JNS
JOURNAL OF NUTRITIONAL SCIENCE

RESEARCH ARTICLE

Determinants of nutritional status among old age population in eastern Ethiopia: a general linear model approach

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(Received 4 April 2022 – Final revision received 13 July 2022 – Accepted 14 July 2022)

Journal of Nutritional Science (2022), vol. 11, e70, page 1 of 8 doi:10.1017/jns.2022.62

Abstract

As the world's aging population grows, nutrition and health issues are becoming a major concern. The aim of the present study was to identify the factors associated with nutritional status among old age population. A community-based cross-sectional study was employed among randomly selected 739 elders over the age of 60 in Dire Dawa City administration, eastern Ethiopia. The validated full mini nutritional assessment tool and appetite test (SNAQ) was used to assess the nutritional status of the study population. Considering the ranked nature of the data, a bivariate and multivariable ordinal logistic regression model (under the generalised linear model) was conducted, with crude and adjusted odds ratios reported along with 95 % confidence intervals. Statistically significant associations are declared at *P*-value less than 0·05. In this study, 22 % (95 % CI: 19 %, 25 %) of elders were malnourished. Participants with >75 years old (AOR 4·95; 95 % CI 1·54, 8·4), being female (AOR 1·6; 95 % CI 1·1, 2·2), illiterate (AOR 1·5; 95 % CI 1·01, 2·2), severe depression (AOR 13·9; 95 % CI 8·2, 23·7) and with poor appetite (AOR 3·3; 95 % CI 2·3, 4·8) were important predictors of malnutrition among older age group. We found that the prevalence of malnutrition and the risk of malnutrition is a public health concern that warrants intervention in the area. Advanced age, illiteracy, depression and poor appetite were important risk factors for malnutrition among older age group. The identified risk factors will guide public health professionals and programmes in the design, implementation of interventions to improve the nutritional status of older age group.

Key words: **General linear model: MNA: Nutritional status: Older age population**

Introduction

Globally, the older age population is rapidly growing as a result of the demographic shift[1]. Africa's aging population, like that of other continents, is becoming an emerging challenge to the public health[2], as a result, an increased proportion with social, economic and health problems in the population. Aging causes significant changes in the organs of the body, particularly the gastrointestinal tract, resulting in decreased salivation, swallowing difficulty, gastrointestinal upset, and constipation all of which affect food intake. Furthermore, the aging population has an impact on social deprivation, which contributes to nutritional needs being met[3,4]. Nutritional deficiencies in the older age population can cause a variety of health problems, including a weakened immune system, increased risk of infection, muscle weakness and bone loss, all of which can lead to an increase in morbidity and mortality[5–7], particularly in low-income countries[8]. Despite adequate nutrient and energy intakes, the nutritional status of older adults can be jeopardised by impaired nutrient metabolism, drug-nutrient interactions or altered nutrient requirements[9]. Meeting dietary and nutritional needs are critical for healthy aging[4] and functional independence and quality of life[10]. However, nutritional issues are still not recognised as a necessity in the care of the older age group in many countries and the most neglected and understudied area, owing to the fact that the entire problem associated with aging is regarded as the fate of aging. The prevalence of malnutrition among older age population significantly varies within the regions[11]. Malnutrition in the older

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age population segment is caused by multifactorial factors such as insufficient food intake, illness or both, which results in increased nutrient loss, poor nutrient absorption or both[12–16], socio-cultural, and socio-economic characteristics[11,15,17,18], depression[15], not able to cover their personal expense[18], alcohol consumption[19], and psychological concern[11]. In Ethiopia, the number of older age group population is dramatically increasing and seeks great attention[20–22], however, to the best of our knowledge, there is a little or lack of comprehensive data about the prevalence and the factors influencing the nutritional status of the older population using mini nutritional assessment (MNA) tool[23,24] in Ethiopia as well in the present study area. Hence, in the study area, the status of malnutrition of the older age population and identifying factors are needed for developing strategies to address the problem and provide holistic support[12,25]. Thus, the purpose of the present study was to determine the prevalence and associated factors of malnutrition among community-dwelling older person in eastern Ethiopia. These could serves as a foundation for future preventive intervention in Ethiopia.

