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Research article

Impact of age on the prevalence of poor-quality dietary variety, associated lifestyle factors, and body composition profile (low body muscle mass and high body fat mass) in older people residing in Colombo district, Sri Lanka

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ABSTRACT

Aims: To assess the impact of age on the prevalence of poor-quality dietary variety, associated lifestyle factors, and body composition profile (low body muscle mass and high-fat mass) in older Sri Lankans.

Methods: In this population-based cross-sectional study, older people of 60 years or above were selected using a multistage cluster sampling technique probability proportionate to the size. They were classified into 3 groups; 60–64, 65–69 and > 70-years. The poor-quality dietary variety was defined based on food variety, dietary diversity and dietary serving scores assessed using 24-h dietary recall. Body composition was measured using bio-electrical impedance. The impact of age on determinants of poor-quality dietary variety and being at risk of low muscle mass and high-fat mass were assessed by using multivariable logistic regression models.

Results: Eight hundred older participants with a mean (SD) 68.1(5.8) years were included. There were 28.4%(n = 227), 36.2%(n = 290) and 35.4%(n = 283) in the 60–64, 65–69 and ≥ 70-year age groups, respectively. The prevalence of poor-quality dietary variety was similar across age groups. The urban living environment, and getting nutritional advice from the GP/hospital were found to have a significant negative association only in the 60–64 age group. A poor-quality dietary variety was significantly associated with no education or up to the primary level in the 65–69 age group and having diabetes or hypertension in the ≥70-year group. Odds of low muscle mass and high-fat mass were 2.43(1.46–4.03) and 2.17(1.30–3.63) respectively among the≥70-year age group compared to the 60-64-year group, after controlling for confounders.

Conclusions: The prevalence of poor-quality dietary variety was similarly high in all age groups. Increasing age was associated with higher odds of low body muscle and high body fat mass despite similar dietary variety, indicating the need for special dietary attention.

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1. Introduction

Dietary variety influences nutrition and health outcomes at all stages of the human lifecycle. A poor-quality dietary variety is a common cause of malnutrition and is linked to several chronic diseases [1]. Current public health dietary advice is for individuals to consume a diet sufficient in all macro- and micronutrients to promote health; and also to limit consumption of dietary components known to contribute to chronic diseases. Worldwide studies have indicated that a healthy dietary variety reduces the risk of diseases, and improves nutritional status and quality of life [2,3]. A healthy dietary variety is especially important for older people as they are a vulnerable group with a risk of developing many nutritional problems associated with physiological changes with ageing [4]. The studies conducted on the dietary variety of older Sri Lankans have shown that it is of poor quality as they neither consume all the food groups nor take each food group in adequate serving sizes as recommended by National dietary guidelines. They mainly take starchy food in higher proportions compared to the other food groups such as protein sources and fruits. They include rice, especially in every meal as it is the staple food among Sri Lankans [5]. Fruits, vegetables and dairy food groups are important as they provide micronutrients (vitamins and minerals) which are essential for metabolic pathways in the body. Fruits, green leaves and vegetables contain Vitamins A, C and E, which have antioxidant properties and prevent older people from cancer and dairy products contain Calcium which is crucial in improving the density of bones and preventing osteoporosis in older people [6].

According to the European Working Group on Sarcopenia in older people, it was defined as "a condition that occurs due to change in muscle with advancing age and characterized by low skeletal muscle strength and/or physical performance, muscle quantity and quality" [7]. Although sarcopenia is primarily age-related, it can also be secondary to chronic diseases such as malignancies and inadequate nutrition; diet is one of the highly contributing factors for the onset and proportion of decline in muscle mass [8]. Sarcopenia results in physical disability, frailty, low quality of life and high mortality. One of the evidence-based interventions to alleviate sarcopenia is to have a healthy dietary variety with sufficient protein intake [9–11].

Another major change in body composition with ageing is a progressive increase in fat mass and the accompanying decrease in skeletal muscle [12]. Studies conducted among people with sarcopenic obesity have indicated an increased risk of disability and mortality [13,14], a condition resulting from changes in biological pathways due to old age characterized by low body muscle mass (sarcopenia) and high body fat mass (obesity) [7].

As dietary variety is a modifiable factor, it can be easily intervened after exploring the associated factors among older people. This could help to find solutions for the non-communicable disease burden among the rapidly growing older population. This study describes the dietary intake of older Sri Lankans in terms of food groups, serving sizes and variety. The findings were intended to inform the policymakers to implement dietary guidelines for the older population and for the welfare agencies to improve nutrition security among them. Furthermore, nutritional components such as antioxidants have been proven to be beneficial for infections and cancers. However, very little research has focused on exploring the poor-quality dietary variety and factors associated with it and the impact of increasing age by quantifying the likelihood of low body muscle mass and high body fat mass within Asian older age groups. Such a study helps to provide basic information for further studies which would help to fill that research gap.

The aim of our study was therefore to assess the impact of age on the prevalence of poor-quality dietary variety, associated lifestyle factors, and body composition profile (low body muscle mass and high body fat mass) among older Sri Lankans.

