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EDITORIAL

Health, nutrition and age-associated illnesses: The way forward

The elderly population in the world is on the rise over the past few decades due to improved quality of life, better medical care and reduced birth rates (United Nations, 2019). Nearly two-thirds of the elderly population lives in the developing world (United Nations, 2017) and Sri Lanka is also predicted to experience the same trend in the future (Department of Census and Statistics. Sri Lanka, 2016). Hence, there is a possibility of an overall increase of the length of the lifetime spent poor if the living environment and the economic status are unsatisfactory. As a result, a clear rise of a myriad of aging-associated illnesses and impairments; non-communicable diseases such as obesity, diabetes mellitus, ischemic heart disease, chronic kidney disease, cancer, and osteoporosis, and cognitive deterioration, dementia, and sarcopenia can be expected (Roberts et al., 2021).

Unhealthy, energy dense-diet that is poor in other nutrients is a leading cause for these chronic illnesses and is believed to be linked to chronic low-grade inflammation (Phillips et al., 2019). Consumption of a pro-inflammatory diet, high in fat, salt, sugar and frequent ultra-processed food low in nutrients poses the risk of chronic diseases. There is plenty of evidence suggesting poor dietary intake of macronutrients, micronutrients and other non-nutritive bioactive compounds by older adults and elderly, not only in poor middle and low-income countries,(Gupta et al., 2017) but also in developed countries (Bird et al., 2017).

Personalized nutritional interventions are of great benefit to attenuate the development of age -associated illnesses and related functional loss and poor quality of life. A balanced and healthy diet that possesses minimal pro-inflammatory potential is beneficial (Roberts et al., 2021). Mediterranean diet appears to be protective, increasing the quality of the diet and good quality of life in the elderly (Govindaraju et al., 2018).

National nutrition strategies are currently in place to enhance healthy aging in the light of preventing associated chronic illnesses. In fulfilling the requirement, the latest version of Food Based Dietary Guidelines (FBDG) for Sri Lankans (Ministry of Health, Sri Lanka, 2021) has paid special attention to both adult and elderly nutrition. All stakeholders should pay careful thought to facilitating and providing a nutritious diet through specific interventions accompanied by refined lifestyle to preserve functionality and to delay the progression of age-associated chronic illnesses among the elderly.

Health and welfare facilities in the country require meticulous scrutiny, revision, and upgrading to minimize the unwanted costs incurred on the healthcare system. Moreover, early attention saves the productive years of the older adults or elderly. That enables them to contribute for the growth of the national economy.

A sound healthcare policy leading to the establishment and the maintenance of a strong primary health care system is of utmost importance in the implementation of proper nutrition throughout life cycle. Appropriate execution of community-level nutrition clinics/centers is an essential need to conduct direct dietary assessments, nutrition screening including necessary laboratory investigations(blood lipids, micronutrient level, serum albumin etc), to do appropriate nutritional and healthcare interventions for vulnerable population as elderly. The implementation of such a robust system appears to be an additional burden to the existing system; however, it definitely is an investment. Primordial prevention would certainly cut down most of the healthcare cost incurred in Sri Lanka due to age-associated chronic illnesses of which poor nutrition is a modifiable risk factor. The creation of a

dedicated national-level institute to develop, and implement policies regarding nutrition and to conduct, monitor and coordinate all nutrition/food and health related programs is a promising initiative that has not been given any consideration in the Sri Lankan context.

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Nutritional Status and its Association with Quality of Life among Cancer Patients in Southern Sri Lanka: A Cross-Sectional Study

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ABSTRACT

Background and objectives: Malnutrition is a prevalent yet frequently overlooked issue among cancer patients, contributing to diminished quality of life (QOL). This study aimed to evaluate the nutritional status and QOL of cancer patients in a tertiary healthcare setting in Southern Sri Lanka.

Materials and methods: This descriptive cross-sectional study included 425 participants from the Oncology Unit of Teaching Hospital, Karapitiya. Data on socio-demographic characteristics were gathered through an interviewer-administered questionnaire. The nutritional status and QOL were assessed using the Patient-Generated Subjective Global Assessment Short Form (PG-SGA SF) and the validated Sinhala version of the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30), respectively. Data analysis was conducted using SPSS Version 25.

Results: From the total subjects (n=425), majority (67.1%, n= 285) were females and 174 (40.9%) belonged to the age group of 51- 61 years. Among them, 168 (39.5%) subjects had cancers in the digestive tract and 110 (25.9%) had breast cancers. Nutritional status according to PG-SGA SF demonstrated that 191 (44.9%) patients were well-nourished and the majority (55.0%, n=234) were malnourished. Among malnourished, 158 were moderately and 76 were severely malnourished. Mean (SD) score for the overall quality of life defined as global health status according to EORTC QLQ-C30 was 54.36 ± 27.5 indicating poor overall QOL (reference value >61.3). All the dimensions of the functioning scale and the symptoms scale had low and high mean scores respectively indicating poor QOL. The association between the overall QOL and different nutritional stages ($p< 0.001$) and all the dimensions of the functional scale and symptoms scale ($p< 0.05$) were statistically significant.

Conclusions: The study reveals a high prevalence of moderate to severe malnutrition among cancer patients, accompanied by poor QOL. A statistically significant correlation between nutritional status and QOL scores reflects the imperative requirement of nutritional interventions aimed at enhancing QOL in this specific population.

INTRODUCTION

Cancer is a multifaceted global health issue and the second leading cause of death globally (Sung et al., 2021). According to WHO, approximately 70% of deaths due to cancer occur in low and middle-income countries (WHO, 2022). The increasing burden of cancer has become a major challenge faced by Sri Lanka and the overall incidence of cancer in Sri Lanka has doubled over the past 25 years and it has become the second commonest cause of hospital mortality in Sri Lanka constituting 14% of all hospital deaths (Gunasekera, Seneviratne, Wijeratne, & Booth, 2018). Nutrition is an important factor in the treatment, management and progression of cancers (Sharma, Kannan, Tapkire, & Nath, 2015). However, it is often ignored in the treatment and follow up and hence, malnutrition is a common though under recognized problem in cancer patients (Leuenberger, Kurmann, & Stanga, 2010). Malnutrition associated with cancer has been shown to precipitate a range of adverse outcomes, such as worsened prognosis, diminished survival rates, heightened sensitivity to treatment toxicity, and reduced tolerance to therapeutic interventions. Furthermore, it exerts a detrimental impact on patients' quality of life (Muscaritoli, Corsaro, & Molfino, 2021). Remarkably, disease-related malnutrition accounts for approximately 20% of mortality among cancer patients, surpassing the direct effects of the cancer itself as a cause of death (Silva, de Oliveira, Souza, Figueroa, & Santos, 2015).Prompt identification of malnutrition or risk of malnutrition is fundamental to its treatment and prevention or reversal of aforementioned negative clinical outcomes (Barker, Gout, & Crowe, 2011). Therefore, it is necessary to use appropriate, locally validated tools to assess the patient's nutritional status and to identify the cases. This enables the estimation of prevalence and classification of them allowing the provision of a suitable dietary plan for them (Lochs & Dervenis, 2003).

Many different tools are available for the assessment of the nutritional status in cancer patients. Patient-Generated Subjective Global Assessment (PG-SGA) is an assessment tool of nutritional status and it is broadly used in academic research and clinical practice as well. The first part of PG-SGA is to be completed by the patients and is referred to as PG-SGA Short Form (PG-SGA SF) (Balstad et al., 2019). PG-SGA SF has been validated as an independent screening tool and it is one of the most commonly used nutrition assessment tools that assess nutritional status (Abbott et al., 2016).Quality of life (QOL) of a cancer patient is an important issue, especially for disease survivors, their families, and caregivers. It is a multidimensional perspective that includes dimensions such as physical, psychological, social and spiritual (Jitender, Mahajan, Rathore, & Choudhary, 2018). In cancer patients, QOL is significantly affected by the specific diagnosis, patient's perception about the condition, the disease's impact on the patient's physical and mental condition, short- and long-term adverse effects of treatment, the patient's coping mechanisms, and the reactions of their family members or other individuals (Ośmiałowska, Misiąg, Chabowski, & Jankowska-Polańska, 2021).

It is intended that QOL measures are for the assessment of patients' perspectives on the impact of health and healthcare interventions on their lives and to allow these perspectives to be considered in clinical decision-making (Addington-Hall & Kalra, 2001).The European Organisation for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire (QLQ-C30) stands as a prominent instrument for evaluating quality of life in oncology research, having been utilized in over 3,000 scholarly studies since its introduction in 1993. Many studies have been conducted to assess the nutritional status and QOL separately on oncology patients worldwide and studies done in Sri Lanka may be very few according to the existing literature. It is a well-known fact that patients with better nutrition can tolerate the anti-cancer treatment and their outcome would be better. Many studies supported a complementary role for dietary interventions in improving patient quality of life across

multiple cancer types by reducing toxicity and perhaps a benefit in treatment efficacy (Mercier et al., 2022). Further, it was recommended that baseline screening for malnutrition risk using a validated instrument following cancer diagnosis and repeated screening during and after treatment to monitor nutritional well-being of cancer patients (Hiatt et al., 2023).If the treatment outcome is better, their QOL will be much better and that must be the holistic management target of cancer patients. Further, a good understanding of the nutritional status of patient helps the clinician and the management team to plan the most appropriate treatment for a better QOL of the patient. Therefore, this study was conducted to assess the nutritional status and the QOL of cancer patients and to identify the correlation between the two parameters. The findings of this study will be useful to generate baseline data on nutritional status and the QOL of life of local patients with cancers and the findings can be used in the decision making in the management and implementation of programs to improve the nutritional status and QOL of cancer patients in future.

This study aimed to evaluate the nutritional status using the Patient-Generated Subjective Global Assessment Short Form and to examine the association between nutritional status and quality of life using European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 among cancer patients managed at Teaching Hospital, Karapitiya,

MATERIALS & METHODS

This research was conceived as a descriptive cross-sectional study conducted over a period spanning from June to July 2022. The study comprised of patients receiving treatment in the oncology and onco-surgical wards, in addition to cancer patients attending the respective outpatient clinics. The study sample was calculated based on the formula from Lowanga & Lameshow (1991). Based on the limited available data suggesting an under-exploration of the nutritional status among cancer patients in Sri Lanka, an anticipated population proportion of 50% for malnutrition was posited. Consequently, the minimum required sample size for robust analysis was determined to be 385 participants. To account for potential attrition, the sample size was augmented by 10%, resulting in a final sample size of 425 individuals. Participants were recruited via convenience sampling method until the target sample size was attained.