Methods and materials

Study design and population

A community-based cross-sectional study was conducted among 739 older age population with aged ≥60 residing in Dire Dawa City administration, eastern Ethiopia.

Study population

All randomly selected older adults aged 60 years or above who lived in Dire Dawa City administration for at least 6 months were included in the study. The study excluded those who had completely bedridden, serious cognitive diseases like Alzheimer's or Parkinson's, were unable to communicate, mentally disabled during data collection.

Sample size and procedure

Considering the prevalence of chronic energy deficiency among older adults from the previous study (17·1 %)[26] and marginal error of 5 % with a 95 % confidence interval, design effect of 2, and 10% non-response rate, a total of 739 sample older adults were needed. A multi-stage cluster sampling approach was adopted to select the study subjects. The 9 kebeles (small local administration) under the city administration were taken as the primary sampling unit in the study. A total of 30 clusters were identified, and 25 older age group from each cluster were randomly selected. In each selected household, all the older age group who met the inclusion criteria were made part of the study. For households with multiple older age individuals, one participant was selected randomly. Potential participants who agreed to participate voluntarily were recruited in the study and informed about the study and then signed voluntary participation form and information was verified by the caregivers wherever necessary in adherence with Declaration of Helsinki protocols[27].

Data collection tools and measurements

Data were collected using an interviewer-administered structured questionnaire through face-to-face interviews. The questionnaire included socio-demographic and nutritional habits. Nutritional status of older adults was assessed using the MNA assessment[28], as recommended by the European Society for Clinical Nutrition and Metabolism[23] and anthropometric measurements. The MNA has been standardised for older adults in the other part of Ethiopia[24]. Malnutrition was assessed using the full MNA score (out of 30) and score was ranged from 0 to 30 points. MNA scored categorised as follows, below 17 (malnourished), 17 to 23·5 (at risk of malnutrition), and otherwise normal[29].

A 24-h multiple meal recall (24HR) was used to collect detailed information on all foods and drinks consumed by respondents in the last 24 h, most commonly from midnight to midnight of the previous day. The sum of each food group consumed by the older age group over a 1-week period was calculated and converted to tertiles for analysis of the dietary diversity score (DDS), and the highest tertile was used to denote the 'high' value for dietary diversity.

Anthropometric measurements were taken under standard procedures to determine body mass index (BMI). The weight of the study participants was measured to the nearest 0·1 kg using a beam balance, without shoes, heavy clothing or other items. Before weighing each study participant, the scale was calibrated by setting it to zero. Height of the study participants was taken using a seca vertical height scale standing upright in the middle of the board. Participants were asked to take off their shoes and stand in Frankfurt plane (stand erect, and look straight in horizontal plain). The occipital (back of the head), shoulder blades, buttocks and heels were touched measuring board and height was record to the nearest 0·01 cm. For the older age group with spinal curvatures, arm length was used to estimate height. The widest calf circumference was measured between the ankle and knee to the nearest 0·1 cm using non-stretchable tape in a sitting position with the leg bent 90° at the knee and manipulated to maintain close contact with the skin without compression of underlying tissues[30]. Knee height was measured from the base of the foot to the top of the knee (Males: Height in cm = 84·88 – (0·24 × age) + (1·83 × knee height) and Females: Height in cm = 64·19 – (0·04 × age) + (2·02 × knee height.) Demi span measurement were used by quantifying the distance from the midline at the sternal notch to the web between the middle and ring fingers along outstretched arm whenever participants were unable to stand on the stadio meter. Height is then calculated using a standard formula (females height in cm = (1·35 × demi span in cm) + 60·1 and males height in cm = (1·40 × demi span in cm) + 57·8)[31]. Hence, BMI was calculated by dividing weight (kg) by height squared (m2). The BMI was also classified according to the World Health Organization (WHO) standards.

