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Determinants of under nutrition among older adults in South Gondar Zone, Ethiopia- A community based study

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1 **Determinants of under nutrition among older adults in South Gondar Zone,**

2 **Ethiopia- A community based study**

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14 **Abstract**

15 **Objectives:** The objectives of this study were to assess the prevalence and determinants

16 of under nutrition among older adults aged ≥ 65 years in south Gondar Zone, Ethiopia,

17 2020.

18 **Design:** A community based cross-sectional study

19 **Setting:** The study was conducted from October 1 to December 15, 2020 in South

20 Gondar Zone, Ethiopia. Study participants were selected by systematic random

21 sampling. Pretested and structured questionnaire adapted from different literatures was

22 used to collect data. Anthropometric measurements were done following standard

1

Participants: A total of 290 older adults aged greater or equal to 65 years of age were included in the study.

Data analysis: Descriptive and summary statistics were employed. Multiple logistic regression was fitted to identify determinants of under nutrition. Odds ratios and their 95% confidence intervals were computed to determine the level of significance.

Outcome measures: Under nutrition was assessed by using BMI

Results: The prevalence of underweight was 27.57%, 95%CI (22.4-32.8) and 2.1%, 95% CI (0.7-3.8) of the elderly were overweight. Based on the mini-Nutritional Assessment tool 29.7%, 95%CI (24.5-35.2) of elderly were malnourished and 61.7%, 95% CI (55.5-67.2) were at risk of malnutrition. Rural residence (AOR= 10.32, 95%CI (3.62-29.39)), unable to read and write (AOR = 3.54, 95%CI (1.64-7.64)), decline in food intake (AOR= 13.47, 95%CI (6.14-29.52)) and household monthly income <35.6USD (AOR = 4.32, 95%CI (1.97- 9.46)) were significantly and independently associated with underweight

Conclusion: The level of under nutrition among the elderly in the study area was high, and making it an important public health burden. Place of residence, educational status, food intake and monthly income were the determinants of under nutrition.

Key words: Older adults, under nutrition, South Gondar

2

Strength and limitation of the study

45

46 • The study was community based unlike hospital based studies it can represent the

47 population.

48 • Instead of height measurement this study used arm span and it can increase the precision

49 of the result because the usual height measurement may under estimate the result.

50 • The study assessed under nutrition by only anthropometric methods of nutritional

51 assessment.

52 • The sample size was small and restricted to south Gondar not the whole country

53 **Introduction**

54 According to a factsheet released by the World Health Organization around 12% of the

55 global population (900 million people) was aged 60 years or over in 2015, with forecasts

56 that this number will nearly double to 22% (2 billion people) by 2050 (1). Chronic

57 diseases and disability are becoming a public health challenge as the world's population

58 ages, particularly in developing nations where the health-care system is underdeveloped

59 and resources are scarce (2). Furthermore, the elderly population in developing countries

60 is expanding at a faster rate than in developed countries(3). This rapid demographic shift

61 leaves these countries with insufficient time to construct their health, economic, and

62 social infrastructures in order to deal with the aging population. Another issue is that in

63 the developing countries, population aging is accompanied by persistent poverty(4).

64 Around 3.2% of Ethiopian population is categorized under elderly population aged ≥ 65

65 years (5).

3

66 Healthy diets and exercise are frequently emphasized in nutrition to reduce the chance of

67 acquiring lifestyle diseases such as cancer, diabetes, and cardiovascular disease.

68 However, as people get older, their nutritional objectives shift to fulfilling greater nutrient

69 needs while consuming less energy and preventing lean muscle loss (6, 7). Malnutrition

70 contributes significantly to morbidity and mortality in the elderly, without a doubt (8).

71 The number of existing geriatric disorders had a positive association with the probability

72 of malnutrition. Poor nutritional status was linked to depression, dementia, functional

73 dependency, and various co-morbidities. Malnutrition and accidental weight loss

74 contribute to health decline, decreased physical and cognitive functional status, higher

75 health-care consumption, premature institutionalization, and increased mortality (9) (10).

76 A recent study have demonstrated that malnourished elderly patients with COVID-19

77 were at greatest risks of severe illness(11). Despite these, the health and nutrition of the

78 elderly is usually ignored; many of the intervention activities are directed toward

79 neonates, children, adolescents, expectant and nursing mothers(12). The well-known and

80 applied anthropometric assessment in older adults is the Body Mass Index (BMI)(13).

81 As far as the authors' best search, there are limited studies in the country and no study

82 has been ever conducted or documented to determine the nutritional status and its

83 determinants among these segments of the population in South Gondar Zone thus far

84 .Therefore, understanding the prevalence and causes of under nutrition among older

85 people has utmost importance to arrest the problem. Hence, this study was carried out to

86 determine the magnitude and determinant factors of under nutrition among people aged

87 ≥65 years in south Gondar Zone, Ethiopia.

88 **Specific objectives**

4

89 To assess the prevalence of under nutrition among older adults in South Gondar Zone
90 ,Ethiopia

91 To explore the determinants of under nutrition among older adults in in South Gondar
92 Zone ,Ethiopia

93 **Methods**

94 **Study area, design and period**

95 The study was conducted in South Gondar Zone. South Gondar is a Zone in the Ethiopian
96 Amhara Region. Based on the 2007 Census conducted by the Central Statistical Agency
97 of Ethiopia (CSA), this Zone has a total population of 2,051,738. With an area of
98 14,095.19 square kilometers, South Gondar has a population density of 145.56; 195,619
99 or 9.53% are urban inhabitants. A total of 468,238 households were counted in this Zone,
100 which results in an average of 4.38 persons to a household. There are 96 health centers, 7
101 primary hospitals, and 1 general hospital in the zone. According to the 2011 CSA, South
102 Gondar zone has a total population of, 2,239,077 (female 1,103,490 male1, 135,587).
103 And 2.8% of the total population is expected to be above the age of 65 years. A
104 community based cross-sectional study was conducted from October 1- December 15,
105 2020.

106 **Study participants, sample size and sampling techniques**

107 All old people aged ≥ 65 years old who were living in 3 randomly selected Districts of
108 South Gondar Zone at the time of data collection were the study population. Those who
109 were critically ill and those cognitively impaired were excluded from the study. The
110 sample size was calculated using single population proportion formula. Taking the

5

111 prevalence of under nutrition 21.9% (14), margin of error of 5%, Z value of 1.96 and

112 taking 15% non-response rate, the final sample size was 300. First three districts from a

113 total of 18 districts were selected by simple random sampling technique method; then

114 census was conducted to enumerate the total number of elderly in each districts. Then the

115 calculated sample was allocated to each Districts proportionally based on the number of

116 elderly. Finally, systematic random sampling technique was used for the selection of

117 individual respondents.

118 **Patient and public involvement**

119 No patients and public were involved in the development of the research question, study

120 design or data interpretation of this study.

121

122

123 **Measurements**

124 **Assessment of under nutrition**

125 In this study arm span was used instead of height measurement. The BMI-height model

126 overestimated the nutritional status of older persons compared to the BMI-arm span model,

127 indicating that conventional height is not a trustworthy anthropometric marker for assessing

128 nutritional status of older adults. As a result, for calculating body mass index (BMI) in older

129 persons, arm span is the best alternative to height (14). Thus, in this study body mass index

130 (BMI) was estimated by weight in kg divided by arm span in meters squared (kg/m^2).

131 Underweight was defined as BMI of less than 18.5 kg/m^2, overweight was defined as 25.0

6

132 kg/m²≤BMI<29.9 kg/m² and obesity was defined ≥30.0 kg/m2 (15, 16) . In addition MNA

133 developed by Nestle Nutrition Institute. The MNA tool was validated in developing setting

134 including Ethiopia (16). Based on MNA scores, elderly is categorized into non-malnutrition

135 group (MNA 12-14), the group with risk of malnutrition (MNA of 8-11) and malnutrition group

136 (MNA score ≤ 7) (17).

137 **Anthropometric measurements**

138 Weight was measured with light clothes and bare footed using a digital weighting scale (Seca®,

139 Germany). Arm span was measured between the tip of the middle figure of one hand to the tip of

140 the middle figure of the other hand using a measuring tape to the nearest 0.1 cm. The

141 anthropometric measurements were measured following a standard procedure (17). All

142 measurements were done twice, and the average value was used for analyses.

143

7

144 **Assessment of predictors**

145 In addition to anthropometric measurements, place of residence, gender, age, economic status,

146 marital status, occupation, educational status, illness in the past three months, food intake status,

147 presence of known chronic disease, current medication intake, physical activity, dietary habits,

148 24hr dietary diversity score and alcohol consumption was assessed. The age of the elderly was

149 defined as age ≥ 65 years .Dietary diversity score was detected using 24 dietary recall method.

150 Dietary diversity as categorized into poor (those who consumed less than 5 food groups out of 9

151 food groups) and good (those who consumed 5 or more food groups out of 9 food groups)(18).

152 Physical activity was defined as doing 150 minutes of moderate-intensity aerobic physical

153 activity per week (19).

154 Pretested and structured questionnaire using face-to-face interviewing with participants were

155 used for data collection. The questionnaire was adapted from Food and Agriculture

156 Organization of united nation (FAO) (20). Data were collected by three diploma nurses and

157 supervised by two public Health officers. A two days comprehensive training was given to

158 data collectors and supervisors. The questionnaire was first prepared in English and then

159 translated into Amharic (the local language), and back into English to ensure consistency. To

160 ensure the quality of the data, every day the questioner was reviewed for completeness, accuracy

161 and clarity by the principal investigator.

162

8

163 **Data processing and analysis**

164 The questionnaires were coded and entered into Epi-data version 3.1 statistical software and then

165 exported to SPSS windows version 25 for further analysis. Data were summarized and presented

166 using descriptive statistics. Bi-variable logistic regression was done between the dependent and

167 predictor variables .Variables having P -value of less than 0.2 during the bi-variable regression

168 were entered into the final multivariable logistic regression. Odds ratios with 95% CI were

169 computed and variables having p-values less than 0.05 in the multivariable logistic regression

170 were considered statistically and significantly associated with the outcome variable.

171 **Results**

172 **Socio demographic and economic related characteristics of participants**

173 A total of 290 elderly participated in the study giving response rate of 96.7%. The reason for

174 non-responses was not willing to participate .The mean (± SD) age of participants was 68.54

175 (4.19) years. Most of them were aged 65-69 years, 52.28 %(169). Among the study participants

176 more than half of them were female 55.86% (162).

