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Dietary Diversity Score: A Measure of Nutritional Adequacy or an Indicator of Healthy Diet?

Habte TY* **and Krawinkel M**

Department of International Nutrition, Institute of Human Nutrition, Justus-Liebig-University Giessen, Giessen, Germany

***Corresponding author:** Habte TY, Department of International Nutrition, Institute of Human Nutrition, Wilhelmstrasse 16a, 35392 Giessen, Germany, E-mail: Tsige-Yohannes.Habte@ernaehrung.uni-giessen.de

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Abstract

At the time when the lack of indicators seemed to constrain appropriate child feeding in developing countries, dietary diversity score (DDS) emerged as a measure of nutritional adequacy that could close the gap. DDS refers to the number of food groups consumed in a given time, often in 24 hrs. Commonly, a diet of at least 4 DDS was valid as nutritionally adequate. Though validations with the test of correlation between DDS and nutrient adequacy ratio (NAR) or mean nutrient adequacy ratio (MAR) have been highly significant ($p<0.001$), the correlation coefficients in most cases were less than 0.5 indicating problems of deficiency. MAR cannot prove itself a true reference of nutrients adequacy because it stands for the mean ratio of all nutrients to recommended allowance of the nutrients, masking the real status of each nutrient. The differences in gender, age and physiology of the participants in the validation of DDS, the variability of nutrient density within food groups, and the neglect of food intake further complicate the accuracy of DDS as a measure of nutrient adequacy. It is true that dietary diversity increases the potential for the provision of different nutrients and healthy phytochemicals that satisfy the requirement for normal growth and health. It also contributes to the ecosystem services by its involvement in primary production, nutrient cycle, food provision and environmental regulation. These favorable characters and the contrasting problems of standardizing DDS as a measure of nutritional adequacy, call for a change that suggest to better use DDS as an indicator of healthy diet.

Keywords: Dietary Diversity; Dietary Diversity Score; Nutritional Adequacy; Nutrient Adequacy Ratio (NAR); Mean Adequacy Ratio (MAR); Healthy Diet

Introduction

Attempts of establishing some association between dietary diversity score and nutritional quality have been known since 1960s, and recoded evidences exist starting early 1980s [1,2]. Several trials are conducted to qualify appropriate feeding practices of the population in developing countries since the Global Consultation on Complementary Feeding convened by WHO identified lack of indicators as one of the constraints of improving young child feeding [3-5]. Consequently, dietary diversity score (DDS) which quantifies the number of food groups in a diet consumed over a reference period emerged as a potential indicator of nutritional adequacy [6].

DDS is differentiated as household dietary diversity score (HDDS) and individual dietary diversity score (IDDS), including child diversity score (CDDS) and women dietary score (WDDS) [7]. HDDS is a proxy measure of the household access to food, or the proxy measure of the socio-economic level of household, whereas the IDDS is a proxy measure of the nutritional quality of individual's diets, particularly that of micronutrient adequacy of a diet [8]. Two to three different arrays of food groups formed the basis for quantifying DDS as indicator of nutritional quality, most often 12 food groups are considered for HDDS and 8 or 9 food groups for IDDS [6,9,10].

The purposes for counting the food groups have varied based on the envisaged target of a project, which can be establishing: a qualitative measure of household-access to a variety of foodstuffs [11,12], an indicator of adequate nutrient intake or a valid measure of nutritional adequacy [9,13-15].

There is some evidence indicating that DDS and nutritional status can both correlate or interact [9]. This inconsistency is attributable to some confounding factors that include location (urban/rural), socioeconomic, demographic, and within food-group variability [9]. There has also been the possibility that diagnostic interpretation of the results of correlation lead to wrong conclusion [2,15-17].

The variability of nutrient content within each food group could be another source of inconsistency [4,18]. These variations limit the comparison and generalization of findings, which in turn hinder the standardization of DDS as a measure of nutritional adequacy [11,19]. Despite the problems of standardization, dietary diversity is still being validated as a measure of nutritional quality by the same old correlation method [12].

