Poor Nutritional Status Among Human Filarial Lymphedema Patients in Ghana: A Cross-Sectional Study

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Abstract

Background

Lymphatic filariasis (LF) is a neglected tropical disease with several infection phenotypes. In addition to mass drug administration, host immune response contributes to microfilariae clearance. An important influence of immunity, nutritional status, remains to be evaluated among filarial lymphedema patients. This study sought to assess the nutritional status of LF patients and its association with the pathology.

Methods

As cross-sectional study was conducted to determine the nutrition status of lymphedema patients in Ahanta West, Ghana. To obtain sociodemographic and nutrition data, a structured questionnaire was administered to the study participants. Anthropometry and 24-hour food recall were used to assess the nutritional status of participants.

Results

While all and 71 (82.6%) had adequate carbohydrate and protein intakes respectively, 83 (96.5%) had inadequate intake of fat. There were widespread inadequate nutrients intakes that were associated with stage of lymphedema: fat, $r = -0.267$, $p = .024$; carbohydrate, $r = 0.305$, $p = .010$; sodium, $r = -0.259$, $p = .029$; copper, $r = -0.249$, $p = .036$; selenium, $r = -0.265$, $p = .025$; pantothenic acid, $r = -0.265$, $p = .025$; vitamin B6, $r = -0.270$, $p = .023$; vitamin B12, $r = -0.288$, $p = .015$; and vitamin A, $r = -0.276$, $p = .020$.

Conclusion

The study shows widespread malnutrition among the participants. A nutritional intervention is recommended to complement current management strategies of filarial lymphedema.

Background

Human lymphatic filariasis (LF) is caused by the nematode parasites; *Wuchereria bancrofti*, *Brugia malayi*, and *Brugia timori*. The disease is characterized by adenolymphangitis, hydrocele, lymphedema and elephantiasis. Currently, it is treated with anti-filarial drugs such as Diethylcarbamazine and Ivermectin through mass drug administration (MDA) in Ghana (1, 2). The World Health Organisation (WHO) provided a minimum package of care for morbidity management and prevention of disability including providing anti-filarial medicine, hydrocele surgery, prevention and treating adenolymphangitis and lymphedema management (3).

LF is described as one of the diseases of poverty with about 1.23 billion people living in endemic areas in 58 countries. Most of endemic communities have low economic status and standards of living as well as poor sanitation. The disability caused by this debilitating disease puts economic burdens on the families of the patients, with some abandoned by their families (4). This is most likely to hamper patients' ability to meet basic needs including proper nutrition needed to ameliorate their diseased condition.

Nutrition, especially balanced diet is critical for maintaining health. Nutritional imbalances have been associated with disease, with excess nutritional intakes leading to obesity and cardiovascular diseases, whereas deficiencies cause stunted growth, poor immune function and nutrient deficiency diseases (5, 6). Nutrition care plan has been incorporated in various treatments including cancer, metabolic syndromes and disease recovery process (7).

The homeostasis of nutrients is key for maintaining healthy immune system. Zinc (Zn) plays an important role in the regulation of both the innate and adaptive immune response, and copper (Cu) is a trace element essential for cellular development (8). Thus, the role of nutrition in the prevention, treatment and management of infectious disease cannot be over emphasized as their levels are altered during infections. Nutrition care plan involves the assessment of the nutrition status to evaluate individuals and population for imbalances, and intervention to ensure proper intake for healthy living (9). Adequate nutrition is required for maintenance of health and optimum immune function.

In LF, the immunity of most patients is believed to be compromised (10), and thus poor nutritional status is likely to result in double disease burden that could worsen their condition. Yet, there is scarce information on the nutritional status of this particular population. Therefore, this study sought to assess the nutritional status of the LF patients to determine the need for appropriate nutritional intervention in addition to the current management strategies of the disease. Here, we show the prevalence of overweight/ obesity was high among filarial lymphedema patients in the Ahanta West District of the Western Region. We also observed widespread inadequate dietary micronutrients i.e. vitamins A and K, thiamine, riboflavin, pantothenic acid, zinc, potassium, magnesium and calcium intake among the study participants.