177 Concerning place of residence, 64.14% (186) of the participants were from rural areas and 58.62

178 % (170) of participants were married regarding to their marital status. When we see their

179 educational status, 45.51% (132) were unable to read and write. Concerning economic

180 dependency, 52.76 % (153) of the respondents were partially dependent economically and 47.57

181 % (138) were farmer before retirement. Regarding monthly income, 52.41% (152) of the

182 participants had low monthly income (<35.6USD) **(Table 1).**

183 **Health and life style characteristics**

9

184 About 73.79% (214) of the respondents had a history of known chronic illness during the

185 interview. Nearly half, 48.62 % (141), of the participant had a complaint of illness in the past 3

186 months before the interview. Concerning the types of chronic diseases, 32.72 % (70) had

187 hypertension and 23.81 % (51) had heart failure. Regarding alcohol intake and cigarette

188 smoking, 60.00 % (174) took alcohol and among them 74.71% (130) took alcohol on daily basis

189 but there was no cigarette smoker. Among the study participants 23.79 % (69) of them took soft

190 drink and other sugary foods once or twice per week; and the rest 76.21 % (221) took

191 occasionally. About 26.21 % (76) of participants consumed meat and other fatty foods (butter

192 and milk products) 1-3 times per week, 6.90 % (20) consumed daily, the rest 66.90% (194) uses

193 occasionally.

194 About 81.72 % (237) of the participants do physical activity and among this majority (75.53 %

195 (179)) of them do walking followed by walking and harvesting 23.63 %(26) and fetching water

196 0.84 %(2**)**. From the total participants, 38.28% (111) of them were suffering from decline in

197 food intake in the last three months and most (97.30 % (108)) of them mentioned loss of appetite

198 as a reason. Among the study participants, 48.28 % (140) took medication; among them 66.43 %

199 (93) took one or two medications **(Table 2).**

200 **Dietary diversity characteristics**

201 The most commonly consumed food groups in the last 24 hours were legumes and nut 75.86 %

202 (220) followed by cereals and roots 51.72% (150) and dark green vegetables 46.55% (135).

203 Regarding the minimum dietary diversity score (DDS), 10.69 % (31) scored well and 89.31 %

204 (259) scored poor **(Table 3).**

205 **Nutritional status of elderly**

10

206 According to this study, the overall prevalence of under nutrition among the participants was

207 27.57 %(80) while 70.34% (204) had normal BMI and 2.07% (6) of them were overweight. Sex

208 wise the prevalence of underweight was 20.34% among females 7.23% among males.As per the

209 mini nutritional assessment tool, 8.6 % (25) were having normal nutritional status, 61.7 % (179)

210 were at risk of malnutrition and 29.7% (86) of elderly are malnourished.

211 **Factors associated with under nutrition**

212 On bivariate logistic regression; residence (living in rural area), sex(being female), not being

213 married, being unable to read and write, illness in the last three months, poor dietary diversity

214 score , decline in food intake and household monthly income <35.6USD were positively

215 associated with under nutrition. Whereas, residence (living in rural area), being unable to read

216 and write, decline in food intake and household monthly income <35.6USD were remained

217 significantly associated with under nutrition on the multivariable logistic regression. The odds of

218 under nutrition was more than 13 times higher among elderly who had history of decline in food

219 intake than their counter parts (AOR= 13.471, 95%CI: 6.147-29.525). This study also showed

220 that elderly whose monthly income was less than 35.6USD were 4.3 times (AOR = 4.319,

221 95%CI: 1.971-9.460) more likely to be undernourished than those with monthly income of

222 greater than or equal to 35.6USD. Being unable to read and write increased the odds of under

223 nutrition among the study participants as compared those with educational status of able o read

224 and write and above (AOR = 3.542, 95%CI: 1.642-7.643). Study participants who lived in rural

225 area were more than 10 times more likely to be undernourished than those from urban area

226 (AOR= 10.320, 95%CI: 3.624-29.390) **(Table 4).**

227 **Discussion**

11

228 The current study assessed the prevalence and determinants of under nutrition among older

229 adults in south Gondar Zone Ethiopia and found that, the overall prevalence of under nutrition

230 was 27.57%. This finding is comparable with the studies done in Nepal 24.8% (95% CI :20.21–

231 29.30) (21). However, it was higher than that of the studies done in Wolaita Zone Ethiopia

232 17.1% (22), Northwest Ethiopia 21.9% (23), Ethiopia 17.6% (95%CI: 15.00, 20.20) (24),

233 Cameron 6% (25), Delhi India 20.8% (26). This difference could be due to geographical

234 difference, variation in socio-economic status of study population. In addition in the current

235 study most of the study participants were from rural area which might be associated with lower

236 food buying power of participants to diversified food items. On the other hand, the prevalence of

237 under nutrition was lower as compared to study done in Ghana 48.0% (25).

238 In this study, the prevalence of under nutrition was high among females 20.34% compared to

239 males 7.23%.In agreement with this, a study from Gondar found that being female (AOR= 3.0

240 ,95% CI (1.6-5.4)) was associated with under nutrition (23).Similarly a study which assessed

241 chronic energy deficiency and associated factors among older population in, Aykel town ,

242 Ethiopia in 2018 showed that under nutrition was significantly associated with female sex

243 (AOR= 1.58, 95%CI(1.04, 2.41) (24). This might be because most female elderly were

244 economically dependent, gender discriminations and less health seeking behavior, which may

245 negatively influence women's health and nutritional status.

246 This study pointed out that 89.31% of the elderly had poor dietary diversity score. This might be

247 due to the study was conducted during fasting period. Additionally most of the participants were

248 economically dependent and unable to read and write.

12

249 This study has revealed that 25.52% of rural elderly people were malnourished in that

250 participants who lived in rural areas were more than 10 times more likely to be undernourished

251 than those from urban area. Thus, it appears that under nutrition is much higher among the

252 elderly residing in the rural areas. This finding is consistent with the results of studies conducted

253 in wolaita zone Ethiopia (22), Northwest Ethiopia (23) and Ethiopia (24).

254 In the current study monthly income of less than 35.6USD had significant association with under

255 nutrition. Similarly studies done in wolaita Zone Ethiopia (22), Northwest Ethiopia(23) and

256 Ethiopia(24) showed that low income had negative effect on nutrition status of elderly. This

257 might be due to food purchasing ability depends on the level of incomes and low income may

258 make elderly to prefer not to eat.

259 Decreased food intake was positively associated with under nutrition. This could be due to the

260 effects of increased age which reduces the natural drive to eat and drink and resulting in anorexia

261 of aging; to their comorbid illness of which most of them had chronic illness and; to the

262 medication they took since most of them took medications. This finding was similar to a study

263 conducted in Wolaita Zone Ethiopia (22)**.**

264 This study pointed out being unable to read and write was 3.5 times (AOR = 3.542, 95%CI:

265 1.642-7.643) more risky to be undernourished than those who can read and write. This finding is

266 consistent with the results of earlier studies conducted in Wolaita Zone Ethiopia (22) and in

267 Northwest Ethiopia(23) . This might be related to the fact that educated people are more likely to

268 consume diversified food and follow healthy eating style.

269 **Strength and limitation of the study**

270 The study was community based unlike hospital based studies it can represent the population.

13

271 Instead of height measurement this study used arm span and it can increase the precision of the

272 result because the usual height measurement may under estimate the result. Even though it   has

273 these strengths there are limitation like, the study assessed under nutrition by only

274 anthropometric methods of nutritional assessment; the study was cross-sectional and the

275 association cannot be causal; the questionnaire was self-reported and there might be bias even

276 though we have conducted a quality control to the best of our ability ;The sample size was small

277 and restricted to south Gondar not the whole country

278

279 **Conclusion**

280 The overall prevalence of under nutrition among the elderly in the study area was high making

281 important public health burden. It was significantly associated with residence, being unable to

282 read and write, decline in food intake and household monthly income. Therefore, there is a need

283 to design and implement programs and strategies to improve nutritional status particularly

284 focusing on those living in rural area and improving household economic status. For this, further

285 studies are needed to generate a database for effective policy making and formulate a national

286 policy on the nutrition of the elderly to ensure healthy aging.

287 **List of abbreviations and acronyms**

288   AOR   Adjusted Odd Ratio

289   BMI   Body Mass Index

290   CDC   Centre for Disease Control

291   CI   Confidence Interval

292   CSA   Central Statistical Agency

14

293   DDS   Dietary Diversity Score

294   ETB   Ethiopian Birr

295   FAO   Food and Agriculture Organization of the United Nations

296   GC   Gregorian Calendar

297   MCH   Mother and Child Health

298   OPD   Outpatient Department

299   OR   Odds Ratio

300   SD   Standard Deviation

301   SPSS   Statistical Package for Social Science

302   WC   Waist Circumference

303   WFP   World Food Program

304   WHO   World Health Organization

305

Declarations

Ethics approval and consent to participate

308   This study have been performed in accordance with the Declaration of Helsinki. Ethical

309   clearance was obtained from Debre Tabor University College of medicine & health

310   science ethical review committee. Then, the participants of the study were informed

311   about the purpose of the study, the importance of their participation, and their right to

312   withdraw at any time. All methods were carried out in accordance with ethical guidelines

313   and regulations. Informed consent was obtained prior to data collection. To keep the

15

314 confidentiality of clients' data, their names was not document. People aged ≥ 65 who

315 were malnourished during the data collection were advised regarding their nutrition.

Consent to publish

317 All the authors have agreed and gave consent for the publication

Availability of data and materials

319 The datasets used during the current study are available from the corresponding author on

320 a reasonable request.

Competing of interest

322 All authors declared that there is no competing interest at all.

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Authors' contributions

327 HY, IM and MA made substantial contributions to conception and design, acquisition of

328 data, or analysis and interpretation of data. GA, AE, MM and FT took part in drafting the

329 article or revising it critically for important intellectual content. All authors agreed to

330 submit to the current journal; gave final approval of the version to be published; and

331 agree to be accountable for all aspects of the work.

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336

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394

395   Table 1: Socio-demographic and economic characteristics of older adults in South Gondar Zone,
396   Amhara, Ethiopia ,2020.

