Dietary Diversity Score as an Indicator of Nutritional Adequacy of Diets among 16-19-Year-Old Adolescents

Ernani R. Bullecer, Lucila B. Rabuco, Dieza Atchel B. Aninao, Ranhel C. De Roxas, Jerica Cristel A. Esguerra, Phoebe Ruth U. Lim and Rowel C. Malimban

Department of Nutrition, College of Public Health, University of the Philippines Manila

ABSTRACT

Objective. This study was conducted to determine the dietary diversity score and its relation to nutritional adequacy among 16-19-year-old adolescents.

Methods. Secondary data analyses were undertaken with a representative sample of 16-19-year-old adolescents (n = 521) in a university campus in Manila in 2008. Dietary diversity scores (DDS) were calculated. Nutrient adequacy ratio (NAR) is the ratio of subject's nutrient intake to the 2002 Recommended Energy and Nutrient Intakes (RENI) for Filipinos. The mean adequacy ratio (MAR) was calculated as the sum of NARs for all evaluated nutrients divided by the number of nutrients evaluated, expressed as a ratio (range from 0 – 1). MAR was used as a measure of adequacy of overall diet. Pearson correlation coefficients between DDS and MAR were calculated and also evaluated for sensitivity and specificity, with MAR taken as the ideal standard of adequate intake.

Results. The adolescents had a mean DDS of 3.94 (1.21) and a mean MAR of 0.67 (0.18). There was a strong correlation between MAR and DDS ($r = 0.543$; $P < 0.0001$). A DDS of 4 was shown to be the best indicators for both MAR equivalent to 0.5 and 0.7 since they provided the best sensitivity and specificity.

Conclusion. DDS can be used as a simple and quick indicator of the nutritional adequacy of the diets among these group of adolescents. Further investigation of this tool is needed for other population groups i.e., adults and elderly.

Key Words: dietary diversity, nutritional adequacy, adolescent

Introduction

Assessment of dietary intake at the individual level such as the 24-hour food recall and food weighing can be time consuming, tedious, and requires a high amount of technical skill both in data collection and analysis.[1] Such dietary methods are quantitative and aim to estimate nutrient consumption. Epidemiologic studies that established diet and disease causation have also focused on single nutrient consumption and disease risk, despite the wide array of nutrients present in food. Although paying attention to diet components is important, there are many undiscovered compounds in food, and possible interactions among nutrients, which suggest using indices of the whole diet and not only a single compound.[2] Nondiversified diet can have negative consequences on individual's health, well-being, and development, as this kind of diet is not likely to meet micronutrient requirements.[3] Despite the link between increasing diversity of the diet and increased nutrient intake, the relationship between dietary diversity and adequate micronutrient intake has not yet been sufficiently validated across different cultural settings and in different age groups.[4]

Dietary diversity is a qualitative measure of food consumption that reflects access to a wide variety of food, and is also a proxy of the nutrient adequacy of the diet for individuals. The dietary diversity questionnaire is a tool providing a more rapid, user-friendly and cost-effective approach to measure changes in dietary quality at the inidividual level.[5] The dietary diversity scores (DDS) are created by adding either the number of individual foods or food groups consumed over the past 24 hours. The DDS aims to capture nutrient adequacy. The DDS is widely recognized as being a key dimension of diet quality. It reflects the concept that increasing the variety of foods and food groups in the diet helps to ensure adequate intake of essential nutrients, and promotes good health. There is ample evidence from developed countries showing that dietary diversity is indeed strongly associated with nutrient adequacy, and thus is an essential element of diet quality. On the other hand, there is less evidence from developing countries where monotonous diets, relying mostly on a few plant-based staple foods, are typical. Previous studies have generally been context-specific, and diversity has been operationalized differently in each study.[5]

Many studies in several different age groups have shown that an increase in individual diversity score is related to increased nutrient adequacy of the diet. DDS have been positively correlated with increased mean micronutrient density adequacy of complementary feeding[6]

Corresponding author: Ernani R. Bullecer, MPH, RND
Department of Nutrition, College of Public Health
University of the Philippines Manila
625 Pedro Gil St., Ermita, Manila 1000 Philippines
Telephone: +632 5255858
TeleFax: +632 5211394
Email: nans_bullecer@yahoo.com

and micronutrient adequacy of the diet in non-breastfeeding children[4,7,8] and adults.[9] However, there is a dearth of information regarding the correlation of DDS with micronutrient adequacy among adolescents. In the Philippines, there is a limited number of studies done in DDS among adolescents, most studies are done among pregnant and lactating women[5] and children.[6,10,11] Use of rapid, simple and inexpensive tool such as DDS can hasten the identification of adolescents with poor nutrient intake. Thus, the purpose of this study was to determine the dietary diversity score and its relation to nutritional adequacy among 16-19-year-old adolescents in a university campus in Manila.