2. Materials and methods

2.1. Study design and study setting

A cross-sectional analytical study was conducted among older people aged 60 years or over, residing in the District of Colombo, Sri Lanka, in March 2019 to describe their quality of dietary variety and body composition profiles. Colombo District is composed of 13 administrative units called Divisional Secretariat (DS) areas, and one DS area is further subdivided into Grama Niladari Divisions (GN) with a population of diverse socio-economic composite [15]. The older population >60 years of age is 13.6% out of the 2.3 million of the total population in the Colombo District. It is higher than the other Districts in Sri Lanka [15]. Thus, the magnitude of the problems related to older people is also higher in Colombo District. In addition, it is a multiethnic and multireligious community. There are traditions and practices unique to different ethnic groups, that are associated with the type of foods consumed, methods of preparation, and seasonal consumption habits [15].

Ethics approval was granted by the Ethical Review Committee of the Faculty of Medicine, University of Kelaniya in Sri Lanka (P 123/6/2018).

2.2. Study population

Participants were older people 60 years old or over, who were residing for at least 3 months in either urban or rural areas of the Colombo district. Those institutionalized or attending daycare centres, diagnosed to be having cancer, chronic renal failure or neurodegenerative disorders, those with pacemakers and those who were unable to give informed consent such as severe cognitive deficit, were excluded from the study.

2.3. Sample size calculation

The sample size calculation was done as per the formula $n = z^2 p (100\text{-}p)/d^2$ described by Lwanga and Lemeshow in 1991 [16]. The estimated value of 20% was taken as the prevalence of undernutrition (p) [17], the desired precision level (d) was 5%, with 95% as the desired confidence level (z) and 2.9 was taken as the value of design effect. Non-response rate was considered as 10% and the final sample size was 800.

2.4. Sampling technique

A multi-stage cluster sampling technique was utilized. One administrative GN sub-unit area was regarded as a cluster and the total sample size per cluster was fixed at 20. As this is a community-based study, the cluster size was fixed at a moderate value of 20 (i.e. 20 participants per cluster). The total number of clusters was 40 after dividing 800 study participants by the cluster size of 20 (i.e. 800 participants/cluster size (20) = 40 clusters). The probability proportionate to the size technique was used in choosing 40 clusters from randomly selected 7 Divisional Secretariat (DS) Divisions out of the total13 DS Divisions within the District of Columbo. 50% of the DS Divisions were selected randomly (7 were picked randomly out of 13) for the feasibility of the study without affecting the validity as per the decision of the expert committee comprised of experts in Public Health, Geriatricians and Nutritionists in Sri Lanka at the preproposal stage.

The number of clusters was allocated to each DS Division proportionate to its' older population. The sampling interval was estimated by dividing the cumulative older population into 7 DS Divisions selected by the number of clusters allocated to each DS Division. The first cluster was selected within the sampling interval using the random number table and subsequent clusters were selected by adding the sampling interval. The voter's register was used to identify the households and the first house to be visited from the cluster in a GN unit was chosen using a random number table. After visiting the first household, the subsequent households were chosen as to the nearest to the right side of the preceding house.

2.5. Data collection

An interviewer-administered questionnaire was utilized. A 24-h dietary recall (Supplementary material 1) was obtained and body composition was measured using bio-electrical impedance (BIA, HBF-212, Japan). Two data collectors, pre-intern medical officers, were trained by the Principal Investigator prior to the data collection process. Researchers obtained written informed consent from the eligible subjects after providing them with study information both verbally and in writing. They were provided with the necessary instructions for the preparation to assess the body composition and data collectors visited again after one week to collect data. These have previously been described [18].

2.6. Assessment of the quality of dietary variety

Dietary variety was assessed using a 24-h multiple-pass recall method. It is commonly used in large nutrition surveys due to its high validity, simplicity and high rate of response [19–21]. It is used to assess the nutrition intake and the quality of the diet a person is consuming [21]. Therefore, it can be used to calculate dietary scores to assess dietary quality [22]. The dietary recall was obtained by a trained person using a standardised protocol on a random day. If the participant had a special diet on the day of recall (i.e., a party) the previous day's dietary recall was assessed. All the food items consumed by a participant during the 24 h were recorded. The amount of each food item consumed was measured using standard measures such as cups, tablespoons, coconut spoons and the size of a box of matches. The participants were shown visual aids (photographs of food servings, food atlas) to improve the recall and accuracy ofdietary intake. When analysing complex food preparations, e.g., chicken kottu, fried rice etc. disaggregation of the recipe was applied to separate all the ingredients in that particular meal. The questionnaire and the dietary recall were obtained on the same day and 5 households were visited per day by one data collector.

The assessment of dietary variety included the consumption of all six food groups in recommended serving sizes according to the guidelines set by the Ministry of Health in Sri Lanka [6] and the variety of food items included in the diet. According to these criteria, the dietary variety was assessed according to 3 dietary scores; Dietary Diversity Score (DDS), Food Variety Score (FVS) and Dietary Serving Score (DSS). These tools have been proven to be good indicators to assess the quality of diet consumed by older people [22]. They have also been validated to be applied among community-dwelling older people in Sri Lanka and shown to reflect their nutritional adequacy among them [22].

