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Evaluation of Nutritional Status Using Anthropometry and Biochemical Indices of Community Dwelling Older Persons in Nigeria

OGECHI CHINYERE NZEAGWU

Department of Human Nutrition and Dietetics, Michael Okpara University of Agriculture Umudike PMB 7267 Umuahia, Abia state, Nigeria.

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ABSTRACT

Background: The number of older persons is on the increase and nutrition and health risks tend to increase with age. Aims: The study evaluated the nutritional status of community dwelling older persons using anthropometric and biochemical indices. Methods: The study was a cross sectional one carried out in semi-urban and rural communities comprising 600 older community dwellers aged e" 65years selected using multi-stage random sampling. Anthropometric status was assessed by body mass index (BMI), mid upper arm circumference (MUAC), waist-hip ratio (WHR), waist circumference (WC) and calf circumference (CC). Biochemical indices of serum haemoglobin (Hb), albumin, ferritin, total cholesterol (TC), low density lipoprotein (LDL), C - reactive protein (CRP) were assessed for 25% of the subjects using standard procedure/methods and compared with recommended cut-off. Results: Most (62.7%) had normal BMI, while 21.33% were overweight. Majority (74%) were at risk of heart disease with WHR. About 75.6% had normal MUAC and 24.33% were malnourished. Some (69.5%) had normal WC and 30.5% had increased risk of abdominal fat adiposity. About 56.2% had normal CC, 43.8% were at risk of malnutrition. There was high prevalence of anaemia as 78% had low Hb. Majority (81%) had serum ferritin levels below normal range. About 43.3% had normal albumin level, 56.7% were within abnormal range of either < 35 or > 50g/l. Most (82.7%) were in lower risk category (< 1mg/l) of CRP. Majority (82%) had desirable total cholesterol, 53.3% had optimal LDL levels. Significant relationship ($p<0.01$) existed between Hb and ferritin for males ($r = 0.794$) and females ($r = 0.839$). Negative relationship was noted for Hb and CRP. There was positive association ($p< 0.01$) between BMI and CC, MUAC, WC; as well as between TC and LDL. Conclusion: Most of the subjects had normal BMI; many were at risk of heart disease with WHR and there was high prevalence of anaemia.

Keywords: Anthropometry, Biochemical indices, Older persons, Evaluation, Community dwelling.

INTRODUCTION

Elderly population is on the increase while nutrition and health risks increase with age[1]. The leading chronic diseases affecting the elderly population are nutrition related. Older persons are usually at risk for several medical and nutritional problems as a result of obesity or under nutrition[2]. Out of the three vulnerable groups (pregnant women, infants, and the elderly persons) that face nutritional and public health threats, the elderly population has been somewhat neglected[3]. Vellas and Anthony[4] reported that malnutrition is very common among elderly people, predominantly in the frail or sick and that poor nutritional status appears to be a major contributing factor of poor prognosis during illness in these individuals. One of the most challenging aspects of providing adequate nutrition for the elderly is the determination of their nutritional status[5]. This problem arises from the fact that aging affects many of the anthropometric, biochemical, haematologic parameters used for assessing nutritional status of the younger generation. Secondly, individuals age at different rates. The objective of the study

is to determine their anthropometric status using body mass index (BMI), waist circumference (WC), waist/hip ratio (WHR), mid-upper arm circumference (MUAC) and calf circumference (CC) as well as biochemical status using haemoglobin level, serum albumin, ferritin, C-reactive protein, cholesterol and low density lipoprotein.

MATERIALS AND METHODS

The study was a cross sectional study carried out in semi urban and rural communities of Ikwuano and Umuahia North Local Government Areas of Abia State, Nigeria. The population of the study comprised all the older persons 65 years and above living in the study area. It has been reported that approximately 5% of the total population in Nigeria are aged 60 and above[6]. The sample size was determined using the extended proportion formula[7], $n = \frac{Z^2 P(100 - P)}{X^2}$. Multi-stage purposive sampling technique was used. The sampling frame was drawn by identifying the elderly through visiting the traditional rulers and village heads of the different communities of the study area, churches and age grades who disseminated information to the older persons of 65 years and above to gather on appointed days for interaction and interview. The addresses of these identified elders were obtained for follow-up interviews and investigations. Seventy-six (76) older persons were sampled from each of the eight sampling areas giving a total of six hundred and eight samples for the study, however, 600 subjects (65 years and above) were used for the study. Four research assistants trained by the researcher for three days were used for the study.