Methods

Subjects

Secondary data analyses were undertaken of the study entitled "Hydration Status among University of the Philippines Manila students" in 2008.[12] The study population comprised of a representative and randomly selected sample of 521 aged 16-19 years old. The study employed a stratified random sampling method among the total population of first year to third year college students. The respondents were first stratified according to colleges and then a systematic sampling method was utilized. An informed consent was obtained from the respondents who were randomly selected for the study.

Anthropometry

Height and weight of each participant were determined according to recommended techniques.[13] Weight was measured using a digital electronic weighing scale (Seca; range 0.1 – 150 kg). Height was measured using microtoise. From the anthropometric data, the Body Mass Index (BMI) was computed for each respondent. Nutritional status was defined according to BMI cut-off points recommended by the WHO.[14] Subjects were classified into four groups: underweight (BM < 18.5), normal (BMI ≥ 18.5, <25), overweight (BMI ≥ 25, <30) and obese (BMI ≥ 30).

Dietary intake

The study collected dietary data by 24-hour recall. A 24-hour recall was conducted with the respondents by trained interviewers who did a face-to-face interview. The respondents were asked to recall all food and beverages including water consumed from the time of waking until the respondent went to sleep the past day. Estimates of the amount and portion sizes of foods, in household measures were also asked. Food models were used to serve as memory aids to assist the respondents in estimating portion sizes of the food items consumed.

Nutrient analyses were done to determine the nutrient intakes of the respondents using the "FCT + Menu Eval" application software developed by the Food and Nutrition Research Institute, Department of Science and Technology (FNR-DOST), Philippines, 2002. The analyses of the software were limited only to the 7 micronutrients (Vitamins A, C, thiamin, riboflavin, niacin, calcium and iron), energy and protein.

Nutrient Adequacy

In order to determine the nutrient adequacy of the diet, the nutrient adequacy ratio (NAR) was calculated for each of the micronutrients, energy and protein. The NAR for a given nutrient is the ratio of a subject's intake to the current recommended allowance for the subject's sex and age category. The Recommended Energy and Nutrient Intakes (RENI) for Filipinos[15] was used as the recommended allowance to compute for NAR. There were no adjustments for bioavailability of nutrients in the analyses which is a limitation of this study.

The mean adequacy ratio (MAR) was calculated as a measure of the adequacy of the overall diet, where MAR is the sum of each NAR (truncated at 1) divided by the number of nutrients.[16] NAR was truncated at 1 so that a nutrient with a high NAR could not compensate for a nutrient with a low NAR.[17]

Dietary Diversity Score

A Dietary Diversity Score (DDS) is defined as the number of food groups consumed over a twenty four hour period. The evaluation of DDS used was based on the method described by Hatloy et al.[17] The diet was classified according to nine food groups as recommended by FAO (2008), which included: (1) Starchy staples (cereals, roots and tubers); (2) Dark green leafy vegetables; (3) other vitamin A rich fruits and vegetables; (4) other fruits and vegetables; (5) organ meat; (6) meat, poultry and fish; (7) eggs; (8) legumes, nuts and seeds; and (9) milk and milk products. The respondent is counted as a 'consumer' of any of the food groups if he/she consumed at least 15 g.[18] The maximum DDS was 9, one (1) point was given for each group consumed over a period of 24 hours, A non-consumer of any of the food groups is given a score of zero.

Statistical Analyses

Data was analyzed by Stata Statistics/Data Analysis Release 9.2 (College Station, Texas: Statacorp LP). Data was reported as mean ± SD. Student's t-test was used to compare the means. Pearson correlation were done to compare DDS with MAR and NARs to test for a significant relationship. The Shapiro-wilk test was done to check for the normality of DDS and MAR. Finally, the DDS cut-off points optimizing sensitivity, specificity for MAR were determined using Receiver Operating Characteristics (ROC) curve analysis.