The purpose of this analytical study is to diagnose the accuracy of dietary diversity score as a measure of nutritional adequacy and to explain the values of dietary diversity for human health and the sustainability of ecological functions.

Methods

The details of the problems of DDS as a measure of nutritional adequacy are diagnosed using relevant literature published since 1980s, standard calculation of nutritional adequacy based on the nutrient composition of foodstuffs and the nutrient requirement of different age, sex and physiological status of people and the accumulated nutritional knowledge and relevant experiences. Considerable attention is payed to the differences in the contexts that influence DDS, the challenges of its standardization, the problems of forfeiting the measure of food intake and the interpretation of the results of validation [18,20].

Following the results of the analysis and based on the potential of dietary diversity in providing a variety of nutrients with different concentration, the supply of healthy phytochemicals, and the benefits of agricultural diversity (diversified food production) to the ecosystem, a proposition towards the delineation and delimitation of the purpose of DDS is suggested [21,22].

Brief review of the methods involved in using DDS as a measure of nutrient adequacy

Dietary diversity score is most often determined by counting the number of selected food groups consumed by a household or individuals over a reference period, which usually ranges between 1-3 days, and in some cases extends to 7 days or even to 15 days [9,23,24]. As indicated in Table 1, the food groups are selected from a given array of recommended food groups, which can be 9 (35), 10 (51) or 12 (37) or other than these.

Groups	FAO [6]	Kennedy & Nantel [9]	FANTA (Swindale & Bilinsky) [10]
I	Starchy staples (cereals, roots, tubers)	Cereals, roots and tubers	Cereals
II	Vitamin A rich fruits and vegetables	Vitamin A rich fruits & vegetables	Roots/tubers
III	Other fruits	Other fruits	Vegetables
IV	Other vegetables	Other vegetables	Fruits
V	Legumes and nuts	Legume, pulses & nuts	Meat/poultry/offal
VI	Fats and oils	Oils and fats	Eggs
VII	Meat, poultry, fish	Meat poultry fish	Fish/sea food
VIII	Milk and milk-products	Dairy	Pulses/legumes/nuts
IX	Eggs	Eggs	Milk/milk
X		Others (sweets, chips, soda - - -	Oil/fats
XI			Sugar/honey
XII			Miscellaneous

Table 1: Food groups used for the assessment of DDS

The base for the classification of foodstuffs in different groups lies on the variability of nutrient density. Some foodstuffs are relatively rich in energy, others in protein, minerals, or vitamins. The classification of foodstuffs on these bases facilitates the search for substitutes of similar nutrient suppliers. But, this does not presuppose any 1 to 1 substitution in the same group as implicated in the determination of DDS when level of food intake is forfeited. Differences in nutrient density within or between food groups hint the regulation of substitution based on the level of intake (Table 2). If, for example, pulses are supposed to satisfy the average daily Fe requirement (15mg/day) the level of intake needs to be adjusted based on the concentration of the nutrient in the concerned foodstuffs. With the assumption that the bioavailability of iron in the pulses is similar and the supply of Fe in the other components of the diet is negligible, a type of pulse that contains 8mg Fe /100g have to be supplied at the rate of 200g/day, whereas 100g of that which contains 15mg Fe/100g can satisfy the requirement.

In foodstuffs of plant origin, the concentration of nutrients generally vary not only according to species but also according to the genotypes or varieties (Table 2). Some studies in CIAT that analyzed more than 1000 accessions of common beans (*Phaseolus vulgaris*) showed that the concentration of iron can range from 3.4 to 8.9mg/100g (mean 5.5mg/100g) and that of zinc from 2.1 to 5.4mg/100g (mean 3.5mg/100g) [25,26]. There is sufficient genetic variability to increase the iron concentration of common beans by about 80% and zinc by 50%, which enabled plant breeders to develop bean variety with high concentration of iron (10mg/100g) [25]. Similarly, wheat genotypes in the genus *Triticum* prove differences that range between 3.4 to 6.8mg/100g for iron and 2.14 – 10.3 mg/100g for zinc [27].

