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Food and Nutrient Intake of Filipinos with Diabetes

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Abstract Diabetes is considered as a worldwide public health problem and its prevalence in the Philippines has been increasing throughout the past decade. Dietary intake is a leading factor that affects diabetes development. Thus, the aim of the study is to analyze the food and nutrient intakes of Filipino adults with type 2 diabetes and to determine the underlying relationship between diabetes and dietary intake. The participants were 1,087 Filipinos with diabetes, ages 18 years and over from the 2013 National Nutrition Survey. In this study, two non-consecutive 24-hour dietary recalls were administered through face-to-face interviews by registered nutritionist-dietitians. The amount of consumed foods and beverages were estimated through standard household measures or food weighing. The energy and nutrient content of foods were assessed by utilizing the FNRI-Individual Dietary Evaluation System (IDES). Mean and usual energy and nutrient intake distributions were assessed using software established by Iowa State University (PC-SIDE version 1.02) and the evaluation of each macronutrient's percentage contribution to total energy intake was done using the Acceptable Macronutrient Distribution Ranges (AMDR). Results of the study showed that Filipinos with diabetes have inadequate protein intake (53%) as well as micronutrient intake, including vitamin C (96%), thiamin (78%), riboflavin (85%), folate (87%), calcium (96%) and vitamin A (66%). Major sources of energy were mainly from carbohydrates (70.1%) consisting of rice, sugar-sweetened beverages, bread and sugar. A weak positive correlation was found between energy, macronutrient intake and fasting blood glucose. Findings of the study indicate that diabetes is affected by one's dietary intake yet further research is required to define the role of micronutrients in diabetes management.

Keywords: *diabetes, food intake, nutrient intake, food sources, fasting blood glucose*

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1. Introduction

Diabetes is a metabolic syndrome that occurs when the pancreas no longer has the capability to make insulin, or when the body cannot utilize the insulin it manufactures effectively [1]. Diabetes is indeed a worldwide public health problem and was the cause of over 4.2 million deaths [2]. In 2019, the global diabetes prevalence approximately affected 463 million people (9.3%) which is expected to rise in 2030 by 578 million or 10.2% and 700 million or 10.9% by 2045 [2]. Diabetes has been rising rapidly in developing countries and has become prevalent among adults 18 years old and above from 4.7% in 1980 rising to 8.5% in 2014 [3]. The diabetes prevalence among Filipino adults ages 20 years old and over have an increasing trend from 3.4% in 2003 to 7.9% in 2018; reflecting a 2.2-percentage point increase for the past decade [4]. The prevalence was higher among adults residing in urban areas (6.4%) compared with those residing in rural areas (4.6%) [5]. The National Capital Region (6.5%) is among the regions with the highest prevalence and this was even above the national prevalence (5.6%) [5].

Diabetes leads to an increased mortality risk and is also related to multiple comorbidities like decreased general well-being and economic burden [6]. Moreover, diabetes is specifically associated to an increased susceptibility to fatty liver disease, dementia, cancer, pancreatitis and depression [7]. Uncontrolled diabetes would result to the occurrence of diabetic microvascular complications, known as diabetic nephropathy, retinopathy and neuropathy which are life-threatening since these are possible factors that presuppose a person to heart disease, premature death, and could also lead to autonomic neuropathy, blindness and renal failure [8,9]. Solutions for slowing the progression of diabetes are hence needed, especially considering the modifiable factors including dietary intake, physical activity and weight. Dietary intake is a leading factor which affects the rates of worldwide morbidity and mortality according to the 2013 Global Burden of Disease Study [10]. Moreover, a previous study reported that diabetic patients who abide by dietary self-care recommendations are often found to have better glycemic control which leads to fewer comorbidities [11].

Although the importance of proper nutrition in diabetes management is clear by playing a part on metabolic control and weight, nutrition is also deemed as among the complex aspects in disease management. Many diabetic people also struggle to sustain a clinically recommended diet. Programs and policies which focus on diabetes also need to be strengthened to prevent the prevalence from increasing even further.

For this reason, further research is essential to clear up uncertain areas of knowledge about the diet of diabetics including the role of fruits, legumes, fish, plant oils, and the quality and quantity of foods consumed. Determining the dietary intake of diabetics would contribute to increasing knowledge regarding specific dietary factors that may influence glycemic response to foods including commonly consumed foods by the population that could affect the development of diabetes. Hence, this study aims to analyze the food and nutrient intakes of Filipino adults with type 2 diabetes and to determine the underlying associations between diabetes and dietary intake.

