and 47.2 mildly underweight. Of all the preschool children, 8.3% were severely, 10.8% moderately and, 66% mildly wasted. The major determinant of general nutrition status was morbidity level (r^2 = 0.269). There was no direct linkage between morbidity and dietary diversity.

Factors that influenced agricultural biodiversity and dietary intake: Factors that influenced agricultural biodiversity and dietary intake included taboos and beliefs, education level of caregivers and household income. Most of the beliefs and taboos are no longer adhered to strictly. The respondents observed that agro-biodiversity and cultural diversity had a feedback relationship. The local farming systems provided the feedstock for songs, poems and dances. The community-based food security systems were based on conservation, cultivation and consumption of local foods. The respondents observed that "most of the traditional believes and taboos pertinent to diversity conservation were no longer adhered to". About 92% of the respondents did not follow any beliefs and most of the respondents had different attitudes to different types of foods, especially those from the wild like the hare. All respondents (100%) did not consider cassava leaves a vegetable and 43.8% did not consider sweet potato leaves as a vegetable. All respondents were not aware that cow blood was used as a vegetable and a delicacy both in raw and cooked forms. Several households had different attitudes towards certain foods. All the respondents said they would not take cassava leaves as vegetables because of the presumed to be poisonous. Forty three point eight percent of the respondents said they knew that sweet potato leaves were initially used as vegetables but they did not know how to prepare them. All the respondents were aware that animal blood especially cow's blood was used as food but they had a negative attitude towards it. Most of their responses were attributed to the loss of indigenous knowledge in food preparation thus limiting both food and nutrient diversity and quality. The average education level of the caregivers was 6.12 years spent in school. Only 3.5% of the caregivers had spent over 13 years in school, 24.3% had not spent any years in school, 53.5% had spent up to eight years and 18.8% had spent between 9-12 years in school. The total income of households assessed revealed absolute poverty [income<2000Ksh (20 US Dollars a month) in 72.2% of the households. Mothers' education level had significant influence on dietary diversity (r^2 = 0.482).

DISCUSSION

Dietary diversity measured by a simple score over the 24 h period and food checklist was sensitive to identify dietary variety and diversity. A general decline in the number food crops and livestock species in the households and in the markets is a reflection of the changes in agro-biodiversity and dietary diversity. The market survey revealed a lesser number of food types available, limiting the availability of food types to households and perhaps contributing to changes in tastes. Lack of variety and diversity of foods in the markets could contribute to the food crop patterns in the smallholder farms and in the changing dietary patterns in households. The resultant effect is the low food variety in the preschool children's diets that translates into poor nutrition status as measured by stunting. Though all preschool children ate foods from the bread/cereals and vegetables groups indicating that nearly all households prioritized their expenditure and availability of the basic foods, lack of variety of the food group was evident in most households. The daily diets monotonous were of low quality and were supplied in low amounts that were not good for healthy growth of children. The food and nutrient intake of the preschool children was below the recommended Dietary Allowances. A higher dietary diversity reflects a higher diet quality and a greater likelihood of meeting the Recommended Dietary Allowances (RDA) for all nutrients. Agricultural biodiversity is significantly associated with dietary diversity, underscoring the need to promote agrobiodiversity in farm households and conservation of the environment as a source of food for households. An increase in agrobiodiversity has promising returns for increased food crops and animal types/varieties that offer affordable variety, diversity and richer food and nutrient diversity for households.

The need to improve the productivity of crop types/varieties and livestock breeds can make a far greater contribution t o productivity variety and diversity of foods and nutrients available and affordable for households. The caregivers' level of education significantly influences dietary diversity through increased understanding of the need to provide a varied diet and sustainable use of the environment. Education has been associated with nutrition status of preschool children (Walingo and Musamali, 2008), arguing that educated women are the gatekeepers of economic development, in understanding the nutrition and health needs of the household and in their household provisioning duties. The caregivers' level of education and nutrition status of the preschool child interacts to affect the morbidity pattern of a child through food provisioning and quick response in illness and infections.

Agricultural biodiversity, mother's education level, dietary diversity, income level and morbidity levels have strong relationships with all indices of nutritional status. Agrobiodiversity and dietary diversity are intricately linked in an interaction that had a greater influence on the health status of a child measured by diarrhea, acute respiratory infections and malaria. A diverse diet has a rich micronutrient diversity that is necessary for nutrition, growth and health of preschool children. The preschool children who have a poor nutrition status tend to have a low diet diversity score and also have higher levels of diarrhea and malaria episodes.

Conclusion: There was a strong relationship between agricultural biodiversity and dietary diversity and between mothers' education level and dietary diversity and the nutritional status of the preschool child. The levels of malnutrition in this area have roots in dysfunctional agrobiodiversity that result in poor food systems that do not deliver adequate quality foods and nutrients, for good nutrition and health status of populations. Morbidity pattern of a preschool child is influenced by the mothers' education, dietary diversity and the preschool child's nutrition status. Dietary diversity is intricately linked to nutrition status and morbidity of a preschool child.

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