FVS is a count of different food items consumed over the last 24 h. FVS excluded beverages and condiments and the theoretical maximum was 15. The level of cut-off used to define nutrition adequacy of the diet in older people was taken as 9 of the food variety score according to the validation study of Rathnayake & others in 2012 [22]. DDS measures the count of food groups consumed over a specific period by summing the number of food groups out of the 6 subgroups, initially described by Kerbs-smith and others in 1987) [23] and as per the dietary guidelines of the Ministry of Health in Sri Lanka [6] (Supplementary material 2). This is calculated without considering a minimum intake of food groups. The score was given out of a maximum of 6. The level of cut-off used to define nutrition adequacy of the diet in older people was taken as 4.5 of the dietary diversity score according to the validation study of Rathnayake and others in 2012 [22]. Due to the complexity of the analysis, dietary fat intake was not considered as a separate subgroup of food in the present study [22,24] but fatty food intake was covered through dairy food, legumes/lentils and meat products. DSS measures the portions of different food groups (Supplementary material 3) consumed as described in the Food-based dietary guidelines of the

Ministry of Health in Sri Lanka [6]. A score of 4 was assigned if a participant was consuming the recommended 4 daily servings of starchy foods. The scores were calculated for all 6 food groups and expressed out of a maximum of 20. The mean value of the DSS, in the present study was used as the cut-off value to identify adequate DSS.

The participants were categorized as consuming a poor-quality dietary variety if he/she had scored a lower value than the cut-off level in all three dietary scores to be defined as nutritionally adequate (FVS <9, DDS<4.5 and DSS score < the mean of the study population).

2.7. Assessment of body composition

Body composition was measured using a commercially available four-electrode single-frequency bio-impedance analyzer machine (HBF-212, Japan). The participants were advised to avoid vigorous physical exercise before 12 h of the measurement, not to eat or drink prior to the hours, to empty the bladder and to remove any metal objects or jewellery. Participants with pacemakers were excluded. All the measuring procedures were carried out as instructed in the manufacturer's manual. The participant was advised to stand straight on the BIA machine with hands on either side of the body and the feet touching the electrodes. The machine applied 0.8 mA alternating electric current flux with 50 kHz operating frequency and recorded the whole-body impedance from foot to foot. The muscle and fat mass percentages were estimated using the whole-body impedance value and pre-entered personal data of the participants (age, gender, height, weight) using a standard equation provided by the manufacturer. The precision and Interoperator reliability of impedance measurements were assured by the supervision of data collectors measuring the same participant under the standard conditions, using the standard procedure reported by Vijewardane and others in 2022 [18].

2.8. Data analysis

SPSS (version 22.0) was used to analyse data. Participants were categorized into 3 groups according to their age, 60–64, 65–69 and ≥ 70 years. Significant associated factors for poor-quality dietary variety were explored using multivariate logistic regression analysis after controlling for confounding factors.

Three models were created to assess the impact of age on the poor-quality dietary variety, low body muscle mass and high body fat mass by using the youngest (60–64 years) age category as the reference group. Model A was adjusted by sociodemographic factors (age, sex, marital status, ethnicity and religion) and socio-economic factors (living environment, level of education, employment status and monthly income); model B was adjusted for model A plus additionally adjusted for co-morbidities (having diabetes mellitus, hypertension, heart disease, COPD) disabilities (disability in hearing, vision, chewing, musculoskeletal disorders), food allergies and betel chewing and the final model C was adjusted for model B plus additionally adjusted for diet-related behaviours (food shopping,

Table 1
Characteristic comparison of older people in 3 age groups.

	60–64 years 227/800	65–69 years 290/800	≥70 years 283/800	[a]P for trend value
Factor	N (%)	N (%)	N (%)	
Female sex	164 (72.2%)	209 (72.1%)	182 (64.3%)	0.07
Ethnicity- Sinhalese	218 (96.0%)	287 (99.0%)	272 (96.1%)	0.06
Marital status- widowed, divorced or unmarried	35 (18.4%)	82 (28.3%)	94 (33.2%)	0.09
Religion-Buddhist	201 (88.5%)	266 (91.7%)	261 (92.2%)	0.30
Living environment-rural	160 (70.5%)	200 (69%)	175 (61.8%)	0.08
Education level-no or up to primary	20 (8.8%)	40 (13.8%)	59 (20.8%)	**0.01**
Unemployment	168 (74.0%)	249 (85.9%)	258 (91.16%)	**0.009**
Not having a monthly income	124 (54.6%)	194 (66.9%)	173 (61.1%)	**0.017**
Presence of Diabetes	81 (35.7%)	103 (35.5%)	109 (38.5%)	0.71
Presence of Hypertension	87 (38.3%)	117 (40.3%)	130 (45.9%)	0.19
Presence of Heart disease	21 (9.3%)	31 (10.7%)	37 (13.1%)	0.38
Presence of Asthma/COPD	6 (2.6%)	14 (4.8%)	17 (6.0%)	0.20
Disability in hearing	14 (6.2%)	34 (11.7%)	73 (25.8%)	**0.009**
Disability in vision	164 (72.2%)	213 (73.4%)	238 (84.1%)	**0.002**
Disability in chewing	19 (8.4%)	53 (18.3%)	107 (37.8%)	**0.009**
Presence of Musculoskeletal disorders	34 (15.0%)	52 (17.9%)	81 (28.6%)	**0.009**
Presence of food allergies	16 (7.0%)	20 (6.9%)	15 (5.3%)	0.65
Current betel chewing	27 (11.9%)	35 (12.1%)	47 (16.6%)	0.19
No responsibility in food shopping	196 (86.3%)	240 (82.8%)	187 (66.1%)	**0.009**
No responsibility in Planning meals	195 (85.9%)	243 (83.8%)	194 (68.6%)	**0.009**
No responsibility in preparing meals	169 (74.4%)	221 (76.2%)	164 (58.0%)	**0.009**
Availability of a home garden	146 (64.3%)	194 (66.9%)	208 (73.5%)	0.07
Skipping meals	42 (18.5%)	60 (20.7%)	62 (21.9%)	0.64
Getting nutritional advice from GP	192 (84.6%)	260 (89.7%)	254(89.8%)	0.13
Getting nutritional advice from hospital	176 (77.5%)	200 (69.0%)	196 (67.5%)	**0.031**
Getting nutritional advice from media	200 (88.1%)	270 (93.1%)	261 (92.2%)	0.11