Results

The anthropometric characteristics of the respondents are summarized in Table 1. Although boys on the average were slightly older, heavier and taller than their girl counterparts, differences were not significant. On the other hand, computing for their BMI, boys have higher BMI as compared to girls and BMI was significantly different (P<0.001).

Table 1. Summary of the anthropometric characteristics of the adolescents (n = 521)

Variable	Boys (n = 132)	Girls (n = 389)	Total (n = 521)
Age (years)	17.64 (1.01)	17.55 (1.02)	17.57 (1.02)
Weight (kg)	63.34 (13.07)	51.84 (10.08)	54.76 (11.99)
Height (cm)	167.18 (6.48)	156.08 (5.44)	158.89 (7.48)
BMI	22.63 (4.41)*	21.26 (3.90)	21.60 (4.07)

Values are expressed as mean (standard deviation)
Significant at P<0.001, as compared to girls

Table 2 shows the MAR and the mean NARs of individual nutrients in the adolescents' diet. MAR was significantly (P<0.01) higher (0.71) among boys than girls (0.65) and averaged 0.67 for the group as a whole. Generally, the NARs for most nutrients were similar among boys and girls except for iron which was higher among boys (0.83) than girls (0.46). Nutrients which had an average of at least 0.7 were niacin, energy and protein. The average NARs for vitamin C, calcium and iron were too low, being less than 0.36 for vitamin C, less than 0.53 for calcium and less than 0.55 for iron.

Table 2. Mean adequacy ratio (MAR) and mean nutrient adequacy ratio (NARs) of adolescents

Variable	Boys (n = 132)	Girls (n = 389)	Total (n = 521)
MAR	0.71 (0.18)*	0.65 (0.18)	0.67 (0.18)
NAR vitamin A	0.66 (0.34)	0.61 (0.35)	0.62 (0.34)
NAR vitamin C	0.39 (0.36)	0.35 (0.35)	0.36 (0.35)
NAR thiamin	0.64 (0.31)	0.67 (0.32)	0.66 (0.31)
NAR riboflavin	0.68 (0.27)	0.68 (0.28)	0.68 (0.28)
NAR niacin	0.98 (0.21)	0.96 (0.13)	0.96 (0.16)
NAR calcium	0.59 (0.29)	0.52 (0.30)	0.53 (0.30)
NAR iron	0.83 (0.26)	0.46 (0.26)	0.55 (0.30)
NAR energy	0.75 (0.23)	0.77 (0.22)	0.77 (0.22)
NAR protein	0.84 (0.20)	0.83 (0.22)	0.84 (0.22)

Values are expressed as mean (standard deviation)
Significant at P<0.01, as compared to girls

Table 3 shows the mean DDS in food groups and total DDS in the adolescent's diet. DDS was slightly higher among boys (4.09) than girls (3.89). However, difference was not significant (P<0.11). The average DDS for the group as a whole was 3.94. Generally, DDS in food groups was similar between the two sexes except for legumes, nuts and seeds group which was significantly higher (P<0.01) among boys.

Pearson correlation coefficients between NARs of nutrients with DDS revealed that all correlations were significant (P<0.0001) with the exception of DDS with niacin among boys. MAR showed a strong correlation (r = 0.54) with DDS in both sexes (Table 4).

Table 3. Mean and standard deviations of DDS in food groups and total DDS in boys and girls

Food Groups	Dietary Diversity Score (DDS)		
	Boys (n = 132)	Girls (n = 389)	Total (n = 521)
Starchy staple	0.99 (0.09)	0.99 (0.11)	0.99 (0.11)
Dark green and leafy vegetables	0.09 (0.29)	0.11 (0.31)	0.10 (0.31)
Other Vitamin A vegetables and tubers	0.26 (0.43)	0.22 (0.41)	0.23 (0.42)
Other fruits and vegetables	0.59 (0.49)	0.63 (0.48)	0.62 (0.48)
Organ meat	0.09 (0.29)	0.07 (0.25)	0.08 (0.26)
Meat, fish and poultry	0.98 (0.12)	0.97 (0.18)	0.97 (0.16)
Eggs	0.32 (0.46)	0.25 (0.44)	0.27 (0.44)
Legumes, nuts and seed	0.22 (0.41) (p = 0.018)	0.13 (0.34)	0.16 (0.36)
Milk and milk products	0.53 (0.50)	0.54 (0.49)	0.53 (0.49)
DDS	4.09 (1.32)	3.89 (1.16)	3.94 (1.21)

