AJFAND ONLINE Scholarly, Peer Reviewed
African Journal of Food, Agriculture, Nutrition and Development
Volume 12 No. 3
May 2012
ISSN 1684 5374
Published by African Scholarly Science Communications Trust

A SYSTEMATIC APPROACH TO FOOD VARIETY CLASSIFICATION AS A TOOL IN DIETARY ASSESSMENT: A CASE STUDY OF KITUI DISTRICT

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Volume 12 No. 3
May 2012
ISSN 1684 5374
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ABSTRACT

Maternal and child mortalities in sub-Sahara Africa can be alleviated through improvement in food and nutrition security. Part of this strategy includes complementing supplementation, fortification and public health improvement efforts by diversifying dietary habits through identification and utilization of various types of local food sources. In Kenya, inadequate evidence-based information on nutrient variations within species still limits the adoption of dietary diversity policies, particularly in support of the implementation of food and nutrition programmes. The gap between knowledge and practice, therefore, needs to be addressed. Dietary diversity is commonly tabulated using computed scores for food diversity (count of food groups consumed during the recall period) and food variety (count of all dietary items consumed during the recall period up to the species level). This simplification of dietary diversity scores is attributed to the complexity involved in collecting accurate information on varieties under each species consumed. This has led to an urgent need to develop simple, consistent, effective and variety-level sensitive methods of measuring food biodiversity within peoples' diets. This paper presents a pilot study carried out with an aim of demonstrating the steps involved in applying a food biodiversity sensitive indicator in food consumption studies using a variety-level biodiversity tool in Kitui district, Kenya. A community food list with variety names and photos was developed and was used during household dietary assessment. The target subjects were women and children (under five years). The indicator was tested among women and children under the age of five and, for comparison, a food diversity score was also administered as an indicator of dietary diversity. Results showed that the food variety scores were more indicative of the food biodiversity resources consumed in the community than food diversity scores. The mean variety scores for mothers in the last 24 hours, 7 days and 1 month preceding the survey were 12.80(±4.11), 21.06(±6.37) and 24.43(±7.44) respectively while those for children were 12.93(±4.47), 20.80(±6.98) and 23.88(±8.13) respectively. The mean food diversity scores for mothers in the last 24 hours, 7 days and 1 month preceding the survey were 7.49(±1.25), 8.60(±0.73) and 8.73(±0.64), respectively while those for index children were 7.36(±1.39), 8.42(±1.01) and 8.55(±0.95), respectively. The differences in mean values for both variety and diversity scores for one day, one week and one month were statistically significant among women and children ($p<0.001$). This approach could provide an alternative indicator for computing dietary diversity in future.

Key words: malnutrition, biodiversity, dietary diversity, assessment

INTRODUCTION

It is estimated that in sub- Saharan Africa, 40% of children are severely or moderately stunted, 28% are underweight while 14% are born with low birth weight [1]. The decline in stunting in Africa has been modest, from 38% around 1990 to 34 % around 2008. Moreover, due to population growth, the overall number of African children under 5 years old who are stunted has increased, from an estimated 43 million in 1990 to 52 million in 2008 [1].

A child born in a least developed country is almost 14 times more likely to die during the first 28 days of life than one born in an industrialized country. Over one-third of all child deaths are due to malnutrition, mostly from increased severity of disease. With underlying malnutrition, acute respiratory infection (ARI), fever, and dehydration from diarrhoea become important contributing causes of childhood morbidity and mortality in developing countries [2,3,4]. Despite the availability of relatively simple and extremely cost-effective interventions to address malnutrition, few countries effectively implement these proven interventions at scale. Poverty is an undeniably significant factor in child malnutrition, but in many high-burden countries, malnutrition rates are much higher than in other countries with similar national income [5].