[a] Obtained from the chi-square test.

planning meals, preparing meals, having a home garden and skipping meals) and seeking nutrition advice (seeking and getting advice from GP, hospital and media). (Supplementary material 4).

These incrementally adjusted models were constructed to understand how the odds change by adding different categories of confounders in previous models and quantified the effect of increasing age on the study outcome. The cut–off value for the low skeletal muscle mass was set as the 25th centile or lower and high body fat mass was set as the 75th centile or higher of the study population. Data were presented using adjusted odds ratio (aOR) and 95% confidence intervals.

3. Results

A total of 800 older people with a mean (SD) age of 68.1(5.8) years participated in this study. There were 28.4%(n = 227), 36.2% (n = 290) and 35.4%(n = 283) individuals in 60–64, 65–69 and ≥ 70-year age groups, respectively. Mean (SD) of the DDS was 4 (0.9), 4.1 (0.9) and 4.1 (0.8), FVS was 6.6 (1.8), 6.6 (1.6) and 6.8 (1.8) and, DSS was 9.5 (2.3), 9.5 (2.3) and 9.4 (2.5) in the three age groups respectively.

Significantly higher proportions were observed to be having lower levels of education, disabilities and unemployment, among the older people in ≥70-year category, compared to other age groups. Among the older people in the 60–64 age category, those without responsibility in food shopping and planning meals, and those who were not getting nutritional advice from the hospital were significant characteristics, compared to other age groups. Among the 65–69 age group, higher proportions of older people were not having a monthly income and were without responsibility for preparing meals **(Table 1)**

Higher proportions of older people were observed to be having a poor-quality dietary variety when considering each dietary score. The difference in proportions of older adults with poor-quality dietary variety is greater when considering the dietary diversity and food variety scores than the dietary serving score (Table 2).

Multivariate regression results of associated factors of poor-quality dietary variety for each group have shown that, after controlling for all the variables in model C as described in the methods. 50.7% (n = 115) in the 60–64 age category, 46.9% (n = 136) in the 65–69 and 46.6% (n = 132) in ≥70 age categories were deemed to have a poor-quality dietary variety. The following factors were significantly associated with poor-quality dietary variety in each age group: urban living environment aOR(0.35; 95% CI: 0.15–0.80), obtaining nutritional advice from GP aOR(0.25; 0.09–0.72)/hospital aOR (0.31; 95% CI; 0.13–0.74) (significant negative effect) in 60–64 age group, and no education or up to primary level aOR (2.2; 95%CI: 0.09–4.87) in 65–69 age group and having diabetes aOR (1.99; 95% CI:1.11–3.57) or hypertension aOR(1.34; 95%CI:0.77–2.37) in ≥70-year age group (Table 3). The effect of age on poor-quality dietary variety was not significant, even after adjusting for model variables **(Table 4)**.

There were 37.4% (n = 85) in the 60–64 age category, 24.8% (n = 72) in the 65–69 group and 20.1% (n = 57) in ≥70 age category found to have low muscle mass. Odds of low muscle mass were 2.43 times higher (95% CI: 1.46–4.03) among the older people in ≥70-year age group compared to the older people in 60–64 years after controlling for confounders in the fully adjusted model (model C) **(Table 5).**

There were 33.9% (n = 77) participants in the 60–64 age category, 25.9% (n = 75) in the 65–69 group and 19.4% (n = 55) in ≥70 age category found to have high-fat mass. Similar to the muscle mass, the odds of high-fat mass were 2.17 times higher (95% CI: 1.3–3.63) among the older people in ≥70-year age group compared to the older people in 60–64-year age category, and the risk for 65–69 group is same as the reference group even after controlling for the confounders in model C **(Table 6)**.

The pattern of consumption of protein sources showed that 21.6% of the sample did not consume animal proteins (e.g. red meat, fish, eggs), 31.6% did not consume legumes and 48.1% did not consume cow's milk (Fig. 1).

Table 2
Distribution of the dietary scores in three age categories.

	60–64 years 227/800	65–69 years 290/800	≥70 years 283/800
Dietary Score N = 800	N (%)	N (%)	N (%)
Dietary Diversity Score			
More than 4.5	73 (32.2%)	91 (31.4%)	99 (35%)
Equal or less than 4.5[a]	154 (67.8%)	199 (68.6%)	184 (65%)
Food Variety Score			
More than 9	34 (15%)	40 (13.8%)	47 (16.6%)
Equal or less than 9[a]	193 (85%)	250 (86.2%)	236 (83.4%)
Dietary Serving Score			
Above 9.45	105 (46.3%)	140 (48.3%)	144 (50.9%)
Equal or below 9.45[a]	122 (53.7%)	150 (51.7%)	139 (49.1%)
Quality of dietary variety (overall)			
Poor-quality	115 (50.7%)	136 (46.9%)	132 (46.6%)
Good-quality	112 (49.3%)	154 (53.1%)	151 (53.4%)

[a] Indicate poor quality dietary variety.