Ethical approval was received from the ethical committee of Abia State University Teaching Hospital, Aba, Nigeria. Another letter of approval was gotten from the traditional rulers and village heads of the different communities seeking their consent and cooperation to use their subjects. Informed consent of the elders (65 years and above) was received and a random selection was made among those that consented.

The sampling instruments included a structured, validated, pre-tested questionnaire. All the anthropometric measurements were done using the methods described by World Health Organization[8]. The instrument for weight measurement was the Bathroom scale (Hanson model), and reading was taken to the nearest 0.1kg. Locally produced stadiometer was used for measuring height for those without kyphosis, non-stretch flexible fibre tape was used to measure the arm span for those with kyphosis and measurement was taken to the nearest 0.1cm.The arm span was measured when the subject stood against a wall with the arms extended laterally at shoulder height. The measurement was made with an assistant at each end of the tape holding the arm and taking the measurement. Non-stretch flexible fibre glass tapes were used for measuring the waist circumference taken with the tape placed midway between the upper hip bone and the uppermost border of the right iliac crest and reading taken to the nearest 0.1cm at the end of normal expiration. The hip circumference was measured with the tape placed around the buttocks in a horizontal plane and the measurement recorded to the nearest 0.1cm. The calf circumference was measured when the subject was standing with the feet apart and tape measure positioned horizontally around the calf and moved up and down to locate the maximum circumference in a plane perpendicular to the long axis of the calf and the measurement was recorded to the nearest 0.1cm. The mid-upper arm circumference (MUAC) was measured at the mid-point located after bending the left elbow at a 90° angle using a fibre glass flexible tape, the circumference was recorded to the nearest 0.1cm. Three measures were taken for all the parameters and the mean calculated. Fasting blood sample was collected from 25% of the total subjects randomly selected from only those who consented to participate in the hematological analysis. Five milliliters of blood was drawn out into the vacuum tube (syringe) by a haematologist and transferred into labeled bottles containing EDTA ethylene diametetracetic acid) which were further packed in iceberg containers to the haematology laboratory for the determination. Haemoglobin(Hb) determination was done using Cyanomethaemoglobin method as described by National Committee for Clinical Laboratory Standards (NCCLS)[9] and calculated after reading in a calibrated photometer. Serum iron (ferritin) was determined using colourimetric methods as described by Tietz[10]. Total cholesterol was determined by enzymatic cholesterol oxidase/

peroxidase method[11] using biosystem cholesterol kit with catalogue number COD11505.Triglyceride was analyzed by the method described by Fossat using the tri ether reaction[11]. Low density lipoprotein (LDL) was determined by the method described by Friedewald[13]. Qualitative determination of C-reactive protein (CRP) was done using the method described by Yositsugy[14].

Data was analyzed - body mass index (BMI) was calculated from weight and height measurements and compared with the report of the WHO[15]. Mid upper arm circumference (MUAC) was compared with the standards[16,17]. Waist and hip ratio (WHR) was compared for safe levels and at risk of heart disease using the standards reported[18,19,20,]. The waist circumference for men and women was compared with the relative risk standard[18,19]. Calf circumference assessed by standard as reported[21]. Using WHO criteria for anaemia, Hb values were classified[22]. In CRP level and cardiovascular risk, classification was by the cut-off levels reported[23]. Cholesterol levels were analyzed with the classification as reported[24,25]. Information gathered from the questionnaire was coded and entered into the computer with the programme SPSS (Statistical Package for the Social Sciences) version 17. Descriptive statistics such as frequencies and percentages were used to analyze data. Pearsons correlation coefficient[26] was used to determine the relationship between anthropometric and biochemical status and of the older persons at 5% and 1% level of significance.

RESULTS AND DISCUSSION

The results of the demographic parameters of the subjects had been reported in an earlier publication[27,28]. The study revealed that more females (63%) were involved in the study than males (37%). Majority (69%) were within the ages of 65-74years. More than 80% had received some level of formal education. About one-third were fully dependent on people for meeting their financial needs and almost three-quarter had average monthly income that was less than ₦12, 000.00 (approx. $53 USD).