Nutrient	Cereals	Pulses	Vegetables	Fruits
Energy (kcal)	340	403	28	55
	(332 – 357)	(344 – 498)	(18 – 43)	(43 – 62)
Protein (g)	10.0	20.7	1.98	0.6
	(8.7 – 10.9)	(17 – 26.2)	(1 – 3.5)	0.2 – 1.4
Ca (mg)	25.8	116.4	40.9	13.9
	(7 – 54)	(51 – 277)	(10 – 135)	(5 – 40)
Fe (mg)	2.78	9.18	0.59	0.26
	(0.8 – 4.72)	(4.98 – 15.7)	(0.3 – 0.86)	(0.1 – 0.)
Zn (mg)	10.5	19.8	27	2.07
	(2 – 35)	(2 – 58)	(3 – 69)	(0 – 16)
Se (mg)	23.7	9.28	0.76	0.31
	(2.8 – 89.4)	(3.1 – 17.8)	(0 – 2.5)	(0 – 0.6)
β carotene (mcg)			416	105
			(15 – 1430)	(25 – 310)
Riboflavin (mg)	0.14	0.18	0.08	
	(0.1 – 0.22)	(0.16 – 0.24)	(0.04 – 0.13)	
Ascorbic acid (mg)				34.2
				(1 – 74)

Table 2: Nutrient composition of each 100g food group (mean and range) [4,18]

The number of food groups in a daily diet of individuals or households are often measured by 24-hour recall. Each participant is required to list all foods and drinks consumed on the previous day without quantifying them. An item consumed from a specific food group is counted only once and DDS of < 4 represents poor diversity [28]. The number of food groups recommended in different studies are different and the optimal array of food groups for the determination of the DDS as an indicator of nutrient adequacy have not yet been thoroughly explored and standardized [5,9,11].

The correlation of DDS and nutrient adequacy ratio (NAR) or mean adequacy ratio (MAR) are considered in the validation of DDS as the measure of nutritional adequacy. NAR refers to the ratio of the level of a nutrient consumed to recommended nutrient intake (RNI) [29]. Mean adequacy ratio is the sum of NARs of all evaluated nutrients divided by the number of nutrients and expressed in percentage. Conceptually, MAR cannot be a true reference of nutrient adequacy because it represents the average ratio of a lump sum that mixes up all inadequacies, adequacies and even surpluses of different nutrients. In practical sense, the mean of the summation of the ratios ((NIa/RNIa + NIb/RNIb + NIc/ RNIc - - -)/N) can mask the true status of a specific nutrient, because each nutrient has its own level of adequacy. For example, if the nutritional adequacy for iron is 140% and that of calcium is 60%, MAR will be 100% reflecting perfect adequacy. The deficiency of calcium is masked by higher level of iron consumption. The number of nutrients commonly considered in the calculation of MAR, which is 11, can still complicate the matter to an even higher extent.

Validation

Positive and significant correlations were recorded between DDS and the mean adequacy ratio of nutrients (MAR) (Table 3). Even though dietary diversity score is repeatedly evaluated as acceptable or even good tool for the assessment of the nutritional adequacy, the results in Table 3 are not confirmative because of the weak levels of correlation coefficient. Correlation coefficients in the order of 1.0 is perfect, 0.5 to 0.7 are medium, 0.3 to 0.49 are low and less than 0.3 are little if at all any correlation [30,31].