Table 3
Multivariate regression analysis of associated factors, odds ratios and their likelihood of having a poor-quality dietary variety among three older age groups.

	Age 60–64 years N = 227		Age 65–69 years N = 290		Age above 70 years N = 283	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Sex-female	0.62 (0.19–2.02)	0.43	0.91 (0.38–2.14)	0.82	1.96 (0.82–4.68)	0.13
Ethnicity- Sinhalese	2.17 (0.20–0.23)	0.52	1.74 (0.11–26.74)	0.69	0.7 (0.09–5.28)	0.72
Marital status- widowed, divorced or unmarried	1.57 (0.66–3.73)	0.31	0.90 (0.49–1.65)	0.74	0.81 (0.42–1.58)	0.53
Religion-Buddhist	2.27 (0.57–9.04)	0.44	1.04 (0.36–2.96)	0.94	4.09 (0.93–17.98)	0.06
Living environment-urban	0.35 (0.15–0.80)	**0.01**	0.66 (0.35–1.25)	0.20	1.09 (0.59–2.02)	0.77
Education level-no or up to primary	0.46 (0.14–1.49)	0.20	2.2 (1.09–4.87)	**0.04**	0.91 (0.45–1.84)	0.79
Unemployment	0.82 (0.32–2.14)	0.69	1.82 (0.92–4.55)	0.20	0.85 (0.31–2.32)	0.75
Not having a monthly income	0.96 (0.41–2.25)	0.92	0.90 (0.45–1.81)	0.76	0.99 (0.52–1.84)	0.97
Presence of Diabetes	0.85 (0.40–1.80)	0.67	0.78 (0.44–1.40)	0.41	1.99 (1.11–3.57)	**0.03**
Presence of Hypertension	1.30 (0.66–2.59)	0.45	1.28 (0.76–2.22)	0.34	1.34 (0.77–2.37)	**0.02**
Presence of heart diseases	1.43 (0.45–4.69)	0.54	0.53 (0.23–1.24)	0.15	1.01 (0.45–2.26)	0.98
Presence of Asthma/COPD	0.36 (0.05–2.53)	0.20	0.49 (0.14–1.72)	0.27	0.26 (0.08–0.89)	0.30
Disability in hearing	0.48 (0.13–1.80)	0.28	0.59 (0.26–1.38)	0.23	0.74 (0.37–1.48)	0.39
Disability in vision	0.51 (0.23–1.12)	0.09	1.08 (0.55–1.83)	0.99	0.77 (0.37–1.63)	0.50
Disability in chewing	1.65 (0.51–5.27)	0.40	0.57 (0.27–1.18)	0.13	0.89 (0.47–1.69)	0.72
Presence of musculoskeletal disorders	0.86 (0.35–2.06)	0.72	0.98 (0.47–2.01)	0.96	0.77 (0.39–1.51)	0.45
Presence of food allergies	0.83 (0.23–3.05)	0.78	3.01 (0.90–10.49)	0.07	0.43 (0.13–1.38)	0.15
Current betel chewing	0.46 (0.16–1.32)	0.15	0.57 (0.24–1.39)	0.22	1.26 (0.59–2.69)	0.54
No responsibility in food shopping	1.02 (0.31–3.38)	0.97	0.44 (0.10–4.89)	0.27	0.55 (0.20–1.57)	0.24
No responsibility in Planning meals	0.44 (0.12–1.64)	0.22	0.88 (0.19–4.09)	0.88	2.12 (0.73–6.28)	0.17
No responsibility in preparing meals	1.40 (0.47–4.20)	0.54	0.82 (0.32–2.13)	0.58	1.46 (0.68–3.13)	0.32
Unavailability of a home garden	0.59 (0.28–1.24)	0.16	0.85 (0.47–1.52)	0.69	0.63 (0.34–1.15)	0.13
Skipping meals	0.51 (0.21–1.21	0.13	0.83 (0.42–1.62)	0.58	0.97 (0.52–1.82)	0.83
Getting nutritional advice from GP	0.25 (0.09–0.72)	**0.01**	0.55 (0.21–1.4)	0.21	1.10 (0.43–2.83)	0.90
Getting nutritional advice from hospital	0.31 (0.13–0.74)	**0.01**	0.66 (0.35–1.2)	0.21	0.96 (0.48–1.91)	0.97
Getting nutritional advice from media	1.25 (0.38–4.13)	0.71	0.57 (0.18–1.82)	0.37	1.01 (0.35–2.91)	0.93

Table 4
Outcome of the likelihood of having a poor-quality dietary variety for 3 older people age groups.