Patients who were diagnosed with cancer, aged more than 18 years and who were under treatment or on follow-up were included in the study. Patients below 18 years of age, uncertain diagnosis of neoplasm, those who did not give consent, serious chronic co-morbidities which may interfere with the perception of one's own health situation, cognitive dysfunction or dementia were excluded from the study.

Data collection was performed after obtaining ethical approval for the study from the Ethical Review Committee of the Faculty of Allied Health Sciences, University of Ruhuna, Galle, Sri Lanka (Reference No:2021.11.58). Administrative clearance was obtained from the Director of the Teaching Hospital Karapitiya and relevant consultants. Informed written consent was obtained from each of the participants who were selected for the study. Study participants were informed that they could leave the study at any time. Confidentiality of the information collected was assured.

Basic information of the subjects was collected by using a pretested interviewer-administered questionnaire which. included socio-demographic data such as age, gender, religion, ethnicity, marital status, occupation, number of children and income level, type of cancer, mode of treatment, time from primary diagnosis and satisfaction with the present health condition according to the patient's perception.

Assessment of nutritional status was done by using the Sinhala version of the Patient-

Generated Subjective Global Assessment Short Form (PG-SGA SF) (Abbott et al., 2016). PG-SGA SF, consists of four components and each of the component patients report on current and former body weight (Box 1); changes in food intake and current type of food/nutritional intake (Box 2); nutritional impact symptoms and other factors that negatively influence food intake/absorption/utilization of nutrients (Box 3); and activities and function based on Eastern Cooperative Oncology Group performance status, converted to layman's language (Box 4). In the PG-SGA Short Form numerical scoring system is used which range from 0 (no problems) to 36 (worst problem). Box 1 of PG-SGA SF has a maximum score of 5, Box 2 has a maximum score of 4, Box 3 has a maximum score of 24, and Box 4 has a maximum score of 3.(Balstad et al., 2019). This tool can be used for the diagnosis of malnutrition and to classify patients as either: A) well-nourished (0-3 points); B) mildly/moderately malnourished (≥4 points); or C) severely malnourished (≥9 points) (Hiatt et al., 2023). Sinhala translation of PG-SGA SF was done by using translation and back translation method by two bilingual experts and face validation of the translated version was done by two experts in nutrition and Community Medicine.

Data on QOL was collected by using the validated Sinhala version of the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ- C30) (Jayasekara, Rajapaksa, & Aaronson, 2008).This questionnaire includes 30 questions in 15 subscales relevant to patients with cancer, five distinct aspects of functioning (physical, role, emotional, cognitive, and social), eight symptoms (fatigue, nausea/vomiting, pain, dyspnoea, insomnia, appetite loss, constipation, and diarrhoea), financial difficulties, and global health/quality of life (Fayers & Bottomley, 2002).

All data were coded and entered into a database, which was created using the Statistical Package of Social Sciences (SPSS) version 25. Data cleaning and checking were done. Data were expressed as means and standard deviations where appropriate. Differences between the proportions of groups were tested for statistical significance using the chi-square test. Descriptive analysis (frequencies) was used to analyse the socio-demographic characteristics of the cancer patients. Pearson correlation was used to assess the correlations of two continuous variables. Two-tailed p-value less than 0.05 was selected as the level of statistical significance.

RESULTS

Among the, 425 cancer patients, 285 (67.1%) of them were females and 140 (32.9%) were males. The majority of the subjects (n=174, 40.9%) were in the age group of 51-61 years and from the others, 121 (28.5%) and 61 (14.4%) were in the age groups of 62-72 years and 40-50 years respectively (Table 1).

In this sample, the majority of the study subjects were Sinhala (n=410, 96.5%) and 11 (2.6%) and 4 (0.9%) were Muslim and Tamil respectively. The majority of the subjects (n=351, 82.6%) were married and most of them (n=256, 60.2%) had one to three children whereas 59 (13.9%) had no children. When considering the occupation of the study subjects 199 (46.8%) were housewives, 134 (31.5%) had lost their employment because of the disease and 33 (7.8%) were self-employers. The monthly income of most of the subjects (n=211, 49.6%) was 15 000-30 000 LKR and 106 (24.9%) subjects had a monthly income of less than 15 000 LKR.

The participants were given a chance to express their satisfaction about their present health condition according to their perception and the level of satisfaction of most of the study participants (n=237, 55.8%) was bad or worse whereas 44.2% (n=188) of the subjects had excellent or good satisfaction about their present health condition. Patients were classified according to the site of the tumor/cancer and the majority of the subjects had cancers in the digestive tract (Figure 1).

Table 1. Socio-demographic characteristics of the cancer patients in Cancer Unit of Teaching Hospital, Karapitiya

Character	Frequency (n)	Percentage (%)
Age (years)		
18-28	11	2.6
29-39	17	4.0
40-50	61	14.4
51-61	174	40.9
62-72	121	28.5
< 72	41	9.6
Gender		
Female	285	67.1
Male	140	32.9
Religion		
Buddhist	408	96.0
Islamic	11	2.6
Hindu	04	0.9
Christian	02	0.5
Ethnicity		
Sinhala	410	96.5
Muslim	11	2.6
Tamil	04	0.9
Marital Status		
Married	351	82.6
Unmarried	37	8.7
Widowed	31	7.3
Divorced	06	1.4
Occupation		
House wife	199	46.8
Left the employment because of disease condition	134	31.5
Private sector	46	10.8
Self- employer	33	7.8
Government sector	13	3.1
Number of children		
1-3	256	60.2
>3	110	25.9
No children	59	13.9

Table 1. Cont.

Character	Frequency (n)	Percentage (%)
Income level (LKR)		
>15000	106	24.9
15000-30000	211	49.6
30000-45000	94	22.1
>45000	14	3.3
Patient's satisfaction about their present health condition (according to the patient's opinion)		
Excellent	30	7.1
Good	158	37.2
Bad	182	42.8
Worse	55	12.9

LKR = Sri Lankan Rupees

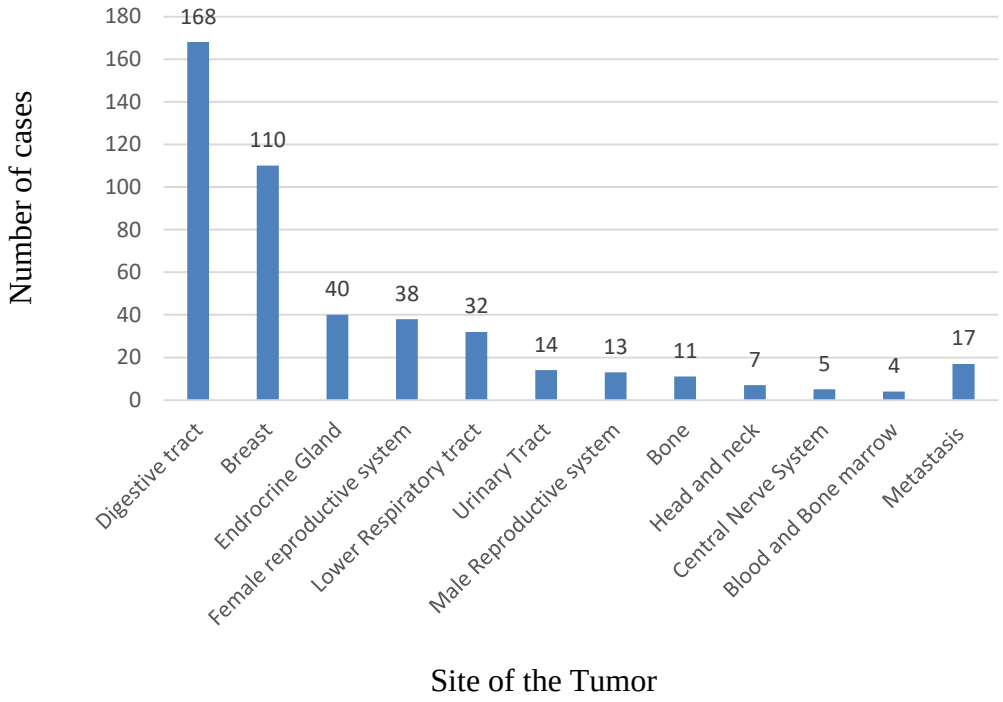

Figure 1. Distribution of the site of the tumour/cancer

Time duration from the primary diagnosis, in most of the study subjects (181, 42.6%) was more than twelve months and 131 (30.8%) subjects were diagnosed during the last six months and others (n=113, 26.6%) between six to twelve months. At the time of data collection, 170 (40%) were on chemotherapy, 70 (16.5%) underwent surgery and 55 (12.9%) were on radiotherapy. Of the remaining subjects, 116 (27.3%) were on other treatments such as hormone therapy (thyroxine) and 14 (3.3%) were not on any treatment.

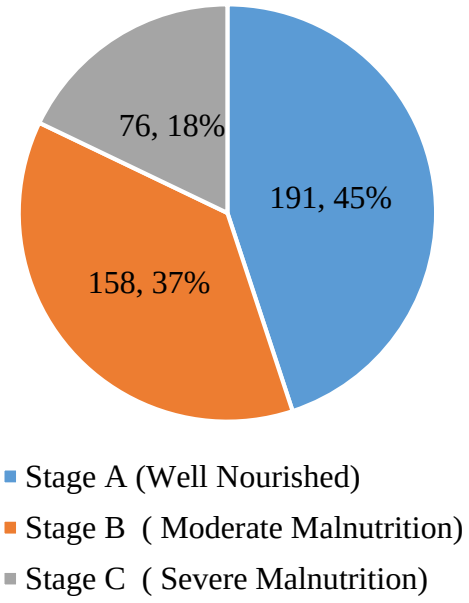

Figure 2. Frequency distribution of nutritional status of the cancer patients in the Cancer Unit of Teaching Hospital Karapitiya by PG-SGA Short Form.
PG-SGA = Patient-Generated Subjective Global Assessment Short Form

According to the analysis of the PG-SGA SF, the majority of the subjects (n =234, 55.0 %) had moderate (Stage B) or severe malnutrition (Stage C) and 191 (45.0%) of subjects were well nourished (Stage A) (Figure 2). From the study subjects who were well nourished, 76 (39.79%) had tumours of the digestive tract, 57 (29.84%) had breast cancers and 19 (9.9 %) had cancers in the endocrine glands such as thyroid. Among the participants with moderate malnutrition, 55 (34.81%) had tumours of the digestive tract, 34 (21.51%) had breast cancers and 19 (12.02 %) had tumours of the female reproductive system. Of those who were severely malnourished, 37 (39.79%) had tumours of the digestive tract, 19 (29.84%) had breast cancers and 8 (9.9 %) had lung cancers.