Variable		Frequency	Percentage (%)
Residence	Urban	104	35.86
	Rural	186	64.14
	Total	290	100.00
Sex	Male	128	44.14
	Female	162	55.86
	Total	290	100.00
Age	65-69	169	58.28
	70-74	95	32.76
	75-79	13	4.48
	>=80	13	4.48

18

	Total	290	100.00
Marital status	Currently married	170	58.62
	Single	2	0.69
	Separated	17	5.86
	Widowed	101	34.83
	Total	290	100.00
Economic dependence	Partially dependent	153	52.76
	Fully dependent	127	43.79
	Independent	10	3.45
	Total	290	100.00
Occupation before retirement	Housewife	84	28.97
	Self employed	46	15.86
	Farmer	138	47.57
	Nongovernment employee	4	1.38
	Government employee	18	6.21
	Total	290	100.00
Current occupational status	Retired	172	59.31
	Housewife	42	14.48
	Self employed	13	4.48
	Farmer	62	21.38
	Nongovernment	1	0.34
	Total	290	100.00
Educational status	Cannot write and read	132	45.52
	Read and write with no formal education	114	39.31

19

	Primary education	24	8.28
	College and above	20	6.90
	Total	290	100.00
Monthly household income	Low (<35.6USD)	152	52.41
	Middle (35.6USD - 106.8USD)	88	30.35
	High (>106.8USD)	50	17.24
	Total	290	100.00

397

398 Table 2 : Health and Life style characteristics of older adults in South Gondar Zone, Amhara,
399 Ethiopia 2020

Variable		Frequency	Percentage (%)
Illness in the past three months	Yes	141	48.62
	No	149	51.38
	Total	290	100.0
Known chronic illness(n=214)	Hypertension	70	32.71
	DM	20	9.35
	Joint Pain	28	13.08
	Heart Failure	51	23.81
	Asthma	17	7.94
	HIV	5	2.24
	Liver Disease	3	1.40
	Other	20	9.35
	None	76	26.21
	Total	290	100.0
Family history of obesity	Yes	1	0.34

20

	No	289	99.66
	Total	290	100.0
Alcohol consumption	Yes	174	60.0
	No	116	40.0
	Total	290	100.0
Frequency of alcohol consumption (n= 174)	Daily	130	74.71
	5-6 days per week	10	5.75
	1-4 days per week	20	11.49
	1-3 days per month	14	8.04
	once per month	1	0.57
	Total	290	100.0
Physical activity	Yes	237	81.72
	No	53	18.28
	Total	290	100.0
Type of physical activity(n=237)	Walking	179	75.53
	Fetching	2	0.84
	Walking and harvesting	56	23.63
	Total	237	100.0
Decline in food intake	Yes	111	38.28
	No	179	61.72
	Total	290	100.0
Reason for decline in food intake(n=111)	loss of appetite	108	97.30
	chewing problem	3	2.70
	Total	111	100.0
Current medication usage	Yes	140	48.28
	No	150	51.72

21

	Total	290	100.0
Number of drugs (n=140)	≤ 2	93	66.43
	≥ 3	47	33.57
	Total	140	100.0

400

401 Table 3: Consumption of the nine food groups by the study subjects in the last 24 hours
402 in South Gondar Zone, Amhara, Ethiopia 2020

Variable		Frequency	Percentage (%)
Cereal and root	Yes	150	51.72
	No	140	48.27
	Total	290	100.0
Dark green vegetable	Yes	135	46.55
	No	155	53.45
	Total	290	100.0
Fruits and vegetable	Yes	107	36.90
	No	183	63.10
	Total	290	100.0
Other vitamin A rich fruits and vegetables	Yes	49	16.90
	No	241	83.10
	Total	290	100.0
Meat and fish	Yes	26	8.97
	No	264	91.03
	Total	290	100.0
Organ meat	Yes	4	1.38
	No	286	98.62
	Total	290	100.0
Legumes and nut	Yes	220	75.86
	No	70	24.14
	Total	290	100.0
Milk	Yes	63	21.72
	No	227	78.28
	Total	290	100.0
Egg	Yes	25	8.62

22

	No	265	91.38	
	Total	290	100.0	
Dietary diversity score	Good	31	10.69	
	Poor	259	89.31	
	Total	290	100.0	

403

404

405 Table 4 : Factors associated with under nutrition among older adults in South Gondar
406 Zone, Amhara, Ethiopia 2020

		Bivariate (COR) ,95%CI	Multivariable(AOR),95%CI	p-value
Educational status	Read and write and above	1	1	
	Cannot read and write	6.56(3.64-11.84)	3.54 (1.64-7.64)	0.01**
Sex	Male	0.34(0.19-0.60)	0.69(0.29- 1.65)	0.38
	Female	1	1	
Marital status	Married	0.43 (0.26- 0.73)	0.85 (0.39- 1.85)	1
	unmarried	1	1	
Residence	Urban	1	1	
	Rural	11.00(4.58-26.39)	10.32 (3.62-29.39)	0.001**
Monthly income	<35.6USD	3.25(1.86-5.70)	4.32(1.98-14.68)	0.001**
	≥35.6USD	1	1	
Illness in the past 3 months	Yes	4.37(2.48-7.76)	9.03(0.37- 22.3)	0.1
	no	1	1	
Decline in food intake	Yes	22.01(10.94- 44.29)	13.471(6.15- 9.53)	0.001**
	No	1	1	
Minimu	Good	0.36(0.12-1.05)	0.389(0.1-	0.18

23

				1.58)	
m dietary diversity	Poor	1			

407   ** p value <0.05

24

gSTROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1 and 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4 and 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	*8*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9 and 10
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13 and 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12,13 1nd 14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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1 **Determinants of undernutrition among older adults in South Gondar Zone, Ethiopia- A**

2 **community-based study**

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14 **Abstract**

15 **Objectives:** The objectives of this study were to assess the prevalence and determinants of

16 undernutrition among older adults aged 65 years in the south Gondar Zone, Ethiopia, in 2020.

17 **Design:** A community-based cross-sectional study

18 **Setting:** The study was conducted from October 1 to December 15, 2020, in the South Gondar

19 Zone, Ethiopia. Study participants were selected by systematic random sampling. A pretested and

20 structured questionnaire adapted from different literature was used to collect data. Anthropometric

21 measurements were taken following the standard procedure.

1

22 **Participants:** A total of 290 older adults aged greater than or equal to 65 years of age were

23 included in the study.

24 **Data analysis:** Descriptive and summary statistics were employed. Multiple logistic regression

25 was fitted to identify determinants of undernutrition. Odds ratios and their 95% confidence

26 intervals were computed to determine the level of significance.

27 **Outcome measures:** Undernutrition was assessed by using Body Mass Index (BMI) and Mini

28 Nutritional Assesment (MNA) tool.

29 **Results:** The prevalence of undernutrition was 27.6%, 95% CI (22.4–32.8), and 2.1%, 95% CI

30 (0.7-3.8) of the study participants were overweight. Based on the Mini-Nutritional Assessment

31 tool, 29.7%, 95% CI (24.5-35.2) of the study participants were undernourished and 61.7%, 95%

32 CI (55.5-67.2) were at risk of undernourishment. Rural residence (AOR = 10.3, 95% CI (3.6-

33 29.4)), inability to read and write (AOR = 3.5, 95% CI (1.6-7.6)), decrease in food intake (AOR

34 = 13.5, 95% CI (6.1-29.5)), and household monthly income of less than 35.6 USD (AOR = 4.3,

35 95% CI (1.9-9.4)) were significantly and independently associated with undernutrition.

36 **Conclusion**: The level of undernutrition among older adults in the study area was high, making it

37 an important public health burden. The determinants of undernutrition were a place of residence,

38 educational status, food intake, and monthly income.

39 **Keywords**: Older adults, undernutrition, South Gondar

40 **Strength and limitation of the study**

41• The study was community-based, unlike hospital-based studies, so it can represent the

42 population.

2

43 • Instead of height measurement, this study used arm span and it can increase the precision of the

44 result because the usual height measurement may underestimate the result.

45 • The study assessed nutrition by only anthropometric methods of nutritional assessment.

46 • The sample size was small and restricted to south Gondar, which means it may not represent the

47 whole country.

48 • The study was conducted during a fasting period, and it might have affected the dietary diversity

49 score.

50 **Introduction**

51 According to a factsheet released by the World Health Organization, around 12% of the global

52 population (900 million people) was aged 60 years or over in 2015, with forecasts that this number

53 will nearly double to 22% (2 billion people) by 2050 (1). Furthermore, the older adult population

54 in developing countries is expanding at a faster rate than in developed countries (2). Around 3.2%

55 of the Ethiopian population is categorized as an older adult population aged ≥ 65 years (3). Chronic

56 diseases and disability are becoming a public health challenge as the world's population ages,

57 particularly in developing nations where the healthcare system is underdeveloped and resources

58 are scarce (4). This rapid demographic shift leaves these countries with insufficient time to

59 construct their health, economic, and social infrastructures to deal with the aging population.

60 Another issue is that in developing countries, population aging is accompanied by persistent

61 poverty(5). Healthy diets and exercise are frequently emphasized in nutrition to reduce the chance

62 of acquiring lifestyle diseases such as cancer, diabetes, and cardiovascular disease. However, as

63 people get older, their nutritional objectives shift to fulfilling greater nutrient needs while

3

64   consuming less energy and preventing lean muscle loss (6, 7). To assess the nutritional status of

65   older adults, the well-known, simple, easy, and applied anthropometric assessment is the Body

66   Mass Index (BMI) (8).

67   Malnutrition contributes significantly to morbidity and mortality among older adults, without a

68   doubt (9). Undernutrition and accidental weight loss contribute to health decline, decreased

69   physical and cognitive functional status, higher healthcare consumption, premature

70   institutionalization, and increased mortality. The number of existing geriatric disorders had a

71   positive association with the probability of malnutrition. Depression, dementia, functional

72   dependency, and other co-morbidities have all been linked to poor nutritional status (10) (11). A

73   recent study s demonstrated that malnourished older adult patients with COVID-19 were at the

74   greatest risk of severe illness(12). Despite these, the health and nutrition of the older adults are

75   usually ignored; many of the intervention activities are directed toward neonates, children,

76   adolescents, expectant and nursing mothers(13).

77   As far as the authors' best search, there are limited studies in Ethiopia and in South Gondar Zone

78   to determine the nutritional status and its determinants among these segments of the population.

79   Therefore, understanding the prevalence and causes of undernutrition among older people has the

80   utmost importance for arresting the problem. Hence, this study was carried out to determine the

81   magnitude and determinant factors of undernutrition among people aged ≥65 years in South

82   Gondar Zone, Ethiopia.

83

84   **Specific objectives**

85   To assess the prevalence of undernutrition among older adults in South Gondar Zone, Ethiopia

4

86 To assess the factors related to undernutrition among older adults in South Gondar Zone, Ethiopia

87 **Methods**

88 **Study area, design, and period**

89 The study was conducted in South Gondar Zone. South Gondar is a Zone in the Ethiopian Amhara

90 Region. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA),

91 this Zone has a total population of 2,051,738. With an area of 14,095.19 square kilometers, South

92 Gondar has a population density of 145.56; 195,619 or 9.53% are urban inhabitants. A total of

93 468,238 households were counted in this Zone, which results in an average of 4.38 persons to a

94 household. According to the 2011 CSA, the South Gondar zone has a total population of, 2,239,077

95 (1,103,490 females and 1, 135males). And 2.8% of the total population is expected to be over the

96 age of 65 years and 60.2% of them are females. A community-based cross-sectional study was

97 conducted from October 1- December 15, 2020.

98 **Inclusion and exclusion criteria**

99 All old people aged $\geq$ 65 years old who were living in 3 randomly selected Districts of South

100 Gondar Zone at the time of data collection were the study population. Those who were critically

101 ill and those cognitively impaired, which were assessed by eyeballing were excluded from the

102 study.