1.1. Study Population

Data from 1087 Filipinos with diabetes aged 18 years and above in the 2013 National Nutrition Survey (NNS) were used in the current analyses. The 2013 NNS is a cross-sectional, population-based survey which shows the current health and nutritional status of Filipinos. The survey employed a stratified three-stage sampling system drawn to embody all 17 regions and 80 provinces of the Philippines. A total of 8592 Filipino households were used as sample population which has 87.7% response rate.

2.2. Dietary Data Collection

Two 24-hour dietary recalls were administered by registered nutritionist-dietitians by face-to-face interviews in each household by using structured questionnaires. The nutritionist (interviewer) recorded all consumed foods and beverages the day before from the time they woke up until they went to sleep in the night time. Household measures (cups, tablespoons and pieces of food item) or food weighing was utilized to estimate the amount of foods consumed. The foods that were weighed are converted to as purchased values using a portion to weight list for common foods compiled by the Food and Nutrition Research Institute (FNRI). If the food reported was a dish or composite food, the respondent was asked to describe the ingredients of the recipe or name the dish or recipe. The nutrient content of these composite foods were identified by calculating each ingredient broken down from the recipe based on INFOODS Guidelines. A first 24-hour food recall was collected in all household members of all sampled households and in order to estimate the day-to-day within-person variability in energy and nutrient intake, a second 24-hour food recall was carried among all members in half (50%) of randomly selected households. The repeated 24-hour food recalls were administered non-consecutively to avoid correlation in nutrient intakes on consecutive days.

Table 1. Food Group Classification

MILK	VEGETABLES	SWEETS
Adult formula (fortified milk powder)	Dark green leafy vegetables	Sweet bakery products
Cow's milk (fluid and powdered)	*Spinach*	*Cookies*
Other milk	*Broccoli*	*Biscuits*
Cheese	*Cabbage, green*	*Sweet breads*
Yoghurt	*Local leafy/petioles/salad vegetables*	*Cakes*
MEATS/FISH/OTHER PROTEIN SOURCES	Deep yellow vegetables	Ice cream, popsicles
Beef	*Carrot*	Candy
Carabeef	*Sweet potato, yellow*	Sugar
Pork	*Cassava, yellow*	Syrup
Goat/lamb	*Squash fruit*	Preserves/jams/jellies
Chicken	*Squash, summer fruits*	Native desserts/snacks
Duck	Starchy vegetables	Sugar sweetened beverages
Sausages/hotdogs	*Sweet potato*	*Fruit-based beverages*
Luncheon meats/cold cuts	*Potato*	*Concentrated fruit juice drinks*
Fish	Other vegetables	*Powdered fruit flavored drinks*
Eggs	Vegetable products/processed vegetables	*Soft drinks*
Beans/nuts	FRUIT & 100% FRUIT JUICE	*Chocolate/chocolate flavor beverages*
GRAINS & GRAIN PRODUCTS	Apple	*Other sweetened beverages*
Refined rice	Avocado	MIXED DISHES
Cereal	Banana	Meat-based mixed dishes
Bread	Mango	Beans-based mixed dishes
Crackers	Melon	Grain-based mixed dishes
Pancakes, waffles, French toast	Citrus fruits	Soups
Noodles	Cherries/berries	OTHER FOODS & BEVERAGES
Pasta	Papaya	Non-alcoholic beverages
Corn grits	100% Fruit juice	Alcoholic beverages
Cornmeal	FATS/OILS	Savory snacks
	Fats	Condiments, sauces, herbs, spices, other seasonings
	Oils	

1.3. Data Processing

The energy and nutrient content of foods consumed were assessed by means of the FNRI-Individual Dietary Evaluation System (IDES) which includes the expanded Food Composition Table (FCT) created from this study. The FCT was lengthened from the original 12 nutrients to a total of 27 nutrients, and it is the first time that these 27 nutrients were used for analysis in a nationally representative Filipino population. Further details regarding the development of the expanded FCT will be stated in another paper.

Improbable values of energy and nutrient intakes were identified through a process described below. Excessive micronutrient intakes were intakes that are 1.5 times higher than the 99th percentile of the observed intake distribution in the respective age group. Those intakes that are exceeding this upper limit were replaced by a random value produced from a uniform distribution in the interval with lower limit equivalent to the 95th percentile of the observed intake and also an upper limit equivalent to 1.5 times the 99th percentile [12].