Analysis of the nutritional status with the type of cancers (Figure 3) demonstrated that from the subjects with cancers of the digestive tract (n=168), the majority (n=87, 54.8%) were moderately or severely malnourished and only 76 (45.2%) were well nourished.

Quality of life of cancer patients

Analysis of the EORTC QLQ - C30 is demonstrated in Table 2 and mean (SD) scores obtained for each of the sub-scales with the mean reference values are indicated. The mean (SD) score for the overall quality of life defined as global health status in this sample was 54.4 ± 27.5 and it indicated poor overall QOL in this group of patients when compared to the reference value. All the dimensions of the functioning scale had low mean sores and all the dimensions of the symptoms scale had high scores (except for diarrhoea) indicating poor QOL.

Correlation between the patient's quality of life and the nutritional status

In this study mean scores of different dimensions of EORTC QLQ - C30 were compared with the nutritional stages of the study subjects to assess the correlation between them (Table 3). According to the results, it was found that there was a statistically significant correlation ($p< 0.001$) between the overall QOL of the study subjects and their nutritional status. Further, similar correlations ($p< 0.001$) were observed between the dimensions of the sub-scales of the EORTC QLQ - C30 and the nutritional status except for "diarrhoea" in the symptoms scale.

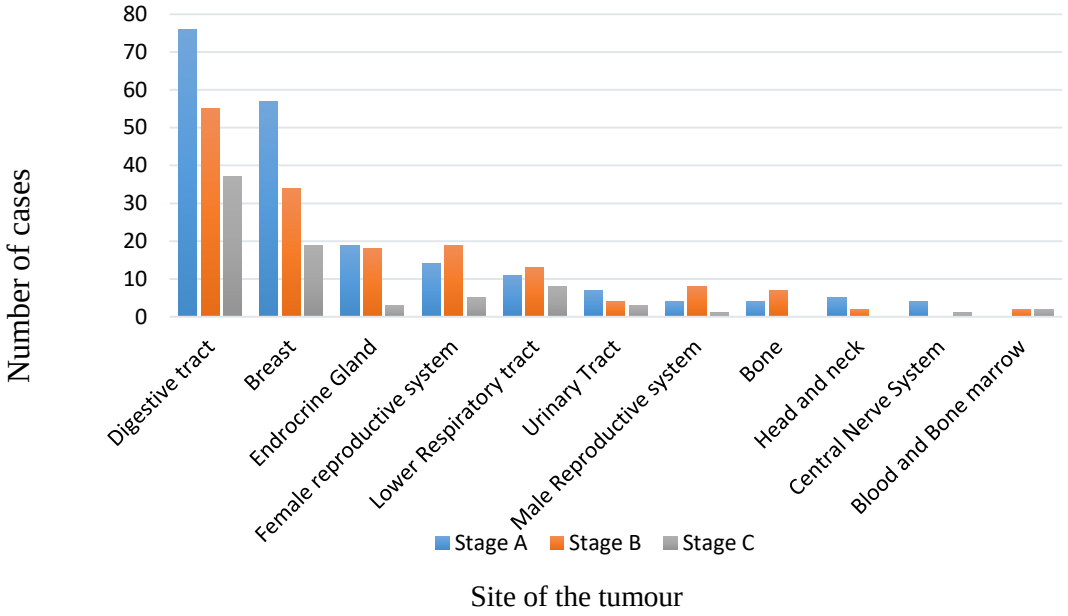

Figure 3. Distribution of nutritional status of cancer patients by the site of the tumour
A = Well nourished, B = Moderate malnutrition, C = Severe malnutrition

Table 2. Mean scores for quality of life by EORTC QLQ - C30

Variable	Mean (±SD)	Mean (EORTC) reference value
The overall quality of life		
Global health status	54.4 ± 27.5	61.3
Functioning scale		
Physical	53.6 ± 28.8	76.7
Role	40.0 ± 31.7	70.5
Cognitive	71.6 ± 28.5	82.6
Emotional	40.7 ± 29.5	71.4
Social	32.7 ± 31.3	75.0
Symptoms scale		
Fatigue	55.3 ± 27.9	34.6
Nausea and vomiting	13.8 ± 27.3	9.1
Pain	47.7 ± 33.0	27.0
Dyspnoea	17.5 ± 28.0	21.0
Insomnia	30.1 ± 38.8	28.9
Appetite loss	34.5 ± 40.6	21.1
Constipation	23.1 ± 38.0	17.5
Diarrhoea	6.5 ± 21.2	9.0
Financial difficulty	91.9 ± 22.1	16.3

EORTC = European Organization for Research and Treatment of Cancer

Table 3. Correlation between the patient's quality of life and nutritional status

Variable	SGA A (n= 191)	SGA B (n=158)	SGA C (n=76)	Mean (EORTC reference value)	p value
	Mean				
The overall quality of life					
Global health status	66.5	51.7	29.6	61.3	0.001*
Functioning scale					
Physical	64.5	50.7	32.6	76.7	0.001*
Role	52.8	36.1	15.8	70.5	0.001*
Cognitive	75.4	71.8	61.6	82.6	0.001*
Emotional	48.2	34.6	34.4	71.4	0.001*
Social	42.8	25.9	21.1	75.0	0.001*
Symptoms scale					
Fatigue	41.5	58.8	82.4	34.6	0.001*
Nausea and vomiting	4.7	14.6	35.0	9.1	0.001*
Pain	37.2	50.1	69.5	27.0	0.001*
Dyspnoea	9.5	19.2	34.2	21.0	0.001*
Insomnia	17.8	35.9	49.2	28.9	0.001*
Appetite loss	10.1	48.3	67.1	21.1	0.001*
Constipation	9.8	24.3	54.0	17.5	0.001*
Diarrhoea	5.4	7.4	7.5	9.0	0.627
Financial Difficulty	94.2	92.8	84.2	16.3	0.001*

* Significant p-value at 0.05 level
EORTC = European Organization for Research and Treatment of Cancer,
SGA = Subjective Global Assessment

Correlation between the quality of life and mode of treatment

The different dimensions of QOL and the different modes of treatment (chemotherapy, radiotherapy, surgery etc.) were analysed to assess the correlation between them. According to the results, there was a significant ($p<0.001$) correlation between the overall QOL (global health score) and the mode of treatment. Further, all the dimensions of the functioning scale had significant ($p<0.001$) correlation with treatment modalities and most of the dimensions of the symptoms scale and modes of treatment did not show significant correlations.

DISCUSSION

In this study sample, the majority were females (67.1%) and the reason behind this may be the higher incidence of breast cancer (the commonest cancer) in Sri Lanka (Jayasinghe, Fernando, Jayarajah, & Seneviratne, 2021). It was also found that the majority of participants (40.9%) were in the age group of 51 to 61 years and it is a well-known fact that the incidence of cancer rises dramatically with age, most likely due to a build-up of risks for specific cancers that increase with age (WHO, 2022).This finding was compatible with two previous studies which were done in 2009 and 2021 in Sri Lanka (Lokuhetty, Ranaweera, Wijeratne, Wickramasinghe, & Sheriffdeen, 2009).

Most of the subjects (74.5%) had low monthly income (less than 30,000 LKR) in this sample and loss of employment due to cancer may be a contributing factor. In this sample, almost one-third of the subjects lost their employment due to the disease condition. Previous studies have reported that cancer survivors have a 1.4 times higher risk of unemployment when compared to healthy controls (de Boer, Taskila, Ojajärvi, van Dijk, & Verbeek, 2009). Low income may be associated with poor nutritional status observed in this study sample other than cancer itself.

According to the site of tumour, most of the patients had cancers in the gastrointestinal tract (39.5%) followed by the breast (25.9%). The Global Cancer Observatory (GCO) report in 2020 reported that breast, lip, oral cavity, colorectal, lung and oesophagus as the top six most prevalent cancers in Sri Lanka. We included cancers in the lip and oral cavity, oesophagus, colon and rectum into one category and that could be the reason for the reported higher prevalence of cancers in the gastrointestinal tract in this study sample.

The majority of subjects in this sample were not satisfied with their present health condition and it may be due to the effect of cancer itself, poor nutrition and the poor socio-economic status. The majority of subjects in this sample were malnourished and this observation confirms with previously published studies where the prevalence of malnutrition was 40-80% (Ferguson et al., 1999; Vergara, Montoya, Luna, Amparo, & Cristal-Luna, 2013). The different rates of prevalence of malnutrition in different studies can be attributed to several factors including differences in assessment tools, differences in ethnicity, food habits, and sample size etc.

In the present study, the quality of life of cancer patients was assessed using EORTC QLQ C30 version 3 which considers assessing the quality of life of cancer patients during the past week. This includes global health status which measures overall QOL, functioning and symptom scales with different dimensions. In this, each item measures a range in score from 0 to 100. A high score for the global health status represents a high QOL and a higher score for a functional scale represents a healthy level of functioning but a high score for a symptom scale represents a higher level of symptomatology or problems.

In the current study, the score for global health is lower than the EORTC reference value for the global score for all cancer types and all stages. Mean scores for all dimensions of the functioning scale were significantly lower than the EORTC reference values and all symptom scales were significantly higher than the EORTC reference values. This could be due to the side effects of cancer disease itself and treatment indicating poor QOL. This finding is also supported by the findings of a recently conducted study in a similar setting in Sri Lanka (Seneviratne, 2020).

A statistically significant association between QOL and the nutritional status of the patients ($p < 0.05$) was observed in this group of patients. In patients who were well-nourished (Stage A), the global quality of life score is above average (66.4 ± 24.8) which is slightly better than the EORTC reference value (61.3 ± 24.2) for all cancer types and scores for all

functional scales were significantly lower than the EORTC reference values. Symptoms scales except for fatigue, pain and financial difficulties are better than the EORTC reference value in patients who were well-nourished. In comparison to the EORTC reference value, the quality of life of participants who were in nutritional stages B and C, the global quality of life score and scores for all functional scales were significantly lower. This indicated that the QOL was low in participants who were in stage B and C and they need more attention to improve QOL. In line with the findings of the current study, some of the previous studies which was done in Philippines and Bangladesh have also observed a high prevalence of malnutrition and there was statistically significant association between QOL and the patient's nutritional status (Alam et al., 2020; Vergara et al., 2013).