103 **Sample size, and sampling techniques**

104 The sample size was calculated using the single population proportion formula for a cross-sectional

105 study by using the formula(.$(Z^2 p (1 - p)/d^2)$, taking the prevalence of undernutrition from a

106 previous study from North West Ethiopia, 21.9%(14)a margin of error of 5%, the Z value of 1.96,

5

107 and taking 15% non-response rate, the final sample size was 300. First, three districts from a total

108 of 18 districts were selected by simple random sampling technique method; then census was

109 conducted to enumerate the total number of older adults in each district. Then the calculated sample

110 was allocated to each district proportionally based on the number of older adults. Finally, a

111 systematic random sampling technique was used for the selection of individual respondents.

Patient and public involvement

113 No patients and public were involved in the development of the research question, study design,

114 or data interpretation of this study.

Measurements

Assessment of undernutrition

117 Undernutrition (underweight) was defined as BMI of less than 18.5 kg/m^2, overweight was defined

118 as 25.0 kg/m^2≤BMI<29.9 kg/m^{2,} and obesity was defined as≥30.0 kg/m2.Thus, in this study body

119 mass index (BMI) was estimated by weight in kg divided by arm span in meters squared (kg/m^2)

120 (15, 16).In this study, arm span was used instead of height measurement.

121 The BMI-height model overestimated the nutritional status of older people compared to the BMI-

122 arm span model, indicating that conventional height is not a trustworthy anthropometric marker

123 for assessing the nutritional status of older adults. As a result, for calculating body mass index

124 (BMI) in older people, arm span is the best alternative to height (17). In addition, the Mini

125 Nutritional Assessment (MNA) tool developed by Nestle Nutrition Institute (18) was used to assess

126 nutritional status. MNA tool is a screening tool to help identify older adult patients who are

127 malnourished (undernourished) or at risk of malnutrition (at risk of undernutrition). It identifies

128 the risk of malnutrition before severe changes in weight or serum protein levels occur. The MNA

6

129 tool was validated in developing settings including Ethiopia (16). Based on MNA scores, an older

130 adult is categorized into a non-undernourished group (MNA 12-14), the group with risk of

131 undernutrition (MNA of 8-11), and the undernourished group (MNA score ≤ 7). The MNA has 6

132 components

133 1. Has food intake declined over the past 3 months due to loss of appetite, digestive problems,

134 chewing or swallowing difficulties? (0 = severe decrease in food intake,   1 = moderate decrease

135 in food intake 2 = no decrease in food intake) ,2. Weight loss during the last 3 months

136 (0 = weight loss greater than 3 kg)   1 = does not know 2 = weight loss between 1 and 3 kg)   3 =

137 no weight loss), 3. Mobility (0 = bed or chair bound 1 = able to get out of bed / chair but does not

138 go out 2 = goes out ,4. Has suffered psychological stress or acute disease in the past 3 months? (0

139 = yes 2 = no), 5. Neuropsychological problems (0 = severe dementia or depression 1 = mild

140 dementia   2 = no psychological problems), 6 .Body Mass Index (BMI) (0 = BMI less than 19, 1

141 = BMI 19 to less than 21, 2 = BMI 21 to less than 23, 3 = BMI 23 or greater) (17).

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149 **Anthropometric measurements**

150 A digital weighing scale (Seca®, Germany) was used to measure weight while wearing light

151 clothing and walking barefoot. Arm span was measured between the tips of the middle figure of

7

152   one hand to the tip of the middle figure of the other hand using a measuring tape to the nearest 0.1

153   cm. The anthropometric measurements were measured following a standard procedure (19). All

154   measurements were taken twice, and the average value was used for analysis.

8

Assessment of predictors

155

156 In addition to anthropometric measurements, face-to-face interview with participants of the study

157 was conducted to asses place of residence, gender, age, monthly income, marital status,

158 occupational status, educational status Illness in the past three months (a state of poor health or

159 sickness reported by the respondent during data collection), decreased food intake in the past three

160 jmonths, presence of known chronic disease, current medication intake, physical activity, dietary

161 habits(sugary and fatty foods)(, 24hr dietary diversity score(which was calculated by summing

162 the number of food groups consumed during last 24 hour), smoking habit and alcohol

163 consumption. The age of the older adult was defined as the age of 65 years.

164

165 A dietary diversity score was detected using the 24-dietary recall method. Poor (those who

166 consumed less than 5 food groups out of 9 food groups) and good (those who consumed 5 or more

167 food groups out of 9 food groups) dietary diversity(20). Physical activity was defined as doing 150

168 minutes of moderate-intensity aerobic physical activity per week (21). Pretested and structured

169 questionnaire which was developed after a review of different literature and by adapting it from the

170 Food and Agriculture Organization of the United Nations (FAO) (22) was used. The data was collected

171 by three diploma nurses and supervised by two public health officers. A two-day comprehensive

172 training was given to data collectors and supervisors. The questionnaire was first prepared in

173 English and then translated into Amharic (the local language) and back into English to ensure

174 consistency. To ensure the quality of the data, every day the questioner was reviewed for

175 completeness, accuracy, and clarity by the principal investigator.

176

9

177   **Data processing and analysis**

178   The questionnaires were coded and entered into Epi-data version 3.1 statistical software and then

179   exported to SPSS windows version 25 for further analysis. Data were summarized and presented

180   using descriptive statistics. Bi-variable logistic regression was done between the dependent and

181   predictor variables. Variables having a P -value of less than 0.2 during the bi-variable regression

182   were entered into the final multivariable logistic regression (23, 24). Odds ratios with 95% CI were

183   computed and variables having p-values less than 0.05 in the multivariable logistic regression were

184   considered statistically and significantly associated with the outcome variable.

185   **Results**

186   **Socio-demographic and economic related characteristics of participants**

187   A total of 290 older adults participated in the study, giving a response rate of 96.7%. The reason

188   for non-responses was not willing to participate. The mean (± SD) age of participants was 68.5

189   (4.2) years. Most of them were aged 65-69 years, 169 (52.2 %. Among the study participants, more

190   than half of them were female 162 (55.9%).

191   Concerning place of residence, 186 (64.1%) of the participants were from rural areas, and 170

192   (58.6 %) of the participants were married according to their marital status. When we look at their

193   educational status, 132 (45.5%) were unable to read and write. Concerning economic dependency,

194   153 (52.8 %) of the respondents were partially dependent economically, and 138 (47.6 %) were

195   farmers before retirement. In terms of monthly income, 152 (52.4% of participants) had a low

196   monthly income (35.6 USD) (**Table 1).**

197   **Health and Lifestyle lifestyle characteristics**

10

198 About 214 (73.8%) of the respondents had a history of known chronic illnesses during the

199 interview. Of those having a chronic illness, 70 (32.7%) had hypertension and 51(23.8 %) had

200 heart failure. Regarding alcohol intake and cigarette smoking, 174(60.0 %) took alcohol, and

201 among them, 130 (74.7%) took alcohol daily but there was no cigarette smoker. Nearly half,

202 141(48.6%), of the participants, had a complaint of illness in the past 3 months before the

203 interview. Among the study participants, 69 (23.8%) of them took soft drinks and other sugary

204 foods once or twice per week, and the rest, 221 (76.2 %) took them occasionally. About 76 (26.2

205 %) of participants consumed meat and other fatty foods (butter and milk products) 1-3 times per

206 week, 20 (6.9 %) consumed daily, and the rest 194 (66.9%) consumed occasionally.

207 About 237 (81.7 %) of the participants do physical activity, and among this majority, 179 (75.5%)

208 of them do walking, followed by walking and harvesting 26 (23.6%) and fetching water 2 (0.8%).

209 Of the total participants, 111(38.3%) were suffering from a decline in food intake in the last three

210 months, and most (108, (97.3%)) mentioned the loss of appetite as a reason. Among the study

211 participants, 140 (48.3%) took medication; among them, 93 (66.4%) took one or two medications

212 **(Table 2).**

213 **Dietary diversity characteristics**

214 The most commonly consumed food groups in the last 24 hours were legumes and nuts with 220

215 (75.9%), followed by cereals and roots with   150 (51.7%) and dark green vegetables with 135

216 (46.6%). Regarding the minimum dietary diversity score (DDS), 31 (10.7%) scored well and 259

217 (89.3%) scored poor **(Table 3).**

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221 **Nutritional status of older adults**

222 According to this study, the overall prevalence of undernutrition among the participants was 80

223 (27.6%), 95%CI (22.4-32.8) and 6 (2.1%), 95% CI (0.7-3.8) of them were overweight. Sex-wise,

224 the prevalence of undernutrition was 20.3% among females and 7.2% among males. According to

225 the mini nutritional assessment tool, 25(8.6%) of study participants had normal nutritional status,

226 179 (61.7%) were at risk of malnutrition, and 86 (29.7%) were malnourished.

227 **Factors associated with undernutrition**   In bivariate logistic regression, residence (living in a

228 rural area), sex (being female), not being married, being unable to read and write, illness in the last

229 three months, poor dietary diversity score, a decline in food intake, and household monthly income

230 <35.6USD were positively associated with undernutrition. Whereas, residence (living in a rural

231 area), being unable to read and write, a decline in food intake, and household monthly income of

232 <35.6 USD were remained significantly associated with undernutrition on the multivariable

233 logistic regression. The odds of undernutrition was more than 13 times higher among older adults

234 who had a history of decline in food intake in the last 3 months than their counterparts (AOR=

235 13.5, 95%CI: 6.1-29.5). This study also showed that older adults whose monthly income was less

236 than 35.6 USD were 4.3 times (AOR = 4.3, 95%CI: 1.9-9.5) more likely to be undernourished than

237 those with a monthly income of greater than or equal to 35.6 USD. Being unable to read and write

238 increased the odds of undernutrition among the study participants as compared to those with

239 educational status of being able to read and write and above (AOR = 3.5, 95%CI: 1.6-7.6). Study

240 participants who lived in rural areas were more than 10 times more likely to be undernourished

241 than those from urban areas (AOR= 10.3, 95%CI: 3.6-29.4) **(Table 4).**

242 **Discussion**

12

243 The current study assessed the prevalence and determinants of undernutrition among older adults

244 in South Gondar Zone Ethiopia and found that the overall prevalence of undernutrition was

245 27.6%(95% CI:22.4–32.8). This finding is comparable with the study done in Nepal where 24.8%

246 (95% CI:20.2–29.3) of study participants were undernourished (25). However, it was higher than

247 that of the studies done in Wolaita Zone, Ethiopia (17.1%) (26), Northwest Ethiopia (21.9%) (14),

248 Ethiopia (17.6% (95%CI: 15.0, 20.2)) (27), Cameron (6%)(28), Delhi India 20.8% (29). This

249 difference could be due to geographical differences or variations in the socio-economic status of

250 the study population. In addition, in the current study, most of the study participants were from

251 rural areas, which might be associated with the lower food buying power of participants who

252 diversified their food items. On the other hand, the prevalence of undernutrition was lower as

253 compared to the study done in Ghana (48.0%) (28).