Materials And Methods

Study Design

A cross-sectional design was employed with quantitative and semi-quantitative methods to assess nutritional quality, usual and estimated intakes. Structured questionnaire was used to collect sociodemographic and dietary data; and anthropometric measurements were taken to assess nutritional status. The study protocols were implemented in accordance with the Declaration of Helsinki.

Study Population and Sampling Technique

LF patients between the ages of 27 and 86 who could walk were conveniently sampled for this study from LF-endemic communities in the Ahanta West District. Participation in this study was voluntary. No sample size calculation was done to arrive at the total sample size. A total of 86 study participants (LF patients) were recruited from Ampatano, Akatakyi, Princess Town, Achowa, Busua, Butre and Dixcove, all in the Ahanta West district in the Western region of Ghana. Ahanta West is one of the 22 districts in the Western Region with a total area of about 636 km^2, and with Agona Nkwanta as the municipal capital. It is approximately 38 km from Takoradi, the regional capital and 260 km from Accra, the capital city of Ghana. Participants were recruited based on patients' availability and willingness to participate in the study.

Data collection

A semi-structured questionnaire was administered to collect personal, demographics, dietary history and habits data. Anthropometric measurements were done to collect data for height to the nearest 0.1 centimetre with Seca® stadiometer, weight to the nearest 0.1 kg, and body mass index (BMI) computed using the OMRON® digital scale and body composition monitor. The same body composition monitor was used for body composition of participants for their visceral fat. Data on usual dietary intake was collected with 24-hour recall from CDC's dietary interview component and Food and Agriculture Organisation (FAO) Three-day 24-hour recall was done for two weekdays and one weekend.

Dietary References

Macronutrient intakes were determined using the acceptable macronutrient distribution ranges (AMDR) and micronutrient intake by comparing participants average intake based on 24-Hour food recall with recommended dietary allowance for adequate intakes. These estimated nutrients intakes have been previously described by Intakes (11), Lee, Choi (12), Pitkin, Allen (13), Ross, Taylor (14), Table (15) and Trumbo, Yates (16).

Data Analysis

Descriptive statistics was used for analysis with categorical variables expressed as frequencies (percentages) and continuous variables as mean (SD). To determine associations between stages of lymphedema and nutritional status, bivariate correlation was performed. Subsequently, the Fisher's Exact test was used to explore the associations between nutrition status (BMI) and socioeconomic parameters. P value less than 0.05 (at 95% confidence level) was considered statistically significant. CDC's Epi Info® 7 was used to create the questionnaire and for data entry. The Nutrient Analysis Template (Food Science and Nutrition Department, University of Ghana, 2010) was used to estimate nutrients composition of foods from the 24-hour recall. Data was cleaned and merged with Microsoft Office Excel 2016 and analysed with IBM SPSS 26.

Ethical Consideration

Ethical approval was obtained from the Committee on Human Research Publication and Ethics at the School of Medical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi with

approval number CHRPE/AP/058/20. Institutional approval was also sought from the Ghana Health Service Directorate at the Ahanta Nkwanta in the Western Region. Written informed consent was obtained from all participants after the research had been adequately explained to them.

Results

Sociodemographic Characteristics of Study Participants

The study participants were from seven LF endemic communities (Achowa, Akatakyi, Ampatano, Busua, Butre, Dixcove, Princess Town) in the Ahanta West District. The age of participants ranged from 27 to 86 years with a mean age of 54.35 ± 13 years. The gender distribution was disproportionate, with about three-quarters females, 65, and the rest being males. More than half of the participants, 45 (52.9%) were married and almost two-thirds, 51 (60.0%) had no formal education, 29 (34.1%) with basic education and only 5 (5.9%) with secondary education. Their major occupations were farming, 27 (31.4%) and fishing-related 26 (30.2%), while 21 (24.4%) were unemployed. The most occurring pathology stages were stages two, 28 (39.4%) and three, 20 (28.2%). These characteristics of study participants are shown in Table 1.