Children who are undernourished between conception and age two are at high risk for impaired cognitive development, which adversely affects the country's productivity and growth. Malnourished children who survive tend to start school late, are more likely to drop out, and have lower adult earnings. The resulting compromised human capital means that malnutrition robs many developing countries of at least 2-3% of economic growth. Investments targeted at between pregnancy and two years of age are most desirable because they target the most vulnerable, and prevent irreparable damage to human capital. Childhood anemia alone is associated with a 2.5% drop in adult wages [5,6]. It is, therefore, not surprising that the countries in this review have low ratings on the human development index and high infant and child mortality rates. These ratings are basic indicators of a country's socioeconomic situation and quality of life [7].

Improving child and maternal nutrition is not only feasible but also affordable and cost-effective. Nutrition interventions are among the best investments in development that countries can undertake. Under nutrition jeopardizes children's survival, health, growth and development, and it slows national progress towards development goals [1].

At the household level, in many countries, malnutrition rates are surprisingly high even in the wealthiest quintile of households. These facts emphasize the point that concerted efforts must be taken to reduce malnutrition; income growth does not automatically solve the problem. Two kinds of investments are needed. Nutrition-specific interventions include, for example, breastfeeding promotion, vitamin and mineral supplements, and deworming. Nutrition-sensitive development across many sectors is also necessary to ensure that development agendas fully utilize their potential to contribute to reductions in malnutrition [5].

Food fortification, supplementation, public health improvement and dietary diversity promotion are some of the strategies that have been recommended in many developing countries including Kenya [8]. Food biodiversity is defined as the existence of a multiplicity of food sources namely plants, animals and other organisms of different genetic identification within a given ecosystem [9]. While food biodiversity is considered essential for food and nutrition security, through its potential improvement in dietary choices and positive health impacts, it is seldom included in nutrition programmes and interventions [9]. This is largely because of insufficient data on food variety with respect to scientific characterization, nutritional composition, and effective methods to determine dietary habits in both food consumption studies and nutritional programmes [9].

The continued lack of access of at-risk populations to micronutrient fortified food products, and the lack of sustainability of nutrient supplementation programmes have contributed to the growing attention on the role agricultural biodiversity (wild and cultivated) could play in nutritionally improving household diets. This increasing attention is fuelled by the emergence of newer scientific data on the nutrient and non-nutrient bioactive properties of some cultivated and wild food resources, which make up a large proportion of traditional food systems in developing countries and sub-Saharan Africa in particular. Reviewing earlier reports on wild foods in Africa, Grivetti and Ogle [10] indicated that wild foods have great potential to prevent micronutrient deficiencies among vulnerable groups in particular. In a study in Mali, Nordeide *et al.* [11,12] reported that wild food resources are associated mostly with traditional food systems in rural communities, although the researchers noted that wild gathered foods can be important nutrient contributors in diets of both rural and urban communities. An increasing body of food compositional data [13-19] confirms earlier reports that food resources (like *Parkia biglobosa*, *Prosopos africana*, *Ficus thonningii*, *Adansonia digitata*) from traditional food systems could be effectively mobilized to ensure dietary diversity. These foods have potential to supply macro and micronutrients, as well as health-protecting anti-oxidants, in the diets of resource poor families and communities in sub-Saharan Africa.

Dietary diversity is of particularly importance to poor populations in developing countries where diets are mainly based on starchy staples, with little or no animal products, fruit nor vegetables [20, 21]. A report by the International Food Policy Research Institute (IFPRI) in the wake of the global food price increases in 2008, indicated that the level of diversity in food systems within countries in East and Southern Africa region was inversely related to the severity of the global food price increases [22]. Therefore, the importance of local food biodiversity and food systems in complementing food and nutrition security efforts among the poor cannot be over-emphasized.

Dietary diversity could be a long term, sustainable strategy providing the rural poor with access to quality diets [23, 24, 25] that would in turn ensure child and maternal nutrition and health improvement. To realize this goal, simple, consistent and effective methods of measuring diversity variations within people's diets as an indicator of biological diversity utilization are essential.