Model[a]	60–64 years 227/800 (Reference category)	65–69 years 290/800 OR (95% CI)	≥70 years 283/800 OR (95% CI)	P value
N/% of poor-quality dietary variety	115 (50.7%)	136 (46.9%)	132 (46.6%)	
Unadjusted	1	1.01 (0.73–1.40)	1.17 (0.83–1.67)	0.61
A	1	0.98 (0.70–1.38)	1.11 (0.77–1.62)	0.77
B	1	1.11 (0.78–1.59)	1.32 (0.89–1.95)	0.38
C	1	1.18 (0.81–1.71)	1.42 (0.94–2.15)	0.25

[a] Model A: adjusted by age, sex, ethnicity, marital status, religion living environment, level of education, employment status and monthly income; model B: adjusted for model A plus additionally adjusted for having diabetes mellitus, hypertension, heart disease, COPD, disability in hearing, vision, chewing, musculoskeletal disorders, food allergies, betel chewing; model C: adjusted for model B plus additionally adjusted for food shopping, planning meals, preparing meals, having a home garden, skipping meals, getting advice from GP, hospital and media.

Table 5
Outcome of the likelihood of having low skeletal muscle mass for 3 older people age groups.

Model[a]	60–64 years 227/800 (Reference category)	65–69 years 290/800 OR (95% CI)	≥70 years 283/800 OR (95% CI)	P value
N/% of low skeletal muscle mass	85 (37.4%)	72 (24.8%)	57 (20.1%)	
Unadjusted	1	1.31 (0.88–1.94)	2.37 (1.60–3.53)	<0.001
A	1	1.20 (0.78–1.24)	2.29 (1.46–3.61)	0.001
B	1	1.17 (0.74–1.86)	2.28 (1.40–3.74)	0.001
C	1	1.29 (0.8–2.07)	2.43 (1.46–4.03)	0.001

[a] Model A: adjusted by age, sex, ethnicity, marital status, religion living environment, level of education, employment status and monthly income; model B: adjusted for model A plus additionally adjusted for having diabetes mellitus, hypertension, heart disease, COPD, disability in hearing, vision, chewing, musculoskeletal disorders, food allergies, betel chewing; model C: adjusted for model B plus additionally adjusted for food shopping, planning meals, preparing meals, having a home garden, skipping meals, getting advice from GP, hospital and media.

Table 6
Outcome of the likelihood of having a high-fat mass for 3 older people age groups.

Model[a]	60–64 years 227/800 (Reference category)	65–69 years 290/800 OR (95% CI)	≥70 years 283/800 OR (95% CI)	P value
N/% 0f high-fat mass	77 (33.9%)	75 (25.9%)	55 (19.4%)	
Unadjusted	1	1.45 (0.97–2.14)	2.13 (1.42–3.18)	<0.001
A	1	1.41 (0.91–2.18)	2.17 (1.36–3.45)	0.005
B	1	1.45 (0.91–2.32)	2.27 (1.37–3.75)	0.006
C	1	1.37 (0.86–2.26)	2.17 (1.3–3.63)	0.01

[a] Model A: adjusted by age, sex, ethnicity, marital status, religion living environment, level of education, employment status and monthly income; model B: adjusted for model A plus additionally adjusted for having diabetes mellitus, hypertension, heart disease, COPD, disability in hearing, vision, chewing, musculoskeletal disorders, food allergies, betel chewing; model C: adjusted for model B plus additionally adjusted for food shopping, planning meals, preparing meals, having a home garden, skipping meals, getting advice from GP, hospital and media.

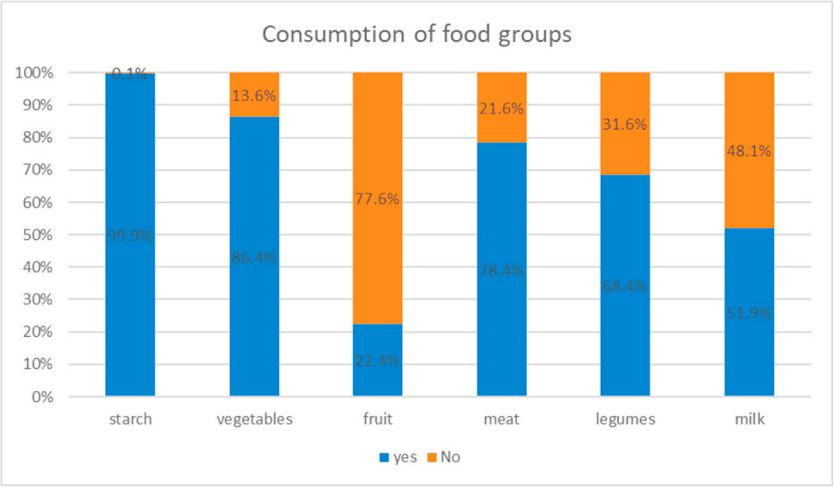

Fig. 1. Consumption of different food groups by the older people in Sri Lanka.

4. Discussion

In this study of community-dwelling older people in the Colombo district in Sri Lanka, we found that nearly half of older people consumed a poor-quality dietary variety. We have further identified factors which were associated significantly with this poor-quality dietary variety independently in different older age groups. The urban living environment, getting nutritional advice from GP/hospital had a significant negative association in the 60–64 age group, while no school education/up to primary level education in the 65–69 age group and having diabetes or hypertension in ≥70-year age group were identified as risk factors. As the age increases, the odds of having low body skeletal muscle mass and high body fat mass significantly increased among the older people in ≥70 -year category when compared with the younger 60-64- year age category, even after controlling for confounding factors.