CONCLUSIONS

In this group of cancer patients, a predominant proportion of patients exhibited moderate to severe malnutrition and correspondingly poor overall quality of life (QOL). The general dissatisfaction with their current health status among the majority of patients are likely to be attributed to multiple factors which include the debilitating effects of cancer itself, inadequate nutrition, and suboptimal socio-economic conditions. Given the statistically significant correlation between nutritional status and overall QOL in this patient population, it becomes imperative to prioritize nutritional assessment which should be accompanied by appropriate intervention. Consequently, we recommend that comprehensive nutritional evaluations need to be integrated into the initial planning stages of overall cancer management. Such an approach serves to enhance QOL and improve patient general health and well-being of the patient.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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Correlations between Body Compositions with Subclinical Atherosclerosis as Assessed by Carotid Artery Intima Media Thickness in Patients with Type 2 Diabetes Mellitus: A Single Centre Study in Southern Sri Lanka

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a risk factor for atherosclerosis. Subclinical atherosclerosis is identified by measuring carotid artery intima media thickness (CIMT) with ultrasound. This study describes selected factors associated with CAIMT and cardiovascular disease (CVD) risk in patients with T2DM.

Materials and methods: Data of 212 patients registered at a diabetes center in Southern Sri Lanka was analyzed. Details on demographic characteristics, anthropometry, fat mass, glycated haemoglobin (HbA_{1c}) level and CIMT of both common carotid arteries were collected. Association of these parameters with CIMT was elicited using appropriate statistical tests.

Results: There were 98 males and 114 females with the mean age of 58±10 years. Majority of them had overweight and obesity. Poor glycemic control (HbA1c>7%) was detected in 164 (73.3%) patients. There were 166 (78.3%) patients with increased CVD risk (≥ 75th percentile CIMT) based on age and gender specific values. Significant positive correlations were observed between mean CIMT and mean age (r=0.308, p=0.001), age of initial detection of T2DM (r=0.180, p=0.008), duration of T2DM (r=0.228, p=0.001), mean HbA_{1c} (r=0.206, p=0.003) and visceral adiposity (r=0.239, p=0.001). Males had significantly higher mean CIMT (0.736±0.16 vs. 0.678±0.011, p=0.003) and visceral fat (12.3±5.0 vs. 9.9±3.9, p=0.001) than females.

Conclusions: This study underscores that a majority of T2DM patients demonstrated both obesity and suboptimal glycemic control, thus elevating their CVD risk. Factors including age, duration of T2DM, late age of diagnosis, elevated levels of visceral fat, and poor glycemic control were substantively correlated with increased CIMT.

INTRODUCTION

There is a rapid increase in the burden of type 2 diabetes mellitus (T2DM) globally and the incidence is projected to be alarmingly high in the future, leaving 552 million people with T2DM by the year 2030 (Guariguata et al., 2014; Whiting et al., 2011). The situation in Sri Lanka is similar and according to the Indoor Morbidity and Mortality Return in 2016, both T2DM and Cardiovascular diseases (CVD) are among the major causes of hospital deaths (Ministry of Health, Sri Lanka.,2016). An individual with T2DM has increased CVD risk which is about two to three times higher compared to the general population (Carson et al., 2014; Juutilainen et al., 2008). The incidence of CVD and cardio-metabolic risk factors are increasing among Sri Lankans (Arambewela et al., 2018; Wijesuriya et al., 2012; Rannan-Eliya, et al., 2023).

Visceral fat is a key component of metabolic syndrome and it has an independent association with atherosclerosis, incidence of coronary artery disease and related events (Bergman et al., 2007). Metabolic syndrome is a common health concern among Sri Lankans at present (Katulanda et al., 2012). Furthermore, metabolic syndrome is known to increase mortality and morbidity due to CVD in patients with T2DM (Randrianarisoa et al., 2019). Poor glycaemic control in patients with DM further increases the CVD risk (Paul et al., 2015).

Estimation of carotid artery intima-media thickness (CIMT) has been used as a method of identifying subclinical atherosclerosis in patients with T2DM (Bosevski & Stojanovska, 2015). It is reported that CIMT remains a forecaster of CVD events independent of conventional CVD risk factors (Polak et al., 2011). It has been hypothesized that the atherosclerotic process initiates simultaneously in carotid, cerebral, and coronary arteries as it is a systemic process (Nambi et al., 2010). This study describes the baseline characteristics and factors associated with CIMT and CVD risk in patients with T2DM from a developing country. Therefore, this study was designed to, evaluate and characterize Cardiovascular Risk in T2DM Patients using CIMT as a marker to estimate the prevalence of subclinical atherosclerosis and assess the overall CVD risk among patients with T2DM. The objective of the study was to identify the demographic, anthropometric, and clinical factors that correlate with CIMT and the cardiovascular disease (CVD) risk in T2DM patients.

MATERIALS AND METHODS

Study setting

The study was conducted at a Diabetes Centre, Co-operative Hospital, Galle, Sri Lanka where the patients are referred to by physicians for regular follow-up.

Study design and data collection

A cross-sectional extraction of data from the medical records of the patients registered at the center from 2014 to 2017 were done. This includes demographic information and anthropometric measurements, glycated haemoglobin (HbA1c) percentage, body fat and carotid arterial intima-media thickness (CIMT) in both common carotid arteries. Poor glycemic control was defined (when HbA1c was > 7%) using the American Diabetes Association guidelines (American Diabetes Association., 2018).

Anthropometric and body fat measurements

Weight, height and waist circumference (WC) were measured following the standard protocols. Height (HT) was measured using a portable stadiometer with a precision of ± 0.1 cm and readability up to 200 cm. Weight (WT) was measured using a portable beam balance with a

precision of ± 0.1 kg and readability up to 100 kg. Waist circumference (WC) was measured to the nearest 0.1 cm using a non-stretchable measuring tape. WC was measured at the midway between the iliac crest and the lower rib margin keeping the tape horizontal but not compressing the skin. All the anthropometric parameters were measured by a single person to minimize the inter-personal variability.

Body mass index (BMI) and central obesity were interpreted using the cut-off values defined for Asia-Pacific region by the World Health Organization (WHO) (WHO.,2000), accordingly, BMI ranged from ≥23 to 24.9 was considered as overweight and BMI ≥ 25 kg/m^2 as obese. Central obesity was defined when WC exceeds ≥ 90 cm in men and ≥ 80 in women. Body composition was estimated by Bioelectrical Impedance Analysis (BIA) machine (Omron-HBF/516B) by a single trained operator and the percentage of total body fat and visceral fat was estimated as per the protocol (Khaled et al., 1988). Western Pacific Regional Office (WPRO) of WHO reference standards for BF% was used to define obesity based on fat mass if BF% is ≥ 25% and ≥35% in men and women respectively are considered as obese (WHO., 1995).

Carotid intima-media thickness (CIMT)

B mode ultrasound scans of carotid arteries were performed by an experienced radiologist who was blind to clinical information and other investigation findings of the study participants. The same radiologist performed the ultrasound scans to minimize the interpersonal variability of data. "GE" ultrasound unit with standard 2D grey scale imaging with 7.5 MHz linear array transducer was used in the measurements. Greyscale amplification and time-gain compensation curve were adjusted to acquire the best quality images. A single focus point was adjusted at the level of the posterior wall of the carotid artery and the measurements were obtained from the posterior wall in optimum magnification. Both common carotid arteries were scanned up to the carotid bifurcation to identify plaques. Carotid-wall intima-media thickness was determined as the distance between the lumen-intima interface to the media-adventitia interface of the artery wall as described earlier (Yanase et al., 2006). In a longitudinal scan, the anterior and posterior walls of the carotid artery were displayed as two bright lines separated by a linear hypoechoeic zone. Carotid-wall intima-media thickness was defined as the distance between two echogenic lines, including both into the measurement and was measured in both common carotid arteries in a plaque free segment. Cardiovascular risk was ascertained based on age and gender-specific percentile cut-off values for CIMT, as outlined in prior literature (Simova, 2015).

Data analysis

Data were examined for normality using histogram plots and normality tests, before the analysis. Continuous variables were expressed as mean (±SD). The categorical variables were presented as frequencies and percentages. The correlation was analyzed using Pearson correlation coefficient. A comparison of the continuous variables was done using the two-sample t-test. The relationship between categorical variables was analyzed by a sample proportion test. The significance level was defined as a probability of less than 0.05.

RESULTS

There were a total of 238 patients registered at the clinic during the period, but 212 were considered in the final analysis excluding the patients with missing data, patients with plaques in carotid arteries, and patients with history of CVD events. Table 1 shows basic characteristics. They were in the age range of 33-83 years.

Table 1. Basic characteristics of patients

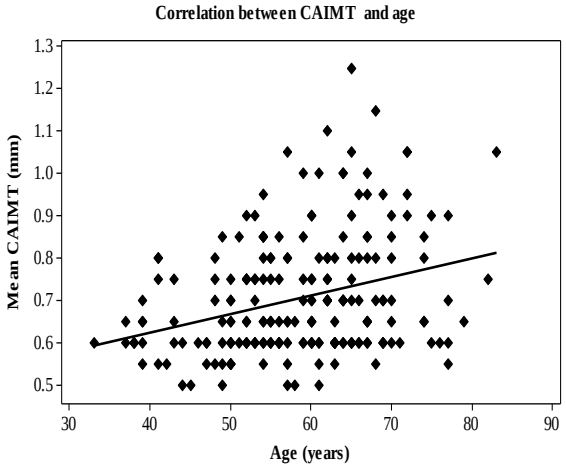
Characteristic	**Patient (n=212)** Mean (±SD
Age (years)	58 ± 10
Age of onset of DM (years)	46 ± 9
Duration of DM (years)	12 ± 6
BMI (kg/m^2)	25.2 ± 3.7
WC (cm)	95.3 ± 11.5
Total fat %	34.0 ± 6.0
Visceral fat %	11.0 ± 4.6
Glycated hemoglobin (HbA_{1c})	8.0 ± 1.4
CIMT (±SD) (mm)	0.704 ± 0.14
Current smokers (n)	17 (8.2%)
Current alcohol users (n)	56 (26.4%)

BMI = Body mass index, WC = Waist circumference, CIMT = Common carotid artery intima media thickness. n = Number of patients. The latest values of the variables are presented. Data are presented as mean (±SD), frequencies and percentages.