254 In this study, the prevalence of undernutrition was high among females (20.3%) compared to males

255 (7.2%).In agreement with this, a study from Gondar found that being female (AOR=3.0,95% CI

256 (1.6-5.4))was associated with undernutrition (14). Similarly, a study that assessed chronic energy

257 deficiency and associated factors among the older population in Aykhel town, Ethiopia in 2018

258 showed that undernutrition was significantly associated with the female sex (AOR=1.6,

259 95%CI(1.0,2.4) (27). This might be because most female older adults were economically

260 dependent. There might be gender discrimination and less health-seeking behavior among females

261 which may negatively influence women's health and nutritional status.

262 This study pointed out that 89.3% of the older adults had poor dietary diversity scores. This might

263 be due to the study being conducted during a fasting period. The fasting period was less than a

264 week at the time of data collection, and it may not have affected the results of anthropometric

265 measurements. Additionally, most of the participants were economically dependent.

13

266 This study has revealed that 25.5% of the rural study population was malnourished in that

267 participants who lived in rural areas were more than 10 times more likely to be undernourished

268 than those from urban areas. Thus, it appears that undernutrition is much higher among those

269 residing in rural areas. This finding is consistent with the results of studies conducted in the

270 Wolaita zone Ethiopia (26), Northwest Ethiopia (14), and Ethiopia (27).

271 In the current study, a monthly income of less than 35.6 USD had a significant association with

272 undernutrition. Similarly, studies that were done in Wolaita Zone Ethiopia (26), Northwest

273 Ethiopia(14), and Ethiopia(27) showed that low income had a negative effect on the nutritional

274 status of older adults. This might be due to food purchasing ability, which depends on income

275 level. A low income may make them prefer not to eat. In addition, poverty and malnutrition are

276 deeply interrelated as poverty is a basic cause of malnutrition (30).

277 In the current study, decreased food intake was associated with undernutrition, which is similar to

278 a study conducted in Wolaita Zone, Ethiopia (26)in which decreased food intake was positively

279 associated with undernutrition. This could be due to the effects of increased age, which reduces

280 the natural drive to eat and drink and result in anorexia of aging; to their comorbid illnesses which

281 most of them had chronic illnesses and, to the medications they took since most of them took

282 medications. In general, decreased food intake is an immediate cause of malnutrition(31).

283 This study pointed out that being unable to read and write was 3.5 times (AOR = 3.5, 95%CI: 1.6-

284 7.6) riskier for being undernourished than those who could read and write. This finding is

285 consistent with the results of earlier studies conducted in Wolaita Zone, Ethiopia (26), and in

286 Northwest Ethiopia (14). This might be related to the fact that educated people are more likely to

287 consume diversified foods and follow healthy eating styles. In addition, education is categorized

288 under the basic causes of undernutrition (32).

14

Strength and limitation of the study

290 The study was community-based, unlike hospital-based studies so it can represent the population.

291 Instead of height measurement, this study used arm span and it can increase the precision of the

292 result because the usual height measurement may underestimate the result. Even though it has

293 these strengths, there are limitations like; the study assessed undernutrition by only anthropometric

294 methods of nutritional assessment; the study was cross-sectional and the association cannot be

295 causal; the questionnaire was self-reported and there might be bias even we have conducted quality

296 control to the best of our ability; the sample size was small (300) and restricted to south Gondar,

297 not the whole country. The study was conducted during a fasting period, and it might have affected

298 dietary diversity score.

Conclusion

300 The overall prevalence of undernutrition among older adults in the study area was high, making it

301 an important public health burden. It was significantly associated with residence, being unable to

302 read and write, a decline in food intake, and household monthly income. Therefore, there is a need

303 to design and implement programs and strategies to improve nutritional status, particularly

304 focusing on those living in rural areas and improving household economic status. Further studies

305 are needed to generate a database for effective policymaking and formulate a national policy on

306 the nutrition of older adults to ensure healthy aging.

307 **List of abbreviations and acronyms**

308 AOR   Adjusted Odd Ratio

309 BMI   Body Mass Index

310 CDC   Centre for Disease Control

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311   CI   Confidence Interval

312   CSA   Central Statistical Agency

313   DDS   Dietary Diversity Score

314   ETB   Ethiopian Birr

315   FAO   Food and Agriculture Organization of the United Nations

316   GC   Gregorian Calander

317   MCH   Mother and Child Health

318   OPD   Outpatient Department

319   OR   Odds Ratio

320   SD   Standard Deviation

321   SPSS   Statistical Package for Social Science

322   WC   Waist Circumference

323   WFP   World Food Program

324   WHO   World Health Organization

325   **Declarations**

326   **Ethics approval and consent to participate**

327   This study has been performed per the Declaration of Helsinki. Ethical clearance was obtained

328   from Debre Tabor University College of health sciences Institutional Research Ethics Review

329   Committee (IRERC) with a reference number of DTU/re/89/27/2020. At all levels, officials were

330   contacted with a formal letter obtained from the IRERC to secure permission. A permission letter

331   has been submitted to South Gondar Zonal Health Bureau. The participants of the study were

332   informed about the purpose of the study, the importance of their participation, and their right to

333   withdraw at any time. All methods were carried out following the ethical guidelines and

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334 regulations. Informed consent was obtained before data collection. To keep the confidentiality of

335 clients' data, their names were not documented. People aged ≥ 65 who were malnourished during

336 the data collection were advised regarding their nutrition.

Consent to publish

338 All the authors have agreed and gave consent for the publication

Availability of data and materials

340 The datasets used during the current study are available from the corresponding author on a

341 reasonable request.

Competing of interest

343 All authors declared that there is no competing interest at all.

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346 article.

Authors' contributions

348 HY, IM, and MA made substantial contributions to conception and design, acquisition of data, or

349 analysis and interpretation of data. GA, AE, MM, and FT took part in drafting the article or revising

350 it critically for important intellectual content. All authors agreed to submit to the current journal;

351 gave final approval of the version to be published; and agree to be accountable for all aspects of

352 the work.

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429

430 Table 1: Socio-demographic and economic characteristics of older adults in South Gondar Zone,
431 Amhara, Ethiopia, 2020.

Variables (n=290)		Undernourished	Not undernourished	Total	Percentage (%)
Residence	Urban	6	99	105	36.2
	Rural	74	111	185	63.8
Sex	Male	21	107	128	44.14

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	Female	59	103	162	55.86
Age	65-69	42	127	169	58.28
	70-74	28	67	95	32.76
	75-79	4	9	13	4.48
	>=80	6	7	13	4.48
Marital status	Currently married	35	135	170	58.62
	Single	0	2	2	0.69
	Separated	3	14	17	5.86
	Widowed	42	59	101	34.83
Economic dependence	Partially dependent	45	108	153	52.76
	Fully dependent	35	92	127	43.79
	Independent	0	10	10	3.45
Occupation before retirement	Housewife	32	52	84	28.97
	Self employed	2	44	46	15.86
	Farmer	42	96	138	47.57
	Nongovernment employee	2	2	4	1.38
	Government employee	2	16	18	6.21
	Total			290	100.00
Current occupational status	Retired	43	129	172	59.31
	Housewife	21	21	42	14.48
	Self employed	1	12	13	4.48
	Farmer	14	48	62	21.38
	Nongovernment	1	0	1	0.34
Educational status	Cannot write and read	63	69	132	45.52

20

	Read and write with no formal education	14	100	114	39.31
	Primary education	3	21	24	8.28
	College and above	0	20	20	6.90
	Total			290	100.00
Monthly household income	Low (<35.6USD)	76	76	152	52.41
	Middle (35.6USD - 106.8USD)	4	84	88	30.35
	High (>106.8USD)	0	50	50	17.24

432

433 Table 2: Health and Lifestyle characteristics of older adults in South Gondar Zone, Amhara,
434 Ethiopia 2020

Variable		Undernourished	Not undernourished	Total	Percentage (%)
Illness in the past three months (n=290)	Yes	59	82	141	48.62
	No	21	128	149	51.38
Known chronic illness(n=214)	Hypertension	15	55	70	32.71
	DM	1	19	20	9.35
	Joint Pain	10	18	28	13.08
	Heart Failure	24	27	51	23.81
	Asthma	6	11	17	7.94
	HIV	0	5	5	2.24
	Liver Disease	3	0	3	1.40
	Other	11	9	20	9.35
	None	10	66	76	26.21
Family history of obesity	Yes	1	1	1	0.34
	No	79	210	289	99.66
Alcohol consumption	Yes	46	128	174	60.0

(n=290)	No	34	82	116	40.0
Frequency of alcohol consumption (n= 174)	Daily	39	11	130	74.71
	5-6 days per week	2	8	10	5.75
	1-4 days per week	2	18	20	11.49
	1-3 days per month	3	11	14	8.04
	once per month	0	1	1	0.57
Physical activity (n =290)	Yes	52	185	237	81.72
	No	28	25	53	18.28
Type of physical activity(n=237)	Walking	39	140	179	75.53
	Fetching	0	2	2	0.84
	Walking and harvesting	13	43	56	23.63
Decline in food intake (n=290)	Yes	68	43	111	38.28
	No	12	167	179	61.72
Reason for decline in food intake(n=111)	loss of appetite	65	43	108	97.30
	chewing problem	3	0	3	2.70
Current medication usage (n=290)	Yes	38	102	140	48.28
	No	42	108	150	51.72
Number of drugs (n=140)	≤ 2	43	50	93	66.43
	≥ 3	25	22	47	33.57
	Total			140	100.0

435

22

436   Table 3: Consumption of the nine food groups by the study subjects in the last 24 hours in South
437   Gondar Zone, Amhara, Ethiopia 2020

Variables (n=290)		undernourished	Not undernourished	Total	Percentage (%)
Cereal and root	Yes	37	103	150	51.72
	No	43	107	140	48.27
Dark green vegetable	Yes	49	86	135	46.55
	No	31	124	155	53.45
Fruits and vegetable	Yes	23	84	107	36.90
	No	57	126	183	63.10
Another vitamin A rich fruits and vegetables	Yes	10	39	49	16.90
	No	70	171	241	83.10
Meat and fish	Yes	1	25	26	8.97
	No	79	185	264	91.03
Organ meat	Yes	0	4	4	1.38
	No	80	206	286	98.62
Legumes and nut	Yes	63	157	220	75.86
	No	17	53	70	24.14
Milk	Yes	11	52	63	21.72
	No	69	158	227	78.28
Egg	Yes	0	25	25	8.62
	No	80	185	265	91.38
Dietary diversity score	Good	4	27	31	10.69
	Poor	76	183	259	89.31

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439

440   Table 4: Factors associated with undernutrition among older adults in South Gondar Zone,
441   Amhara, Ethiopia 2020

		Bivariate (COR) ,95%CI	Multivariable(33),95%CI	p-value
Educational status	Read and write and above	1	1	
	Cannot read and write	6.56(3.64-11.84)	3.54 (1.64-7.64)	0.01**
Sex	Male	0.34(0.19-0.60)	0.69(0.29- 1.65)	0.38
	Female	1	1	
Marital status	Married	0.43 (0.26- 0.73)	0.85 (0.39- 1.85)	1
	unmarried	1	1	
Residence	Urban	1	1	
	Rural	11.00(4.58-26.39)	10.32 (3.62-29.39)	0.001**
Monthly income	<35.6USD	3.25(1.86-5.70)	4.32(1.98-14.68)	0.001**
	≥35.6USD	1	1	
Illness in the past 3 months	Yes	4.37(2.48-7.76)	9.03(0.37- 22.3)	0.1
	no	1	1	
Decline in food intake	Yes	22.01(10.94- 44.29)	13.471(6.15- 9.53)	0.001**
	No	1	1	
Minimum dietary diversity	Good	0.36(0.12-1.05)	0.389(0.1- 1.58)	0.18
	Poor	1		

442   ** P value <0.05

24

gSTROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1 and 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4 and 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	*8*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9 and 10
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13 and 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12,13 1nd 14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Manuscripts

1 **Determinants of undernutrition among older adults in South Gondar Zone, Ethiopia- A**

2 **community-based study**

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14 **Abstract**

15 **Objectives:** The objectives of this study were to assess the prevalence and determinants of

16 undernutrition among older adults aged 65 years in the south Gondar Zone, Ethiopia, in 2020.