Dietary diversity is mainly tabulated by summarizing consumption data into scores for food groups (count of food groups consumed during the recall period) and food variety (count of all dietary items consumed during the recall period) [26, 27, 28, 29-32]. Most dietary assessments to date have collected information only as far as the species level. The information obtained could be used to calculate food variety score (sum of all food items consumed by the person(s) in a given period of time) and food diversity score (a sum of all food groups consumed by the person(s) of interest in a given period of time) [26, 27, 29].

Consumption of different varieties within a species may have a significant impact on nutritional contribution of that crop, as considerable differences in nutrient composition have been found among varieties of the same crops. This goes to demonstrate that intake of a given variety as opposed to an alternative variety could have an impact on nutritional outcome within a population [32]

This study improvised on the dietary assessment tool taking into consideration the varietal differences within foods in people's diets. The method was designed with scores that could be generated into household or index child for the specified recall period.

The objective of this pilot study was to demonstrate how this variety-level tool can be used in studying food biodiversity utilization at a community level. The method was compared with the food group-level scoring method as a way of testing how the proposed food consumption indicator might function in comparison with the tested and proven methods.

METHODOLOGY

Site description

This study was carried out in Kitui district, situated in the Eastern part of Kenya. The area is predominantly occupied by the Kamba community. The district is faced with challenges of water for domestic and agricultural production, low soil fertility and has a limited road network. The levels of protein-energy malnutrition and micronutrient deficiencies, particularly vitamin A, zinc and iron deficiencies in the district are among the highest in the country [33]. Kitui is, therefore, listed among the food-insecure districts in Kenya [34].

Sample selection

The sampling site (Kitui district) was stratified into six agro-ecological zones, which were selected with the use of Geographical Information System techniques, to ensure that they were representative of the district in terms of development domains. These were characterized by different combinations of agricultural potential, amount of rainfall, population densities and market access factors. This resulted in five strata: very dry, dry, sub-humid, humid and township.

From each stratum, four villages were randomly selected out of which 50 households were randomly picked using a sampling frame that was developed in collaboration with local administrative and cultural leaders. For consistency and standardization within the research team and government structures, a household was taken to mean all members of a common decision making unit that commonly cooked and dined together.

Research team selection and training

Local enumerators and supervisors were identified and trained by the principal investigator through role play modules.

A community food list was developed before conducting household interviews. The list was used during household interviews to facilitate in identifying varieties that had been consumed in the selected households during the food recall period.

Community food list compilation procedures

The research team worked with local communities to come up with a representative and complete food list. Five essential steps were followed:

(a) Key informant interviews

This was done by holding interview-like discussions with 5-7 informants who were identified as good sources of local food knowledge in each village. The informants included agricultural extension workers, community health workers, village headmen, church leaders and leaders of women's groups.

(b) Focus group discussions

Data for the foods lists were obtained from 10-15 persons from each community by a trained facilitator. A guide was used to give direction during such discussions by following food groups that had been prepared. The number of food groups was arrived at in consultation with local experts based on knowledge of the foods consumed and typical food combinations. Participants in the focus group discussions were asked to mention all the foods consumed under each food group, and then list all the respective different food varieties with local names. The use of a local language to capture all the names of the foods consumed in the area was effective in keeping the group engaged, participating and contributing. This was done in each village.

(c) Market visits

Market visits were conducted in each village in order to gather more information on the food available in the area that the key informant interviews and focus group discussions might have missed. The additional local food names from market surveys were included in the list obtained from focus group discussions in the villages.

(d) Food photos
To equip the research team with the correct names of local varieties and appearance, the research team took photos of all the foods they came across, with the assistance of community members.

(e) Harmonization meeting
In order to harmonize all the food lists generated from village-level focus group discussions, a meeting of representatives from all focus group discussions was arranged. This was done to avoid duplication and confusion of varieties. One comprehensive food list was generated that represented the entire study community. This was used as part of the questionnaire that was used during the household dietary assessment. Ethnobiologists were recruited to identify and give proper scientific names of the foods that were generated. The questionnaire was finalized with the incorporation of food lists, arranged with varieties under the species and the food group, respectively, before rolling out the team for data collection.

