Available online at https://asric.africa/agricultural-sciences
ASRIC Journal on Agricultural Sciences Vol.5(2)(2023) 205-218

Dietary Intake Constraints of Rural Households in Southwestern Nigeria: Implications for Nutrition Innovation

Awodele Racheal Iyabo[1]*, Aminu Oluwafunmilayo Olarewaju[2*], Lukman Abiodun Akinbile[3]

[1]Babcock University, Ogun State.
[2]Department of Agricultural Economics and Extension,
Olusegun Agagu University of Science and Technology, Ondo State
[3]Department of Agricultural Extension and Rural Development, University of Ibadan, Oyo State.

Corresponding author: funmiaminu83@gmail.com
Received 19 July 2024; revised 07 August 2024; accepted 05 September 2024

Abstract
The menace of poverty, hunger and malnutrition, still persists among rural households in Nigeria. It is paramount to tailor agricultural extension programmes and nutritional intervention to the dietary needs of the rural populace. Hence, this study examines the dietary intake of rural households and the underlying constraints affecting them. Multistage sampling procedure was used to select 240 rural households and data was garnered with the aid of interview schedule. Data were analyzed using mean, frequency, percentages, and Pearson product-moment correlation. The intake of micronutrients was lower than the Recommended Dietary Allowance per day. Intake of fat (91.3%), cholesterol (90.0%), and calcium (89.2%) were majorly inadequate. Nutrient adequacy was low for 60.8%. Starchy staples (99.6%) were most consumed, while eggs (17.5%), milk/milk products (9.6%) were least consumed. Average diet diversity score was 4.11±1.13. Consumption of root and tuber ($\bar{x}$=18.41) was higher compared to cereals ($\bar{x}$=13.79) and legumes/nuts ($\bar{x}$=12.13). Dietary intake level was low for 60.0%. Consumption of adequate diet was majorly constrained by low income ($\bar{x}$=1.50), high cost of food items ($\bar{x}$=1.48) and inadequate knowledge ($\bar{x}$=0.98). The study concludes that rural households had not been feeding adequately, hence the need for nutrition innovations to guide against unhealthy diets.
Keywords: Nutrient intake, Micronutrients, Adequate diet, Food consumption, Nutrition innovation, Constraints

1.0 Introduction

Food is one of the most basic needs and necessities for human survival; it is core to human and economic development. Food can be referred to as any edible substance, which consumers eat or drink to satisfy hunger and nutritional requirement. It consists of nourishing and nutritive components such as carbohydrates, fats, proteins, essential minerals, vitamins, and water. Adequate intake of food is necessary for the maintenance of the normal state of the human mind and the normal physiological activities of the body. This could only be achieved through healthy and balanced dietary intake.

According to Gale (2009), dietary intake refers to individual daily eating patterns including specific foods and calories consumed and relative quantities. The ability of rural households to consume diverse food groups is dependent on food accessibility, availability, affordability, and utilization in the right proportion to meet the household's nutrition recommendations (Obayelu and Osho, 2020). Diet adequacy of rural households is very important to the maintenance of their growth and development in every area.

The diet adequacy of an individual is best measured using established dietary intake and nutrition indicators. Food and Agricultural Organization (FAO) provides an indicator of undernourishment for most countries and considers mean dietary energy supply as a proxy for food energy consumption. The FAO indicator consists of three parameters namely; the average quantity of calories available for human consumption, the

inequality in access to those calories among the population and the mean minimum amount of calories required by the population (De-Haen, 2011). Another indicator is dietary diversity which shows the different food groups consumed by an individual over a given period of time. Dietary diversity scores correlate with measures of food consumption and are a good measure of household food access and caloric availability. But household food access cannot singlehandedly guarantee the adequate dietary intake of an individual as knowledge of adequate combinations of food nutrients in their right proportions is paramount to a balanced diet.

A lack of balance diets is one of the major causes of malnutrition among rural households. Many developing countries including Nigeria still have unacceptable proportions of malnutrition, under-nutrition, and nutrition deficiencies among women and children in particular. Nutrient intake inadequacy constitutes an impediment to human, social, and economic development. Both caloric and nutrition insufficiencies lead to various health problems, which ultimately affect the economic growth and prosperity of a country. Past studies have established that the consumption of diverse diets assists in combating diseases (Akerele et al., 2017). According to Omotayo (2020), rural households with increased income are more likely to achieve adequate nutrient intake and healthy living. Increased income is not realistic for all rural households. High quality and diverse diets that would meet rural households' nutritional needs in terms of value and amount should be affordable, harmless, and culturally acceptable, while equally contributing to household nutrition and health status (Otekunrin and Otekunrin, 2021).

Studies have argued for (Spronk et al., 2014) the significant association between higher nutrition knowledge and better dietary intake especially in the absence of a nutrition intervention or campaign. This has led to researchers questioning the relevance of knowledge of nutrition in influencing favourable attitudes to nutrition leading to appropriate food choices and adequate dietary intake. However, a full understanding of complex concepts like dietary intake cannot be comprehensive unless underlying factors such as nutrient intake adequacy, frequency of food consumption, and constraints to dietary intake, among others, are considered. The outcome of this study is crucial to appropriate nutrition innovations and education among rural households in southwest, Nigeria.

1.1 Research objectives

1. To examine the dietary intake of rural households in the study area.
2. To identify the constraints to adequate dietary intake among rural households in the study area.

1.2 Hypotheses of the study

H_0 There is no significant relationship between constraints to dietary intake and dietary intake of rural households.

2.0 Methodology

2.1 Description of the study area

The study was conducted in Ogun and Ekiti States, Nigeria. Ogun State lies within the tropics with a coordinate of 6.9980° N, 3.4737° E. It has a land area of 16,409,26 square kilometres and bounded in the South by Lagos State and the Atlantic Ocean, in the North by Oyo State, in the East by Ondo State and in the West by Benin Republic. Ekiti State has coordinate of 7.7190° N, 5.3110° E and bounded by Kwara and Kogi States in the South, Osun State in the East and bounded by Ondo State in the East and in the south, with a total land Area of 5887.890sq km (Government of Ekiti State, 2023). Agriculture is the major source of livelihood for the rural inhabitants of the two States and this is characterized by cultivation of yam and cassava as the major crops and common tree crops in the area include cocoa, oil palm, cashew and kolanut.