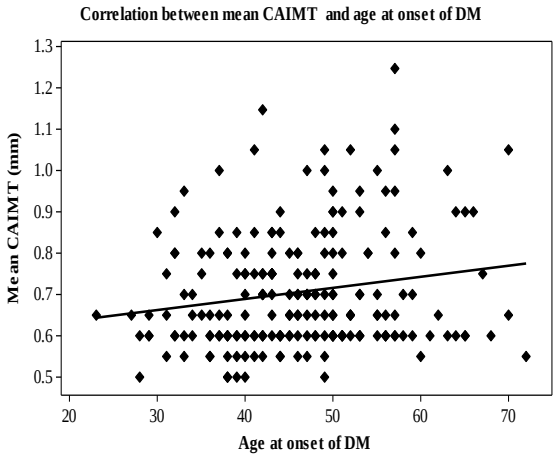
Mean right and left CIMT showed a significant positive correlation with mean age (r=0.286, p=0.001; r=0.280, p=0.001), age of initial detection of diabetes mellitus (r=0.176, p=0.010; r=0.156, p=0.023), duration of DM (r=0.202, p=0.003; r=0.215, p=0.002), mean HbA_{1c} level (r=0.172, p=0.012; r=0.203, p=0.003) and percentage of visceral adiposity (r=0.219 , p=0.001) (Figures 1 A - E). However, waist circumference, BMI, and body total fat did not show significant correlation with the CIMT.

There were 146 (68.9%) patients with overweight and obesity, 62 (29.2%) with normal BMI and 4(1.9%) with underweight defined by BMI. There were 176 (83.0%) patients with obesity defined by the total body fat percentage. There were 184 (86.8 %) patients with central obesity defined according to the waist circumference. The majority of the patients had poor glycemic control 164 (73.3%) according to HbA_{1c} levels. However, most of them had attended a dietician 169 (79.7%).

There were 166 (78.3%) patients with a high risk of CVD ($\geq 75^{th}$ percentile CIMT), 37 (17.4%) with average risk, and 9 (4.2%) with low risk according to the age and gender-specific CIMT values of the right common carotid artery. According to CIMT of left common carotid artery, there were 178 (83.9%) patients with high, 28 (13.2 %) with average and 6 (2.8 %) with low CVD risk. The mean left CIMT was significantly higher than the right CIMT (0.722±0.164 VS 0.688 ± 0.143, p=0.024). Table 2 shows the comparison between males and females.



(A)



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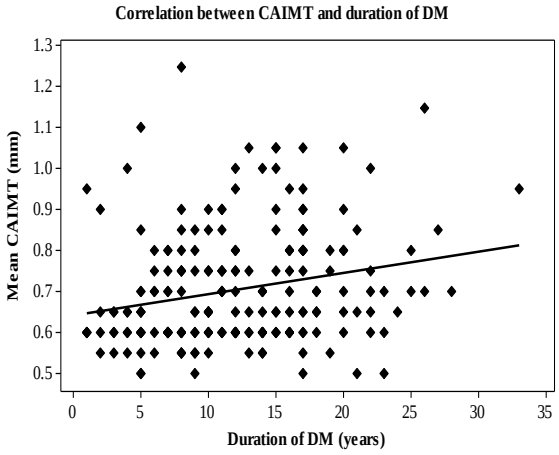

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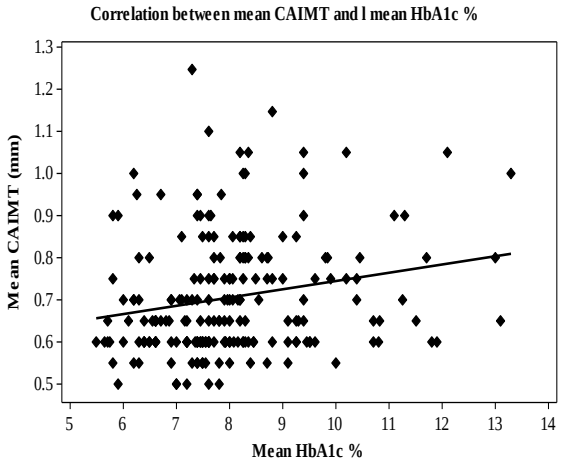
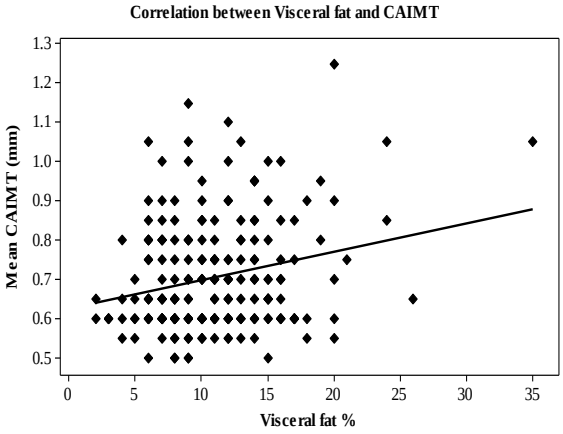


(D)



(E)

Figure 1. Correlation between mean CIMT and (A). Age, (B). Age at onset (initial detection) of diabetes mellitus, (C). Duration of diabetes mellitus, (D). Mean HbA_{1c} level, (E). Mean visceral fat percentage

Table 2. Comparison of characteristics between males and females

Characteristics	Male (n=98) Mean ± SD	Female (n=114) Mean ± SD	P
Age (years)	59 ± 10	58 ± 10	0.374
CIMT (mm)	0.736 ± 0.16	0.678 ± 0.11	0.003
Right CIMT(mm)	0.718 ± 0.16	0.661± 0.11	0.004
Left CIMT(mm)	0.753 ± 0.19	0.695 ± 0.13	0.011
Visceral fat %	12.3 ± 5.0	9.9 ± 3.9	0.001
Total fat %	29.0 ± 4.0	38.2 ± 4.2	0.001
Obesity by total fat mass (n)	83 (84.7%)	93 (81.6%)	0.544
BMI (kg/m^2)	26.0 ± 3.9	24.5 ± 3.6	0.003
Obesity and overweight by BMI (n)	74 (75.5%)	72 (63.1%)	0.049
Waist circumference (cm)	95.7 ± 12.0	95.0 ± 11.2	0.679
Central obesity by WC (n)	73 (74.5%)	111(97.4%)	0.001
HbA_{1c} %	7.83 ± 1.30	8.17 ± 1.58	0.087
Poor glycemic control (n)	73 (74.5%)	91 (79.8%)	0.357

CIMT = Carotid artery intima media thickness, BMI = Body mass index, WC = Waist circumference, HbA_{1c} = Glycated hemoglobin, n = Number of patients

DISCUSSION

In this study we have found in the majority, the age of onset (initial detection) of T2DM was in the fourth decade. Most of them had an increased prevalence of global obesity and central obesity, elevated fat mass and poor glycemic control. Most of the patients are at high risk for cardiovascular disease (CVD) according to common carotid arterial intima-media thickness (CIMT). According to previous studies, obesity is highly prevalent among patients with DM and increases the CVD risk. A prospective follow-up study on adult females showed that obesity or weight gain before the development of diabetes mellitus is strongly associated with coronary heart disease (Cho et al., 2002). A retrospective study done on patients undergoing coronary computed tomography angiography revealed that there was an increased burden of coronary artery disease (CAD) for BMI > 25 kg/m^2 compared to patients with normal BMI (Hulten et al., 2017). In Sri Lanka, the prevalence of obesity among the general population is 34.4 % defined by the Asian cut-off values according to Katulanda et al. (Katulanda et al., 2010). We have found it very high (68.9%), almost doubled in this group of patients with T2DM. They have found the prevalence of central obesity as 26.2 % while we found central obesity as 86.8% in patients with T2DM which is nearly four times. The mean age of initial detection of T2DM in adults is lower in Asians than Caucasians. It is about 53.7 and 53.8 years for Americans in 1997 and 2011 respectively (National Center for Health Statistics., 2013). Asians such as Chinese have found the onset of T2DM as 3 years earlier than Caucasians (Chiu et al., 2011). Moreover, there is a higher prevalence of young diabetes (age of onset ≤ 40 years) among Asians than Caucasians (International Diabetes Federation., 2014). We have found the initial detection of T2DM at 46 years.

Weight gain causes an unfavorable metabolic profile and is a powerful risk factor for CVD. After 2 years of follow-up of newly diagnosed patients with T2DM in

Korea, the group who had gained weight (≥ 10%) indicates a high risk for stroke while weight loss (≥ 10%) causes increased all-cause mortality (Kim et al., 2019). Weight control has been identified as a keystone in the management of diabetes mellitus (Cho et al., 2002). Weight loss has shown an association with improved glycemic control and slow progression of complications related DM. A review article by Ross et al. suggested that prevention of weight gain or weight reduction is an important strategy to maintain glycemic control and to reduce morbidity and mortality in patients with DM (Ross et al., 2011). Retrospective analysis of 3-year weight trajectories of newly diagnosed patients with T2DM demonstrated that those with higher stable weight, lower stable weight, or weight-gain patterns were more likely than those who lost weight to have above-goal HbA_{1C} (Feldstein et al., 2008). A review article based on randomized-controlled trials has shown that with maximal metformin therapy, all non-insulin anti-diabetes drugs were associated with similar HbA_{1c} reductions (Phung et al., 2010). Sometimes weight gain occurs as an adverse effect of drug treatment such as insulin. A retrospective study on treatment chart review for two years of patients on insulin has shown weight gain (Boldo & Comi, 2012). Further, weight is linked to increased morbidity and mortality among DM patients. In the USA a long-term follow-up study (median of 9.6 years) to assess the effect of intensive physical activities on DM patients showed that weight loss did not reduce the rate of cardiovascular events in overweight or obese adults (Wing et al., 2013). A survey conducted on the US population displayed that better medication adherence is associated with weight loss in patients with DM (Grandy et al., 2013). However, there are studies that have found a positive association between weight loss and cardiovascular morbidity and mortality in DM (Doehner et al., 2012). A study conducted among community-dwelling elderly revealed that weight change might be detrimental for the elderly and therefore stabilization of weight is recommended (Beleigoli et al., 2017).