Values are expressed as mean (standard deviation)

Table 4. Pearson correlation coefficients between nutrient adequacy ratio (NAR) of certain nutrients and dietary diversity score (DDS)

Nutrient	Dietary Diversity Score (DDS)		
	Boys (n = 132)	Girls (n = 389)	Total (n = 521)
MAR	0.541	0.541	0.543
NAR vitamin A	0.642	0.510	0.547
NAR vitamin C	0.256 (p = 0.003)	0.356	0.330
NAR thiamin	0.261 (p = 0.002)	0.248	0.248
NAR riboflavin	0.494	0.416	0.435
NAR niacin	0.020 (p = 0.813)	0.282	0.184
NAR calcium	0.364	0.380	0.379
NAR iron	0.390	0.346	0.339
NAR energy	0.356	0.352	0.349
NAR protein	0.345	0.354	0.351

All correlation coefficients significant at P < 0.0001, unless otherwise indicated

Figure 1 shows the relationship between DDS and NARs of energy, protein, calcium and iron. For all nutrients, there was an increase in NAR as DDS increased. For energy, NAR reached 0.8 at a DDS of 4, while NAR reached 0.8 at a DDS of 3 for protein. NAR reached 0.8 at a DDS of 6.5 for calcium and iron. Meanwhile, all NARs for vitamins increased as DDS increased except for vitamin C (Figure 2). NAR reached 0.8 at a DDS of 5 for vitamin A, at a DDS of 7.5 for vitamin C, at a DDS of 7 for thiamin, DDS of 5 for riboflavin and a DDS of 2 for niacin.

Mean MAR values for different values of DDS are presented in Figure 3. As MAR increases, DDS also increased. Figures 4 and 5 indicate the sensitivity and specificity of the receiver-operator characteristic curves for MAR using DDS. If one selects < 0.5 MAR as a cut-off for sensitivity and > 0.5 MAR as a cut-off for specificity, then a

DDS of 4 is most appropriate. It gives a sensitivity of 70.19% and a specificity of 74.74%. If one selects < 0.7 MAR as a cut-off for sensitivity and > 0.7 MAR as a cut-off for specificity, then a DDS of 4 is most appropriate. It gives a sensitivity of 81.78% and a specificity of 55.84%.

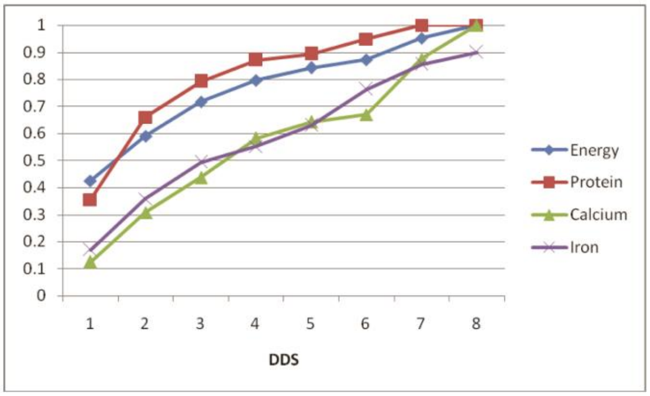

Figure 1. Mean nutrient adeqaucy ratio (NAR) of energy, protein and minerals at different levels of dietary diversity score (DDS)

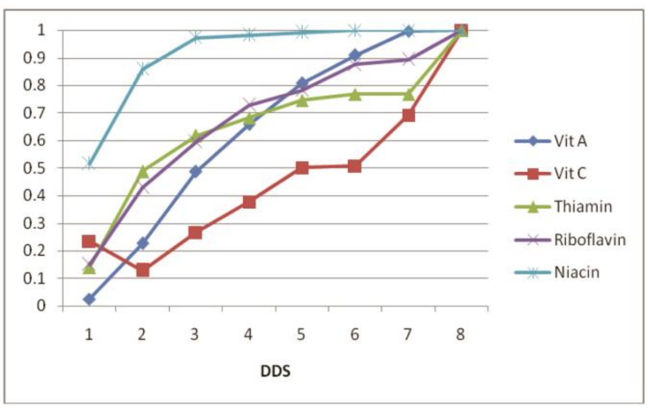

Figure 2. Mean nutrient adequacy ratio (NAR) of vitamins at different levels of dietary diversity score (DDS)