Correlates	Correlation coefficient (r)	Validation	DDS	Sources
DDS and MAR	r = 0.39, P<0.001	DDS assess NA* fairly good	6	Hatloy, *et al*. 1998
	r = 0.3, >> >>	Not conclusive	7.8	Torheim, *et al*. 2004
	r = 0.42, >> >>	DDS appropriate indicator of NIA*	12	Mirmiran, *et al*. 2004
	r = 0.134, P<0.01	No comment		Sealey-Potts, *et al*. 2014
	r = 0.65, P<0.001	DDS of 4 is best indicator of MAR less than 50%		Steyn, *et al*. 2006

NA* = Nutritional adequacy; NIA* = Nutrient intake adequacy

Table 3: Correlation coefficient between dietary diversity score (DDS) and mean nutrient adequacy ratio (MAR)

Nutrient or nutritional adequacy literally refers to the fulfillment of daily nutrients requirement by adequate consumption of diverse foodstuffs that form a balanced diet. In this sense adequacy is an indicator of equilibrium between nutrient requirement and intake. The ideal or perfect correlation coefficient for nutrient adequacy is 1 meaning all nutrients consumed can satisfy the recommended allowance or the nutrient requirement [1]. Equality or equilibrium does not have any progressive form. As there is no "more equal or less equal" there is also no "more adequate or less adequate". A diet can be either adequate, deficient or surplus of a nutrient in question. Anything below the recommended level of intake can cause deficiency with or without discernable clinical signs and with potential adverse nutritional and health consequences. A good mineral balance is indispensable for normal growth and health; but deficiency, overdose or imbalance between inorganic nutrients have negative effect on health [32].

As indicated earlier (page 3), the use of MAR to validate DDS as a measure of nutrient adequacy could be misleading because of the masking effect of the different concentration of nutrients and level of intake that can end up in hidden hunger. This could have severe consequences on the wellbeing of human beings. In the earlier years of nutritional studies (at about the beginning of the 20th century), Wilcock and Hopkins fed rats with a mixture of food containing all nutrients they believed to be essential for survival, but the rats died. Later they recognized that the mixture was deficient in the amino acid tryptophan [33]. This proved to be the first practical example that showed the deficiency of a single essential nutrient could invalidated the rough estimation of nutritional quality [34].

Even mild micronutrient deficiency can result in the lack of wellbeing and general fatigue, reduced resistance to infection and low mental processes affecting memory, concentration, attention and mood. In the years as early as the 18th century the renowned chemist Justus von Liebig in his "Low of Minimum" stated that if one nutrient is deficient growth will be restricted [35]. Similarly, if a baby is supplied with all of the nutrients except for one, it strives for few months, after which it will begin to waste away and develop symptoms from which it will ultimately succumb.

In the studies indicated in Table 3 the validations are not consistent probably because of relativism, a range of ideas and positions that may implicate the lack of consensus on how DDS and nutrient adequacy should be defined. The comparison of DDS of different countries have been challenging because of the use of different food groups and scoring systems. Unlike recent studies, older studies have shown significant associations between DDS and nutritional indicators. However, an analysis of the association of dietary diversity and nutritional status in several countries showed both significant correlations and interactions probably because of the confounding effects of socioeconomic factors such as health, education and wealth [24].

A detailed study about the correlation of DDS and nutrient adequacy ratio (NAR) came up with similar results as that of DDS and MAR. The correlation coefficients between DDS and nutrient adequacy ratio in the different studies are variably low indicating its low potential to predict nutrient adequacy (Table 4). The levels of correlation coefficients which are low and widely variable (e.g. for vitamin A, r = 0.14 – 0.43) inflict a considerable challenge to the standardization of DDS as a measure of nutrient adequacy. In none of the studies can DDS prove an overwhelmingly acceptable predictor of nutrients adequacy because the values of all correlation coefficients except for one are below 0.5.