HFIAS measured with score corresponded to the sum of these points and could range from 0 (food security) to 27 (maximum food insecurity). Households food insecurity categorised as food secure either 0 or 1, mildly from 2 to 8, moderately from 9 to 16 and severely from 17 to 27

according to the Food and Agriculture Organization HFIAS classification[32].

Geriatric depression score (GDS) scale item 15 (GDS-15) was used to assess depression among older adults. A GDS of 10–15 were considered as severe while, 5–9 as mild depression and greater than or equal to five as no depression. The Simplified Nutritional Appetite Questionnaire (SNAQ) ware used to assess appetite and contains 4 items with a maximum score of 20 points. Score > 14 no risk and Score ≤ 14 points indicates significant risk for about 5 % weight loss within 6 months[33].

The wealth status was determined through principal component analysis (PCA) as per the standard demographic and health survey methodologies. Scored was summed and ranked into wealth tertiles. The highest tertile used to label 'wealthies or the highest' wealth index category.

Data quality

We conducted a pilot study for anthropometric pretest and we assessed the technical error of measurement (TEM). Data collectors with unaceptable level of inter and intraobserver TEM were retrained or other wise were not used for anthropometric measurement. Weight scale was calibrated with known weight before data collection. The data were collected by ten trained diploma nurses, and the supervisors were three Bacheolor holder in health officers. Prior to the data collection, two days training was given on data collection tools, ethics and approach in the interviewing techniques. Weighing scale was checked against a standard weight for its accuracy on daily basis. Calibration was performed before weighing each study participant by setting it to zero.

Statistical analysis

After data were collected through KoBo Tool mobile application and exported to MS Excel for checking the completeness and inconsistencies, and then exported to SPSS version 25 for analysis. The data are presented in tables, graphs, percentages, frequencies, mean, medians, and standard deviations. After measurement of weight and height, BMI was calculated automatically. Similarly, the geriatric depression score and DDS were computed using the compute command based on the raw data. In addition, we compiled the MNA score from its components after being coded appropriately. The outcome variable, malnutrition status was categorised as those with malnutrition (MNA score below 17), at risk of malnutrition (MNA score between 17-23.5) and normal nutritional status (MNA score above 23.5) based on the overall sum score of each subject and calculated using the compute command in SPSS. Then, both bivariable and multivariable ordinal logistic regression were conducted under the General Linear Model. Those variables with *P*-value less than 0·20 and important predictors in bivariate analysis were taken to multivariable ordinal logistic regression analysis. The logistic regression results are presented as adjusted odds ratios with 95 % confidence intervals (CIs), and a *P*-value less than 0·05 was considered significant. Important assumptions were checked using the standard procedures including multicollinearity assessed using standard error (SE>2), statistically significant correlation, and/or a variance inflation factor above 10, done under usual linear regression among independent variables. The Akaike Information Criterion (AIC) was used for model selection, and the smallest AIC value represented a better fitting model. The fitness of the model was assessed using the Hosmer and Lemeshow tests with $P > 0{\cdot}05$ used as fit model.

Results

A total of 739 older age group were recruited via house-to-house visits. Almost (78·5 %) of the study participants were between the age group of 65 and 74 years, having a mean

Table 1. Demographic characteristics of participants (*n* 739)