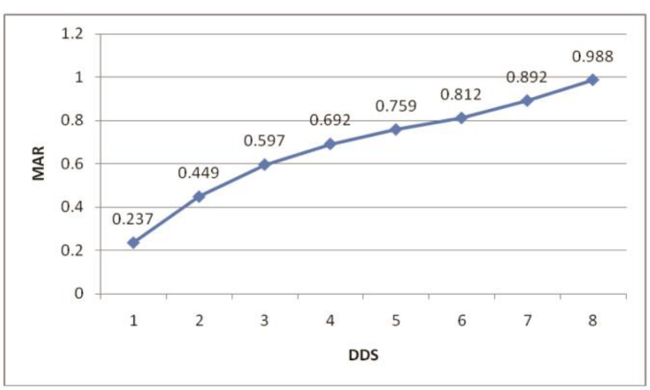

Figure 3. Mean adequacy ratio (MAR) for different levels of dietary diversity score (DDS)

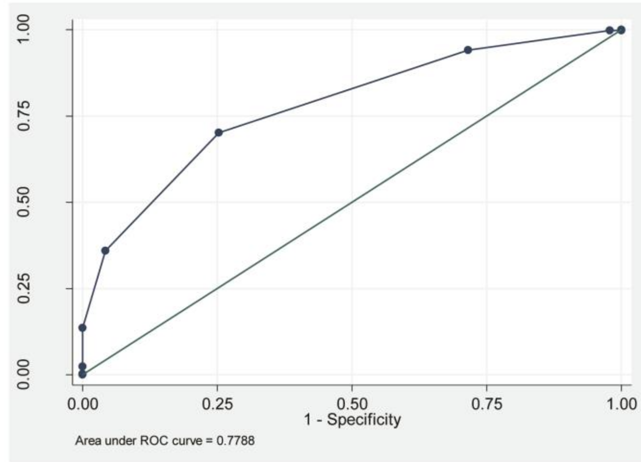

Figure 4. Sensitivity and specificity (%) for different cut-off points of dietary diversity score (DDS), when MAR is 0.5

Summary of sensitivity and specificity for different DDS cut-off points, when MAR is 0.5

DDS	Sensitivity	Specificity
1	99.77%	0.00%
2	99.77%	2.11%
3	94.13%	28.42%
4	**70.19%**	**74.74%**
5	35.92%	95.79%
6	13.62%	100.00%
7	2.35%	100.00%
8	0.23%	100.00%
9	0.00%	100.00%

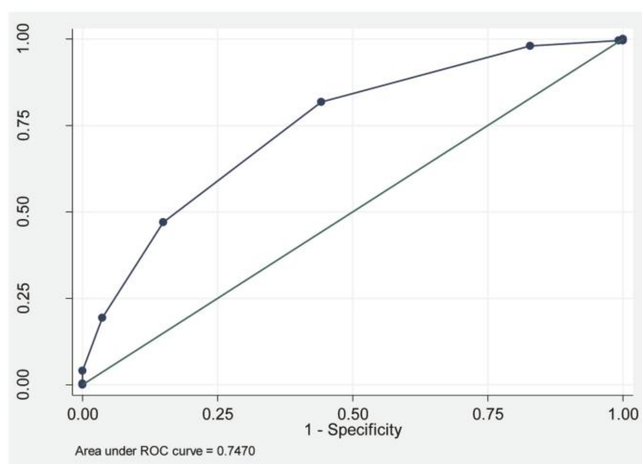

Figure 5. Sensitivity and specificity (%) for different cut-off points of dietary diversity score (DDS), when MAR is 0.7

Summary of sensitivity and specificity for different DDS cut-off points, when MAR is 0.7

DDS	Sensitivity	Specificity
1	99.60%	0.00%
2	99.60%	0.73%
3	97.98%	17.15%
4	**81.78%**	**55.84%**
5	46.96%	85.04%
6	19.43%	96.35%
7	4.05%	100.00%
8	0.40%	100.00%
9	0.00%	100.00%