Nutrients	Kennedy, *et al.* 2007	Mirmiran, *et al.* 2006	Steyn, *et al.* 2006	Hatloy, *et al.* 1998	Mirmiral, *et al.* 2004	Sealy-Potts, *et al.* 2014
Vit. A	0.43	0.32	0.19	0.3	0.26	0.136
Vit. C	0.29	0.44	0.15	0.29	0.14	0.15
Thiamin	0.31		0.22		0.05	0.08
Riboflavin	0.4	0.44	0.36		0.16	0.058
Niacin	0.23		0.49			0.081
Pyridoxin	0.13	0.22	0.48			0.28
Folate	0.35		0.29			0.248
Vit. B12	0.06	0.24	0.13			0.009
Ca	0.02	0.54	0.25		0.35	0.001
Zn	0.1	0.24	0.4		0.32	0.05
Fe	0.15	0.24	0.26		0.03	0.141
Mg					0.29	

Table 4: Correlation coefficient (r) between dietary diversity score and nutrient adequacy ratio (NAR)

Dietary diversity score is considered as a measure of macro- and micronutrients adequacy irrespective of the level of food intake [7,14,19]. Some studies, which validated the mean DDS for good, indicated differing micronutrients deficiency for mothers and their children; and low food intake was explained as the cause of the problem [36]. In other studies the combination of both low diversity and low food intake are given as the cause of nutrient inadequacy [19,37].

In a study conducted in Bangladesh, with the daily diet of women consisting of rice, dairy products, eggs, meat, fish, vitamin A rich fruits and vegetables mixed in the proportion that 84% of the diet consists of rice; more than 97% of the women were deficient in vitamin A and Ca [36]. Low food intake and dietary diversity with DDS (4.2) were mentioned to result in the deficiency problems. In line with this, inadequate micronutrient intake was identified as the major cause for vitamin A, folate, iron and zinc deficiencies among young children and women of childbearing age residing in developing countries [37,38].

A test of nutritional adequacy in Africa based on foodstuffs available for consumption and the nutrient requirement of the population classified according to age, gender, physiological status and physical activity level indicated deficiency, adequacy and surplus status of nutrients for similar number of food groups. (own analysis, Table 5) [39].

	Cereals	R&t*	Pulses	Veges.	Fruits	Meat	Fat	Milk	Sugars*	Others
Algeria	625	118	25	326	175	82	41	323	90	22
Egypt	630	79	22	556	274	115	19	170	66	14
Ethiopia	397	208	46	36	33	25	5	47	16	49
Kenya	326	129	49	137	148	58	22	268	49	38
Zimbabwe	441	49	33	38	38	63	30	77	77	101
S. Africa	510	88	16	99	93	175	41	159	85	189
Cameroon	310	359	55	200	230	46	22	36	30	134
Ghana	264	1036	41	99	400	120	27	22	33	66
Mean	438	94	36	186	174	86	26	137	56	77

*R&t = root and tubers; Sugars = cane sugar, beet sugar and honey

Table 5: Food ingredients available for consumption (g/capita/day) [18,40]

Cereals form the major component of the diet in North, East and South Africa. In North Africa wheat is the major (70%) cereal, and coarse cereals (20%) are secondary. In East and South Africa coarse cereals (maize, sorghum, millet) are predominant (66%), and maize accounts for about 60% of the coarse cereals. Roots and tubers are the major staple food ingredients in West Africa. Cassava and yam make about 90% of the root and tubers in Ghana; cassava is only 64% of the roots and tubers in Cameroonian diet, the rest consists of potatoes, sweet potatoes and yam. Rice is an important complement in the diets of West Africa, Egypt and South Africa.

The pulses mainly consist of dry legumes, oil seeds and tree nuts in different proportions. In North Africa the proportions range between 78% legumes, 13% oil seeds and 9% tree nuts; in East Africa, South Africa and Ghana they consist of 90%: 6%: 4%; 46% : 50%: 4%; and 5%: 88%: 7% respectively. Such variabilities within food groups could inflict considerable differences in nutrient consumption because of differences in nutrient concentration (Table 2).