Table 1
Characteristics of study participants

Variable		n (%)	p-value
Age	25–34 years	3 (3.5)	.001
	35–44 years	26 (30.2)	
	45–54 years	15 (17.4)	
	55–64 years	22 (25.6)	
	> 65 years	20 (23.3)	
	Mean (SD)	54.35 (13.289)	
Gender	Male	21 (24.4)	< .001
	Female	65 (75.6)	
Marital Status	Single	8 (9.4)	< .001
	Married	45 (52.9)	
	Divorced/ Widowed	32 (37.6)	
Education	No formal education	51 (60.0)	< .001
	Basic	29 (34.1)	
	Secondary	5 (5.9)	
Occupation	Farming	27 (31.4)	< .001
	Fishing	11 (12.8)	
	Trader	8 (9.3)	
	Skilled worker	4 (4.7)	
	Unemployed	21 (24.4)	
	Fish monger	15 (17.4)	
Stage of LF	1	1 (1.4)	< .001
	2	28 (39.4)	
	3	20 (28.2)	
	4	11 (15.5)	
	5	3 (4.2)	
	6	7 (9.9)	
	7	1 (1.4)	

Variable		n (%)	p-value
BMI	Underweight	2 (2.6)	< .001
	Normal weight	36 (46.8)	
	Overweight	26 (33.8)	
	Obese	13 (16.9)	
	Mean (SD)	25.54 (4.852)	
VF	Normal	60 (69.8%)	< .001
	High	26 (30.2)	

Nutritional Status of Patients

Anthropometry

The nutritional status of the participants is shown in Table 1 with an average BMI of participant being 25.54 ± 4.85. Almost half of the participants, 36 (46.8%), had normal BMI with a little over half, 39 (50.7%), being either overweight or obese. More than a third, 60 (69.8%) of participants had normal visceral fat.

Dietary Recall

Figure 1 shows the intake of macronutrients. All the participants had adequate intake of carbohydrate. However, almost all of them, 83 (96.5%) had inadequate intake of fat. A large number of the participants, 71 (82.6%) had adequate intake of protein. The micronutrients intakes are depicted in Figs. 2 (vitamins) and 3 (minerals). There were widespread inadequacies with micronutrients intakes with absolute inadequacies in the intake of vitamins A and K, thiamine, riboflavin, pantothenic acid, zinc, potassium, magnesium and calcium. All the other micronutrients were also mostly inadequate amongst the participants, with sodium being the mostly consumed, that is, 34.9% of participants having adequate intake.

Association between Nutritional Status and stage of lymphedema participants

Bivariate correlation showed weak, negative correlation for the stage of LF pathology with protein, r = -0.166, p = .166, and fat, r = -0.267, p = .024, and a weak, positive correlation with carbohydrate, r = 0.305, p = .010 (α = .01) as shown in Table 2. There were negative correlations with the stage of LF and all the micronutrients tested in this study except thiamine. The significant correlations were sodium, r = -0.259, p = .029, copper, r = -0.249, p = 0 .036, selenium, r = -0.265, p = 0.025, pantothenic acid, r = -0.265, p = 0 .025, vitamin B6, r = -0.270, p = 0.023, vitamin B12, r = -0.288, p = 0.015, and vitamin A, r = -0.276, p = 0.020. The stage of LF correlated positively with BMI, r = 0.130, p = 0.309, and visceral fat r = 0.037, p = 0.776, but did not reach significance as shown in Tables 2.