2.2 Sampling procedure and sample size

The population of the study comprised all rural households in Ogun and Ekiti States, Nigeria. Multistage sampling procedure was used to select respondents. There are 6 states in southwest, Nigeria which are: Oyo, Ogun, Lagos, Osun, Ekiti and Ondo states. Simple random sampling was used to select 30% of the six states in southwest, Nigeria. The selected states were Ogun and Ekiti states. Ogun state has 20 Local

Government Areas (LGAs), while Ekiti state has 16 LGAs. Purposively, Odeda and Odogbolu LGAs were selected in Ogun state, while Ilejemeje and Ido-osi LGAs were selected in Ekiti State, owing to the predominantly rural nature of these LGAs (Agbeyangi et al., 2017). Odeda and Odogbolu have 10 and 15 wards respectively, while Ilejemeje and Ido-osi have 10 and 11 wards, respectively. In each LGA, 25% of the wards was selected, that is, three wards were selected from Odeda, Ilejemeje and Ido-osi, while four wards were selected from Odogbolu. Simple random sampling was used to select 10% of communities (17 communities) from the number of communities in each selected ward. The estimated number of households was generated via household numbering in each community. Lastly, 30% of the households in each community were randomly selected to make a total of 240 households. At the household level, the household head or adult representative was interviewed.

2.3 Data collection

A structured questionnaire was used to collect relevant information from the respondents. Pre-test instrument was administered to rural households in Ido LGA of Oyo state, which is completely outside of the study area. The split half method was used to determine the reliability of the instrument. A correlation coefficient (r) of ≥ 0.70 was adjudged adequate for the research instrument.

2.4 Measurement of variables

2.4.1. Constraints to the consumption of adequate diet

Constraints to the consumption of adequate diet were measured on a three-point rating scale of severe constraint (2), Mild constraint (1), and Not a constraint (0). The mean scores of each item were computed and used to rank the constraints in order of severity.

2.4.2. Dietary intake of rural households

The dietary intake of rural households was determined by adding the standardized scores of respondents' average nutrient intake, nutrient intake adequacy, dietary diversity scores and frequency of food consumption. Then the mean of the dietary intake values was calculated and used to categorize respondents into either having a low or high level of dietary intake.

2.4.2.1. Nutrient intake

To determine nutrient intake, respondents were asked to indicate all food and drinks consumed in the last 24 hours. A dietary tool, known as "24-hour dietary recall", was used to obtain data from the respondents about the masses and volumes of all foods and drinks consumed within the previous 24 hours. Afterwards, an application software, known as Total Dietary Assessment (TDA) was employed to obtain the amounts (masses) of nutrients contained in and consumed from all the foods and drinks. The nutrient composition of the food and drinks consumed was statistically measured to determine the actual nutrient intake of respondents in the last 24 hours. The average nutrient intake for all respondents was computed and this was compared with the required Recommended Dietary Allowances (RDA) per day for each nutrient to determine their correlation. Nutrients assessed were calories, protein, carbohydrates, dietary fiber, fat, iron, zinc, vitamin A, vitamin C, thiamine, riboflavin, niacin, vitamin B6, folate, vitamin B12, cholesterol, calcium, phosphorous, sodium, potassium, and magnesium. RDA used in this study was according to Sencer and Orhan (2005), Smolin and Grosvenor (2010), and Celep *et al*. (2017).

2.4.2.2. Nutrient intake adequacy

Asides from presenting the amounts (masses) of all nutrients consumed, the TDA application also compares these amounts to the recommended daily intake (RDA) for each nutrient and presents the adequacy in percentages (for example, 30% for calcium means the respondent was only able to meet 30% of the recommended intake for calcium from the consumed foods and drinks). Percentages less than 80% represented inadequate intakes; those between 80 and 120% represented adequate intakes while those greater than 120% represented excess, but not toxic intakes. To determine the level of nutrient intake adequacy, the percentages of the various food nutrients were standardized and then pooled together. Using the mean computed as the benchmark, respondents were categorized as either having a high or low level of nutrient adequacy.

2.4.2.3. Dietary diversity score

Dietary diversity using 24-hour dietary recall was measured by determining the number of food groups consumed in the last 24 hours. Using information collected from the 24-hour dietary recall, the dietary diversity scores for households were derived using the FAO guidelines for measuring household dietary diversity. In this study, dietary diversity was based on 9 food groups as contained in FAO (2013). A score of one (1) was awarded to each food group consumed over the reference period and zero (0) for no consumption. The sum of all points was calculated for the dietary diversity score of each household. The mean score was used as a benchmark to categorize the diet diversity score of households into low or high.

2.4.2.4. Frequency of food consumption

The frequency of consumption of the 9 food groups within 30 days reference period was measured using a 4-point scale of '3'-at least every other day; '2' once or twice in a week; '1' 1-3 days in the month and '0' not at all. The mean of the food consumption score was computed and used to categorize the frequency of food consumption of households into low and high. Also, the weighted mean scores were used to rank each of the food groups.

2.5 Data analysis

The data collected were analyzed with the aid of descriptive statistical tools which include frequencies, percentage distribution, and mean. The hypothesis testing focused on the relationship between constraints to the consumption of adequate diet and dietary intake. Hypothesis was tested using Pearson product-moment correlation.

3.0 Results

3.1 Dietary intake of respondents

The dietary intake indicators used in this study were nutrient intake and nutrient intake adequacy, dietary diversity using 24-hour dietary recall and frequency of food consumption within 30 days reference period.

3.1.1 Nutrient intake of respondents

Table 2 reveals respondents' mean nutrient intake in the last 24 hours. Comparing the average nutrient intake with the Recommended Dietary Allowances (RDA) per day, it was found that respondents' average intake of calories ($\bar{x}$=1920.71±1052.6), dietary fiber ($\bar{x}$=16.07±19.04), fat ($\bar{x}$=31.86±21.76), vitamin C ($\bar{x}$=32.49±78.52), thiamine ($\bar{x}$=1.099±1.25), riboflavin ($\bar{x}$=1.27±1.27), niacin ($\bar{x}$=10.59±11.78), vitamin B6 ($\bar{x}$=0.63±0.70), folate ($\bar{x}$=215.46±238.24), vitamin B12 ($\bar{x}$=1.79±2.29), cholesterol ($\bar{x}$=87.20±111.97), calcium ($\bar{x}$=417.97±328.95), sodium ($\bar{x}$=2206.65±2233.89), potassium ($\bar{x}$=2196.32±2146.85) and magnesium ($\bar{x}$=206.93±209.67) were lower than the recommended RDA. But the average intake of protein ($\bar{x}$=64.27±39.09), carbohydrate ($\bar{x}$=341.25±201.56), zinc ($\bar{x}$=13.94±11.17), vitamin A ($\bar{x}$=1522.27±2223.61) and phosphorus ($\bar{x}$=1004.77±976.66) exceeded the recommended RDA. The average intake of iron ($\bar{x}$=17.24±10.79) was above the recommended intake for men but below the recommended intake for women.