Regarding the food sources of energy and nutrients, these were investigated by creating a list consisting of 87 food groups under 9 major categories (Table 1) which is in a similar layout to the food categories established by the United Nations Food and Agriculture Organization (FAO) [13] and United States Department of Agriculture (USDA) [14], while showing frequently consumed foods and their traditional way of food consumption. All foods, including those less consumed foods, were considered in the analysis.

1.4. Statistical Results

Mean and usual energy and nutrient intake distributions were assessed by utilizing the software program established by Iowa State University, PC-SIDE version 1.02. Within-person variation of nutrient intakes was also considered for across days. This software estimates usual nutrient intake distribution percentiles including the proportion lower than the estimated average requirements (EAR) defined by the Philippine Dietary Reference Intakes 2015. To estimate the prevalence of nutrient inadequacy in a group, the proportion of individuals with usual nutrient intakes lower compared to the Estimated Average Requirement (EAR) was considered [15].

The Acceptable Macronutrient Distribution Ranges (AMDR) was used to assess carbohydrates, total fat, and protein intakes as percentage of total energy intake. Proportions of inadequate and excessive intakes were categorized as less than AMDR lower range and greater than AMDR upper range, respectively. With regards to the prevalence of insufficient intake of iron, the probability approach was utilized [16]. First, the risk of inadequate intake of each individual was calculated followed by the prevalence of inadequate iron intake, which pertains to the average risk of inadequacy is computed. Computations for summary statistics were conducted using STATA version 13 (StataCorp, College Station, Texas 2013).

1.5. Ethical Review

The Ethics Committee of FNRI approved the survey protocol and data collection instruments. All surveyed households provided informed consent prior to participation.

1.6. Conflict of Interest

The author declares no conflict of interest with the conduct of the study.

2. Results

Table 2 shows the usual intake of energy and macronutrients of Filipinos with diabetes. The mean usual energy, total fat, protein, carbohydrates, total sugar and dietary fiber was 1669 kcal/day, 29.9 g, 56.6 g, 288.1 g, 26.4 g, and 8.7 g per day respectively.

Inadequate protein intake was found to be prevalent at 47%. As percentage of total energy, fat, protein and carbohydrates contributed to 13.8%, 15.3% and 70.1% of daily energy intake, respectively. Comparing against the AMDR recommendations, 53% of Filipinos with diabetes did not consume adequate protein. In terms of energy and macronutrient intake, Filipinos with diabetes (n=1087) consumed a mean dietary intake of energy (1669.4 kcal ± 15.7), carbohydrates (288.1g ± 3.2), total fat (29.9g ± 0.5), saturated fat (15.1g ± 0.4), monounsaturated fatty acids (10.7g ± 0.2), polyunsaturated fatty acids (5.1g ± 0.1), and protein (56.6g ± 0.6).

High prevalence of inadequacy was found for all vitamins and minerals: Vitamin C (96%), thiamine (78%), Riboflavin (85%), folate (87%), calcium (96%) and vitamin A (66%) while other vitamins such as vitamin B6, vitamin B12, zinc, and niacin have a low prevalence of inadequacy.

Table 3 shows that rice, fish & shellfish, fats & oils, other sweetened beverages (instant coffee), bread, condiments and sugar were the top foods mostly consumed by Filipinos with diabetes. The mean intake per capita of the following food groups are: rice (248.6 g), fish & shellfish (62.3 g), fats & oils (5.8 g), other sweetened beverages (12.9 g), breads (28.7 g), condiments (3.3 g) and sugar (3.9 g). Other sweetened beverages and sugar contributed 15-18.7% of total sugar, fresh fruit (11.7%), breads (8.3%), native desert and rice contributed 4.7% in total sugar intake. (Figure 1)

Rice contributed nearly 70% of carbohydrates, while the other top food sources of carbohydrates contributed only 6% below (bread, other sweetened beverages, and noodles). Same results in energy, rice has high contribution of energy, next is pork, bread and fish & shellfish. (Figure 2 & Figure 3)

In protein, rice was also the top source of protein, next came from fish & shellfish, pork and chicken. Only one percent below came from dark green leafy vegetables in addition to other vegetables. Pork and fats & oils were the top sources of total fat and only 7.3% came from fish & shellfish. (Figure 4 & Figure 5)

Bread, fish & shellfish, noodles, condiments and pork were the top 5 sources of sodium and only 3% below came from crackers, sweet breads, chicken, cakes, and eggs & egg dishes. (Figure 6)

Table 2. Usual Intake of Filipinos with Diabetes (n=1087)