Table 2
Correlation table for association between leg stage and nutrients intake

Variables		Stage of LF	
		r	Sig.
Macronutrients	Protein	-0.166	0.166
	Fat	− .267*	0.024
	Carbohydrate	.305**	0.01
Micronutrients (Vitamins)	Vitamin C	-0.137	0.254
	Vitamin B1	0.019	0.872
	Vitamin B2	-0.117	0.331
	Vitamin B3	-0.185	0.123
	Pantothenic acid	− .265*	0.025
	Vitamin B6	− .270*	0.023
	Folate	-0.135	0.262
	Vitamin B12	− .288*	0.015
	Vitamin A	− .276*	0.02
	Vitamin E	0.018	0.879
	Vitamin K	-0.096	0.426
Micronutrients (Minerals)	Ca	-0.081	0.504
	Fe	-0.219	0.067
	Mg	-0.147	0.222
	P	-0.205	0.086
	K	-0.211	0.078
	Na	− .259*	0.029
	Zn	-0.143	0.233
	Cu	− .249*	0.036
	Mn	-0.117	0.33
	Se	− .265*	0.025

Variables	Stage of LF	
	r	Sig.

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Association between nutritional status (BMI) and sociodemographic characteristics of study participants

There were no significant associations between nutritional status of participants and sociodemographic parameters: age ($p = 0.946$), gender ($p = 0.071$), marital status ($p = 0.760$), education ($p = 0.347$), and occupation ($p = 0.272$) as shown in Table 3.

Table 3
Association between nutritional status (BMI) and socioeconomic characteristics of study participants

Variable		BMI				Fisher's Exact Test sig.
		Underweight	Normal weight	Overweight	Obese	
Age	25–34 years	0	1	1	0	.960
	35–44 years	0	10	11	4	
	45–54 years	0	7	5	3	
	55–64 years	1	9	5	4	
	> 65 years	1	9	4	2	
Gender	Men	1	11	6	0	.071
	Women	1	25	20	13	
Marital Status	Single	0	5	1	1	.760
	Married	1	17	17	7	
	Divorced/ Widowed	1	14	8	4	
Education	No formal education	1	23	14	9	.347
	Basic	0	11	11	3	
	Secondary	1	2	1	0	
Occupation	Farming	2	15	5	5	.272
	Fishing	0	6	5	0	
	Trader	0	2	2	2	
	Skilled worker	0	1	1	0	
	Unemployed	0	9	5	2	
	Fish monger	0	3	8	4	

Discussion

Complementing the existing LF morbidity management strategies with novel approaches for individuals presenting with end stages of the disease is worthwhile. Proper nutrition is required for optimum health (17–20). Here, we show the link between nutritional status and filarial lymphedema in the Ahanta West District of the Western Region of Ghana.

The average BMI of the study participants, 25.54 kg/m^2 shows an overweight population. Most of participants also had normal (healthy) visceral fat. While this may not be unusual due to the related pathology, lymphedema, which contributes to total body weight (21), the dietary recall reveals quite a disturbing outlook of their nutritional status. The mean age of the participants shows an older population, and the age distribution is disproportionate with more women than men. This gender disparity is consistent with the study by Kwarteng, Arthur (22), and the age shows a growing population of LF patients, pointing possibly to old cases of the disease and apparently low incidence of new cases.

In the present study, the education level of the participants is low, owing to the apparent remote and deprived nature of these communities. Sociodemographic status such as educational level and employment have been associated with dietary choices in a number of studies (23–25). These have a lot of influence on individuals, with higher education associated with healthy diet choices. In this study, there was no association found between the sociodemographic status of the participants and their nutritional status. With majority of them having no formal education and basic education, coupled with low economic activities, there is obviously no clear-cut differences in social class among the participants. This lumps them up together with similar sociodemographic characteristics, making associations difficult. Mutheneni, Upadhyayula (26), in their study in India elaborated on the influence of socioeconomic status on lymphatic filariasis. The study by Caprioli, Martindale (27) also shows the bidirectional influence between leg lymphedema and sociodemographic status. Nutrition status is strongly influenced by sociodemographic status, and leg lymphedema has been found to impact the socioeconomic aspects of LF patients and caregivers in a study by Caprioli, Martindale (27).