3.1.2 Nutrient intake adequacy of respondents

Furthermore, respondents were categorized according to their nutrient intake adequacy as shown in Table 1. Inadequate intake of fat (91.3%) and cholesterol (90.0%) was highest among the respondents. Equally high was the inadequate intake of calcium (89.2%), vitamin C (85.0%), vitamin B6 (83.8%), magnesium (79.2%), dietary fiber (73.8%), folate (72.9%), potassium (69.6%), vitamin B12 (67.9%), niacin (64.6%), sodium (57.9%), calories (56.7%), thiamin (54.6%) and riboflavin (53.3%) by majority of the respondents. Respondents who inadequately (49.6%) take protein were higher compared to those with adequate intake (30.4%%) and excess intake (20.0%). The intake of zinc was inadequate for 47.5% of the respondents, adequate for 30.4% and in excess for 29.2% of the respondents. In addition, carbohydrate intake was inadequate for 40.0% of the respondents and in excess for 26.7% of the respondents. Only about one third of the respondents ensure adequate intake (33.3%) of carbohydrate. Excess intake of vitamin A (61.3%) was highest among sampled respondents compared to other nutrients intake. The percentage of respondents who took phosphorous in excess was 45.0%, adequate intake was ensured by 16.3%, while inadequate

intake was recorded among 38.8% of the respondents. Furthermore, the intake of iron was in excess for 47.1% of the respondents, adequate for 22.9% and inadequate for 30.0%.

Table 1: Nutrient intake and nutrient intake adequacy

Nutrients	RDA/day	Mean±SD	Inadequate intake F (%)	Adequate intake F (%)	Excess intake F (%)
Calories (Kcal)	2200-2400	1920.71±1052.6	136 (56.7)	70 (29.2)	34 (14.2)
Protein (g)	46 (male) 56 (female)	64.27±39.09	119 (49.6)	73 (30.4)	48 (20.0)
Carbohydrate (g)	225-325	341.25±201.56	96 (40.0)	80 (33.3)	64 (26.7)
Dietary fiber (g)	38 (male) 25 (female)	16.07±19.04	177 (73.8)	34 (14.2)	29 (12.1)
Fat(g)	50-90	31.86±21.76	219 (91.3)	18 (7.5)	3 (1.3)
Iron (mg)	8 (male) 18 (female)	17.24±10.79	72 (30.0)	55 (22.9)	113 (47.1)
Zinc (mg)	11 (male) 8 (female)	13.94±11.17	114 (47.5)	56 (23.3)	70 (29.2)
Vitamin A (µg)RE	700 (male) 900 (female)	1522.27±2223.61	73 (30.4)	20 (8.3)	147 (61.3)
Vitamin C (mg)	90 (male) 75 (female)	32.49±78.52	204 (85.0)	19 (7.9)	17 (7.1)
Thiamine-B1 (mg)	1.2	1.099±1.25	131 (54.6)	38 (15.8)	71 (29.6)
Riboflavin-B2 (mg)	1.1 (male) 1.3 (female)	1.27±1.27	128 (53.3)	43 (17.9)	69 (28.7)
Niacin-B3 (mg)	16 (male) 14 (female)	10.59±11.78	155 (64.6)	43 (17.9)	42 (17.5)
Vitamin B6 (mg)	1.3-1.7	0.63±0.70	201 (83.8)	21 (8.8)	18 (7.5)
Folate (µg)	400	215.46±238.24	175 (72.9)	34 (14.2)	31 (12.9)
Vitamin B12 (µg)	2.4	1.79±2.29	163 (67.9)	38 (15.8)	39 (16.3)
Cholesterol (mg)	> 300	87.20±111.97	16(90.0)	14(5.8)	10(4.2)
Calcium (mg)	1000	417.97±328.95	214(89.2)	18(7.5)	8(3.3)
Phosphorus (mg)	700	1004.77±976.66	93(38.8)	39(16.3)	108(45.0)
Sodium (mg)	2400	2206.65±2233.89	139(57.9)	36(15.0)	65(27.1)
Potassium (mg)	4700	2196.32±2146.85	167(69.6)	36(15.0)	37(15.4)
Magnesium	410 (male) 310 (female)	206.93±209.67	190(79.2)	37(15.4)	13(5.4)

Sources of RDA: Sencer and Orhan (2005), Smolin and Grosvenor (2010), and Celep et al. (2017)

3.1.3 Level of nutrient intake adequacy

The various food nutrients were standardized and then pooled together. Using the mean computed as the benchmark for the categorization of respondents, Table 2 revealed that the level of nutrient adequacy was low for 60.8% of the respondents and high for 39.2%.

Table 2: Categorisation of respondents based on their level of nutrient intake adequacy (standardised)

Nutrient intake	Freq.	%	Mean	Std. Dev.
Low (< mean)	146	60.8	20.98	14.92
High (≥ mean)	94	39.2		

3.1.4 Dietary diversity of 24-hour of dietary intake

In this study, dietary diversity was based on 9 food groups as contained in FAO (2013). Table 3 presents the percentage distribution of respondents based on their dietary diversity in the last 24 hours. Almost all the respondents (99.6%) ate starchy staples in the last 24 hours. Majority consumed other fruits and vegetables rich in Vitamin A (76.7%), muscle meat and fish (72.9%) and legumes/nuts/seeds (70.8%) in

the last 24 hours. Half of the respondents consumed dark green leafy vegetables (50.0%). However, eggs (17.5%), milk and milk products (9.6%) and organ meat (0.4%) were sparingly consumed in the last 24 hours by the respondents.