	Dietary Reference Intakes		Mean/Median Intake Percentiles						Inadequate/Excessive Reported Intake	
Nutrients	**EAR/AMDR**	**UL**	**10th**	**25th**	**Median**	**Mean ± SE**	**75th**	**90th**	**% <EAR/ AMDR**	**% >AMDR / >UL**
Macronutrients										
Energy intake (kcal)	-	-	986	1243	1589	1669.4 ± 15.7	2008	2456		
Total fat (g/d)	-	-	11.9	17.4	26.1	29.9 ± 0.5	38.1	52.6	-	-
Saturated fat (g)	-	-	5.1	7.8	12.1	15.1 ± 0.4	18.5	27.8	-	-
Monounsaturated fatty acids (g)	-	-	3.9	5.8	8.9	10.7 ± 0.2	13.6	19.6		
Polyunsaturated fatty acids (g)	-	-	2.0	2.9	4.3	5.1 ± 0.1	6.4	9.0	-	-
Protein (g/d)	53	-	33	42	54	56.6 ± 0.6	68	83	47	-
Carbohydrate (g/d)	-	-	166	212	274	288.1 ± 3.2	349	428	-	-
Total sugars (g/d)	-	-	10.4	15.7	23.4	26.4 ± 0.5	33.8	46	-	-
Dietary fibre (g/d)	-	-	4.9	6.2	7.9	8.7 ± 0.1	10.2	13.3	-	-
As percentage of total energy										
Total Fat (%)	15-30	-	11.5	12.5	13.7	13.8 ± 0.1	15.0	16.3	1	25
Protein (%)	10-15	-	7.8	10.6	14.5	15.3 ± 0.2	19.2	24.0	53	2
Carbohydrate (%)	55-75	-	59.1	65.2	71.1	70.1 ± 0.2	76.1	79.8	5	30
Antioxidants										
Vitamin C (mg/d)	56	1000	8.6	12.6	19.3	23.1 ± 0.5	29.6	41.3	96	0
Vitamin E (mg)	-	-	1.1	1.5	2.2	2.6 ± 0.1	3.2	4.6	-	-
B vitamins										
Thiamine (mg/d)	1.1	-	0.4	0.6	0.7	0.8 ± 0.01	0.9	1.1	78	-
Riboflavin (mg/d)	1.3	-	0.4	0.5	0.6	0.7 ± 0.01	0.8	1.1	85	-
Niacin (mg/d)	13.4	35	10.7	13.7	17.6	18.4 ± 0.2	22.2	27.0	13	2
Vitamin B6 (mg)	1.7	100	1.8	2.2	2.8	2.9 ± 0.2	3.5	4.2	2	0
Folate (DFE µg)	320	1000	84	119	173	199.5 ± 3.4	251	347	87	0
Vitamin B12 (mg)	2	-	2.0	2.7	3.7	4.2 ± 0.1	5.1	6.9	9	-
Bone-related nutrients										
Calcium (mg/d)	600	3000	172	218	285	315.4 ± 4.4	377	492	**96**	0
Phosphorus (mg/d)	580	4000	484	614	784	816.4 ± 8.5	983	1191	21	0
Magnesium (mg)	-	-	102	127	162	171.2 ± 1.9	185	253	-	-
Vitamin D (mg)	-	-	1.6	2.3	3.3	3.7 ± 0.1	4.6	6.2	-	-
Other micronutrients										
Vitamin A (µg RE/d)	466	3000	159	231	358	439.2 ± 9.4	554	810	**66**	0
Iron (mg/d)	-	-	5.2	7.2	10.7	13.2 ± 0.3	16.2	24.0	-	-
Zinc (mg)	3.75	45	3.2	4.1	5.4	6.0 ± 0.1	7.2	9.3	**18**	0
Sodium (mg/d)	-	-	305	459	701	813.1 ± 15.2	1043	1460	-	-
Potassium (mg)	-	-	763	950	1203	1264.5 ± 13.3	1511	1845	-	-
Selenium (mg)	28.3	400	54	70	92	97.6 ± 1.1	119	148	<1	0

Food sources of Filipinos with diabetes (n=1087).