Table 1 reflects the result of the anthropometric parameters assessed. Majority (62.17%) had normal BMI while few (21.33%) were overweight. The mean BMI for both the males and females were within the normal range[15]. Low BMI values for both males and females had been reported[29,30]. The difference in BMI status of the subjects in the present study and the earlier studies could be due to time gap in the two studies because with time improved health facilities and nutritional awareness may have reduced the rate of malnutrition. In the waist-and-hip ratio (WHR) distribution, only (26%) had safe levels. More (74.4%) of the subjects were categorized as at risk of heart disease. The mean values of the WHR for both males and females in this study were not in the safe category. This was attributed to age. Despres[31] had reported that abdominal or central obesity increases with advancing age and is associated with an increased risk of insulin resistance, hypertension and dyslipidemia. Hip circumference has been reported to correlate with WC, BMI and cardiovascular disease[32]. Most (69.5%) had normal waist circumference. A few 15.9% (24.1% males and 10.9% females) had waist circumference that placed them on increased risk of abdominal fat adiposity. Both the male and female subjects in the present study had no increased risk of obesity from their waist circumference. People who carry excess fat and all overweight individuals have their WC values above normal[33,34]. Waist circumference has been said to assume a greater value at old age[35]. Some (75.6%) had normal MUAC distribution; however, few (29%) males and 22% females were malnourished using the MUAC classification of < 23cm for males and < 22cm for females. More (56.2%) subjects had normal calf circumference. Some (43.8%) were at risk of malnutrition from the calf circumference probably indicating loss of total body muscle mass. Sieber[36] reported that a calf circumference of less than 31cm is a sensitive sign for existing malnutrition and sarcopenia. The significant differences ($P<0.01$) recorded for all the anthropometric parameters between the males and females except for waist, hip and calf circumference could be due to different socio-economic status, activity levels, food availability and food intake of the subjects[27, 37]. More males were overweight than females. In an earlier publication it was revealed that more females lived alone, had less income and were more financially dependent[27]. These may have contributed to fewer females in the overweight category. Also another observation was that most

Table 1: Anthropometric indices distribution of the subjects by gender

Parameters	Males N	Females %	Total N	%	N	%
BMI grades (kg/m^2)						
Normal 18.5 – 24.9	130	58.04	243	64.63	373	62.17
Overweight 25 – 29.9	55	24.55	73	19.41	128	21.33
Underweight <18.5	38	16.96	31	8.24	69	11.5
Obese e" 30	1	0.45	29	7.71	30	5.0
Total	224	100	376	100	600	100
Mean ±SD	(21.90 ±3.58		23.08 ± 4.04	T = - 3.602	P = 0.000	***)
Waist – Hip Ratio						
At risk of heart disease						
Males >0.90	172	76.79	272	72.34	444	74.0
Females > 0.80						
Safe levels Males < 0.90	52	23.21	104	27.66	156	26.00
Females < 0.80						
Total	224	100	376	100	600	100
Mean ± SD	(0.92 ±0.04		0.96 ±0.04	T = 2.846	P = 0.005	**)
MUAC						
Normal Male < 23cm	159	70.98	295	78.46	454	75.67
Female < 22cm						
MalnourishedMale < 23cm	65	29.02	81	21.54	146	24.33
Females < 22cm						
Total	224	100	376	100	600	100
Mean ± SD	23.76 ±2.37		24.56 ±2.77	T = -3.649	P = 0.000	***)
Waist circumference						
Normal Male <94cm	145	64.7	272	72.3	417	69.5
Female <80cm						
Increased riskMale 90-101cm	54	24.1	41	10.9	95	15.8
Females 81-87cm						
Substantially at riskMale < 102cm	25	11.2	63	16.8	88	14.7
Females < 88cm						
Total	224	100	376	100	600	100
Mean ± SD	(78.47 ±8.64		76.88 ±10.98	T = 1.852	P = 0.065	Ns)
Calf circumference						
Normal < 31cm	134	59.8	203	54.0	337	56.2
At risk <31cm	90	40.2	173	46.0	263	43.8
Mean ± SD	(30.85 ±2.66		31.13 ±3.15	T = -1.137	P = 0.256	Ns)