The major occupations of the study subjects were farming and fishing related activities, with the latter being the main economic activity. This observation has been described in another study by de Souza, Otchere (28). Farming activities in these communities are subsistent in nature, providing mainly for the family with very little to sell. The predominant stages of LF among the participants, stages two and three, similar to the study by Minetti, Tettevi (29) indicates some level of mobilisation as compared to advanced stages where patients are incapacitated.

Changes in nutritional status have been found to impair the metabolism and function of immune cells, as a healthy nutritional status is most desired (17). Carbohydrate was the only adequate nutrient intake amongst all the participants, and a fairly good number (82.6%), with adequate protein intake. In addition, carbohydrate intake was positively associated with the stages of LF. This suggests a moderate consumption of carbohydrate, and it is not surprising as most of the study participants are farmers and so have access to foods which are rich in carbohydrates. On the contrary, fat intake was inadequate in almost all of the participants. While this observation may contribute to the healthy visceral fat levels observed, fat is an integral part of a healthy and balanced diet, hence recommended amounts must be consumed. However, in another instance, this may be beneficial due to the impaired lymphatic system, a major feature in LF. The lymphatic system is responsible for the absorption and transportation of fats after digestion and its impairment is most likely to hamper this process (30, 31). Furthermore, we observed that fat intake was generally inadequate among the study participant, the same was negatively

associated with the stages of LF. What accounts for this observation is currently unknown, and warrant further studies.

Micronutrients, vitamins A and K, thiamine, riboflavin, pantothenic acid, zinc, potassium, magnesium and calcium intakes were mostly inadequate among the study participants. These micronutrients contribute to immunity of the host (32, 33). Thus, the inadequacies of these micronutrients could potentially worsen the pathology of the disease. Elsewhere, Zinc, Vitamins C and D have been documented to contribute to the development of the innate and adaptive cells with deficiencies impairing haematopoiesis (20, 34). Other micronutrients such as selenium, iron, copper, vitamins A, D, C, E, B6 and B12 have vital and synergistic roles in various stages of immune response and function (18, 19, 33, 35, 36). This calls for some form of nutritional intervention to complement current strategies in the elimination of LF. A positive correlation between the stages of lymphedema and thiamine was observed. But it is not clear why only this vitamin is positively correlated with the stages of LF although its consumption was absolutely inadequate. In other infection scenarios such as HIV, thiamine deficiency has been found to downgrade the expression of angiotensinogen, angiotensin converting enzyme (ACE) and angiotensin type 1 receptor mRNAs (37). Since ACE is central to the regulation of fluids in the body, we suggest the observed association between thiamine and LF stage could be beneficial for fluid regulation.

Assessment of nutritional status of LF patients is crucial to providing baseline data for subsequent actions that will improve the general health and wellbeing of this population. A key limitation of the present study was the challenge with obtaining blood samples, which gives a more objective assessment of nutritional status. Hence, future studies should assess serum levels of some micronutrients among individuals presenting with lymphatic filariasis.

Conclusion

In conclusion, this study illustrates that malnutrition is prevalent among lymphedema patients in rural Ghana. Therefore, attention should be targeted at economically disadvantaged populations living with filarial infections. In addition, there is the need to improve on the health-seeking behaviour of individuals living in LF-endemic communities, primarily by focusing on nutrition education. Findings from this study offers baseline information about the need for integrated nutrition education in the national filariasis elimination programme.

List Of Abbreviations

LF Lymphatic filariasis

MDA Mass Drug Administration

WHO World Health Organization

BMI Body Mass Index

CDC Center for Disease Control

FAO Food and Agriculture Organization

AMDR Acceptable macronutrient distribution ranges

ACE Angiotensin converting enzyme

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Committee on Human Research Publication and Ethics at the School of Medical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi with approval number CHRPE/AP/058/20. Institutional approval was also sought from the Ghana Health Service Directorate at the Ahanta Nkwanta in the Western Region. Written informed consent was obtained from all participants after the research had been adequately explained to them.