Table 3. Top 20 foods consumed by Filipinos with diabetes 8th NNS (n=1087)

Rank	Food groups	% Consumer	Mean intake per capita [g], (SE)
1	Rice	86.6	248.6 (1.8)
2	Fish & Shellfish	75.5	62.3 (1.2)
3	Fats & Oils	60.3	5.8 (0.3)
4	Other Sweetened Beverages	37.4	12.9 (1.3)
5	Bread	37.2	28.7 (1.3)
6	Condiments	35.5	3.3 (0.2)
7	Sugar	33.2	3.9 (0.2)
8	Dark Green Leafy Vegetables	29.3	17.4 (0.9)
9	Fresh Fruit	25.9	29.3 (2.4)
10	Pork	25.3	34.3 (1.7)
11	Chicken	23.1	18.7 (1.5)
12	Eggs & Egg Dishes	23	9.6 (0.7)
13	Other Vegetables	22.9	31.6 (1.2)
14	Beans, Nuts & Peas	10.6	5.7 (2.2)
15	Deep Yellow Vegetables	10.4	7.6 (1.1)
16	Milk Powdered	9.6	1.9 (0.3)
17	Noodles	8.8	11.0 (1.1)
18	Starchy Vegetables	5.1	8.6 (2.4)
19	Beef	5.1	5.7 (1.8)
20	Sweet Breads	4.9	3.6 (1.7)