Characteristics	Participants Mean ± SD and *n*(%)
Age	70·7 ± 6·2 years
BMI	24·7 ± 4·08 kg/m^2
Age (years)	
65–74	580 (78·5)
75–84	121 (16·4)
>84	38 (5·1)
Sex of participants	
Male	358 (48·4)
Female	381 (51·6)
Marital status	
Married	358 (48·4)
Single	1 (0·1)
Divorced	110 (14·9)
Widowed	270 (36·5)
Educational status	
Illiterate	547 (74)
Literate	192 (26)
Primary caregiver	
Child	244 (33)
Living alone	366 (49·5)
Partner	63 (8·5)
Relative	66 (8·9)
Family size	
<5	610 (82·5)
≥5	129 (17·5)
Wealth index	
Low	206 (27·9)
Medium	295 (39·9)
High	238 (32·2)
Dietary diversity score	
Poor DDS	155 (21)
Medium DDS	403 (54·5)
Good DDS	181 (24·5)
Household food insecurity	
Food secured	380 (51·4)
Mild food insecure	66 (8·9)
Moderate food insecure	190 (25·7)
Severe food insecure	103 (13·9)
Geriatric Depression Score (GDS)	
No depression	233 (31·5)
Mild depression	295 (39·9)
Severe depression	211 (28·6)
Nutritional Appetite level	
Risk for 5 % weight loss	407 (55·1)
No risk for 5 % weight loss	332 (44·9)

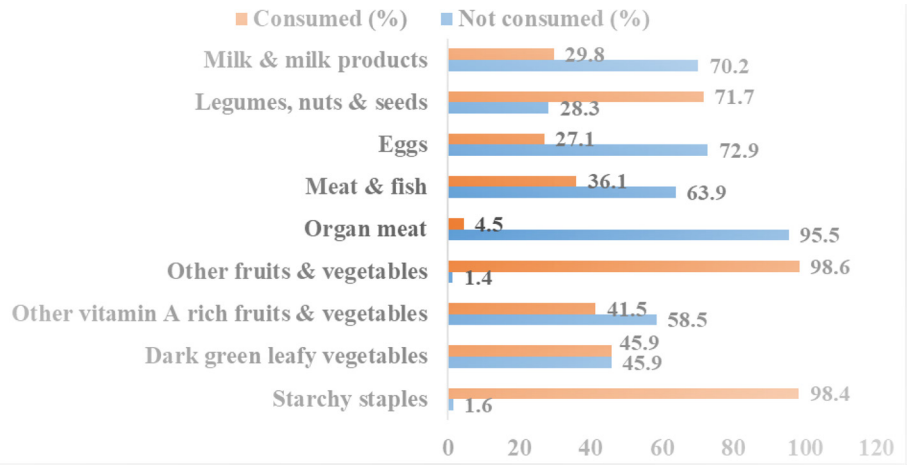

Fig. 1. Food consumption of elders in eastern Ethiopia in the last 24 hours (n = 739)

age of 70·67 years with (SD ± 6·2 years). Around 51·6 % (*n* 381) were female and 48·4 % (*n* 358) participants were married. Almost 73·9 % (*n* 544) participants were illiterate and nearly 50 % (*n* 366) participants were cared by their child. Almost 32·2 % (*n* 238) of participants were in the highest wealth quartiles (Table 1).

Food consumption of elders

Majority of participants (70·2 and 95·5 %) did not use milk and milk products and organ meat, respectively. Moreover, 98·4 and 98·6 % of participants were used starchy staple and other fruits and vegetables, respectively (Fig. 1).

Magnitude of malnutrition among elders

It was observed that 22 % (95 % CI 19 %, 25 %) of elders were malnourished while 49 and 29 % of elders were at risk of malnutrition and well-nourished, respectively (Fig. 2).

In addition, the mean age of malnourished, at risk of malnutrition and well nourished were 74·1 ± 7·9 years, 69·5 ± 4·8 years, and 68·3 ± 3·8 years, respectively. The mean age of elders in the malnourished group was higher than at risk of malnutrition and well-nourished, respectively (Table 2).