Ns = Not significant

*** = highly significant (P<0.01), **= significant at (p<0.05)

Table 2: Biochemical Parameters Distribution by Gender

Parameters	Males		Females		Total	
	n	%	n	%	n	%
Heamoglobin(Hb) (g/dl)						
Normal						
Males 13 – 18	6	10.5	27	29.0	33	22.0
Females 11.5 – 16.5						
Indicative of anaemia						
Males < 13						
Females < 12	51	89.5	66	71.0	117	78.0
Mean±SD	(10.96		10.93	T=	P=	Ns)
	±1.499		±1.10	0.175	0.861	
Ferritin (µg/l)						
Low levels	50	87.7	72	77.4	122	81.3
Males <15						
Females <12						
Normal range	7	12.3	21	22.6	28	18.7
Males 15 - 200						
Females 12 – 150						
Mean±SD	(11.14		11.00	T=	P=	Ns)
	±2.98		±2.20	0.339	0.735	
Albumin (g/l)Normal 35 – 50	25	43.9	40	43.0	65	43.3
Abnormal <35 or >50	32	56.1	53	57.0	85	56.7
Mean±SD	(38.14		38.86	T=	P=	Ns)
	±24.81		±31.67	-0.146	0.884	
Total cholesterol (mg/dl)						
< 200 desirable	46	80.7	77	82.8	123	82.0
200 – 239 borderline high risk	5	8.8	9	9.7	14	9.3
Mean±SD	(143.70		126.91	T=	P=	Ns)
	±68.87		±68.64	1.453	0.148	
Low density lipoprotein (LDL) mg/dl						
< 100 optimal	26	45.6	54	58.1	80	53.3
100 – 129 near optimal	13	22.8	15	16.1	28	18.7
130 – 159 border line high	7	12.3	7	7.5	14	9.3
160 – 189 high	2	3.5	4	4.3	6	4.0
> 190 very high	9	15.8	13	14.0	22	14.7
Mean±SD	(105.04		95.20	T=	P=	Ns)
	±64.47		±62.97	0.921	0.359	
C-Reactive protein (CRP) mg/l						
< 1 mg/l lower risk	45	78.9	79	84.9	124	82.7
1 – 3 moderate risk	10	17.5	8	8.6	18	12.0
<3 high risk	2	3.5	6	6.5	8	5.3
Mean±SD	0.922		0.78	T=	P=	Ns
	±1.02		±0.93	0.875	0.383	

Ns = Not significant

Table 3: Correlation of anthropometric and haematologic status of males and females

Sex		HB	FER	ALB	CRP	CHOL	LDL
	BMI	0.076	0.247	0.392	0.081	0.255	0.222
Male	WT	0.195	0.307	0.242	0.084	0.161	0.158
	HT	0.169	0.312*	0.388**	0.009	0.252	0.204
	WC	0.170	0.311*	0.437**	0.079	0.229	0.190
	CC	0.072	0.108	0.083	0.086	0.018	0.059
	MUAC	0.216	0.287	0.387**	0.014	0.226	0.172
	HB		0.794*	0.107	-0.056	0.022	0.019
Female	HB		0.839**	0.268**	-0.261	-0.005	0.016
	BMI	0.000	0.093*	0.003	0.031	0.070	0.122
	WT	0.009	0.127	0.013	0.060	0.059	0.135
	HT	-0.045	0.051	0.019	0.006	0.003	0.078
	WC	0.002	0.126	0.062	0.090	-0.042	0.044
	CC	0.035	0.121	0.009	0.036	0.049	0.119
	MUAC	-0.001	0.109	-0.064	0.038	-0.004	0.056

* Correlation is significant at p< 0.05

**Correlation is significant at p< 0.01

of the males, who worked, may have retired and as such spent less energy. The men mostly sit and read newspapers and the females still run around cooking and shopping. This study revealed that among this group, the double burden of malnutrition existed. FAO[38] noted existence of underweight, overweight and obesity in their study population. In the present study, more women in the obese category could be because of their socio-economic background which could make them to consume more of energy dense foods which are mostly cheaper than good protein sources, fruits and vegetables because of their meager resources. The study revealed that more subjects were malnourished when MUAC was used than when BMI was used. This could be because BMI measures fatness and degree of malnourishment while MUAC provides an index of body energy and protein stores[39]. This study showed strong positive association between BMI and calf circumference, mid-upper arm circumference, waist circumference, hip circumference in both sexes.

Table 2 shows the biochemical parameters of the subjects. Majority (78%) comprising of 89.5% males and 71% females had low Hb levels, indicative of anaemia. This showed that the prevalence of anaemia was high among the study population. Chitambar and Anthony[40] observed that anaemia was present in 36% of the population in developing countries and about 8% of the population of developed countries. It has been reported that anaemia of the aged is the result of a reduction in the bone marrow reserve capacity (erythropoietin dependent progenitor cell proliferation) with decreased hormonal responsiveness to haematological stress[41]. Wardlaw *et al.*[42] noted that the stomach slows its acid production as people age, as well as the synthesis of intrinsic factor. These physiological changes may have contributed to the prevalence of anaemia. In addition, they lived in malaria endemic areas which can also affect haemoglobin levels.