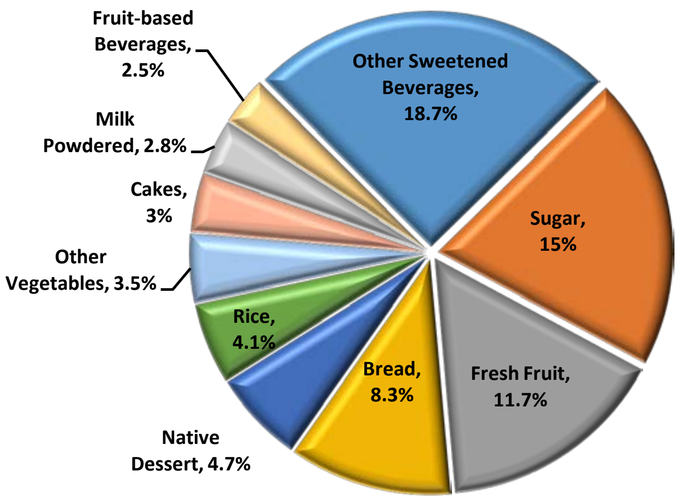

Figure 1. Top Food Sources of Total Sugar

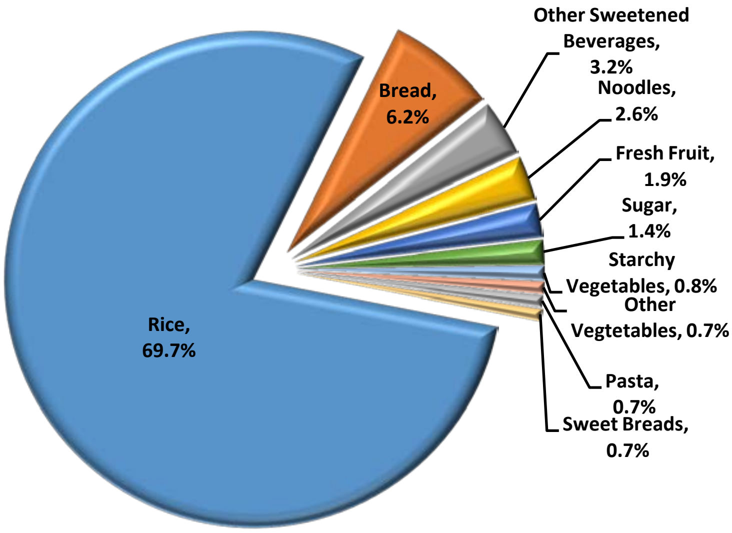

Figure 2. Top Food Sources of Carbohydrates

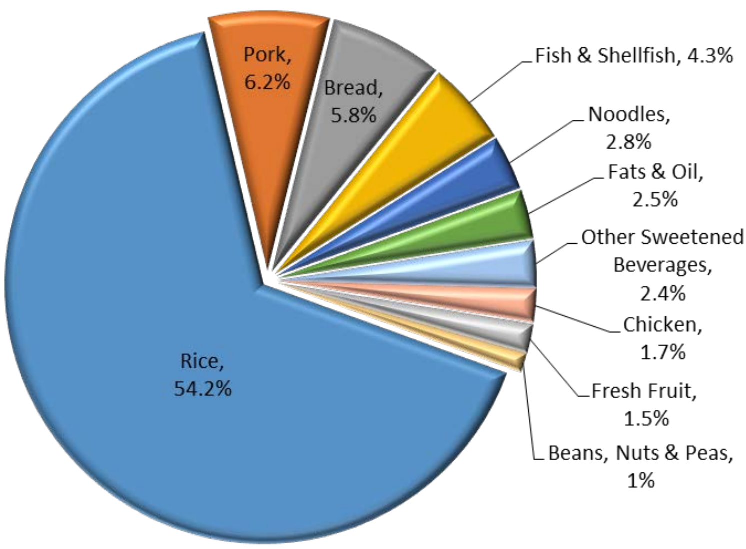

Figure 3. Top Food Sources of Energy

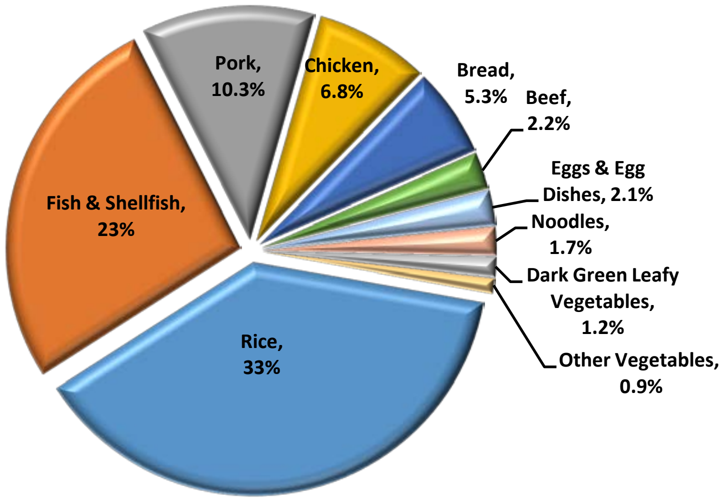

Figure 4. Top Food Sources of Protein

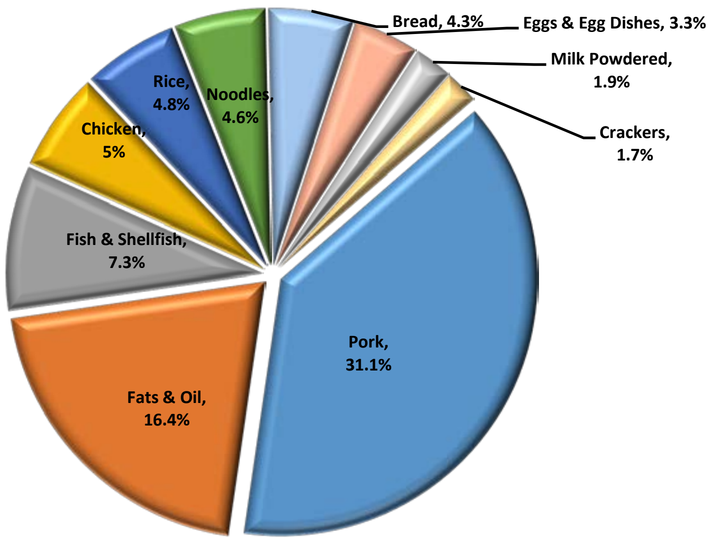

Figure 5. Top Food Sources of Total Fat

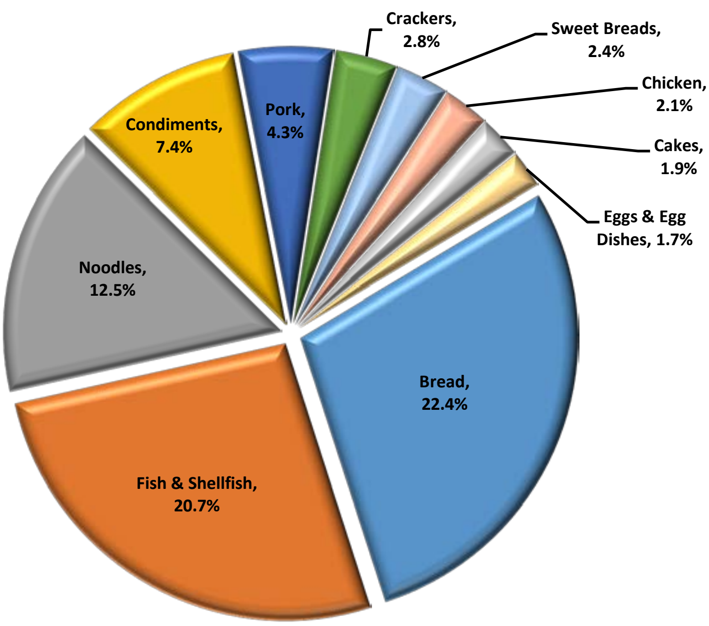

Figure 6. Top Food Sources of Sodium

Table 4. Correlation between energy, macronutrient intake and fasting blood glucose of Filipinos with diabetes (n=1087)