We found that visceral fat measured by BIA is significantly associated with subclinical atherosclerosis indicated by CIMT, but the two commonly measured anthropometric measurements of obesity, BMI and WC have no significant association with CIMT. This finding highlights the lack of sensitivity of both routinely measured anthropometric measurements in assessing visceral fat content or predicting the subclinical atherosclerosis and the need for a better clinical indicator of visceral fat to screen patients in routine clinical setting. However, there are mixed findings on this. Some studies had made known that waist circumference as a determinant of subclinical atherosclerosis in community-dwelling individuals (Alizargar & Bai, 2018). Study done on a group of patients with T2DM in the USA revealed the presence of an inverse association between BMI, WC, and severity of the calcified plaque in the aorta (Yuan et al., 2016) while suggesting increased waist circumference and longer DM duration as independent predictors of CVD only in women (Hong et al., 2015). Measurements of abdominal obesity (reflected by waist-to-hip ratio and WC) correlate better than BMI with arterial stiffness and with subclinical atherosclerosis evaluated by CIMT, independently of the presence of diabetes or hypertension (Recio-Rodriguez et al., 2012). In a group of patients without T2DM or cardiovascular disease, visceral fat is a better predictor of subclinical atherosclerosis than waist circumference (Rallidis et al., 2014).

According to the present study the higher visceral fat, older age, later onset (initial detection) DM, longer duration of DM, and poor glycemic control are associated with increased CIMT which is a surrogate marker of atherosclerosis. The inclusion of CIMT makes the screening superior to detecting coronary artery diseases in

asymptomatic patients with T2DM (Akazawa et al., 2016). A prospective analysis done on members of the Framingham Offspring study cohort has shown that mean common carotid arterial thickness predicts the cardiovascular outcome and it improves the classification of risk of CVD when added to the Framingham risk score (Polak et al., 2011). Further, a longitudinal study among a Finish cohort has discovered a close relationship between carotid arterial structural change (reflected in ultrasonography) with ischemic heart disease (Salonen & Salonen, 1991). A nested case-control study using the participants of the Rotterdam study demonstrated that CIMT is associated with cerebrovascular and cardiovascular events (Bots et al., 1997). A Japanese study has revealed endothelial dysfunction with excess visceral adipose tissue in patients with T2DM (Kurozumi et al., 2016). A cross-sectional study on Japanese exhibits high visceral fat with low subcutaneous fat accumulation as an important determinant of carotid atherosclerosis in patients T2DM (Bouchi et al., 2015). A Romanian study demonstrated that age, HbA_{1c} and visceral fat area are independent predictors of CIMT and therefore controlling abdominal obesity and hyperglycemia (Silaghi et al., 2015). A follow-up study done on patients undergoing coronary angiography showed that duration of T2DM was strongly and positively correlated with all-cause and cardiovascular mortality (Silbernagel et al., 2012).

In this group, male patients had higher mean CIMT, BMI, visceral fat percentage, and a higher proportion of overweight and global obesity (based on BMI) compared to females. In contrast, females had a higher total fat percentage and a higher proportion of patients with abdominal obesity defined by waist circumference compared to males. However, there was no significant difference of mean age, waist circumference, HbA_{1c} percentage and proportion of patients with poor glycemic control between males and females. Existing literature suggests that CIMT would increase with conventional CVD risk factors such as age and male gender (Davis et al., 2001; Silaghi et al., 2015), presence of DM, hypertension and its duration (Rynkowska-Kidawa et al., 2018; Sharma et al., 2009), metabolic syndrome and abdominal obesity (Kerimkulova et al., 2018). A higher proportion of visceral adiposity may alter adipokine profile predisposing the patients to develop CAD (Konishi et al., 2009) and is identified as an independent predictor of diabetes mellitus according to a follow up study among Koreans (E. H. Kim et al., 2018).

The present study is confined to a single center, which inherently restricts the generalizability of the findings across diverse healthcare settings. Future multi-center studies are recommended to validate and extend the observed results.

CONCLUSIONS

In conclusion the present study elucidates that a significant proportion of patients with T2DM were burdened with obesity and suboptimal glycemic control, consequently elevating their risk for cardiovascular disease as evidenced by elevated CIMT. Moreover, the study found that the initial diagnosis of diabetes occurred at a relatively early age. Factors such as later age at the time of diagnosis, advanced age, an extended duration of diabetes management, elevated percentage of visceral adiposity, and poor glycemic control were positively associated with increased CIMT among T2DM patients. Intriguingly, males presented with statistically higher CIMT and levels of visceral fat compared to females. Given these findings, we advocate for targeted interventions aimed at controlling visceral adiposity and glycemic levels as viable strategies to mitigate the progression of atherosclerosis and, by extension, reduce the overall risk of cardiovascular diseases among patients with T2DM.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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Contribution of Coconut Fat to the Daily Calorie and Fat Intake of Adult Women from Rural Settings in Sri Lanka

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ABSTRACT

Background: Coconut is a major ingredient in habitual South-Asian diets including Sri Lanka and is a major source of fat. Reliable and recent information on dietary energy and macronutrient intakes and coconut consumption levels are lacking.
Aim: This study aimed to assess the dietary energy and macronutrient intake and the contribution of coconut to the energy and fat intake of women in rural settings in Sri Lanka.
Methods: A cross-sectional survey was conducted with 408 women (age: 33 ± 6 years) living in rural settings. Nutrient intakes were determined using 24-hour recalls. Socio-demographic and lifestyle characteristics, perceptions, and practices of coconut consumption were collected by an interviewer-administered questionnaire. Habits of coconut consumption were assessed by a food frequency questionnaire.
Results: The daily energy intake of women was 1765 ± 390 kcal/d and the fat intake was 46 ± 18 g/d, which accounted for 23 ± 7% of the total energy intake. The polyunsaturated: saturated fat (P:S) ratio was 0.08. Coconuts contributed to 14 ± 6% of the total energy, 54 ± 21% of the total fat, and 68 ± 26% of the total saturated fat intake. Coconut milk was the major source of coconut fat (33 ± 20%) in their habitual diet followed by coconut scrapes (15 ± 14%) and coconut oil (6 ± 8%).
Conclusions: Coconut contributes to more than half of the total fat and two-thirds of the saturated fat in the high saturated-low polyunsaturated fat diet of women in the rural setting in Sri Lanka. Coconut milk is the major individual contributor of fats.

INTRODUCTION

Coconut palm (*Cocos nucifera*) is one of the major plantation crops in tropical Asian countries including Sri Lanka, India and the Philippines. Almost all the lipids in coconut are present in its kernel. Coconut oil, milk, and scraped or ground flesh are the main coconut products used for culinary purposes. Approximately 92% of the total fatty acids in coconut oil comprises of saturated fatty acids (SFA), in which 63.3% is medium chain triglycerides (MCT) and the most abundant fatty acid is lauric acid (12:0) (Chempakan, 1992). Coconut is a poor source of mono-unsaturated fatty acids (MUFA) and poly-unsaturated fatty acids (PUFA), while oleic (18:1) and linoleic (18:2) acids are the only MUFA and PUFA present in considerable amounts (Perera, 2002).

National-level data on dietary coconut fat (CF) consumption among Sri Lankans is not available. According to a consumer demand report, approximately 10-20% of the total energy in an average Sri Lankan diet is derived from coconut, which is second only to the staple, rice (Samarajeewa and Gunathilake, 2002). Dietary intake studies conducted about two decades ago have shown that Sri Lankans consumed nearly 60% of their dietary fats from coconut (Alahakoon and Silva, 2003; Marambe, Silva, and Sivakanesan, 2005). The mean CF consumption of people in a rural coconut growing area in Sri Lanka was 37.6 ± 18.9 g/d, which contributed to 15.9 ± 5.4% of the total energy and 78.4 ± 12.3% of the total saturated fat intake (Marambe, Silva and Sivakanesan, 2005). However, the dietary habits and CF consumption levels of the Sri Lankan community may have changed over time with the socio-demographic changes, nutrition transition, and changes in economic systems in the recent past.

An increase in per capita availability of food, especially, animal protein and fat as well as plant oils and hydrogenated fats, might have changed the percentage contribution of CF to the daily energy intake (Jayatissa, Wickramasinghe and Piyasena, 2014; Wijesekere, 2015). In addition, the increase in consumption of imported oils such as palm and sunflower oils and the negative perception regarding CF about increasing cardiovascular disease (CVD) risk (Eyres *et al.*, 2016) might have also influenced the coconut consumption in the recent past. However, CF is still one of the significant sources of saturated fat in the diets of Sri Lankans. Thus, it is an important dietary component to modify for the reduction in saturated fat consumption combating the epidemic of chronic non-communicable diseases. Therefore, it is a timely need to update the local literature on the contribution of CF to the total energy and fat intake as well as the perceptions and practices of coconut consumption among Sri Lankans. The findings will support understanding the required dietary modifications to address the growing prevalence of obesity and other chronic diseases such as CVD and diabetes. Therefore, the present study was conducted to assess the daily macronutrient intake, CF consumption, contribution of CF to the total energy and fat intake, and the perceptions and practices of coconut consumption among women in rural settings in Sri Lanka.

MATERIALS & METHODS

Study design

A cross-sectional survey was conducted among non-pregnant, non-lactating, and apparently healthy adult women at the age between 20-55 years, whose dietary habits were not compromised due to uncontrolled non-communicable diseases and who resided in purposely selected two rural settings in Sri Lanka during 2015 and 2016. A sample of 245 women from the Matale Divisional Secretariat in Matale district of Central Province and 163 women from a community living in rubber plantations in Mathugama Divisional Secretariat of Kalutara district in the Western Province of Sri Lanka were recruited.

Ethical approval was obtained from the ethics review committee of the Faculty of Livestock, Fisheries & Nutrition, Wayamba University of Sri Lanka (No. 201509H102) and it was conducted adhering to the ethical principles. Subjects were interviewed at their homes and

written consent was obtained from all participants before the data collection.

Data collection tools and measurements

Information on socio-demographic characteristics such as age, level of education, and lifestyle characteristics were obtained by a pre-tested, interviewer-administered questionnaire. Information on weekly household coconut consumption, monthly coconut oil intake, knowledge and perceptions of the subjects on coconut consumption, and their cooking practices were also collected.
From each subject, a single 24-hour recall was taken via an in-depth interview for food items, preparation methods and quantity eaten. The subjects defined the food quantities eaten using household food measures and those quantities were converted into grams. A qualitative Food Frequency Questionnaire (FFQ) was used to collect data on CF consumption frequencies. The questionnaire consisted of common foods that are prepared with CF, which includes coconut milk, scrapes, or oil.