17 **Design:** A community-based cross-sectional study

18 **Setting:** The study was conducted from October 1 to December 15, 2020, in the South Gondar

19 Zone, Ethiopia. Study participants were selected by systematic random sampling. A pretested and

20 structured questionnaire adapted from different literature was used to collect data. Anthropometric

21 measurements were taken following the standard procedure.

1

22 **Participants:** A total of 290 older adults aged greater than or equal to 65 years of age were

23 included in the study.

24 **Data analysis:** Descriptive and summary statistics were employed. Multiple logistic regression

25 was fitted to identify determinants of undernutrition. Odds ratios and their 95% confidence

26 intervals were computed to determine the level of significance.

27 **Outcome measures:** Undernutrition was assessed by using Body Mass Index (BMI) and Mini

28 Nutritional Assessment (MNA) tool.

29 **Results:** The prevalence of undernutrition was 27.6%, (95% CI 22.4–32.8), and 2.1%, (95% CI

30 0.7-3.8) of the study participants were overweight. Based on the Mini-Nutritional Assessment

31 tool, 29.7%, (95% CI24.5-35.2) of the study participants were undernourished and 61.7%, (95%

32 CI 55.5-67.2) were at risk of undernourishment. Rural residence AOR = 10.3, (95% CI 3.6-29.4),

33 inability to read and write AOR = 3.5, (95% CI 1.6-7.6), decrease in food intake AOR = 13.5,

34 (95% CI 6.1-29.5), and household monthly income of less than 35.6 USD AOR = 4.3, (95% CI

35 1.9-9.4) were significantly and independently associated with undernutrition.

36 **Conclusion**: The level of undernutrition among older adults in the study area was high, making it

37 an important public health burden. The determinants of undernutrition were a place of residence,

38 educational status, food intake, and monthly income.

39 **Keywords**: Older adults, undernutrition, South Gondar

40 **Strength and limitation of the study**

41• The study was community-based, unlike hospital-based studies, so it can represent the

42 population.

2

43• Instead of height measurement, this study used arm span, as it can increase the precision of the

44 result because the usual height measurement may underestimate the result.

45• The study assessed nutrition by only anthropometric methods of nutritional assessment.

46• The sample size was small and restricted to south Gondar, which means it may not represent the

47 whole country.

48• The study was conducted during a fasting period, and it might have affected the dietary diversity

49 score.

50 **Introduction**

51 According to a factsheet released by the World Health Organization, around 12% of the global

52 population (900 million people) was aged 60 years or over in 2015, with forecasts that this number

53 will nearly double to 22% (2 billion people) by 2050 (1). Furthermore, the older adult population

54 in developing countries is expanding at a faster rate than in developed countries (2). Around 3.2%

55 of the Ethiopian population is categorized as an older adult population aged ≥ 65 years (3). Chronic

56 diseases and disability are becoming a public health challenge as the world's population ages,

57 particularly in developing nations where the healthcare system is underdeveloped and resources

58 are scarce (4). This rapid demographic shift leaves these countries with insufficient time to

59 construct their health, economic, and social infrastructures to deal with the aging population.

60 Another issue is that in developing countries, population aging is accompanied by persistent

61 poverty(5). Healthy diets and exercise are frequently emphasized in nutrition to reduce the chance

62 of acquiring lifestyle diseases such as cancer, diabetes, and cardiovascular disease. However, as

63 people get older, their nutritional objectives shift to fulfilling greater nutrient needs while

3

64 consuming less energy and preventing lean muscle loss (6, 7). To assess the nutritional status of

65 older adults, the well-known, simple, easy, and applied anthropometric assessment is the Body

66 Mass Index (BMI) (8).

67 Malnutrition contributes significantly to morbidity and mortality among older adults, without a

68 doubt (9). Undernutrition and accidental weight loss contribute to health decline, decreased

69 physical and cognitive functional status, higher healthcare consumption, premature

70 institutionalization, and increased mortality. The number of existing geriatric disorders had a

71 positive association with the probability of malnutrition. Depression, dementia, functional

72 dependency, and other co-morbidities have all been linked to poor nutritional status (10) (11). A

73 recent study demonstrated that malnourished older adult patients with COVID-19 were at the

74 greatest risk of severe illness(12). Despite these, the health and nutrition of the older adults are

75 usually ignored; many of the intervention activities are directed toward neonates, children,

76 adolescents, expectant and nursing mothers(13).

77 As far as the authors' best search, there are limited studies in Ethiopia and in South Gondar Zone

78 to determine the nutritional status and its determinants among these segments of the population.

79 Therefore, understanding the prevalence and causes of undernutrition among older people has the

80 utmost importance for arresting the problem. Hence, this study was carried out to determine the

81 magnitude and determinant factors of undernutrition among people aged ≥65 years in South

82 Gondar Zone, Ethiopia.

83

84 **Specific objectives**

85 To assess the prevalence of undernutrition among older adults in South Gondar Zone, Ethiopia

4

86   To assess the factors related to undernutrition among older adults in South Gondar Zone, Ethiopia

87   **Methods**

88   **Study area, design, and period**

89   The study was conducted in South Gondar Zone. South Gondar is a Zone in the Ethiopian Amhara

90   Region. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA),

91   this Zone has a total population of 2,051,738. With an area of 14,095.19 square kilometers, South

92   Gondar has a population density of 145.56; 195,619 or 9.53% are urban inhabitants. A total of

93   468,238 households were counted in this Zone, which results in an average of 4.38 persons to a

94   household. According to the 2011 CSA, the South Gondar zone has a total population of, 2,239,077

95   (1,103,490 females and 1, 135,587 males). And 2.8% of the total population is expected to be over

96   the age of 65 years and 60.2% of them are females. A community-based cross-sectional study was

97   conducted from October 1- December 15, 2020.

98   **Inclusion and exclusion criteria**

99   All old people aged ≥ 65 years old who were living in 3 randomly selected Districts of South

100   Gondar Zone at the time of data collection were the study population. Those who were critically

101   ill and those cognitively impaired, which were assessed by eye-balling were excluded from the

102   study. Eye-balling is the rapid judgment of how sick a patient is based on only visual cues with no

103   specific knowledge of the patient's illness

104   **Sample size, and sampling techniques**

105   The sample size was calculated using the single population proportion formula for a cross-sectional

106   study by using the formula$(.(Z^2 p (1 - p)/d^2)$, taking the prevalence of undernutrition from a

5

107 previous study from North West Ethiopia, 21.9%(14)a margin of error of 5%, the Z value of 1.96,

108 and taking 15% non-response rate, the final sample size was 300. First, three districts from a total

109 of 18 districts were selected by simple random sampling technique method; then census was

110 conducted to enumerate the total number of older adults in each district. Then the calculated sample

111 was allocated to each district proportionally based on the number of older adults. Finally, a

112 systematic random sampling technique was used for the selection of individual respondents.

113 **Patient and public involvement**

114 No patients and public were involved in the development of the research question, study design,

115 or data interpretation of this study.

116 **Measurements**

117 **Assessment of undernutrition**

118 Undernutrition (underweight) was defined as BMI of less than 18.5 kg/m^2, overweight was defined

119 as 25.0 kg/m^2≤BMI<29.9 kg/m^2, and obesity was defined as≥30.0 kg/m^2.Thus, in this study body

120 mass index (BMI) was estimated by weight in kg divided by arm span in meters squared (kg/m^2)

121 (15, 16).In this study, arm span was used instead of height measurement.

122 The BMI-height model overestimated the nutritional status of older people compared to the

123 BMI-arm span model, indicating that conventional height is not a trustworthy anthropometric

124 marker for assessing the nutritional status of older adults(17). As a result, for calculating body

125 mass index (BMI) in older people, arm span is the best alternative to height (17). In addition, the

126 Mini Nutritional Assessment (18) tool developed by Nestle Nutrition Institute (18) was used to

127 assess nutritional status. MNA tool is a screening tool to help identify older adult patients who

128 are malnourished (undernourished) or at risk of malnutrition (at risk of undernutrition). It

6

129 identifies the risk of malnutrition before severe changes in weight or serum protein levels occur.

130 The MNA tool was validated in developing settings including Ethiopia (16). Based on MNA

131 scores, an older adult is categorized into a non-undernourished group (MNA 12-14), the group

132 with risk of undernutrition (MNA of 8-11), and the undernourished group (MNA score ≤ 7). The

133 MNA has 6 components. The respondent was asked to answer questions A – F. when the

134 respondent was unable to answer the question, the respondent's caregiver was asked to answer or

135 check the medical record.

136

137 A. Has food intake declined over the past 3 months due to loss of appetite, digestive problems,

138 chewing or swallowing difficulties? (0 = severe decrease in food intake,   1 = moderate decrease

139 in food intake 2 = no decrease in food intake) , B. Weight loss during the last 3 months

140 (0 = weight loss greater than 3 kg)   1 = does not know 2 = weight loss between 1 and 3 kg)   3 =

141 no weight loss), C. Mobility (0 = bed or chair bound 1 = able to get out of bed / chair but does not

142 go out 2 = goes out ,D. Has suffered psychological stress or acute disease in the past 3 months? (0

143 = yes 2 = no), E. Neuropsychological problems (0 = severe dementia or depression 1 = mild

144 dementia   2 = no psychological problems), F .Body Mass Index (BMI) (0 = BMI less than 19, 1

145 = BMI 19 to less than 21, 2 = BMI 21 to less than 23, 3 = BMI 23 or greater) (17).