Consent for publication

Not Applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

There is no funding to declare for this study.

Authors' contributions

The study was conceived and designed by GOT, EKAA and AK. Acquisition of data was by GOT, EKAA, SOA, PK, BCA, and KK. Data analysis and interpretation was by GOT, EKAA, AK, SOA, PK, BCA and KK. EKAA drafted the manuscript, and was critically reviewed by All.

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Figures

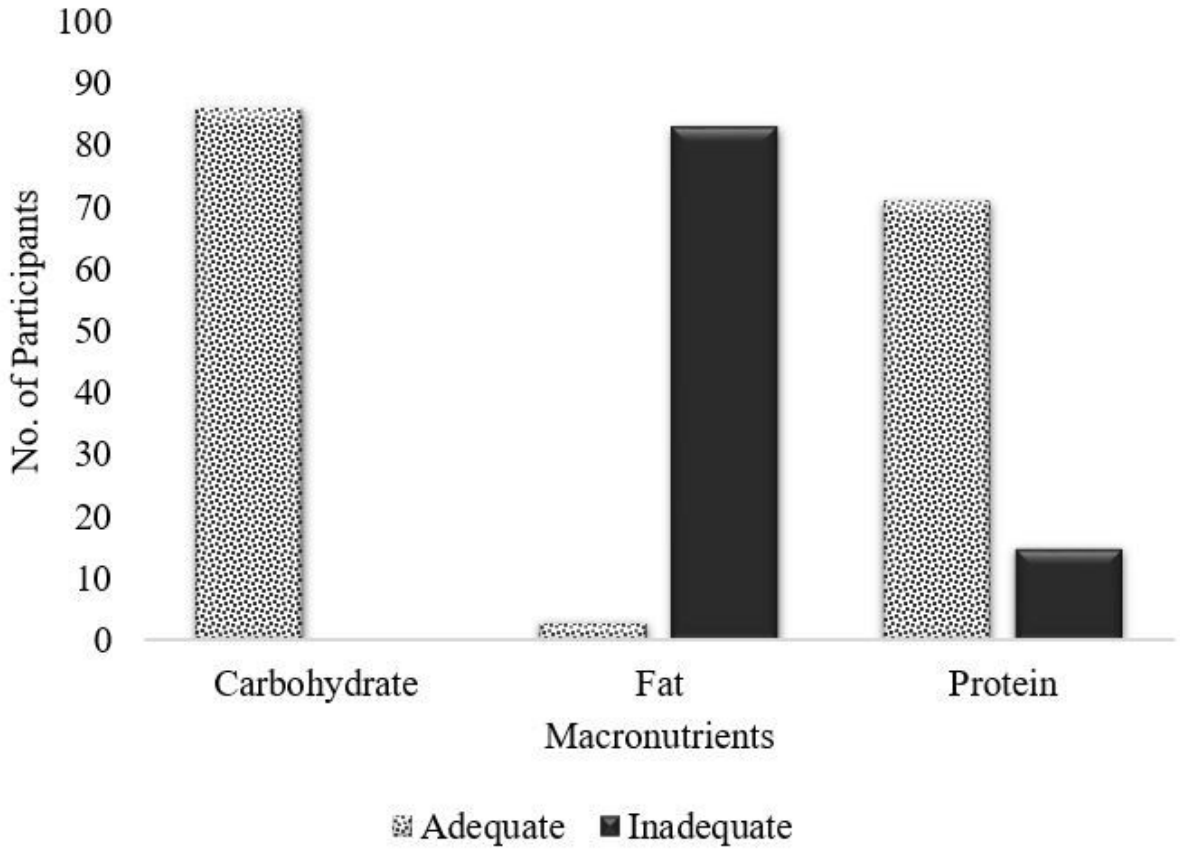