Inclusion and exclusion criteria for households
Selected households had to have a child between 6-59 months. If in a given household, there was more than one child in that age bracket, the younger one was chosen for the study. The study also preferentially selected households that had a mother as the surrogate respondent for both the household and the selected child because of the reliable nature of information from women about food in most households. A total of 1000 households were selected for the study. Selected households were coded (1-1000) prior to interviews for proper identification during and after data entry. A list of substitute-households was prepared to cater for any non-response households. In consultation with research supervisors, enumerators randomly picked from the substitute list new households and gave them the code the substituted households had been given.

Household interviews
Respondents consented to responding to the interview questions freely before taking part. The mother or caretaker of the child responded on behalf of the household and was also the surrogate respondent for the selected child. The frequency of food varieties consumed in the last 24 hours, seven days and one month proceeding the survey day were recorded for both the mother and the index child, based on varieties reported to have been consumed.

Respondents were asked whether the household had consumed each food species in all food groups. If the response was positive, then they would be asked to specify the varieties using the food list generated, followed by the frequency of consumption of the variety in the last twenty four hours, last seven days and one month prior to the survey day. These steps were repeated for the index child until all the foods listed in the food frequency questionnaire were covered.

Data entry and analysis Data collection and entry were carried out simultaneously using "Quefax", data management assistant software developed by International Livestock Research Institute and International Centre for Research in Agro-forestry (ILRI-ICRAF) research methods group [35]. Data were analysed using SAS [36]. The general linear model was used to fit response as a function of status, days and status (child, woman) by days interaction. Both variables were highly significant (p<.0001). For both scores, the interaction effects were significant, suggesting the differences among period of recall varied amongst children and women.

RESULTS

Food diversity scores

Foods were grouped into nine food groups: (a) cereal products (b) roots, tubers and plantains; (c) vegetables; (d) fruits; (e) legumes; (f) animal foods and products; (g) sugars, stimulants and beverages and (h) spices and condiments and (i) fats/oils. Food groups were counted for both the mother and the index child in the household. Results indicated that as the recall period increased, more and more households tended to score higher diversity values (aggregation towards the higher values). For shorter recall periods however, a continuum of households was observed from low to medium and high diversity scores. This was observed in both mother and the index child dietary diversity scores. Using the last one month prior to the interview as the recall period, 80.4% of the women had a maximum score of 9 food groups and this fell to 71.1% when considering the last seven days and finally 23.3% in the last twenty four hours prior to the interview. Index children's dietary diversity scores were not different as 63.9%, 72.2% and 21.7% had a maximum score of nine in the last month, seven days and 24 hours, respectively at the period preceding the survey. The mean food diversity scores for mothers in the last 24 hours, 7 days and 1 month preceding the survey were 7.49(±1.25), 8.60(±0.73) and 8.73(±0.64), respectively while those for index children were 7.36(±1.39), 8.42(±1.01) and 8.55(±0.95), respectively (Table 1). The mean diversity scores for children in one and seven days were significantly different and although different from one day diversity scores for children, the 30 days scores were not significantly different from those in seven days. The mean diversity scores for women in one day were significantly different from 7 days scores although not significantly different from 30 days scores. Comparison of mothers and children scores in similar recall periods revealed significantly different scores (Tables 2 and 3).

Food variety scores

This method seemed to even-out the previously observed 'aggregation' of score towards the higher values. Scores from both the mothers and index children showed normal distribution and this seemed to be independent of the duration of the recall period. The mean variety scores for mothers in the last 24 hours, 7 days and 1 month preceding the survey were 12.80(±4.11), 21.06(±6.37) and 24.43(±7.44), respectively while those for index children were 12.93(±4.47), 20.80(±6.98) and 23.88(±8.13), respectively (Table1). The longer the recall period was, the higher the reported mean scores. The one, seven and 30 days mean variety scores for women were all significantly different from each other as was the case for mean scores of children.