Data analysis

The dietary intakes of energy and macronutrients of the subjects were determined by analyzing the 24-hour recalls using the modified version of Foodbase 2000 software (Institute of Brain Chemistry and Human Nutrition, UK) (Thamilini, Silva and Krishnapriya, 2014), which consists of nutrient compositions of local food dishes. The percentage contribution of CF to the daily energy intake was calculated as: [(energy intake from coconut/ total energy intake) * 100%]. The percentage contribution of CF to the daily total fat intake was calculated as: [(CF intake/ total fat intake) * 100%]. The percentage contribution of CF to the daily SFA intakes was calculated as: [(SFA from CF/ total SFA intake) * 100%]. Amounts of CF contained in various food dishes were calculated separately for coconut scrapes, milk, and oil using the recipes of each mixed dish- for the amounts of each ingredient in the recipe.

The frequency of consumption of coconut-containing dishes was assessed by the FFQ using a frequency scale; daily, weekly, monthly, and rarely (eaten less than once a month). Statistical analysis was carried out using SPSS statistical software, version 15.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

The study population consisted of 408 women with a mean age of 33 ± 6 years. These women were from 408 households, of which the average number of members was four. The majority of the women (52%) attained the education level up to the General Certificate of Education Ordinary Level examination (Grade 11).

Household coconut consumption

The mean daily household coconut consumption in a family of four members was 0.92 ± 0.42 nuts. Coconut was mainly used for coconut milk extraction (0.72 ± 0.38 nuts/d) and the rest was used for coconut scrapes (0.20 ± 0.12 nuts/d) for culinary purposes. The mean household coconut oil consumption was 2.67 ± 1.52 L/month. Coconut oil was consumed by 98.1% of households as their major cooking oil, whereas others consumed different types of oils such as palm oil and sunflower oil.

Dietary energy and macronutrient intakes

Daily energy and macronutrient intakes and the percentage contribution of macronutrients to the total energy intake of women in the rural setting in Sri Lanka are presented in Table 1. Daily energy and protein intakes were 1765 ± 390 kcal/d and 46 ± 17 g/d, respectively. Daily total fat intake (46 ± 18 g/d) has contributed to 23 ± 7% of their total energy intake, of which saturated fat has contributed to 17 ± 6%. The Polyunsaturated: saturated fat (P:S) ratio was 0.08 ± 0.04.

Table 1. Intake of energy and nutrients by Sri Lankan women in the rural settings

Parameter	Daily intake (Mean ± SD) (n=408)
Total energy (kcal)	1765 ± 390
Protein (g)	46 ± 17
Carbohydrates (g)	307 ± 73
Fat (g)	46 ± 18
SFA (g)	32 ± 14
Cis MUFA (g)	5.7 ± 3.2
Cis PUFA (g)	2.4 ± 1.1
Energy from protein (%)	10 ± 3
Energy from carbohydrates (%)	67 ± 8
Energy from fat (%)	23 ± 7
Energy from SFA (%)	17 ± 6
Energy from Cis MUFA (%)	2.8 ± 1.3
Energy from Cis PUFA (%)	1.2 ± 0.4
PUFA: SFA ratio	0.08 ± 0.04

MUFA = Monounsaturated fatty acids, PUFA= Polyunsaturated fatty acids, SFA= Saturated fatty acids, SD = Standard deviation

Energy and fat intake from coconut

Daily energy and fat intake from coconut (coconut milk, oil, and scrapes) and the percentage contribution of CF to the total energy and fat intakes of women in the rural setting in Sri Lanka are presented in Table 2. Overall, CF contributed 14 ± 6% of the total energy, 54 ± 21% of the total fat, and 68 ± 26% of the total SFA intakes of the women in this study. The CF in these diets is derived from coconut milk (14 ± 9 g) followed by coconut scrapes (7 ± 8 g) and coconut oil (2.8 ± 4 g).

Table 2. Contribution of coconut to energy and fat for Sri Lankan women in rural settings

Level of consumption (Mean ± SD)	Coconut milk	Coconut scrapes	Coconut oil	Total
Amount (g)	59 ± 39	21 ± 22	2.9 ± 4.0	
Energy (Kcal)	135 ± 89	75 ± 79	26 ± 36	236 ± 117
Fat (g)	14 ± 9	7 ± 8	2.8 ± 4.0	24 ± 12
SFA (g)	13 ± 8	6 ± 7	2.4 ± 3.3	21 ± 10
Contribution for total energy (%)	8 ± 5	4 ± 4	1.5 ± 2.0	14 ± 6
Contribution for total fat (%)	33 ± 20	15 ± 14	6.3 ± 7.7	54 ± 21
Contribution for total SFA (%)	42 ± 25	19 ± 18	7.6 ± 9.3	68 ± 26

SAF = Saturated fatty acids, SD = Standard deviation

The frequency of consumption of different coconut-containing food dishes by women in the rural setting in Sri Lanka is presented in Table 3. The majority (93%) of women consumed dishes with coconut milk daily whereas the dishes with coconut scrapes (73%) and oil (60%) were consumed weekly.

Table 3. Frequency of coconut product consumption by Sri Lankan women in rural settings

Coconut product	Frequency of consumption (%)			
	Daily	Weekly	Monthly	Rarely or not consumed
Dishes with coconut milk	93	6	1.0	0
Dishes with coconut scrapes	19	73	5.3	3.4
Dishes with coconut oil	34	60	3.8	2.4

Perceptions and practices regarding coconut consumption

Among them, 78% of participants had not restricted either or both coconut oil and coconut milk. The reasons given by them for not restricting were "because it is an ingredient in traditional cooking practice', 'prefer the taste', 'a nutritious food', 'trust on local oil products than the imported oils' and 'easy accessibility to the coconuts and coconut oil'. Those who have restricted coconut milk and/or oil consumption had given the reasons as 'coconut is high in saturated fat and cholesterol which will increase the risk for coronary heart disease (CHD)', 'medical advice to restrict coconut oil consumption', 'its ability to aggravate gastritis and/ or diabetes conditions', 'its ability to increase body weight and pimples', 'dislike of the taste and smell of coconut oil' and ' it is not a healthy oil which affects the overall health'.

During cooking, the first extraction of coconut milk (added only a little water and milk extraction is the richest with CF) was used by all women in the study with no restriction. To get the extraction of coconut milk, water at room temperature was used by the majority (91%), while 3.8% used warm water and 4.8% used both warm water and water at room temperature alternatively. Hand squeezing of coconut scrapes to extract milk was the most common practice among these women (84%), whereas 11% used a blender and 5.8% used both methods alternatively. The household coconut supply was mainly fulfilled through retail purchases (81%) and others obtained coconut from home gardens (9.1%) and received by neighbors and relatives (9.9%).

DISCUSSION

The dietary assessment of women in the present study reveals important information on macronutrient intake, especially dietary fats in Sri Lankan rural population. We assume that the dietary patterns of these women reflect the dietary patterns of the entire household as consumption of home-made food by all the family members is the usual practice in rural settings in Sri Lanka. The energy and protein intake of women in the present study was lower than the Recommended Dietary Allowance (RDA) for Sri Lankan adult women (RDA: 1950 kcal/day and 53 g/day, respectively) (MRI, 2007). Their percentage consumption of energy from protein and fat fell within the recommended ranges of Food Based Dietary Guidelines for Sri Lankans (10-15% and 15-30%, respectively) (*Food Based Dietary Guidelines for Sri Lankans*. 2021). However, the percentage consumption of energy from carbohydrates and SFA was greater than the recommended dietary guidelines (50-65% and <10%, respectively) (WHO, 2003; *Food Based Dietary Guidelines for Sri Lankans*. 2nd edn, 2011).

The percentage of energy consumption from PUFA is significantly lower than the recommendation (6-11%) and the PUFA: SFA (P: S) ratio of the women is notably lower than the recommended value of 1.0. This is potentially due to the high SFA and low PUFA content in CF which includes about 92% of SFA and 2.5% of PUFA (Mendis, 1996). The major source of fat for the study participants was coconut in the present study. It is found that a low P: S ratio of around 0.2 raises blood cholesterol levels and thus, increases the risk

for CHD, whereas higher ratios around 0.8 are associated with favorable effects on blood cholesterol and cardiovascular health (Garrow, James, and Ralph, 2000). Hence, the diet of present study participants comprises unfavorably high levels of SFA and low levels of PUFA, which potentially contribute to elevating their risk of CHD.

Participants of the present study have consumed a major portion of their fat and SFA in the daily diet from CF. The other dietary fat sources such as animal fat (meat, eggs, fish, milk, butter, cheese, etc.) and other vegetable oils (palm oil, sunflower oil) were consumed at lower levels. The contribution of CF to the total fat intake of the women in this study (54 ± 21%) was only marginally lower than the findings of another recent study (59%) in 2005 (Marambe, Silva, and Sivakanesan, 2005). Thus, the consumption of CF has decreased over time, which may be due to several reasons such as the availability of other dietary fat sources in the market, an increase of animal sources of food consumption, urbanization and changes in food habits, a decline of coconut cultivation and the harvest, fluctuations of coconut prices and health concerns on SFA, cholesterol and chronic diseases.

Daily household coconut consumption in this study (0.92 ± 0.42 nuts per day for a family of four) was slightly higher than the general recommendation of one medium-sized coconut per day for a Sri Lankan family of five members (*Food Based Dietary Guidelines for Sri Lankans*, 2021). The highest contribution for daily CF intake of women was from coconut milk (59%) followed by coconut scrapes (29%) and coconut oil (12%). This reflects the Sri Lankan traditional cooking practices that are mainly based on curries made with coconut milk, porridge, and milk rice (rice cooked in coconut milk). Coconut scrapes are mainly used for coconut Sambol (a mixture of coconut scrapes, onion, and chili as key ingredients) and coconut Rotti (a flatbread mixed with coconut) which are frequent components of Sri Lankan diet. Cooking in oil such as frying and tempering was less frequent among this study group and thus, the consumption of coconut oil was comparatively lower than coconut milk and scrapes. This finding emphasizes that limiting the consumption of coconut milk and scrapes, which accounts for nearly 90% of the CF in the diet of women in rural settings in Sri Lanka, is a potential avenue to reduce the high SFA content in their diet.