Discussion

Having a variety of foods in the diet has been proven to ensure adequate intake of essential nutrients and hence promote good health.[16] This study showed that DDS had a positive correlation with MAR in these group of adolescents. Other studies on DDS have reported similar results in children as well as in adults.[16,17,18] Thus, DDS can be used to predict dietary quality. DDS can also be considered to estimate nutrient adequacy. Based on this study, there was a significant and positive correlation between DDS and most NARs. The result of the study was also consistent with other studies.[19,20,21,22]

In general, the average DDS of the adolescents (3.94) was low which means that their diets are not that diverse. This may be due to low DDS for dark green leafy vegetables (0.10), other vitamin A vegetables and tubers (0.23), organ meats (0.08) and legumes (0.16). This is probably due to the typical consumption of fast food items like hamburgers, pizza etc. among adolescents. Starchy staples (0.99), meat/fish/poultry (0.97) and milk and milk products (0.53) are the most commonly eaten food groups as shown in their DDS. The DDS for these food groups are also comparable between the two sexes. However, for the fruit group, girls (0.63) had a higher DDS compared to boys (0.59). This is consistent with the study done in Iran[23] where girls had a higher total DDS and DDS for fruits, vegetables and grains. In contrast, in Australia[24] one quarter of adolescents did not consume the fruit group and the fruit variety score was the lowest. Only less than 25 % of all adolescents had adequate fruit intake.

The low DDS can be attributed to low MAR (0.67) and NARs for most nutrients. Using a cut-off of 0.7 for adequate intake, it was found that certain nutrients were particularly deficient in the diet, these being vitamin A, C, thiamin, riboflavin, calcium and iron. However, the MAR which is an index of overall diet quality, is significant and positively correlated ($r = 0.543$, $P < 0.0001$) to DDS. Most NARs for various nutrients were significantly correlated ($P < 0.0001$) with DDS except for niacin among boys. The positive correlation of energy and protein intakes with DDS is contrary to the results obtained in other studies done among adults[25] and the elderly.[20] The difference may be attributed to the number of respondents, dietary habits and scoring methods.

DDS cut-off points were tested for their sensitivity and specificity against definitions of a nutrient adequate diet. The nutrient adequate diet was defined as having a MAR between 0.5 and 0.7 (50-70% MAR) for nutrient intake. The sensitivity test was used to identify as many inadequate diets as really being inadequate, thereby identifying the DDs cut-off point that would indicate inadequacy (high sensitivity), but at the same time being able to identify respondents with a nutrient adequate diet (high specificity). A DDS of 4 was shown to be the best indicator of MAR both for 0.5 and 0.7 since they provided the best sensitivity and specificity. This is consistent with the results of the study done by Steyn[4] among South African children.

It should be noted that the non-adjustment for the bioavailability of nutrients in the calculation of NAR may have overestimated the nutrient adequacy of respondents. Furthermore, the use of a 15 g cut-off to be considered as a 'consumer' in any of the food groups could be restrictive as compared to the use of 0 g and 10 g cut-offs in previous studies. The impact of imposing the 15 g minimum may also vary across food groups.[18] Thus, this could have under- or overestimated the DDS of some respondents.

Conclusion

Dietary intakes among these group of adolescents showed inadequate nutrient intakes as measured by low NARs and MAR and was confirmed by poor dietary diversity scores (DDS). Thus, DDS is a good indicator of nutritional adequacy among these group of adolesents. DDS can thus be a good subsititute for traditional dietary assessment tools in community settings or situations where quick assessment – not requiring highly skilled field workers/trained dietitians to complete – are often required to assess the situation Furthermore, DDS will also hasten the identification of individuals and households in greatest need.

It is recommended that this tool be tested for other group of adolescents living in diverse settings such as in resource-poor households, rural and peri-urban areas, and out-of-school youths. It will also be worthwhile to test this tool in other population groups i.e, adults and elderly. Moreover, it is also suggested to incorporate the bioavailability of nutrients in the calculation of nutrient adequacy and to compare the use of different cut-offs *i.e.* 0 g, 10 g and 15 g in the analysis of dietary score data.