Macronutrients	Fasting Blood Glucose
	r
Energy (kcal/d)	0.08*
Total Fat (g/d)	0.12*
Saturated fat (g/d)	0.09*
Monounsaturated fatty acids (g)	0.12*
Polyunsaturated fatty acids (g)	0.10*
Protein (g/d)	0.08*
Carbohydrate (g/d)	0.05
Total sugar (g/d)	0.10*
Dietary fiber (g/d)	0.09*

*significant.

Table 4 shows that there is a weak positive relationship between the energy, total fat, saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), protein, total sugar, dietary fiber and the fasting blood glucose (FBG) of Filipinos with diabetes. This indicates that if the energy and macronutrient intake is increased, the fasting blood glucose would also increase and vice versa.

3. Discussion

The study focused on the energy and nutrient intakes of Filipinos with diabetes ages 18 years old and above. Each component of the food intake was considered in the study specifically including energy, macronutrients, and micronutrients as each food consumed is composed of a larger pattern of many nutrients and existing dietary exposures from each food have a particular significance to the onset of diabetes [17]. A considerable high prevalence of inadequate protein intake was found in which 53% of Filipinos with diabetes did not consume sufficient amounts of dietary protein and this could put these individuals at a higher susceptibility to protein loss (Table 2). The inadequacy could be a resultant factor of poor quality protein intake as manifested in the topmost source of protein consumed by these individuals is rice which is an incomplete protein or a protein with low biological value (BV). It has been shown that low protein diets have adverse effects aside from decreased lean body mass and increased hepatic lipidosis, it could also result to fatty liver, reduced energy digestibility, and decreased body weight if prolonged [18]. In a previous study, it has been observed that people with type 2 diabetes have a higher rate of muscle protein loss than patients without diabetes [19]. Muscle protein loss could in turn result to catabolism [20]. This increases the likelihood of a diabetic person to have inadequate protein stores due to inadequate dietary intake coupled with increased protein needs due to protein catabolism. On the other hand, adequate protein intake improved one's glycemic control, helping through satiety and maintenance of lean body mass, especially for older adults with increased protein requirements and susceptibility to functional disability [21,22]. Protein intake was also found to be important in maintaining functional capacity in diabetic older adults [23]; acts as an insulin secretagogue which stimulates sustained insulin response and insulin secretion that could help reduce blood sugar response to ingested carbohydrate [24]. In previous reviews, contradictory to the adverse effects of inadequate protein intake, previous studies stated that low protein intake retarded the progression of diabetic nephropathy [25,26].

The high prevalence of insufficient micronutrient intakes for vitamin C (96%), calcium (96%), folate (87%), riboflavin (85%), thiamin (78%) and vitamin A (66%) among our subjects in this study (Table 2) is also alarming since these micronutrients are involved in glycemic control [27], antioxidant activity [28], and glucose metabolism [29]. These results of the present study are consistent with previous literature stating that people with diabetes are susceptible to micronutrient deficiencies due to an increased need to control excessive oxidative stress created by irregularities in glucose metabolism [29,30]. Relative to the high prevalence of inadequate vitamin C intake (96%), sufficient intake is vital since vitamin C functions in the body as a potent antioxidant [31].

Diabetes is linked with oxidative stress which increases free radical formation, insulin resistance and lipid peroxidation that damages enzymes [32]. This suggests the role of vitamin C in protecting important biomolecules from oxidation by participating in the oxidation-reduction reactions [33].

In terms of food sources, sugar-sweetened beverages (SSBs) are commonly consumed by Filipinos with diabetes (Table 3). The mean capita intake of SSBs was 12.9 g per day and had contributed to 18.7% total sugar intake. Sugar-sweetened beverages are composed of rapidly absorbable carbohydrates such as sucrose, fructose and high-fructose corn syrup which elevate blood glucose levels [34]. A previous study stated that decreasing sugar-sweetened beverage intake could be used as a dietary strategy which would help diminish diabetes-related negative health outcomes and promote improved glycemic control [35]. Contrastingly, vegetable food groups with the following mean per capita intake such as deep yellow vegetables (7.6 g/day), starchy vegetables (8.6 g/day), dark green leafy vegetables (17.4 g/day) and other vegetables (31.6 g/day) were among the least consumed food groups (Table 3). Green leafy vegetable and yellow vegetable intake were found to be associated with lowering the risk of diabetes because of its fiber content [36]. Vegetables are likewise rich sources of flavonoids, antioxidant compounds (carotenoids, vitamin C and E), folate and potassium which helps protect against the adverse effects of diabetes [36].