More than 80% of the subjects had serum ferritin levels below the normal range and only 12.3% males and 22.6% females were within the normal range. None was found in the high level. The low levels reported for Hb likely affected the ferritin levels. It had been noted that serum ferritin is a useful measure of elevated iron stores under most circumstances[43]. About forty three (43.3%) of the subjects had normal albumin values (35-50) g/l. Another 56.7% were in the abnormal range

(<35 or >50g/l). Out of the eighty-five subjects in the abnormal range, (92%) had serum albumin level less than 35g/l and 8% had more than 50g/l. Low levels had been reported to be an indication of compromised protein status[43]. Earlier report in this study indicated that some of the subjects were malnourished using BMI and MUAC measurements. These indices of protein store may have also resulted to the low albumin levels found in some of the subjects. Bales and Ritchie[45] reported that with age, serum albumin levels decline slightly (0.8g/l per decade in persons more than 60 years of age). Majority (82.7%) of the subjects were in the lower risk category (<1mg/l) using CRP. Few (12.0%) were in the moderate risk category (1-3mg/l). Increased high-sensitivity (hs-CRP) concentrations reflect the presence and intensity of inflammation in response to injury or acute infection[23]. Thus more of the respondents found in the lower risk category could be due to the absence of inflammation or infection. Total cholesterol revealed that more than three-quarter of the subjects – males (80.7%) and females (82.8%) had desirable (<200mg/dl) levels while the rest (9.3%) and (8.7%) were in the borderline high risk (200 – 239mg/dl) and high risk (^{3} 240mg/dl) respectively. The majority in the desirable cholesterol level could be due to genetic factors or because older people from this part of the world may not generally be consuming much foods high in cholesterol and saturated fatty acids. In an earlier publication of an aspect of this study, it was reported that carbohydrate foods majorly consumed with sauces that contained different forms of green leafy vegetables, meat or fish formed the bulk of the dietary energy intakes of the subjects[37]. They may have also been involved in activities like farming, trekking, bicycling which are part of physical activity that can help to reduce cholesterol levels. These activities were observed to be common in the study area. About 53.3% of the subjects had LDL levels in the optimal (< 100 mg/dl) and near optimal 18.7% (100-129 mg/dl) category. Grundy[46] revealed that high serum cholesterol levels and related disorders of serum lipoproteins promote the development of atherosclerosis which in turn is a precursor of atherosclerotic cardiovascular disease (ASCVD). There was no significant relationship (P>0.05) in all the variables between the males and females probably indicating that sex may not have any specific effect in any of the parameters.

Table 3 is a summary of the relationship between the anthropometric and biochemical parameters. Significant relationship (p<0.01) existed between Hb and ferritin for males (r = 0.794) and females (r = 0.839). Similar relationship occurred between Hb and albumin in females (r = 0.268). This is an indication that both ferritin and albumin levels increase with increase in Hb. Negative relationship was noted for Hb and CRP (r = -0.261) indicating that as Hb increased CRP reduced and low CRP shows lower risk. This study showed strong positive association between BMI and calf circumference, mid-upper arm circumference, waist circumference, hip circumference in both sexes showing relationship among the parameters since each of them reflect undernutrition and overnutrition at one level or the other. The significant association between waist and hip ratio was for only males. These anthropometric parameters (BMI, CC, MUAC, WC, WHR) are related because they measure body fat distribution (BMI, WC, WHR), muscle mass (BMI, CC, MUAC) and protein stores (MUAC, BMI, CC) which all relate to under nutrition or over nutrition[47,48]. Increase in BMI has been reported to bring about raised values in the other parameters and overweight has been linked with poor nutritional status in rural elderly women[49]. Low BMI which is an indication of underweight places the elderly at risk of mortality[50]. Positive association (p< 0.01) between BMI and CC, MUAC, WC is an indication that body composition parameters were affected by underweight, overweight or obesity. **Conclusion:** The study revealed that although most subjects had normal BMI, many were at risk of heart disease and showed some levels of malnutrition using other anthropometric parameters. There was high prevalence of anaemia as majority had low Hb and low ferritin levels. Most of the subjects were in lower risk category of CRP and also had desirable total cholesterol.

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