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References

1. Kennedy G, Ballard T, Dop M. Guidelines for Measuring Household and Individual Dietary Diversity. FAO Nutrition and Consumer Protection Division, Food and Nutrition Technical Assistance (FANTA) Project, 2008.
2. Azadbakht L, Esmaillzadeh A. Dietary diversity score is related to obesity and abdominal adiposity among Iranian female youth. Public Health Nutr. 2011; 14(1): 62-9.
3. Kant AK. Dietary patterns and health outcomes. J Am Diet Assoc. 2004; 104(4):615-35.
4. Steyn NP, Nel JH, Nantel G, Kennedy G, Labadarios D. Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? Public Health Nutr. 2006; 9(5):644-50.
5. Daniels MC. Dietary Diversity as a Measure of the Micronutrient Adequacy of Women's Diets: Results from Metropolitan Cebu, Philippines Site. Washington, DC: Food and Nutrition Technical Assistance II Project, Academy for Educational Development, 2009.
6. FANTA. Developing and Validating Simple Indicators of Dietary Quality and Energy Intake of Infants and Young Children in Developing Countries: summary of findings from analysis of 10 data sets. Working Group on Infant and Younch Child Feeding Indicators. Food and Nutrition Technical Assistance (FANTA) Project, 2006.
7. Hatloy A, Hallund J, Diarra MM, Oshaug A. Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). Public Health Nutr. 2000; 3(1):57-65.
8. Ruel M, Graham J, Murphy S, Allen L. Validating simple indicators of dietary diversity and animal source food intake that accurately reflect nutrient adequacy in developing countries. Report submitted to GL-CRSP, 2004.
9. Foote JA, Murphy SP, Wilkens LR, Basiotis PP, Carlson A. Dietary variety increases the probability of nutrient adequacy among adults. J Nutr. 2004; 134(7):1779-85.
10. Daniels MC, Adair LS, Popkin BM, Truong YK. Dietary diversity scores can be improved through the use of portion requirements: an analysis in young Filipino children. Eur J Clin Nutr. 2009; 63(2):199-208.
11. Kennedy GL, Pedro MR, Seghieri C, Nantel G, Brouwer I. Dietary diversity score is a useful indicator of micronutrient intake in non-breastfeeding Filipino children. J Nutr. 2007;137(2):472-7.
12. Aninao DA, De Roxas RC, Esguerra JC, et al. Hydration status among U.P. Manila students aged 16-19 years old. College of Public Health, University of the Philippines Manila. Unpublished. 2008.
13. Gibson R. Principles of Nutritional Assessment. New York: Oxford University Press; 1990.
14. BMI Classification. World Health Organization, 2004.
15. Recommended Energy and Nutrient Intakes for Filipinos. Food and Nutrition Research Institute. Department of Science and Technology, 2002.
16. Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J. The effects of variety in food choices on dietary quality. J Am Diet Assoc. 1987; 87(7):897-903.
17. Hatloy A, Torheim LE, Oshaug A. Food variety – a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. Eur J Clin Nutr. 1998; 52(12):891-8.
18. Arimond M, Wiesmann D, Becquey E, et al. Simple food group diversity inidcators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. J Nutr. 2010; 140(11):2059S-69S.
19. Kant AK. Indexes of overall diet quality: a review. J Am Diet Assoc.1996; 96(8):785-91.
20. Marshall TA, Stumbo PJ, Warren JJ, Xie XJ. Inadequate nutrient intakes are common and associated with low diet variety in rural, community dwelling elderly. J Nutr. 2001; 131(8):2192-6.
21. Kant AK, Block G, Schatzkin A, Ziegler RG, Nestle M. Dietary diversity in the US population, NHANES II, 1976-1980. J Am Diet Assoc. 1991; 91(12):1526-31.
22. Tucker KL. Eat a variety of healthful foods: old advice with new support. Nutr Rev. 2001; 59(5):156-8.
23. Mirmiran P, Azadbakht L, Esmaillzadeh A, Azizi F. Dietary diversity score in adolescents – a good indicator of the nutritional adequacy of diets: Tehran lipid and glucose study. Asia Pac J Clin Nutr. 2004;13(1):56-60.
24. Magarey A, Daniels LA, Smith A. Fruit and vegetable intakes of Australians aged 2-18 years: an evaluation of the 1995 National Nutrition Survey data. Aust N Z J Public Health. 2001; 25(2):155-61.
25. Mirmiran P, Mohammadi F, Azizi F. Dietary diversity and its relation to diet quality in Tehran. Res Med. 2003; 27:33-41.