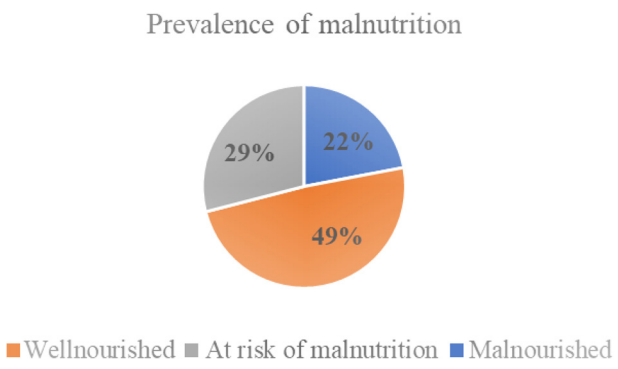

Fig. 2. Prevalence of malnutrition among elders using the mini nutritional assessment tool in eastern Ethiopia

Determinants of nutritional status among elders

A significant association was observed between the nutritional status of older age group people and age, sex, educational status and caregiver at $P < 0{\cdot}05$ (Table 3).

The multivariable analysis result showed that the odds of having possible malnourishment among the old people who aged were >75 years were almost five times (AOR 4·95; 95 % CI 1·54, 8·4, $P = 0{\cdot}003$) more than those who aged 65–74 years old. Being a female had an increased risk of malnourishment 1·6 (AOR 1·6; 95 % CI 1·1, 2·2, $P = 0{\cdot}006$) times higher than being male older age population. Malnourishment among the older age group who were illiterate 1·5 (AOR 1·5; 95 % CI 1·01, 2·2, $P = 0{\cdot}04$) times more than the older age group who were literate. Those who were in severe depression had 13·9 times (AOR 13·9; 95 % CI 8·2, 23·7, $P < 0{\cdot}0001$) more chances of being malnourished as compared to those who were not depressed (Table 4).

Discussion

The proportion of global population entering to older age population is rapidly growing at alarmin rate with many public health concerns including malnutrition and its adverse consequences. Their nutritional status reveals a number of health-threatening deficiencies caused by low dietary intakes and many age related physiological alterations. According to the MNA scoring, more than half (49 %) and 22 % (n 158) were found to be at risk of malnutrition and malnourished, respectivtively. However, the present finding was higher than local finding reported from 15·7 % Harari region, Ethiopia[18], 10·4 % in South Africa[34], 12·5 % in Sri Lanka[19], and 10·5 % in Korea[35] and 14 % in Bangladesh[36]. The present finding was consistent with local studies from Debre Markos town (22·7%), Northwest Ethiopia[37], Hawassa city (28·3%), Southern Ethiopia[24], Iran (49·6%)[38], Nepal (24·8%)[39]. This could be due to differences in the study population's profile and characteristics that could affect their nutritional status.

In an attempt to investigate the relationship of various variables with nutritional status, a significant relationship between

Table 2. Prevalence of malnutrition among the study participants according to the Mini Nutritional Assessment Scale

Variables	Nutritional status			P
	Malnutrition Mean ± SD (95 % CI)	At risk Mean ± SD (95 % CI)	Well-nourished Mean ± SD (95 % CI)	
Total MNA score	14·9 ± 3·9 (14·4, 15·4)	21·5 ± 1·1 (21·4, 21·6)	25·1 ± 0·9 (25·06, 25·3)	<0·0001
Age (years)	74·1 ± 7·6 (73·1, 75·0)	69·5 ± 4·8 (68·8, 70)	68·3 ± 3·8 (67·8, 68·9)	<0·0001

CI, confidence interval; MNA, Mini nutrition assessment; SD, standard deviation.
ANOVA test for mean differences between nutritional status groups. All others are χ^2 tests. Mean ± SD.

age and malnutrition was investigated. Aging's physiological changes have a direct impact on nutrient metabolism. Furthermore, physiological aging related conditions such as sarcopenia and osteoporosis may gradually limit older people's mobility, further limiting their ability to shop, prepare foods and even consume foods. A similar finding was reported in another study[19,40].

An analysis of the relationship between educational status and nutritional status revealed a significant association. Several authors discovered that a higher educational level contributes to a better nutritional status[36,41,42]. People who are more educated, for example, are better informed about the importance of food for health and are better able to understand nutritional guidelines[43].