Results of the study also showed pork as the top source of fat contributing 31.1% of the total fat intake (Figure 5). Red meat such as pork, especially processed meat contains components that have possible mechanistic links to insulin resistance such as saturated fatty acid (SFA), glycotoxins, trimethylamine N-oxide (TMAO), and nitrites [37]. In a previous study, red meat consumption is found to be correlated with inflammation, which in turn heightens the risk for developing diabetes [38]. Saturated fat specifically increases serum free fatty acids which may contribute in increasing insulin resistance both in liver and muscle, through interruption of hormone metabolic pathways in receptor and its substrate basis [39]. While Advanced Glycation End Products (AGEs) which is produced after processing or cooking at high temperatures contributes to hyperglycemia [37] and nitrites contribute to inflammation and also oxidative stress [40].

Aside from vegetables, fresh fruits are also one of the least consumed food groups contributing a mean per capita intake of 29.3 g/day (Table 3). Since fresh fruits and vegetables are among the least consumed, this could be a factor leading to the inadequacy of vitamin C [41].

Inadequate thiamine intake which is likewise found in the study may be a factor related to the onset of diabetes as thiamine plays a role mainly in glucose metabolism [42]. Aside from inadequate dietary intake of thiamine, excessive simple sugar intake such as from SSBs also influences renal thiamine losses which make thiamin deficiency even more possible in diabetic people [43]. Meanwhile, the inadequate riboflavin intake found in this study could negatively affect one's oxidant/antioxidant balance [44]. As oxidative stress is majorly involved in the mechanism of diabetes, riboflavin plays a role as an antioxidant independently by conversion of reduced riboflavin to oxidized form or as a component of glutathione redox cycle [45,46]. Riboflavin also reduces hyperglycemia by the absorption of glucose from the intestine [45] and through carbohydrate metabolism [47].

Moreover, inadequate folate intake may put our subjects at a higher risk of endothelial dysfunction in type 2 diabetes since consumption of folate has a protective effect on vascular endothelial cells against high blood glucose-induced injury in diabetes [48]. Moreover, folate deficiency has been reported to be linked with oxidative stress in patients with diabetes, in relation to a rise in homocysteine levels [29].

Adequate calcium intake is also essential for diabetic people since calcium is not only required for bone health but may also have a role in improving pancreatic insulin secretion as well as peripheral insulin sensitivity [49,50]. Moreover, calcium intake, insulin production and sensitivity have been found in previous studies to be associated with glucose homeostasis in diabetic adults [51,52].

However, in our study our diabetic subjects had inadequate calcium intake which might lead to worsening health and nutritional status. Conversely, the inadequacy of vitamin A intake could be attributed to the poor consumption of vegetables and fruits especially the green-yellow and deep colored vegetables. In a previous study, Vitamin A is known to protect an individual against insulin resistance [53].

Evaluating further the association of energy intake, macronutrients and fasting blood sugar, our results show a weak positive correlation. This simply indicates that if the energy and macronutrient intake is increased, the fasting blood glucose would slightly increase and vice versa. Contradicting results have been published with regards to the association of fasting blood sugar and macronutrients. One study showed no relationship between the macronutrient protein and fasting blood glucose levels [54]. Another study stated that increased energy intake leads to an increased glucose production in liver and glucagon levels which then results in increased blood glucose levels [55]. Excessive fat intake also leads to increased fat stores in the liver and in peripheral muscles which contribute to insulin sensitivity and thus, increased blood glucose levels as well [55].

4. Conclusion

Overall, the present study showed that Filipinos with diabetes have inadequate protein intake as well as micronutrient intake, specifically vitamin A, vitamin C, riboflavin, thiamin, folate and calcium. The importance of proper food sources should also be given importance since it has been found that sugar-sweetened beverages and red meat are commonly consumed but vegetables and fruits are the least consumed food groups. The major source of energy was from carbohydrates consisting of rice, sugar-sweetened beverages, bread and sugar. These foods are mostly high in glycemic index and also glycemic load. Although there was a weak positive correlation between energy, macronutrient intake and fasting blood glucose levels there is an indication that consumption of these foods affects blood glucose level however, further research is necessary to describe the role of micronutrients in diabetes management considering their role in oxidative stress and also inflammation.

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