Table 3: Dietary diversity of 24-hour of dietary intake

S/N	Food Groups	Percentages
1	Starchy staples	99.6
2	Other Vitamin A fruits and vegetables	76.7
3	Muscle meat and fish	72.9
4	Legumes/nuts/seeds	70.8
5	Dark green leafy vegetables	50.0
6	Eggs	17.5
7	Other fruits and vegetables	13.3
8	Milk and milk products	9.6
9	Organ meat	0.4

3.1.5 Level of dietary diversity

Table 4 shows that dietary diversity score was low for 57.9% of the respondents and high for 42.1%. It was found that the average diet diversity score was 4.11±1.13.

Table 4: Categorisation of respondents based on their level of dietary diversity

Dietary diversity	Freq.	%	Mean	Std. Dev.
Low (< mean)	139	57.9	4.11	1.13
High (≥ mean)	101	42.1		

3.1.6 Frequency of food consumption

The frequency of food consumed by respondents within 30 days reference period is presented in Table 5. It was found that rice was the most consumed cereal by 67.5% of the respondents at least every other day. More than half of the respondents (54.2%) consumed pap/eko between one to two days in a week in the last 30 days. Macaroni/spaghetti was consumed by 39.6% of the respondents once in 2 - 4 weeks and it was never consumed by 29.6%. In the last 30 days, the majority of the respondents never consumed oatmeal (67.1%), noodles (66.7%), biscuits (64.6%), cornflakes (62.5%), golden morn (57.5%) and custard (53.8%). Within the cereal group of food, rice ($\bar{x}$=2.68), pap/eko ($\bar{x}$=1.84) and semovita ($\bar{x}$=1.74) ranked 1st, 2nd and 3rd as the most consumed cereals.

Within the root and tuber food group, 51.3% of the respondents consumed pounded yam and 47.1% consumed yam at least every other day. In the last 30 days, some of the respondents also consumed plantain (41.3%), amala-yam flour (38.3%), amala-plantain flour (36.3%) and amala-lafun (32.1%) at least every other day. Garri was taken between 1-2 days weekly by 60.4% of the respondents. Once in 2-4 weeks, poundo yam (40.4%), sweet potatoes (54.6%) and irish potatoes (38.8%) were taken by respondents in the last 30 days. But the aforementioned foods were never taken by 44.6%, 36.3% and 52.5% of the respondents respectively. Within the root and tuber group of food, amala-yam flour ($\bar{x}$=2.11), pounded yam ($\bar{x}$=2.04) and yam ($\bar{x}$=1.98) ranked 1st, 2nd and 3rd as the most consumed root and tuber food, while sweet potatoes ($\bar{x}$=0.73), poundo yam ($\bar{x}$=0.70) and irish potatoes ($\bar{x}$=0.56) ranked 10th, 11th and 12th as the least consumed root and tuber food.

The result of this study reveals that within the legumes and nuts food group, beans, moimoi and *akara* were consumed by 52.1%, 53.8% and 48.2% of the respondents, respectively 1 - 2 days weekly. In the last 30 days, groundnut (66.3%), kulikuli (66.3%), soybean/soybean products (61.3%), egusi (54.6%), ogbono (52.5%) and locust beans (52.1%) were taken by majority of the respondents once in 2 - 4 weeks. About half of the respondents (50.8%) never take walnut in the last 30 days. Within the legume and nut group of food, beans ($\bar{x}$=2.13), moimoi ($\bar{x}$=2.10) and *akara* ($\bar{x}$=1.65) ranked 1st, 2nd and 3rd as the most consumed legume, while ogbono ($\bar{x}$=0.61), walnut ($\bar{x}$=0.49) and gbegiri ($\bar{x}$=0.38) ranked 9th, 10th and 11th as the least consumed legume and nut.

Table 5: Distribution of respondents based on their frequency of food consumption

SN	Food groups	At least every other day		1-2 days in a week		once in 2-4 weeks		Never		$\bar{x}$	Rank
A	***Cereals***	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**		
1	Rice	162	67.5	78	32.5	0	0.0	0	0.0	2.68	1st
2	Pasta (Macaroni /spaghetti)	46	19.2	28	11.7	95	39.6	71	29.6	1.20	5th
3	Wheat	15	6.3	49	20.4	118	49.2	58	24.2	1.13	6th
4	Pap/Eko	48	20.0	130	54.2	37	15.4	25	10.4	1.84	2nd
5	Semovita	85	35.4	63	26.3	37	15.4	55	22.9	1.74	3rd
6	Bread	52	21.7	91	37.9	2	0.8	95	39.6	1.42	4th
7	Noodles	47	19.6	22	9.2	11	4.6	160	66.7	0.82	7th
8	Biscuits	26	10.8	45	18.8	14	5.8	155	64.6	0.76	8th
9	Custard	11	4.6	20	8.3	80	33.3	129	53.8	0.64	10th
	Breakfast Cereal										
10	Cornflakes	11	4.6	21	8.8	58	24.2	150	62.5	0.55	11th
11	Oatmeal	0	0.0	10	4.2	69	28.8	161	67.1	0.37	12th
12	Golden Morn	21	8.8	11	4.6	70	29.2	138	57.5	0.65	9th
B	***Roots and tubers***										
1	Amala (Yam flour)	92	38.3	95	39.6	41	17.1	12	5.0	2.11	1st
2	Amala (Plantain flour)	87	36.3	55	22.9	33	13.8	65	27.1	1.68	7th
3	Amala (Lafun)	77	32.1	81	33.8	24	10.0	58	24.2	1.74	6th
4	Fufu	66	27.5	78	32.5	46	19.2	50	20.8	1.67	8th
5	Eba	66	27.5	90	37.5	40	16.7	44	18.3	1.74	5th
6	Garri	11	4.6	145	60.4	35	14.6	49	20.4	1.49	9th
7	Yam	113	47.1	47	19.6	42	17.5	38	15.8	1.98	3rd
8	Pounded Yam (Iyan)	123	51.3	40	16.7	41	17.1	36	15.0	2.04	2nd
9	Poundo Yam	0	0.0	36	15.0	97	40.4	107	44.6	0.70	11th
10	Sweet potatoes	0	0.0	22	9.2	131	54.6	87	36.3	0.73	10th
11	Irish Potatoes	0	0.0	21	8.8	93	38.8	126	52.5	0.56	12th
12	Plantain	99	41.3	55	22.9	63	26.3	23	9.6	1.96	4th
C	***Legumes and Nuts***										
1	Beans	78	32.5	125	52.1	26	10.8	11	4.6	2.13	1st
2	Moimoi	78	32.5	129	53.8	11	4.6	22	9.2	2.10	2nd
3	Akara	36	15.0	118	49.2	53	22.1	33	13.8	1.65	3rd
4	Gbegiri	0	0.0	24	10.0	43	17.9	173	72.1	0.38	11th
5	Groundnut	1	0.4	42	17.5	159	66.3	38	15.8	1.03	5th
6	Kulikuli	1	0.4	11	4.6	159	66.3	69	28.8	0.77	7th
7	Egusi	20	8.3	62	25.8	131	54.6	27	11.3	1.31	4th
8	Soybean/Soybean products	0	0.0	11	4.6	147	61.3	82	34.2	0.70	8th
9	Ogbono	0	0.0	10	4.2	126	52.5	104	43.3	0.61	9th
10	Locust beans/iru	21	8.8	22	9.2	125	52.1	72	30.0	0.97	6th
11	*Walnut (Asala)*	0	0.0	0	0.0	118	49.2	122	50.8	0.49	10th