Table 3. χ^2 test for factors associated with nutritional status of elders in eastern Ethiopia (*n* 739)

Variables	Nutritional status			P
	Malnutrition *n* (%)	At risk *n* (%)	Well-nourishment *n* (%)	
Age (years)				<0·0001*
65–74	84 (53·2)	297 (81·6)	199 (91·7)	
≥75	74 (46·8)	67 (18·4)	18 (8·3)	
Sex of participants				
Female	86 (54·4)	180 (49·5)	92 (42·4)	0·06
Male	72 (45·6)	184 (50·5)	125 (57·6)	
Marital status				
Married	48 (30·4)	179 (49·2)	131 (60·4)	<0·0001*
Divorced	18 (11·4)	61 (16·8)	31 (14·3)	
Widowed	92 (58·2)	123 (33·8)	55 (25·3)	
Educational status				
Illiterate	135 (85·4)	277 (76·1)	135 (62·2)	<0·0001*
Literate	23 (14·6)	87 (23·9)	82 (37·8)	
Primary caregiver				
Child	29 (18·4)	121 (33·2)	94 (43·3)	<0·0001*
Living alone	80 (50·6)	188 (51·6)	98 (45·2)	
Partner	24 (15·2)	27 (7·4)	12 (5·5)	
Relative	25 (15·8)	28 (7·7)	13 (34)	
Family size				
<5	132 (83·5)	304 (83·5)	174 (80·2)	0·55
≥5	26 (16·5)	60 (16·5)	43 (19·8)	
Wealth index				
Low	42 (26·6)	102 (28)	62 (28·6)	0·61
Medium	68 (43)	136 (37·4)	91 (41·9)	
High	48 (30·4)	126 (34·6)	64 (29·5)	
DDS				
Poor DDS	25 (16·5)	88 (24·2)	41 (18·9)	0·12
Medium DDS	84 (53·2)	196 (53·8)	123 (56·7)	
Good DDS	48 (30·4)	80 (22)	53 (24·4)	
HFIS				
Food secured	82 (51·9)	187 (51·4)	111 (51·2)	0·48
Mild food insecure	9 (5·7)	33 (9·1)	24 (11·1)	
Moderate food insecure	48 (30·4)	89 (24·5)	53 (24·4)	
Severe food insecure	19 (12)	55 (15·1)	29 (13·4)	
Geriatric Depression Score (GD)				
No depression	5 (3·2)	87 (23·9)	141 (65)	<0·0001*
Mild depression	37 (23·4)	196 (53·8)	62 (28·6)	
Severe depression	116 (73·4)	81 (22·3)	14 (6·5)	
Level of appetite (SNAQ)				
Risk for 5 % weight loss	145 (91·8)	208 (57·1)	54 (24·9)	<0·0001*
No risk for 5 % weight loss	13 (8·2)	156 (42·9)	163 (75·1)	

HFIS, household food insecurity; SNAQ, Simplified Nutritional Appetite Questionnaire.
* χ^2 test significant at $P < 0·05$.

Table 4. Multivariable ordinal logistic regression analysis output for significant predictors of malnutrition in the older age population (*n* 739)

Parameters	Nutritional status			B	SE	AOR (95 % CI)	*P*
	Malnutrition *n* (%)	At risk *n* (%)	Well-nourished *n* (%)				
Age (years)							
65–74	84 (53·2)	297 (81·6)	199 (91·7)			1·00	
≥75	74 (46·8)	67 (18·4)	18 (8·3)	1·4	0·5	4·95 (1·54–8·4)	0·003
Sex of participants							
Female	86 (54·4)	180 (49·5)	92 (42·4)	0·4	0·17	1·6 (1·1–2·2)	0·006
Male	72 (45·6)	184 (50·5)	125 (57·6)			1·00	
Educational status							
Illiterate	135 (85·4)	277 (76·1)	135 (62·2)	0·4	0·2	1·5 (1·01–2·2)	0·04
Literate	23 (14·6)	87 (23·9)	82 (37·8)			1·00	
GDS							
No depression	5 (3·2)	87 (23·9)	141 (65)			1·00	
Mild depression	37 (23·4)	196 (53·8)	62 (28·6)	1·3	0·2	4·0 (2·6–6·1)	<0·0001
Severe depression	116 (73·4)	81 (22·3)	14 (6·5)	2·6	0·26	13·9 (8·2–23·7)	<0·0001
Appetite test							
Risk for 5 % weight loss	145 (91·8)	208 (57·1)	54 (24·9)	1·2	0·18	3·3 (2·3–4·8)	<0·0001
No risk for 5 % weight loss	13 (8·2)	156 (42·9)	163 (75·1)			1·00	