The level of food consumption is highly variable ranging between 852g/capita/day (1914kcal/capita/day) in Ethiopia to more than 2000g/capita/day (3000kcal/capita/day) in Egypt and Ghana (Table 6). The global average for the years 2000 – 2015 is estimated at 2803 – 2940 kcal/capita/day; with an average of 2681 kcal for developing countries and 3380 kcal for industrial countries [41].

Country	Apparent food intake		Dietary energy
	g/capita/day	kcal/capita/day	kcal/kg
Algeria	1827	3491	1911
Egypt	2059	3369	1636
Ethiopia	852	1914	2246
Kenya	1294	2253	1741
Zimbabwe	946	2304	2436
S. Africa	1454	2858	1965
Cameroon	1489	2457	1650
Ghana	2140	3522	1645
Mean	1508	2771	1904

Calculated based on FAOSTAT: Food balance sheet Africa 2009

Table 6: Apparent food consumption in different regions of Africa

In terms of gravimeter, North Africa and Ghana excel the average daily per capita food consumption by about 30%, while that of East Africa underlies by -30%. An analysis of nutritional adequacy in each nation showed that Egypt and Ghana are exposed to over nutrition; but underweight coexists with overweight because of unequal access to food [42]. Even though the DDS in all countries is similar at minimum 6 points, all of the diets are deficient in calcium probably because of low levels of pulses, vegetables, milk and milk products. In East Africa, the diets are deficient in vitamin A, riboflavin, folic acid, vitamin C, calcium and iron because of low availability of foodstuffs and the predominance of staple foods [39].

As the foodstuffs of plant origin differ in their nutrient concentration, it is vital to maintain the proportion of staples, pulses and vegetables at the level where they satisfy the micronutrient requirements. Table 5 reveals the consumption of low level mineral rich pulses or legumes (36g/capita/day) in all countries. Even if the optimum level of food groups to include in the daily diet is yet to be set, some 100g of pulses is recommended to cover half of the daily iron requirement and at least 400g/day of vegetables and fruits is recommended as the component of healthy diet [42].

In general, the study exemplifies how the variability within a food group both in quality and quantity as well as the differences in the level of intake of the same food group and that of total consumption of a diet can limit DDS as a measure of nutrition adequacy.

Nutritional concepts and dietary diversity

Adequate supply of all nutrients is of paramount importance to satisfy the nutritional requirements of human beings for body maintenance, growth, strength, physical work, cognitive ability, immunity and good health. During early life, the growth and development of the body as well as its maintenance are dependent on correct supply of all essential nutrients. In later life or during maturity, when development and growth are complete, the body requires food mainly for the purpose of work, body maintenance and repair. Mistakes made during the growth period can be permanent and irreversible. In reference to current global nutritional status, about one third of the population of all age and gender groups suffer from the deficiencies of micronutrients, particularly that of iron, zinc, iodine, selenium, and vitamin A [43]

Recent developments show that it is not only inadequate supply of nutrients that cause nutritional problems but also their excessive consumption, which lead to the accumulation of body fat, overweight, obesity, and associated major global health challenges. In 2013, the worldwide prevalence of overweight and obesity increased to 36.9% in men and 38% in women; in the developed countries the prevalence of overweight and obesity among children and adolescences was 23.8% for boys and 22.6% for girls [17]. According to the same sources, overweight and obesity caused 3.4 million deaths in 2010 worldwide. In this regard, the adverse effects of overdose and deficiency of nutrients, problems of food adulteration and food safety as well as the level of consumption of food, which is predominantly dependent on food availability, accessibility and utilization, occupy central position in the principles of nutrition [44,45].

Metabolic energy generators such as soluble carbohydrates, fats and proteins, when consumed in excess amount, cause overweight and obesity with subsequent health problems. Similarly, excessive intake of vitamins and minerals can influence human wellbeing and health. In order to control over-consumption of micronutrients, guidelines that limit the upper cutoff points are established [46]. There is always the possibility of health problems due to nutrient deficiency, overconsumption, interactions and contamination [47].