3.1.7 Level of food consumption

As presented in Table 6, the consumption of root and tuber ($\bar{x}$=18.41) was higher compared to cereals ($\bar{x}$=13.79) and legumes/nuts ($\bar{x}$=12.13).

Table 6: Level of food consumption

Food consumption	Freq.	%	Mean	Std. Dev.
Cereals				
Low (< mean)	121	50.4	13.79	6.54
High (≥ mean)	119	49.6		
Roots and Tubers				
Low (< mean)	103	42.9	18.41	7.77
High (≥ mean)	137	57.1		
Legumes and Nuts				
Low (< mean)	121	50.4	12.13	4.27
High (≥ mean)	119	49.6		
Overall				
Low (< mean)	107	44.6	44.33	14.86
High (≥ mean)	133	55.4		

3.1.8 Level of dietary intake

The result in Table 7 shows that dietary intake level of 60.0% of the respondents was low while 40.0% had high dietary intake level.

Table 7: Distribution of respondents based on their level of dietary intake (standardized)

Dietary intake	Freq.	%	Mean	Std. Dev.
Low (< mean)	144	60.0	26.17	14.56
High (≥ mean)	96	40.0		

3.2 Constraints to the consumption of adequate diet

The result in Table 8 shows the distribution of the respondents based on the constraints faced in the consumption of adequate diet. The major constraints to rural households' consumption of adequate diet were low income ($\bar{x}$=1.50), high cost of food items ($\bar{x}$=1.48), unavailability of necessary food item, illness ($\bar{x}$=1.28) and nature of job ($\bar{x}$=1.18). Other constraints to adequate dietary intake were inadequate knowledge on nutritious food ($\bar{x}$=0.98) and seasonality of food items ($\bar{x}$=0.87) The least constraints to consumption of adequate diet were religious institution ($\bar{x}$=0.44), geographical location ($\bar{x}$=0.40) and cultural taboo ($\bar{x}$=0.40).

Table 8: Distribution of respondents based on their constraints to the consumption of adequate diet

SN	Items	Severe constraint		Mild constraint		Not a constraint		$\bar{x}$	Rank
		F	%	F	%	F	%		
1	Low income	160	66.7	41	17.1	39	16.3	1.50	1st
2	High cost of food items	142	59.2	69	28.8	29	12.1	1.48	2nd
3	Unavailability of necessary food item	120	50.0	94	39.2	26	10.8	1.39	3rd
4	Illness limit the consumption of certain food	122	50.8	62	25.8	56	23.3	1.28	4th
5	Nature of job discourages consumption of nutritious food	94	39.2	95	39.6	51	21.3	1.18	5th
6	Inadequate knowledge of nutritious food	61	25.4	113	47.1	66	27.5	0.98	6th
7	Seasonality of food items	52	21.7	105	43.8	83	34.6	0.87	7th
8	Religious institution	24	10.0	58	24.2	158	65.8	0.44	8th
9	Geographical location	10	4.2	77	32.1	153	63.8	0.40	9th
10	Cultural taboo	21	8.8	55	22.9	164	68.3	0.40	9th

3.3 Hypotheses testing

PPMC relationship between constraints to the consumption of adequate diet and dietary intake

Table 9 shows that in the study area, the relationship between constraints to the consumption of adequate diet and dietary intake was negative and insignificant (r=-0.065, p>0.05).

Table 9: Relationship between constraints to the consumption of adequate diet and dietary intake

Variables	r-value	p-value	decision
Constraints	-0.065	0.315	Not significant

4.0 Discussion

4.1 Dietary intake of respondents

4.1.1 Nutrient intake of respondents

Respondents' average intake of calories, dietary fiber, fat, vitamin C, thiamine, riboflavin, niacin, vitamin B6, folate, vitamin B12, cholesterol, calcium, sodium, potassium and magnesium were lower relative to the recommended Recommended Dietary Allowances (RDA). This result corroborates Oladoyinbo *et al.* (2017) who found that intake of sodium, potassium, calcium, vitamin C and magnesium were below the RDA in Osun State, Nigeria. The deficiency of the aforementioned nutrients was also observed among black women in informal settlements in South Africa (Acham et al., 2011). Past studies revealed that micronutrient deficiency had been a global phenomenon caused largely by dietary deficiencies of vitamins and minerals, primarily iodine, iron, vitamin A, vitamin D and zinc, with important health consequence (Celep et al., 2017). However, the average intake of protein, carbohydrate, zinc, vitamin A and phosphorus exceeded the recommended RDA. This result agrees with Oladoyinbo *et al.* (2017) who found that intakes of nutrients such as carbohydrates, zinc and protein were above the RDA in Osun State, Nigeria.