Figure 1

Macronutrient intake of participants

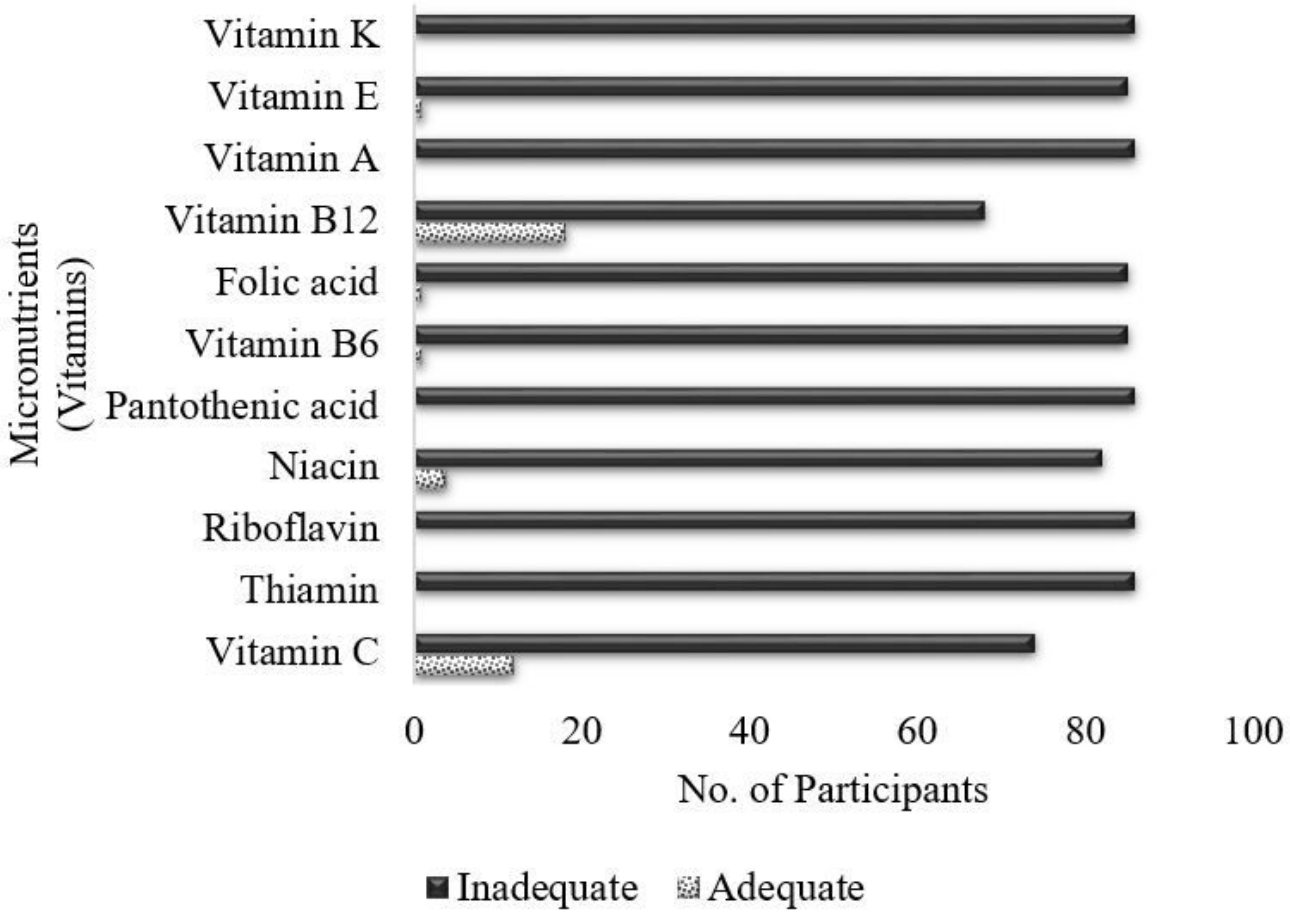

Figure 2

Micronutrients (vitamins) intake of study participants

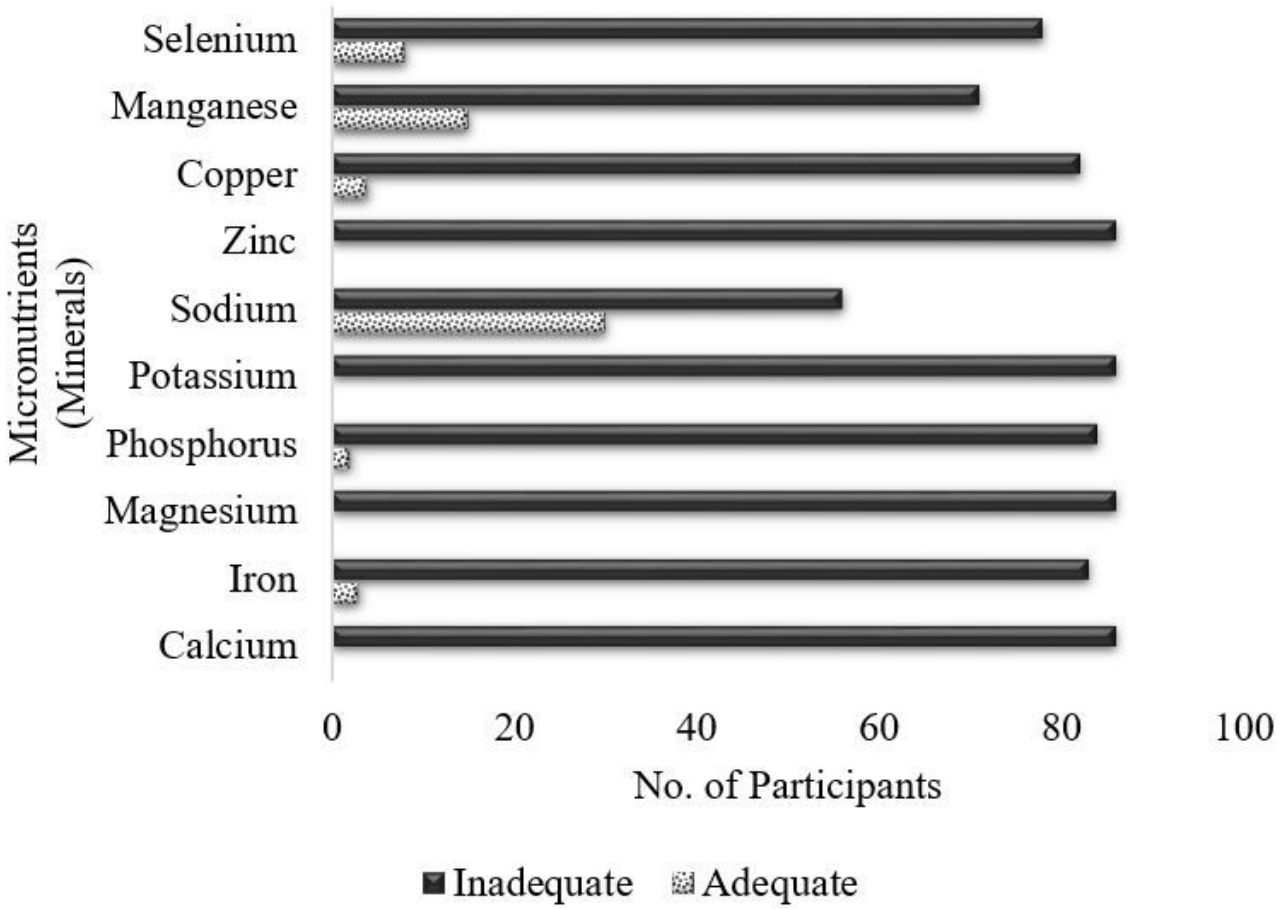

Figure 3

Micronutrients (minerals) intake of study participants