4.1. Factors associated with a poor-quality dietary variety

According to previous studies, the poor-quality dietary variety is evident both in developing and developed countries in the world and they all show the poor quality of the diet considering both the variety and diversity of food and comparable to this study [25,26]. The body composition has been assessed by using various methodologies in almost every age category, however, there was no quantification of the risk/odd in different age categories among older people [27].

There is evidence from previous studies similar to our study, for poor-quality dietary variety in Sri Lanka, where the mean (SD) of DDS, FVS and DSS were 4.4 (0.9), 8.4 (2) and 11.4 (2.5) respectively obtained from a study conducted among 200 older people in a rural community [19]. Nearly similar results 7.3 (1.2), 8.7 (1.5) and 10.9 (2) were obtained for DDS, FVS and DSS in a study conducted among 311 older people, recruited from 12 care homes in 6 provinces in Sri Lanka [5]. According to a study in 2014 by Rathnayake and others, mean daily intakes of fruits, vegetables, animal and plant proteins, and dairy products were below the national recommendations except for starch intake [5]. DDS and DSS scores among the age group >70 years are quite similar to the other age groups. This interesting finding may be due to the extended nature of the family in the Sri Lankan setting where older people are cared for by close family members. This could potentially minimize the impact of age on certain dietary habits among the older population.

Similar to our work, a National survey conducted in Thailand using 7300 older community residents revealed that low dietary diversity is associated with low education level and low income [28]. Similarly, Conklin and others in 2014 reported that a low

education level was independently associated with low dietary diversity [25]. Therefore, education appears to be a key component for supporting healthy food choices in older community residents.

A significant number of older people in ≥70-year age group not only attained a low education level and were unemployed but also had many disabilities compared to the other younger age groups. The physiological changes with the ageing process may be the reason for the disabilities and further lead to unemployment. Especially, if they are having disabilities in vision and hearing, this may negatively impact their dietary variety. Our results suggest that identifying those older people with such disabilities should be carried out via the primary health care teams as these defects are easily correctable e.g. use of hearing aids. A population-level strategy could include the provision of such disability aids by social services as most older people have to depend on their children in obtaining these facilities. Nearly half of the older people in each age category were found to be having poor-quality dietary variety. These findings are important, indicating that there is potentially increasing public health concern due to the rapidly expanding older population with future increasing demand for the provision of public health services. The presence of physical disabilities limits older people accessing (e.g. food shopping) or preparing meals. This can contribute to a situation of not consuming all the food groups as part of a healthy diet or not consuming sufficient quantities of food [29].

Nearly three-quarters of older people in each age category were unemployed and nearly half had no income. This might have contributed to not consuming all the food groups especially proteins which are relatively expensive in Sri Lanka compared to other food groups among older people [30]. Studies using UK purchase data from the retail sector have indicated that there is a decline in protein purchasing from the supermarket from the age of 60 years [8]. This type of comparable data is not available in Sri Lanka, but the approach of using big-data approaches to track shopping habits using loyalty cards might offer an option for monitoring of purchasing patterns of older people in the future.

Among the older people in the 60–64 age group, getting nutritional advice from the General Practitioner or hospital was significantly associated with a reduced likelihood of a poor-quality dietary variety. Nutritional education and advice have a health-promoting effect according to most behavioural change theories [31] and act positively in promoting a good quality dietary variety. In this process, the primary health care team has a vital role in promoting healthy dietary habits among the community as a whole. Older people in this age group living in an urban environment had a good quality dietary variety in contrast to those in a rural environment. Accessibility to food is probably higher in urban compared to rural areas. Promoting nutrition advice through media outlets as well as improving the food supply chain in rural areas have the potential to improve the dietary variety of older people.

Our results suggest that there is an increased likelihood of having a poor-quality dietary variety among older people with diabetes or hypertension in ≥70- year age group. Whether this is a mere association or having these conditions has any implication on dietary variety is not clear. Further research is required to establish whether this is an effect of poor-quality dietary variety rather than the cause.

4.2. Impact of age on body composition

Sarcopenia is the main nutritional problem affecting older adults with concomitant loss of muscle function, linked to frailty [7]. It is considered as an inevitable consequence of ageing. Skeletal muscle mass reaches a peak in the early adult years and then declines by approximately 0.5–1.0% per year, which begins at around 40 years of age. In the early stages, a gradual loss of lean muscle mass may be masked by a concurrent increase in fat mass which contributes to the body weight. The present study quantified this impact with increasing age; we found that the older people in >70-year age group had approximately 2.5 times increased odds of low muscle mass and over two-fold increased odds of high-fat mass, compared to the 60–64 -year group. Although the likelihood of having a low muscle mass and high fat mass is greater in the ≥70 years age group, lower values of dietary scores were observed in all 3 age groups. According to the ESPEN guidelines, it is necessary to consume proteins 1–1.2 g/kg body weight per day to prevent this age-related sarcopenia [32]. The results of our study have shown that consumption of protein sources was low in these older people and they were not achieving the ESPEN guidelines for protein intake.