4.1.2 Nutrient intake adequacy of respondents

As shown in Table 1, it was found that most of the nutrient intake by majority of the respondents was inadequate, some of the nutrients were taken in excess by respondents and very few respondents ensure adequate intake of nutrients assessed in this study. The intake of fat, cholesterol, calcium, vitamin C, vitamin B6, magnesium, dietary fiber, folate, potassium, vitamin B12, niacin, sodium, calories, thiamin and riboflavin were inadequate among the respondents with percentage values above average. Contrariwise in Brazil, inadequacy ranged from 30 to 50% for vitamins C, B1, B6, and riboflavin in adults (Verly-Jr et al., 2019). The result of this study is an indication of poor micronutrient status among the respondents. Though micronutrients are required in small amounts, they are essential for the normal functioning of the body. Also, the intake of protein, zinc and carbohydrate were inadequate. Contrariwise, Eforouku (2018) reported an excess intake of carbohydrates among rural farming households in northwestern Nigeria. Findings from this study align with the submission of Akerele et al. (2014) who conducted a study in southwest Nigeria on protein-energy malnutrition and discovered that protein-rich foods are usually expensive and not all households have the purchasing power to acquire them. However, the intake of vitamin A, phosphorous, and iron was in excess as found in this study. Contrariwise in rural Pakistan, the deficiency of Vitamin A is of utmost concern as its shortage was reported among 85% of respondents due to the rise in costs of food rich in Vitamin A; such as eggs, vegetables, and fruits, among others (Pakistan Agricultural Research Council, 2009).

4.1.3 Level of nutrient intake adequacy

Respondents' nutrient intake was mostly inadequate or in excess. The level of nutrient intake adequacy was low for most of the respondents as revealed in Table 2. This result corroborates Verly-Jr *et al*. (2019) that a high prevalence of inadequate nutrient intake is still observed in developing countries. It can be inferred from the findings of this study that the portion of food eaten by the respondents did not suffice for the various nutrients needed by the body in adequate measure. Hence, respondents could not be said to be nutritionally secure due to low nutrient intake. It had been reported that the increased prevalence of poor-quality diets had been noted to be harmful and their impact is becoming manifest throughout the developing world, even among low-income populations (Popkin, 2006). According to FAO (2014), well-nourished individuals and households that are nutritionally secure can better withstand, endure and recover more quickly from external shocks.

4.1.4 Dietary diversity of 24-hour dietary intake

Dietary diversity is the number of food groups consumed by an individual in the last 24 hours. Carbohydrates-based diets were widely consumed by nearly all the respondents in the last 24 hours. This result implies that cereals and roots and tubers dominate the diet of rural households in southwest, Nigeria. Most of the respondents consumed dark green leafy vegetables and other fruits and vegetables rich in Vitamin A. This explained why the intake of Vitamin A was found to be in excess as earlier discussed. Fruits and vegetables are more abundant in rural areas and most times they were not purchased by households because they were grown in the environment. Even if fruits and vegetables were to be bought, it is relatively cheap and affordable. Similarly, meat and fish, and legumes/nuts/seeds were largely consumed by rural households in the last 24 hours. This can be attributed to the fact that bush meat was abundant in rural areas, so money is not needed for their purchase most times. However, the consumption of eggs, milk and milk products and organ meat was sparing in the last 24 hours among rural households. This result explained why some of the respondents were deficient in protein intake and certain micronutrients as earlier discussed. This result was consistent with the findings of Agada and Igbokwe (2015) where protein and micronutrient intake were found to be low among rural households in North Central Nigeria. Likewise, in a study conducted by Omotayo (2020) among rural households in southwest Nigeria, it was found that eggs, milk, and milk products were the least consumed food groups. Even among under-five children in rural farming households in southwest Nigeria, eggs and dairy products are the least-consumed food groups (Otekunrin et al., 2022). The concentration of the respondents in the consumption of certain food groups suggests low diet diversity because no single food group contains all the essential nutrients needed for the normal functioning of the body system.

4.1.5 Level of dietary diversity

The level of dietary diversity was low for more than half of the respondents. It was found that most of the respondents consumed few food groups. The average diet diversity score of 4 food groups obtained in this study is at variance with Otekunrin et al. (2022) who reported an average of 3 food groups among under-five children in rural farming households in southwest Nigeria. An increase in the number of food groups consumed had been noted to be a measure of diet adequacy. The higher the dietary diversity score, the more a household is food secure in terms of a balanced diet (Musemwa *et al*., 2018). Hence, food groups consumed by households must make provision for some diet diversity for both macro and micronutrients.

4.1.6 Frequency of food consumption

In this study, cereals, majorly rice was increasingly consumed by rural households. This aligns with Oladoyinbo *et al.* (2017) that food from the cereal group was highly consumed among rural households in southwest, Nigeria. Apart from, yam and some of its products as well as beans and some of its products were more frequent in the diet of rural households in the study area. These foods are readily available as they were grown by most rural households at the subsistence and commercial levels. Also, the high consumption of these foods might be attributed to their easy accessibility and affordability. The result of this study is in agreement with Have *et al.* (2020) who found rice as the most frequently consumed cereals, yam as the most eaten roots and tubers and beans as the most frequently consumed legume among Nigerian households. Similarly, in South Africa, Musemwa et al. (2018) reported the diet composition of most South Africans to be cereals. The low consumption of processed cereals observed in this study might be due to the financial incapability of the respondents. Hence, they result in the consumption of food within their income. Continuous consumption of unhealthy food items can lead to obesity and increased susceptibility to diseases. According to Joffe (2007), a combination of excessive energy intake relative to physical activity and low nutrient density predisposes to several chronic diseases, including type 2 diabetes, ischemic heart disease, and cancers, among others.

4.1.7 Level of food consumption

The most consumed food group was root and tuber, followed by cereals and legumes/nuts. Obviously, carbohydrate-based diets were more consumed among rural households compared to protein-based diets. Hence, the bulk of what is consumed among rural households in southwest Nigeria were energy-based diets.

Similarly, among households in North Central Nigeria, Agada and Igbokwe (2015) reported root and tuber, and cereals as the most consumed food. Households resulting in the consumption of foods that cannot guarantee their adequate dietary intake signified food poverty, that is, inability to afford, or to have access to, food to make up a healthy diet and low income. This agrees with the submission of Obayelu and Orosile (2015) that food poverty is the consequence of the failure of local livelihoods to guarantee access to sufficient food at the household level.

4.1.8 Level of dietary intake

The low dietary intake level observed among rural households indicates that the food consumed did not adequately meet their balance diet requirements. Respondents are most likely to consume what is produced (for those who are farmers) or what is available in their local environment which might not suffice for their adequate dietary intake. Moore *et al.* (2008) submitted that a dietary pattern is influenced by factors related to the local food environment. In addition, Moore *et al.* (2008) asserted that households residing in areas with the lowest-ranked food settings are less likely to have healthy diets than those in the best-ranked food settings. Furthermore, the low dietary intake of the respondents might be attributed to their poor financial status as most rural households earn low income. Previous studies revealed that poor dietary quality is common among low socioeconomic status groups who consume lower amounts of healthy foods in comparison to households with higher socioeconomic status (Darmon and Drewnowski, 2008; Claro et al., 2007).