146

147 **Anthropometric measurements**

148 A digital weighing scale (Seca®, Germany) was used to measure weight while wearing light

149 clothing and walking barefoot. Arm span was measured between the tips of the middle figure of

150 one hand to the tip of the middle figure of the other hand using a measuring tape to the nearest 0.1

7

151   cm. The anthropometric measurements were measured following a standard procedure (19). All

152   measurements were taken twice, and the average value was used for analysis.

8

153 **Assessment of predictors**

154 In addition to anthropometric measurements, face-to-face interview with participants of the study

155 was conducted to assess the place of residence, gender, age, monthly income, marital status,

156 occupational status, educational status, illness in the past three months (a state of poor health or

157 sickness reported by the respondent during data collection), decreased food intake in the past three

158 months, presence of known chronic disease, current medication intake, physical activity, dietary

159 habits(sugary and fatty foods)(, 24hr dietary diversity score(which was calculated by summing

160 the number of food groups consumed during last 24 hour), smoking habit and alcohol

161 consumption. The age of the older adult was defined as the age greater or equal to 65 years.

162

163 A dietary diversity score was detected using the 24-dietary recall method; participants were

164 categorized into poor (those who consumed less than 5 food groups out of 9 food groups) and good

165 (those who consumed 5 or more food groups out of 9 food groups) dietary diversity(20). Physical

166 activity was defined as doing 150 minutes of moderate-intensity aerobic physical activity per week

167 (21). Pretested and structured questionnaire which was developed after a review of different

168 literature and by adapting it from the Food and Agriculture Organization of the United Nations (FAO)

169 (22) was used. The data was collected by three diploma nurses and supervised by two public health

170 officers. A two-day comprehensive training was given to data collectors and supervisors. The

171 questionnaire was first prepared in English and then translated into Amharic (the local language)

172 and back into English to ensure consistency. To ensure the quality of the data, every day the

173 questionnaire was reviewed for completeness, accuracy, and clarity by the principal investigator.

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175 **Data processing and analysis**

176 The questionnaires were coded and entered into Epi-data version 3.1 statistical software and then

177 exported to SPSS windows version 25 for further analysis. Data were summarized and presented

178 using descriptive statistics. Bi-variable logistic regression was done between the dependent and

179 predictor variables. Variables having a P -value of less than 0.2 during the bi-variable regression

180 were entered into the final multivariable logistic regression (23, 24). Odds ratios with 95% CI were

181 computed and variables having p-values less than 0.05 in the multivariable logistic regression were

182 considered statistically and significantly associated with the outcome variable.

183 **Results**

184 **Socio-demographic and economic related characteristics of participants**

185 A total of 290 older adults participated in the study, giving a response rate of 96.7%. The reason

186 for non-responses was not willing to participate. The mean (± SD) age of participants was 68.5

187 (4.2) years. Most of them were aged 65-69 years, 169 (52.2 %. Among the study participants, more

188 than half of them were female 162 (55.9%).

189 Concerning the place of residence, 186 (64.1%) of the participants were from rural areas, and 170

190 (58.6 %) of the participants were married according to their marital status. When we look at their

191 educational status, 132 (45.5%) were unable to read and write. Concerning economic dependency,

192 153 (52.8 %) of the respondents were partially dependent economically, and 138 (47.6 %) were

193 farmers before retirement. In terms of monthly income, 152 (52.4% of participants) had a low

194 monthly income (35.6 USD) (**Table 1).**

195 **Health and Lifestyle lifestyle characteristics**

10

196 About 214 (73.8%) of the respondents had a history of known chronic illnesses during the

197 interview. Of those having a chronic illness, 70 (32.7%) had hypertension and 51(23.8 %) had

198 heart failure. Regarding alcohol intake and cigarette smoking, 174(60.0 %) took alcohol, and

199 among them, 130 (74.7%) took alcohol daily but there was no cigarette smoker. Nearly half,

200 141(48.6%), of the participants, had a complaint of illness in the past 3 months before the

201 interview. Among the study participants, 69 (23.8%) of them took soft drinks and other sugary

202 foods once or twice per week, and the rest, 221 (76.2 %) took them occasionally. About 76 (26.2

203 %) of participants consumed meat and other fatty foods (butter and milk products) 1-3 times per

204 week, 20 (6.9 %) consumed daily, and the rest 194 (66.9%) consumed occasionally.

205 About 237 (81.7 %) of the participants do physical activity, and among this majority, 179 (75.5%)

206 of them do walking, followed by walking and harvesting 26 (23.6%) and fetching water 2 (0.8%).

207 Of the total participants, 111(38.3%) were suffering from a decline in food intake in the last three

208 months, and most (108, (97.3%)) mentioned the loss of appetite as a reason. Among the study

209 participants, 140 (48.3%) took medication; among them, 93 (66.4%) took one or two medications

210 **(Table 2).**

211 **Dietary diversity characteristics**

212 The most commonly consumed food groups in the last 24 hours were legumes and nuts with 220

213 (75.9%), followed by cereals and roots with   150 (51.7%) and dark green vegetables with 135

214 (46.6%). Regarding the minimum dietary diversity score (DDS), 31 (10.7%) scored well and 259

215 (89.3%) scored poor **(Table 3).**

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219 **Nutritional status of older adults**

220 According to this study, the overall prevalence of undernutrition among the participants was 80

221 (27.6%), 95%CI (22.4-32.8) and 6 (2.1%), 95% CI (0.7-3.8) of them were overweight. Sex-wise,

222 the prevalence of undernutrition was 20.3% among females and 7.2% among males. According to

223 the MNA tool, 25(8.6%) of study participants had normal nutritional status, 179 (61.7%) were at

224 risk of malnutrition, and 86 (29.7%) were malnourished.

225 **Factors associated with undernutrition**

226 In bivariate logistic regression, residence (living in a rural area), sex (being female), not being

227 married, being unable to read and write, illness in the last three months, poor dietary diversity

228 score, a decline in food intake, and household monthly income <35.6USD were positively

229 associated with undernutrition. Whereas, residence (living in a rural area), being unable to read

230 and write, a decline in food intake, and household monthly income of <35.6 USD were remained

231 significantly associated with undernutrition on the multivariable logistic regression. The odds of

232 undernutrition were more than 13 times higher among older adults who had a history of decline in

233 food intake in the last 3 months than their counterparts (AOR= 13.5, 95%CI: 6.1-29.5). This study

234 also showed that older adults whose monthly income was less than 35.6 USD were 4.3 times (AOR

235 = 4.3, 95%CI: 1.9-9.5) more likely to be undernourished than those with a monthly income of

236 greater than or equal to 35.6 USD. Being unable to read and write increased the odds of

237 undernutrition among the study participants as compared to those with an educational status of

238 being able to read and write and above (AOR = 3.5, 95%CI: 1.6-7.6). Study participants who lived

239 in rural areas were more than 10 times more likely to be undernourished than those from urban

240 areas (AOR= 10.3, 95%CI: 3.6-29.4) **(Table 4).**

241 **Discussion**

12

242 The current study assessed the prevalence and determinants of undernutrition among older adults

243 in South Gondar Zone Ethiopia and found that the overall prevalence of undernutrition was

244 27.6%(95% CI:22.4–32.8). This finding is comparable with the study done in Nepal where 24.8%

245 (95% CI:20.2–29.3) of study participants were undernourished (25). However, it was higher than

246 that of the studies done in Wolaita Zone, Ethiopia (17.1%) (26), Northwest Ethiopia (21.9%) (14),

247 Ethiopia (17.6% (95%CI: 15.0, 20.2)) (27), Cameron (6%)(28), Delhi India 20.8% (29). This

248 difference could be due to geographical differences or variations in the socio-economic status of

249 the study population. In addition, in the current study, most of the study participants were from

250 rural areas, which might be associated with the lower food buying power of participants who

251 diversified their food items. On the other hand, the prevalence of undernutrition was lower as

252 compared to the study done in Ghana (48.0%) (28).

253 In this study, the prevalence of undernutrition was high among females (20.3%) compared to males

254 (7.2%).In agreement with this, a study from Gondar found that being female (AOR=3.0,95% CI

255 (1.6-5.4))was associated with undernutrition (14). Similarly, a study that assessed chronic energy

256 deficiency and associated factors among the older population in Aykhel town, Ethiopia in 2018

257 showed that undernutrition was significantly associated with the female sex (AOR=1.6,

258 95%CI(1.0,2.4) (27). This might be because most female older adults were economically

259 dependent. There might be gender discrimination and less health-seeking behavior among females

260 which may negatively influence women's health and nutritional status.

13

261 This study pointed out that 89.3% of the older adults had poor dietary diversity scores. This might

262 be due to the study being conducted during a fasting period. The fasting period was less than a

263 week at the time of data collection, and it may not have affected the results of anthropometric

264 measurements. Additionally, most of the participants were economically dependent And may not

265 have the economic freedom to purchase diversified food items.

266 This study has revealed that 25.5% of the rural study population was malnourished in that

267 participants who lived in rural areas were more than 10 times more likely to be undernourished

268 than those from urban areas. Thus, it appears that undernutrition is much higher among those

269 residing in rural areas. This finding is consistent with the results of studies conducted in the

270 Wolaita zone Ethiopia (26), Northwest Ethiopia (14), and Ethiopia (27).

271 In the current study, a monthly income of less than 35.6 USD had a significant association with

272 undernutrition. Similarly, studies that were done in Wolaita Zone Ethiopia (26), Northwest

273 Ethiopia(14), and Ethiopia(27) showed that low income had a negative effect on the nutritional

274 status of older adults. This might be due to food purchasing ability, which depends on income

275 level. A low income may make them prefer not to eat. In addition, poverty and malnutrition are

276 deeply interrelated as poverty is a basic cause of malnutrition (30).

277 In the current study, decreased food intake was associated with undernutrition, which is similar to

278 a study conducted in Wolaita Zone, Ethiopia (26)in which decreased food intake was positively

279 associated with undernutrition. This could be due to the effects of increased age, which reduces

280 the natural drive to eat and drink and result in anorexia of aging; to their comorbid illnesses which

281 most of them had chronic illnesses and, to the medications they took since most of them took

282 medications(10). In general, decreased food intake is an immediate cause of malnutrition(31).

14

283 This study pointed out that being unable to read and write was 3.5 times (AOR = 3.5, 95%CI: 1.6-

284 7.6) riskier for being undernourished than those who could read and write. This finding is

285 consistent with the results of earlier studies conducted in Wolaita Zone, Ethiopia (26), and in

286 Northwest Ethiopia (14). This might be related to the fact that educated people are more likely to

287 consume diversified foods and follow healthy eating styles. In addition, education is categorized

288 under the basic causes of undernutrition (32).