Nutrients are contained in foodstuffs in different contexts, structures and levels that form the organizational and functional components of edible plants. There is always a marked variability in the concentration of nutrients and biologically active ingredients in foodstuffs of plant origin. This suggests that only a mixed supply at recommended level can satisfy the nutrient requirements of all age and gender groups of human beings. However, since the beginning of the 20th century, 75% of plant genetic diversity has been lost as farmers worldwide ignore multiple of local varieties and landraces in order to plant genetically improved uniform and high-yielding varieties, leaving a large proportion (about 75%) of the world food to be generated from only 12 plant and 5 animal species [48].

At about the middle of the 20th century, food production system started to change in order to promote food availability and hinder the looming hunger. The results at that time were so attractive that the practice eventually expanded to an extent that large areas of natural vegetation are cleared to produce excessive amount of cereals and soybean. The availability of surplus cereals and soybean in some regions enhanced the idea of value added chain when the surplus food items are converted to meat and processed market food. Due to homogenization and intensification of agriculture the global food diversity declines and the consumption of processed food and meat increases, with a dramatic increase in diet-related diseases, in spiraling incidents of diabetes and heart diseases that become epidemic [49].

The loss of food diversity is also closely associated with the destruction of biodiversity worldwide. Only few selected varieties have been multiplied to dominate the world food resources. Extensive areas of land all over the world are cleared from natural vegetation for purposes of homogenous and intensive agricultural practices. Life influencing functions of biodiversity are distracted. The synthesis of nutrients from natural resources, the production of food, fiber and bioenergy, the maintenance of nutrient cycle, and the regulation of the sustainable use of soil, water, the atmosphere and climate are negatively affected due to the loss of biodiversity and its subset dietary diversity. In view of these extended roles and values, dietary diversity appears to be a broader concept than just an aspect of nutrition that inconclusively take care of nutritional adequacy.

According to the current stand of knowledge, biodiversity particularly plant biodiversity can provide sources of both nutrients and medical agents that contribute to sociocultural well-being [50]. The consumption of diverse recommended foodstuffs resulted in the decline of human mortality [51]. Dietary diversity is associated to longevity and reduced degenerative diseases such as cardiovascular diseases, diabetes and cancer [52]. Increased varieties of vegetables and fruits in the diet were associated with reduced incidence of stomach cancer [53]. Dietary diversity with the inclusion of traditional leafy vegetables proved to have anti-parasitic effect, antioxidant activity, anti-diabetic remedy and remedies for gout [54-56].

Conclusion

The variability of nutrient concentration within food groups, and the complex influence of sociodemographic, economic, environmental and technological characteristics hinder dietary diversity score as a standard measure of nutritional adequacy.

The correlation coefficients between DDS and NAR or MAR though highly significant, are lower than 0.5; and MAR is by any standard of measure an erroneous evaluator of DDS.

DDS, which considers only the number of food groups consumed over given time, and that which disregards food intake, could not prove a true measure of nutritional adequacy.

Dietary diversity indisputably increases the potential for the provision of diverse nutrients and healthy phytochemicals. It also contributes to the ecosystem services by its involvement in primary production, nutrient cycle, food provision and environmental regulation (water purification, waste treatment, climate regulation, disease control).

In view of its favorable purposes and contrasting problems of using DDS as a measure nutritional adequacy, it is suggested to use dietary diversity score as an indicator of healthy food with ecological benefit.

Dietary diversity consisting among others of food groups classified as sources of energy (cereals, tubers, roots), protein providers (pulses, solid food of animal origin), mineral suppliers (pulses, other legumes, vegetables, solid food of animal origin, milk), and vitamin sources (vegetables, green vegetables, fruits, solid food of animal origin) can be recommended as the indicator of healthy diet. Since the number of food groups involved in the above stated functions is four, it is rational to use this as the minimum cut-off point for healthy diet.

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