4.2 Constraints to the consumption of adequate diet

The prominent constraint militating against adequate dietary intake was low income and this aligns with the study of Meludu and Ajibade (2008) that poverty is the major constraint to adequate diet in southwest, Nigeria. Also, Agada and Igbokwe (2015) reported that economic constraints is one of the factors limiting access to nutritious food in Nigeria. Individuals cannot live above their income, hence inadequate dietary intake among rural households is inevitable in the face of dwindled financial status. In order to cope, households might resort to buying smaller quantities of food, switching to different types of food, reducing dietary diversity, and skipping meals (Oldewage-Theron et al., 2006). The high cost of food items is one of the major constraints limiting rural household consumption of adequate diet. The high cost of food items could make rural people unable to consume certain food items that would have enhanced their dietary intake owing to poor income. The findings from this study align with Eforuoku (2018) who reported prominent constraints to adequate dietary intake in northwest Nigeria to be the high cost of food items, low income, and seasonality of food items. According to Obayelu and Orosile (2015), a household may slash its food purchases and alter its consumption patterns in order to cope with rapid food inflation. The study revealed that the unavailability of necessary food items constrained dietary intake. This implies that respondents desired the consumption of some food items but were \constrained by their unavailability. Also, some of the respondents were constrained by illness to eat certain food items even if they know they contain nutrients that are of benefit to the body. Further, the nature of jobs discourages the consumption of nutritious food. The nature of the job of some respondents might not afford them the opportunity to prepare certain food especially delicacies that are time-consuming, thereby depriving them of the nutrients in such food unless the nutrients are gotten from other food substitutes. Some of the sampled respondents had no adequate knowledge of nutritious food. Knowledge is crucial to adequate dietary intake and a healthy lifestyle. Even when money and other resources are available to rural households to feed adequately, their lack of knowledge of the proper combination of food items can result in poor health status. The ability of some respondents to eat adequately is limited by the seasonality of food items implying that certain food items are not available during the off-season. The study found that rural households' consumption of adequate diet was not severely constrained by religious institutions, geographical location, and cultural taboos.

4.3 Hypotheses testing

PPMC relationship between constraints to the consumption of adequate diet and dietary intake

There was an inverse relationship between constraints to the consumption of adequate diet and dietary intake, though not significant. This result implies that constraints to the consumption of adequate diet do not significantly influence rural households' dietary intake. However, the negative correlation coefficient obtained implies that the higher the constraints faced by respondents the lower their dietary intake and vice versa. Previous studies established that financial constraints may orient people toward choosing dietary patterns that have low micronutrient density and high energy density (Darmon et al.. 2002, 2003 in Verly-Jr et al. (2019).

5.0 Conclusion and Recommendations

The study concludes that rural households in southwest Nigeria had not been feeding well as the majority could not attain adequate diet. The nutrient intake is either mostly inadequate or in excess. Most rural households' intake of nutrients, especially micronutrients is below the Recommended Dietary Allowance (RDA) per day. The intake of vitamin A was in excess, while the intake of fat, cholesterol, calcium, vitamin C, vitamin B6, magnesium, dietary fiber, folate, potassium, vitamin B12, niacin, sodium, calories, thiamin, and riboflavin were inadequate. Few groups of food were consumed by the respondents and this resulted in the observed low level of nutrient adequacy. Rice, yam, and some of its products, as well as beans and some of its products, were more frequent in households' diets. Hence, energy-based foods were more consumed compared to other food groups. The dietary intake adequacy level of the households was low. Diet inadequacy suggests the susceptibility of rural households and their members to diseases, malnutrition, and undernourishment with the resultant effect on farm labour and productivity. Adequate dietary intake was majorly constrained by low income, high cost of food items, unavailability of necessary food items, and inadequate knowledge of nutritious food. The study recommends the need to organize nutrition education and innovation by extension agents through non-formal training so as to promote the consumption of foods that will enhance rural households' dietary intake to achieve adequacy. There is a need for nutrition awareness campaigns among rural households by the extension agents on the importance of micronutrients in the body and the different kinds of food rich in these micronutrients. Lack of knowledge of nutritious food by dome households suggests the need for adult education to enlighten households on the importance of adequate dietary intake.

References

Acham, H., Oldewage-Theoren, W. H., Egal, A. A. (2011). Dietary diversity, micronutrient intake and their variation among black women in informal settlements in South Africa: A cross-sectional study. *Int. J. Nutr. Metab.*, Vol. 4(2): 24-39

Agada M. O., Igbokwe E. M. (2015). Dietary Diversity of Rural Households in North Central Nigeria. *European Journal of Nutrition and Food Safety*, Vol. 5(3): 150-155. Retrieved from DOI: 10.9734/EJNFS/2015/14875

Agbeyangi, O. A., Sam-wobo, S. O., Ekpo, U. F., Akinloye, O. A., Mafiana, C. F. (2017) Impact of Rectal Artesunate on Haematological Parameters of Children of Ogun State, South-Western Nigeria. *World Scientific News*. Vol. 80 (93): 1-11

Akerele, D. Ibrahim, M. K., Adewuyi, S. (2014). Socioeconomic determinants of protein and calorie consumption and potential risk of protein-energy malnutrition among households in south-west Nigeria. *Int J Soc Econ*, Vol. 41, 75: 1-19

Akerele D., Sanusi R. A., Fadare O. A., Ashaolu O. F. (2017). Factors infuencing nutritional adequacy among rural households in Nigeria: how does dietary diversity stand among infuencers? *Ecology of Food Nutrition*, 56(2):187–203

Celep, G. S., Kaynar, P., Rastmanesh, R. (2017). Biochemical functions of micronutrients. Adv Obes Weight Manag Control. Vol. 6(2): 43-45. DOI: 10.15406/aowmc.2017.06.00147

Claro, R. M., Carmo, H. C. E., Machado, F. M. S., Monteiro, C. A. (2007). Income, food prices, and participation of fruit and vegetables in the diet. *Rev Saude Publica*. Vol. 41:557–64. *https://doi.org/10.1590/S0034-89102007000400009.*

Darmon, N., Drewnowski, A. (2008). Does social class predict diet quality? *Am J Clin Nutr*. Vol. 87:1107–17. *https://doi.org/10.1093/ajcn/87.5.1107*

Darmon, N., Ferguson, E., Briend, A. (2003). Do economic constraints encourage the selection of energy dense diets? *Appetite*, 41:315–322. *https://doi.org/1 0.1016/S0195-6663(03)00113-2*

Darmon, N., Ferguson, E. L., Briend, A. A, (2002). Cost constraint alone has adverse effects on food selection and nutrient density: an analysis of human diets by linear programming. *Journal Nutrition*, 132:3764-3771. *https://doi.org/10.1093/ jn/132.12.3764*

De-Haen, H., Klasen, S., Qaim, M. (2011). What Do we Really Know? Metrics for Food Insecurity and Undernutrition, *Food Policy*, 36: 760-769.