Proteins improve satiety and help to reduce body weight and fat mass; this is a good dietary recommendation to maintain a healthy body weight [11]. To alleviate sarcopenic muscle loss, primary care clinicians should emphasise the need to consume a sufficient amount of protein in every meal, in combination with physical activity. This can be achieved with plant-based sources of protein [33] for a healthy and sustainable diet. There are issues commonly faced by the healthcare sector of Sri Lanka in promoting animal-based proteins i.e. cultural barriers, myths and misconceptions [30]. Promotion of diet quality and physical activity within the workplace and post-retirement can support lifestyle choices before age-related physiological changes occur. As observed for protein sources, only 22.4% of the older population consumes fruits and 86% consume vegetables. All the food groups except starchy food, were consumed in inadequate serving sizes as recommended by the national dietary guidelines. Fruits, vegetables, dairy and legumes are good sources of vitamins and minerals which are necessary for most cellular processes in the body. Especially the vitamins and fatty acids present in these food groups help to reduce sarcopenia among older people. There are many community-level health promotion societies run by the Ministry of Health and elderly societies run by the Elderly Secretariat of Sri Lanka for both younger and older adults, which are good platforms to promote healthy dietary behaviours. We propose that it is very feasible to use these as health promotion settings across older communities in Sri Lanka.

When considering the broad scenario of the findings of our study, age >70 years is the vulnerable group likely to have an unfavourable body composition, poor-quality dietary variety and non-communicable diseases. The older people in this age group were not having regular means of income and most have to depend on their children for financial support, with no public 'old-age/retirement' pension provision in Sri Lanka setting. This should bring new high-level policies and strategies to ensure the economic security of older people to prevent nutrition poverty, such as introducing targeted and increased food rations, a protected pension

scheme for those without and government-sponsored insurance schemes.

4.3. Strengths

This study has several strengths. The multistage cluster sampling technique-probability proportionate to the size is a feasible method used in community surveys enabling the sample to be more representative. The questionnaire was further assessed by experts in nutrition and geriatric care and it was administered by an interviewer to clarify the questions to the participants. Data collectors were trained to collect 24-h dietary recall data and body composition measurements. The validity and reliability of the body composition measurements were ensured by using the standard protocol and measuring it thrice in each individual and taking the average value. A poor-quality dietary variety was assessed using three dietary scores which were validated to be used in the community setting in Sri Lanka. The 24-h multiple-pass recall method is well-recognized in assessing the diet in low-resource settings like the community sector in Sri Lanka. Assessment of serving sizes in familiar sizes for older people and usage of visual aids helped in minimising recall bias. The data collectors received the contribution of the caregiver almost every time, especially in the 24-h dietary recall, to verify the information given by the older person, this is more favourable as in the cultural setting of Sri Lanka, older people are in extended families sharing the same diet with other family members.

4.4. Limitations

The sample population may not be representative due to the exclusion of some older people with chronic diseases and could have underestimated the result of poor-quality dietary variety in the study. The serving sizes of food groups consumed by older people were assessed according to the dietary guidelines which were developed to be used for the adult population in Sri Lanka [6]. The 24-h dietary recall method may underestimate an individual's nutrient intake. It thus may not represent their habitual dietary variety or seasonal variation of dietary consumption captured in other methods such as the food frequency questionnaire. We chose 24-h recall given the resource limitations. and the accuracy may be influenced by the respondent's memory. This study could not employ other methods such as FFQ due to the limitation of resources, which could have minimized the negative outcome to a certain extent. Factors like memory and the ability to communicate with the older participant and the training of the interviewer can influence the success of the recall. The cut-off levels of body composition measures are based on the European populations and are not validated for application in this Asian population. We have used arbitrary values to classify muscle mass and fat mass as high or low, this may affect the external validity of the study. We were unable to assess physical activity, one of the confounders in sarcopenia. However, this would not have an impact on the relationships observed as the univariable level albeit physical activity will attenuate the risk of sarcopenia in older age. The cross-sectional study made it impossible to assert a causal relationship however our findings are primarily in agreement with the wider literature.

4.5. Future studies

A poor-quality dietary variety is a multifaceted issue, and future studies are needed to identify other potential factors such as economic status, food choices and food-related behaviours including food purchasing patterns and cultural beliefs of the people to enhance the healthy dietary variety in the older population. According to the newly emerging research data, quantifying diet, as well as the timing of meals, is important to include in the healthy dietary variety when health and wellbeing are considered.

5. Conclusion

Our study provides prevalence estimates of poor-quality dietary variety with increasing age in low-resource settings such as in Sri Lanka. We identified potential risk factors for a poor-quality dietary variety which can help policymakers to formulate strategies for targeted promotion to improve dietary variety among Sri Lankan older people. Given the fact that poor-quality dietary variety is a main contributing factor for many chronic diseases, focusing on this may have the potential to lower the burden of non-communicable diseases and associated healthcare expenditure. We also identified the potential impact of age on low skeletal muscle mass and high-fat mass among older populations within a low- and middle-income country setting, indicating specific public health interventions with the view of promoting a healthy dietary variety amongst an older population, especially in the oldest group.

Declarations

Ethics statement

This study was reviewed and approved by the Ethical Review Committee, Faculty of Medicine, University of Kelaniya, Sri Lanka (approval number: P 123/6/2018).

All participants (or their proxies/legal guardians) provided informed consent to participate in the study.

All participants (or their proxies/legal guardians) provided informed consent for the publication of their anonymised case details and images.

Data availability statement

Research data will be available upon request.

CRediT authorship contribution statement

Samantha Chandrika Vijewardane: Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Aindralal Balasuriya:** Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization. **Alexandra M. Johnstone:** Writing – review & editing, Supervision, Resources, Methodology. **Phyo Kyaw Myint:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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