289 **Strength and limitation of the study**

290 The study was community-based, unlike hospital-based studies so it can represent the population.

291 Instead of height measurement, this study used arm span and it can increase the precision of the

292 result because the usual height measurement may underestimate the result. Even though it has

293 these strengths, there are limitations like; the study assessed undernutrition by only anthropometric

294 methods of nutritional assessment; the study was cross-sectional and the association cannot be

295 causal; the questionnaire was self-reported and there might be bias even we have conducted quality

296 control to the best of our ability; the sample size was small (300) and restricted to south Gondar,

297 not the whole country. The study was conducted during a fasting period, and it might have affected

298 dietary diversity score.

15

299 **Conclusion**

300 The overall prevalence of undernutrition among older adults in the study area was high, making it

301 an important public health burden. It was significantly associated with residence, being unable to

302 read and write, a decline in food intake, and household monthly income. Therefore, there is a need

303 to design and implement programs and strategies to improve nutritional status, particularly

304 focusing on those living in rural areas and improving household economic status. Further studies

305 are needed to generate a database for effective policymaking and formulate a national policy on

306 the nutrition of older adults to ensure healthy aging.

307 **List of abbreviations and acronyms**

308 AOR   Adjusted Odd Ratio

309 BMI   Body Mass Index

310 CDC   Centre for Disease Control

311 CI   Confidence Interval

312 CSA   Central Statistical Agency

313 DDS   Dietary Diversity Score

314 ETB   Ethiopian Birr

315 FAO   Food and Agriculture Organization of the United Nations

316 GC   Gregorian Calander

317 MCH   Mother and Child Health

318 OPD   Outpatient Department

319 OR   Odds Ratio

320 SD   Standard Deviation

321 SPSS   Statistical Package for Social Science

16

322 WC   Waist Circumference

323 WFP   World Food Program

324 WHO   World Health Organization

325 **Declarations**

326 **Ethics approval and consent to participate**

327 This study has been performed per the Declaration of Helsinki. Ethical clearance was obtained

328 from Debre Tabor University College of health sciences Institutional Research Ethics Review

329 Committee (IRERC) with a reference number of DTU/re/89/27/2020. At all levels, officials were

330 contacted with a formal letter obtained from the IRERC to secure permission. A permission letter

331 has been submitted to South Gondar Zonal Health Bureau. The participants of the study were

332 informed about the purpose of the study, the importance of their participation, and their right to

333 withdraw at any time. All methods were carried out following the ethical guidelines and

334 regulations. Informed consent was obtained before data collection. To keep the confidentiality of

335 clients' data, their names were not documented. People aged ≥ 65 who were malnourished during

336 the data collection were advised regarding their nutrition.

337 **Consent to publish**

338 All the authors have agreed and gave consent for the publication

339 **Availability of data and materials**

340 The datasets used during the current study are available from the corresponding author on a

341 reasonable request.

342 **Competing of interest**

17

343   All authors declared that there is no competing interest at all.

344   **Funding statement**

347   **Authors' contributions**

348   HY, IM, and MA made substantial contributions to conception and design, acquisition of data, or

349   analysis and interpretation of data. GA, AE, MM, and FT took part in drafting the article or revising

350   it critically for important intellectual content. All authors agreed to submit to the current journal;

351   gave final approval of the version to be published; and agree to be accountable for all aspects of

352   the work.

353   **Acknowledgment**

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429

430 Table 1: Socio-demographic and economic characteristics of older adults in South Gondar Zone,
431 Amhara, Ethiopia, 2020.

Variables (n=290)		Undernourished	Not undernourished	Total	Percentage (%)
Residence	Urban	6	99	105	36.2
	Rural	74	111	185	63.8
Sex	Male	21	107	128	44.14
	Female	59	103	162	55.86
Age	65-69	42	127	169	58.28
	70-74	28	67	95	32.76
	75-79	4	9	13	4.48
	>=80	6	7	13	4.48
Marital status	Currently married	35	135	170	58.62
	Single	0	2	2	0.69
	Separated	3	14	17	5.86
	Widowed	42	59	101	34.83
Economic dependence	Partially dependent	45	108	153	52.76
	Fully dependent	35	92	127	43.79
	Independent	0	10	10	3.45
Occupation	Housewife	32	52	84	28.97

20

before retirement	Self employed	2	44	46	15.86
	Farmer	42	96	138	47.57
	Nongovernment employee	2	2	4	1.38
	Government employee	2	16	18	6.21
	Total			290	100.00
Current occupational status	Retired	43	129	172	59.31
	Housewife	21	21	42	14.48
	Self employed	1	12	13	4.48
	Farmer	14	48	62	21.38
	Nongovernment	1	0	1	0.34
Educational status	Cannot write and read	63	69	132	45.52
	Read and write with no formal education	14	100	114	39.31
	Primary education	3	21	24	8.28
	College and above	0	20	20	6.90
	Total			290	100.00
Monthly household income	Low (<35.6USD)	76	76	152	52.41
	Middle (35.6USD - 106.8USD)	4	84	88	30.35
	High (>106.8USD)	0	50	50	17.24

432

433 Table 2: Health and Lifestyle characteristics of older adults in South Gondar Zone, Amhara,
434 Ethiopia 2020

Variable		Undernourished	Not undernourished	Total	Percentage (%)
Illness in the past	Yes	59(41.8%)	82(58.2%)	141	48.62

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three months (n=290)	No	21(14.1%)	128(85.9%)	149	51.38
Known chronic illness(n=214)	Hypertension	15(21.4%)	55(78.6%)	70	32.71
	DM	1(5%)	19(95%)	20	9.35
	Joint Pain	10 (35.7%)	18 (64.3%)	28	13.08
	Heart Failure	24 (47.1%)	27(52.9%)	51	23.81
	Asthma	6(35.3%)	11(64.7%)	17	7.94
	HIV	0(0%)	5(100%)	5	2.24
	Liver Disease	3(100%)	0(0%)	3	1.40
	Other	11(55%)	9(45%)	20	9.35
	None	10 (13.2)	66(86.4%)	76	26.21
Family history of obesity	Yes	1(100%)	0(0%)	1	0.34
	No	79 (27.3%)	210(72.7%)	289	99.66
Alcohol consumption (n=290)	Yes	46 (26.4%)	128 (73.6%)	174	60.0
	No	34(29.3%)	82 (70.7%)	116	40.0
Frequency of alcohol consumption (n= 174)	Daily	39 (30%)	91(70%)	130	74.71
	5-6 days per week	2 (20%)	8 (80%)	10	5.75
	1-4 days per week	2(10%)	18(90%)	20	11.49
	1-3 days per month	3(21.4%)	11(78.6%)	14	8.04
	once per month	0 (0%)	1(100%)	1	0.57
Physical activity (n =290)	Yes	52(22%)	185(78%)	237	81.72
	No	28 (52.8%)	25 (47.2%)	53	18.28
Type of physical activity(n=237)	Walking	39 (21.8%)	140 (78.2%)	179	75.53
	Fetching	0 (0%)	2 (100%)	2	0.84

22

		undernourished	Not undernourished	Total	Percentage
	Walking and harvesting	13(23.2%)	43(76.8%)	56	23.63
Decline in food intake (n=290)	Yes	68(61.3%)	43(38.7%)	111	38.28
	No	12(6.7%)	167(93.3%)	179	61.72
Reason for decline in food intake(n=111)	loss of appetite	65(60.2%)	43(39.2%)	108	97.30
	chewing problem	3(100%)	0(0%)	3	2.70
Current medication usage (n=290)	Yes	38(27.1%)	102(72.9%)	140	48.28
	No	42(28%)	108(72%)	150	51.72
Number of drugs (n=140)	≤ 2	43(46.2%)	50(53.8%)	93	66.43
	≥ 3	25(53.2%)	22(46.8%)	47	33.57
	Total			140	100.0

435

436 Table 3: Consumption of the nine food groups by the study subjects in the last 24 hours in South
437 Gondar Zone, Amhara, Ethiopia 2020

Variables (n=290)		undernourished	Not undernourished	Total	Percentage (%)
Cereal and root	Yes	37(26.7%)	103(75.3%)	150	51.72
	No	43(30.7%)	107(69.3%)	140	48.27
Dark green vegetable	Yes	49(36.3%)	86(63.7%)	135	46.55
	No	31(20%)	124(80%)	155	53.45
Fruits and vegetable	Yes	23(21.5%)	84(78.5%)	107	36.90
	No	57(31.1%)	126(68.9%)	183	63.10
Another vitamin A rich fruits and vegetables	Yes	10(20.4%)	39(79.6%)	49	16.90
	No	70(29.0%)	171(71.0%)	241	83.10
Meat and fish	Yes	1(3.8%)	25(96.2%)	26	8.97
	No	79(30.0%)	185(70.0%)	264	91.03
Organ meat	Yes	0(0%)	4(100%)	4	1.38
	No	80(28%)	206(72%)	286	98.62
Legumes and nut	Yes	63(28.6%)	157(71.4%)	220	75.86

23

	No	17(24.3%)	53(75.7%)	70	24.14
Milk	Yes	11(17.5%)	52(82.5%)	63	21.72
	No	69(30.4%)	158(69.6%)	227	78.28
Egg	Yes	0(0%)	25(100%)	25	8.62
	No	80(30.2%)	185(69.8%)	265	91.38
Dietary diversity score	Good	4(12.9%)	27(87.1%)	31	10.69
	Poor	76(75.6%)	183(24.4%)	259	89.31

438

439

440 Table 4: Factors associated with undernutrition among older adults in South Gondar Zone,
441 Amhara, Ethiopia 2020

		Bivariate (COR) ,95%CI	Multivariable(33),95%CI	p-value
Educational status	Read and write and above	1	1	
	Cannot read and write	6.56(3.64-11.84)	3.54 (1.64-7.64)	0.01**
Sex	Male	0.34(0.19-0.60)	0.69(0.29- 1.65)	0.38
	Female	1	1	
Marital status	Married	0.43 (0.26- 0.73)	0.85 (0.39- 1.85)	1
	unmarried	1	1	
Residence	Urban	1	1	
	Rural	11.00(4.58-26.39)	10.32 (3.62-29.39)	0.001**
Monthly income	<35.6USD	3.25(1.86-5.70)	4.32(1.98-14.68)	0.001**
	≥35.6USD	1	1	
Illness in the past 3 months	Yes	4.37(2.48-7.76)	9.03(0.37- 22.3)	0.1
	no	1	1	
Decline in food intake	Yes	22.01(10.94- 44.29)	13.471(6.15- 9.53)	0.001**
	No	1	1	

24

Minimum dietary diversity	Good	0.36(0.12-1.05)	0.389(0.1- 1.58)	0.18
	Poor	1		

442   ** P value <0.05

25

gSTROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1 and 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4 and 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	*8*
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9 and 10
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13 and 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12,13 1nd 14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.