Eforuoku, F. (2018). Determinants of dietary intake among rural farming households in northwestern Nigeria. An unpublished Ph.D thesis in the Dept. of Agric. Ext. and Rural Dev., University of Ibadan, Nigeria.

FAO (2014). Strengthening the links between Nutrition and Resilience in food and agriculture – a discussion paper available at: *www.fao.org/3/a-i3777e.pdf*

Food and Agriculture Organization-FAO, (2013) *Guidelines for measuring household and individual dietary diversity*. Prepared by Gina Kennedy, Terri Ballard and Marie Claude Do Nutrition and Consumer Protection Division, Food and Agriculture Organization of the United Nations. Pp. 1-60

Gale, (2009). Dietary intake and nutrition status. The Gale Encyclopedia of Senior Health: A Guide for Seniors and Their Caregivers. *Encyclopedia.com.* Available at *http://www.encyclopedia.com*

Government of Ekiti State (2023). About Ekiti. Retrieved from *https://www.ekitistate.gov.ng/about-ekiti/#:~:text=It%20is%20located%20between%20longitudes,Area%20of%205887.890sq%20km.*

Have, J. V., Owolabi, A., Steijns, J., Kudla, U., Melse-Boonstra, A. (2020). Protein intake adequacy among Nigerian infants, children, adolescents and women and protein quality of commonly consumed foods. *Nutrition Research Reviews*, pp 1-19doi:10.1017/S0954422419000222

Joffe, M. (2007). Health, livelihoods, and nutrition in low-income rural systems. *Food and Nutrition Bulletin*, Vol. 28(2), The United Nations University

Meludu, N. T., Ajibade, O. Y. (2008). Rural Dwellers' Knowledge of Nutrition and their Food Consumption Pattern in Oyo State. *African Journal of Biomedical Research*, Vol. 12(1):15-22

Moore L. V., Roux A. V. D., Nettleton J. A., Jacobs D. R. (2008). Associations of the local food environment with diet quality - A comparison of assessments based on surveys and geographic information systems. The multi-ethnic study of atherosclerosis. *American Journal of Epidermiology*, Vol. 167(8): 917-924.

Musemwa L., Ndhleve S., Sibanda M., Zhou L., Muchenje V., Nakin M. D. V. (2018). Implications of Livelihood Strategies on Household Dietary Diversity in the Eastern Cape Province of South Africa. *Journal of Human Ecology*, Vol. 61(1-3): 31-43. DOI: 11.258359/KRE-36

National Bureau of Statistics-NBS. (2012). Poverty Profile for Nigeria. Annual Report, Federal Republic of Nigeria; 2012.

Obayelu O. A., Orosile O. R. (2015). Rural livelihood and food poverty in Ekiti State, Nigeria. *Journal of Agriculture and Environment for International Development*, Vol. 109 (2):307-323 DOI: 10.12895/jaeid.20152.373

Obayelu O. A., Osho F. O. (2020). How diverse are the diets of low-income urban households in Nigeria? *Journal of Agriculture Food Resources*, Vol. 2:1–8

Oladoyinbo, C. A. 1., Ugwunna, U. M. 1 and Ekerette, N. N. (2017). Dietary diversity and nutrient intake adequacy among women in Iwo Local Government Area, Osun State Nigeria. African *Journal of Food, Agriculture, Nutrition and Development*, Vol. 17(4): 12641-12656 DOI: 10.18697/ajfand.80.16280

Oldewage-Theron W. H., Dicks E. G., Napier C. E. (2006). Poverty, household food insecurity and nutrition: Coping strategies in an informal settlement in the Vaal Triangle,South Afric. *Public Health*, Vol. 120: 795-804.

Otekunrin O. A., Otekunrin O. A., Ayinde I. A., Sanusi R. A., Onabanjo O. O., Ariyo O. (2022). Dietary diversity, environment and health-related factors of under-five children: evidence from cassava commercialization households in rural South-West Nigeria. Environmental Science and Pollution Research (2022) 29:19432–19446. Retrieved from *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8556792/pdf/11356_2021_Article_17221.pdf*

Otekunrin O. A., Otekunrin O. A. (2021). Healthy and Sustainable diets: implications for achieving SDG2. In: Leal Filho W., Azul A.M., Brandli L., Özuyar P.G & Wall T. (eds) Zero Hunger. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham

Pakistan Agricultural Research Council (2009). Household poverty and food security situation survey for the year 2008-09. Islamabad: Social Sciences Division, PARC.

Popkin B. M. (2006). Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *American Journal Clinical Nutrition*, Vol. 84:289–98.

Omotayo A. O. (2020). Parametric assessment of household's food intake, agricultural practices and health in rural Southwest, Nigeria. Vol. 6(11): E05433. Retrieved from https://doi.org/10.1016/j.heliyon.2020.e05433

Sencer, E., Orhan, Y. (2005). Nutrition Diet. Turkey: Istanbul Medical publishing.

Smolin, L. A., Grosvenor, M. B. (2010). *Nutrition science and applications*. 2nd ed. USA: John Wiley and Sons.

Spronk I., Kullen C., Burdon C., O'Connor H. (2014) Relationship between nutrition knowledge and dietary intake. *British Journal of Nutrition*. 111: Pp. 1713–1726.

Verly-Jr, E., Sichieri, R., Darmon, N., Maillot, M., Sarti, F. M. (2019). Planning dietary improvements without additional costs for low-income individuals in Brazil: linear programming optimization as a tool for public policy in nutrition and health. *Nutrition Journal*, Vol. 18(40): 1-12 *https://doi.org/10.1186/s12937-019-0466-y*