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Comparison of children and women mean variety scores within similar recall periods revealed that mean scores for women in one day were significantly higher than children's although children had significantly higher mean variety scores in 7 days than women (Tables 4 and 5).

DISCUSSION

Biodiversity is reflected at three levels- the ecosystem or agro-ecological zone, the species contained in the ecosystem, and the genetic diversity within the species. However, few national or regional consumption surveys investigate or report food intakes at the cultivar/variety/breed level [9].

The study community seemed to consume a wide range of foods within the same species. The consumption of different varieties and breeds within a species may have a significant impact on nutritional adequacy, as considerable differences in nutrient composition have been found among varieties of the same crops ([9,37]. While food biodiversity is considered essential for food and nutrition security, and can contribute to the achievement of the Millennium Development Goals (MDGs) through improved dietary choices and positive health impacts, it is seldom included in nutrition programmes and interventions. This has been largely because of insufficient data on local foods such as missing scientific identification and nutrient composition. Needless to say, appropriate methods for obtaining, analysing and using these data in food consumption studies and nutritional programmes have also been a hindrance. [9]. The need for an indicator that reflects the real measure of biodiversity consumption within a given community cannot be over-emphasized. The food variety score used in this study seemed to provide a more disaggregated pattern of diversity within people's diets compared to diversity score that lumps varieties and species under food groups. This means that the longer the period of recall, the more likely the households were to have prepared and consumed different varieties. Longer recall periods, however, are associated with less precision and inaccuracy and could be the major limitation of this approach. Most of the mean scores for children and women alike were significantly different across the different recall days and within the same recall days but compared between women and children. It should be pointed out however, that significance is based on variety and diversity numbers computed. It will be interesting to know whether these differences in numbers of varieties reported carry any nutritional and health benefits. Though not included in this paper, further analysis of this indicator in combination with indicators related to nutrition and health may help to determine whether the observed disaggregation of scores has any nutrition and health implications. Previous studies have indicated strong correlations were found between dietary diversity scores with nutrition and health outcomes. Dietary diversity, closely related to dietary quality, had strong associations with increased longevity and protection against chronic diseases [38, 39] and improved food and nutritional status [26,27,40] have been reported. Micronutrient density was also reported to increase with increasing dietary diversity [41]. Unlike in this study, the variations within the species were not considered in the above studies. It should also be mentioned that the differences within species were only considered in plants because the research team could not easily establish a mechanism for identifying different breeds prior to the study. Future studies need to look extend the concept of the study to beyond plant food sources. In a different approach, novel approach that measures the functionality of the nutrition indicator, the nutritional functional diversity metric has been proposed. This ecological indicator is based on plant species composition on farm and the nutritional composition of these plants for 17 nutrients that are key in human diets and for which reliable plant composition data are available. Even in this indicator, reviews suggested considering varieties within species. It looks clear, therefore, that the use of varieties in the consumption indicator of biodiversity cannot be ignored, irrespective of the approach [42].

In this study, there were frequently consumed varieties whose nutritional composition data were unavailable in the literature. Studies of this nature could help in establishment of priority or preferred varieties for nutrient composition analysis by targeting local food biodiversity, which have remained underutilized and under-promoted in food in nutrition interventions.

In this study, varieties of different species were counted in the computation of the indicator. However, during the expert consultation on nutrition indicators for biodiversity that was held in Washington DC [9], it was even suggested that various parts of the consumed food resource be considered separately. This indicates that the research community is already thinking of a more dis-aggregated indicator to properly reflect on the level of food biodiversity utilization. The findings of this study could, therefore, be of interest to national and international organizations that are responsible for policy making such as the United Nations' Food and Agriculture Organization.