AOR, adjusted odd ratio; CI, confidence interval; GDS, Geriatric Depression Score; SNAQ, Simplified Nutritional Appetite Questionnaire.
Maximum SE = 0·5, Significant at <0·05.

Furthermore, depression is one of the most well-known risk factors for malnutrition in the geriatric population, and those who suffer from depression lose weights and other changes that could affect dietary inatke and health condition of elders[44–46]. This could be due to a lack of appetite, a decrease in interest in self-care or physical weakness[47]. In our study, we investigated a strong link between poor nutritional status and depression. However, due to the cross-sectional design of our study, we cannot infer the direction of the relationship. Indeed, present epidemiological data suggest that deficiencies in micronutrients essential for brain metabolism, such as B vitamins, vitamins C and E, and omega-3 fatty acids, may increase the risk of depression[48]. Similar findings were made in Debre Birhan, Ethiopia[49], in South Africa[34], and in Bangladesh[50]. The similarity could be due to loneliness and depression, which affect food intake and increase the likelihood of being malnourished and at risk of malnutrition. Loss of appetite was another important indicator of malnutrition. This could be due to the strong link between depression and loss of appetite. Depression causes changes in appetite and weight, leading to malnutrition. Regular diet and healthy nutrition via a healthy mental and psychological conditions are associated with malnutrition in the older age group.

The present study has several limitations, including a cross-sectional design that does not allow for the establishment of causality. Furthermore, differences in cognitive status among individuals may be at the root of information bias associated with memory loss. Finally, there may be some unidentified factors and residual bias contributing to the residual confounding effects accounting for unmeasured factors.

Conclusion

The present study looked at the nutritional status of older age population across a variety of socio-economic parameters and found that nutritional status is related to age, gender, educational status, depression and loss of appetite. In conclusion, the the burden of malnutrition among community dewellers is a major public health concern and might contribute to the quality of life. Hence, interventions correcting the nutritional status of elders are stronly required for a functionally active, good health and better quality of life is needed. From the standpoint of public health, there is a need to raise nutrition awareness among the older age group and the government structures as well.

Acknowledgements

The authors thank all of the study participants, data collectors and supervisors who participated in the study.

There is no fund granted for this work.

LD., AO. and AB. participated substantially in the conceptualisation, design, data acquisition, formal analysis, statistical analysis, supervision, preparing figures and drafting of the manuscript. K. A. participated in designing, reviewing the drafted manuscript, preparing figures and approving the final manuscript to be submitted. All authors reviewed and approved the final version of the manuscript.

The authors declare no conflicts of interest in this work.

All necessary data for this work are available within the manuscript. Additional data can be obtained from the corresponding author on a reasonable request.

All methods of this study were carried out in accordance with the Declaration of Helsinki-Ethical principle for medical research involving human subjects. Before beginning data collection, ethical clearance was obtained from Dire Dawa University, Public Health Department Institutional Review Board (IRB) with a reference number of DDU/PH/IRB/350/21. After detailed information about the research objectives, benefits were clarified, written informed consent to participate was obtained from participants and legally authorised representatives (of illiterates and could not sign on the prepared consent form) and their privacy and confidentiality were

maintained. All personal identifiers were excluded, and data were kept confidential and used for the proposed study only.

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