CONCLUSION

The study demonstrated that local communities can, to a great extent, identify foods and the cultivars they consume**.** Food consumption data can be collected below subspecies level if the cultivars and varieties are pre-listed. The use of a food catalogue in guiding survey enumerators and respondents on identification of varieties cannot be over-emphasized. This study demonstrated that the use of a variety-sensitive food variety score as indicator of dietary diversity can be used alongside other tested dietary diversity assessment indicators like food diversity. Food variety score seemed to capture more details of the local food biodiversity resource. The relationship between this indicator and the nutrition and health indicators is beyond the scope of this paper. The amount of food biodiversity consumed by the study subjects generally increased with increase in recall period.

ACKNOWLEDGEMENT

The authors wish to appreciate staff at Kenyatta University, National Museums of Kenya, Kenyatta National Hospital, ICRAF/ILRI Research Methods Group for having substantially contributed to the implementation of the study and International Development Research Centre (IDRC) for providing the funding.

Table 1: Mean diversity and food variety scores for women and children

Variables	Sample size	Mean	Std. Deviation
Child variety score in 7 days	898	20.80	6.98
Child variety score in 24hrs	897	12.93	4.47
Child variety score for 1month	898	23.88	8.13
Mothers variety score for 1month	898	24.43	7.44
Mothers variety score in 7 days	898	21.06	6.37
Mothers variety score in 24hrs	898	12.780	4.11
Child diversity score in the last 7 days	898	8.42	1.01
Child diversity score in the last 24hrs	897	7.36	1.39
Child diversity score in 1month	898	8.55	0.95
Mothers diversity score in 1month	898	8.73	0.64
Mothers diversity score in the last 7 days	898	8.60	0.73
Mother diversity score in the last 24hrs	898	7.49	1.25

Table 2: Least Squares Means for effect days*STATUS (dietary diversity)

days	STATUS	Dietary diversity score (LSMEAN)	Standard Error	Pr > |t|	LSMEAN Number
1	child	7.32934132	0.03460729	<.0001	1
1	mother	8.58424726	0.03459003	<.0001	2
7	child	8.37986042	0.03459003	<.0001	3
7	mother	7.47956132	0.03459003	<.0001	4
30	child	8.50348953	0.03459003	<.0001	5
30	mother	8.71057884	0.03460729	<.0001	6

Table 3: Probability table (dietary diversity)

Least Squares Means for effect days*STATUS Pr > |t| for H0: LSMean (i)=LSMean (j) Dependent Variable: dietary_div_score						
i/j	1	2	3	4	5	6
1		<.0001	<.0001	0.0021	<.0001	<.0001
2	<.0001		<.0001	<.0001	0.0988	0.0098
3	<.0001	<.0001		<.0001	0.0115	<.0001
4	0.0021	<.0001	<.0001		<.0001	<.0001
5	<.0001	0.0988	0.0115	<.0001		<.0001
6	<.0001	0.0098	<.0001	<.0001	<.0001	

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ISSN 1684 5374
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Table 4: Least Squares Means table for effect days*STATUS (food variety score)

days	STATUS	Variety score LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	Child	12.9301397	0.2062904	<.0001	1
1	Mother	21.1625125	0.2061875	<.0001	2
7	Child	20.7547358	0.2061875	<.0001	3
7	Mother	12.8404786	0.2061875	<.0001	4
30	Child	23.8045862	0.2061875	<.0001	5
30	Mother	24.4895314	0.2061875	<.0001	6

Table 5: Probability table (food variety scores)

Least Squares Means for effect days*STATUS Pr > |t| for H0: LSMean (i)=LSMean (j) Dependent Variable: variety score						
i/j	1	2	3	4	5	6
1		<.0001	<.0001	0.7585	<.0001	<.0001
2	<.0001		0.1620	<.0001	<.0001	<.0001
3	<.0001	0.1620		<.0001	<.0001	<.0001
4	0.7585	<.0001	<.0001		<.0001	<.0001
5	<.0001	<.0001	<.0001	<.0001		0.0189
6	<.0001	<.0001	<.0001	<.0001	0.0189	

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