However, national-level data on the energy, macronutrient intakes and dietary CF consumption levels among Sri Lankans are still inconsistent. Findings from this present study may not adequately represent the national-level nutrient consumption of Sri Lankans due to the limited sample size, and it is possible under or over-reporting due to the usage of a single 24-hour recall as the primary source of data collection. Therefore, there is a timely need for a national-level population survey to assess the CF intake among adults in Sri Lanka and its association with the risk of CHD. It is crucial to recognize the major sources of SFA in the diet to initiate dietary modifications and to develop translational approaches for dietary behavioral change to increase the P:S ratio of Sri Lankans' diet to reduce the risk of CHD.

CONCLUSION

Coconut fat, which predominantly comprises SFA with low PUFA, is the major source of dietary fat among the rural population in Sri Lanka. Coconut milk is the most common component consumed, followed by coconut scrapes and coconut oil. Intake of high SFA and low PUFA were the major concerns in the habitual diet of Sri Lankan women in rural settings. Dietary modifications to reduce SFA and to increase PUFA contents in the diet of the rural population in Sri Lanka are of paramount importance.

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DECLARATION OF CONFLICT OF INTERESTS

The content of this publication is solely the responsibility of the authors and does not necessarily represent the official views of the National Science Foundation of Sri Lanka. The authors declare no conflict of interest.

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Fasting Plasma Glucose Levels in Relation to the Nutritional Status, Dietary Intake, and Lifestyle Factors among a Group of Sri Lankan Undergraduates: A Cross-Sectional Study

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ABSTRACT

Introduction: Diabetes mellitus (DM) is a global public health concern intricately linked to dietary habits, physical inactivity, and other lifestyle factors.
Objectives: This cross-sectional study aimed to elucidate the associations between fasting plasma glucose (FPG) levels, nutritional status, dietary patterns, and lifestyle factors among undergraduates at the Faculty of Allied Health Sciences, University of Ruhuna, Sri Lanka.
Materials & Methods: It was a descriptive cross-sectional study. Data were collected via a self-administered questionnaire. Anthropometric measurements were obtained following standard protocols. Fasting plasma glucose was quantified using the GOD-PAP method. Statistical analysis was performed using appropriate statistical tools.
Results: Participants (n = 100) were in the age range of 20 - 28 years and 58% were females. Their FPG levels ranged from 70 to 108 mg/dL with 3% of impaired fasting glycaemia (IFG) and no instances of DM. Mean (SD) BMI was 20.9 (3.4) kg/m2 . Among them, 29% were overweight or obese. A statistically significant positive correlation was observed between FPG and both waist circumference (p=0.004) and BMI (p=0.019). Dietary assessment revealed suboptimal adherence to recommended portion sizes across all six food categories. Despite 82% consuming three main meals per day, meal-skipping was reported by 36% of the participants. Adequate water intake was reported among 60%, the majority abstained from alcohol and smoking. However, a considerable percentage reported consumption of junk foods. Physical inactivity and inadequate sleep were reported by 73% and 72% of the participants respectively.
Conclusions: The prevalence of IFG among the studied undergraduate population is low. However, the majority exhibited suboptimal dietary practices and insufficient engagement in physical activities, which warrant further attention for preventive health strategies.

INTRODUCTION

The global prevalence of prediabetes was estimated at 7.3% of the adult population in 2017 and half of them were under 50 years of age (Hostalek, 2019). It is revealed that the global prevalence of pre-diabetes will be >470 million in 2030 according to an analysis published in 2014 (Adam et al., 2014). A cross-sectional study carried out on a nationally representative sample of 5000 adults between 2005 and 2006 in Sri Lanka showed that the age and sex-standardized prevalence of total diabetes (previously diagnosed and undiagnosed) and total pre-diabetes among adults ≥ 20 years in Sri Lanka were 10.3% and 11.5% respectively (Katulanda et al., 2008). Diabetic and pre-diabetic cases compared to normal glucose tolerance people are older, physically inactive, and living in urban areas (Katulanda et al., 2008). The projected diabetes prevalence in Sri Lanka for the year 2030 is 13.9% (Katulanda et al., 2008). Further, Katulanda et al, have shown that diabetes and prediabetes patients had higher BMI, waist circumference, waist-to-hip ratio, systolic/diastolic blood pressure, low-density lipoprotein and triglycerides (Katulanda et al., 2008). In Asian countries like India, young adults adapting to the new lifestyle tend to develop type 2 DM (T2DM) increasing the burden of non-communicable diseases (NCDs). In the recent past, there is an increased trend of developing T2DM and pre-diabetes not only among the adults and elders but also in young adults (Nagarathna et al., 2020).

Lack of physical activity decreased high-density lipoprotein cholesterol (HDL-Ch), family history of T2DM, increased body mass index, and high blood pressure were found to be the common risk factors for T2DM. According to the existing literature, unawareness and over-positivity of own health might considerably affect college students in New York. These findings point to a greater need to increase awareness, promoting early detection and adaptation to a healthy lifestyle by changing their behaviors to prevent T2DM (Antwi et al., 2020).

A survey conducted on students aged 18 and older at a Midwest Public University, Mankato, USA revealed lack of physical activity, increased body mass index, and abdominal obesity as major risk factors for T2DM (Ferrian et al., 2011). Undergraduates are vulnerable developing diabetes due to physical inactivity, decreased blood HDL-Ch and unhealthy dietary practices.

There is a paucity of literature in these areas for undergraduates and hence, it is important to add new knowledge to the local literature. This will be beneficial for designing educational and health promotion programs targeting undergraduates at the early stage of their lives.Therefore, our objectives were to describe the fasting plasma glucose (FPG) level, nutritional status, diet and other lifestyle factors among undergraduates at the Faculty of Allied Health Sciences, University of Ruhuna.

MATERIALS & METHODS

Study participants

It was a descriptive cross-sectional study conducted from August to September 2022. All the undergraduates in one batch (n= 100) who were apparently healthyand were not on specific diet plans at the Faculty of Allied Health Sciences, University of Ruhuna were recruited following convenient sampling.

Study instruments and data collection procedure

Ethical approval for the project was obtained from the Ethical Review Committee, Faculty of Allied Health Sciences (Reference no: 125.07.2022). After obtaining the informed written

consent a pretested, self-administered questionnaire was used to collect data on their socio-demographic data, other necessary basic information including lifestyle, dietary behaviors, and exercise/physical activities. Involvement in Yoga, housework and domestic chores, brisk walking, dancing, gardening, workplace activity, carrying/moving moderate loads (< 20kg), manual labor (e.g.: roofing, thatching, painting), games and sports for at least 150 - 300 minutes per week were considered as regular involvement of exercise/physical activities (Ministry of Health, 2021). Information on the duration of exercise/physical activities and the frequency of consuming different food categories (Cereals and starchy foods, Pulses/ fish/ eggs/ lean meat, fruits, fresh milk and its fermented products, nuts/ oily seeds, salty foods, sugary food items, junk foods, supplements and junk foods) and number of meals consume within a day were obtained.

Anthropometric measurements

Height, weight, waist circumference (WC), and hip circumference (HC) were measured following the standard protocols. The height of the participants in bear feet without headwear was measured using a stadiometer with a precision of 0.1 cm. The weight of the participants in bear feet and light clothing was measured using a digital beam balance with a precision of 0.1 kg (Thu Tran et al., 2018). Body mass index (BMI) was calculated using the weight in kilograms and height in meters (Lim et al., 2017). Waist circumference was measured at the level of the midpoint between the lowest point of the rib cage and the top of the iliac crest horizontally using a standard measuring tape without pressing on to the skin after breath-out while standing to thenearest 0.1 cm. Hip circumference was measured to the nearest 0.1 cm at the widest position of the buttocks while standing (WHO, 2008; Thu Tran et al., 2018).

Fasting plasma glucose estimation

Sample of venous blood was collected after eight hours of fasting. Fastingplasma glucose (FPG) was estimated in duplicates using GOD-PAP method (Human GmbH, Glucose liquicolor, complete test kit; Cat no.10121) by BS120-Mindray fully automated biochemistry analyzer. American Diabetes Association criteria (ADA, 2022) was used to define diabetes (FPG ≥126 mg/dl) and IFG (FPG ≥100 mg/dL to <126 mg/dL). When FPGconcentration was not within the normal range the repeat estimation was performed before confirming the IFG.

Data analysis

Data was analyzed using SPSS version 21. Frequencies/percentages were used to present the categorical variables (gender, ethnicity, total monthly family income, meal, water, and alcohol consumption patterns, number of sleeping hours, smoking, regular exercise, and consumption of food items) and continuous variables (age, anthropometric parameters and blood glucose estimation) were presented as mean and standard deviations. The association between two continuous variables (anthropometric parameters and FPG) was determined using the Pearson correlation coefficient. The level of significance was considered as 0.05.

RESULTS

Basic characteristics of the participants

Socio-demographic and other basic characteristics of 100 study participants are shown in Table 1. Participants were in the age range of 20 and 28 years. Ethnically, 95% (n=95) of the sample identified as Sinhalese, and females constituted 58% (n=58) of the sample. Most of them earned the 50 000 LKR or below per month.

Table 1. Demographic characteristics of the undergraduates

Basic characteristics	**(n=100)**
Age	
Mean ± SD (years)	24.4 ± 1.8
Gender	
Male	42 (42%)
Female	58 (58%)
Anthropometry	
Weight Mean ± SD (kg)	54.6 ± 11.4
Height Mean ± SD (cm)	160.9 ± 9.1
BMI Mean ± SD	20.9 ± 3.4
Waist circumference Mean ± SD (cm)	75.3 ± 8.1
Hip circumference Mean ± SD (cm)	83.0 ± 9.4
WHR Mean ± SD	0.91 ± 0.7
Blood glucose estimation	
Fasting plasma glucose level Mean ± SD (mg/dL)	83.4 ± 6.6
Number of normoglycaemic participants	97(97%)
Number of participants with impaired fasting glycaemia	03 (03%)
Number of participants with diabetes mellitus	00 (00%)
Ethnicity	
Sinhalese	95 (95%)
Other	05 (5%)
Total monthly family income	
≤ LKR 25000	23 (23%)
> LKR 25000-≤ LKR 50000	29 (29%)
> LKR 50000- ≤ LKR 75000	19 (19%)
>LKR 75000-≤ LKR 100000	08 (8%)
No regular income	21 (21%)

BMI = Body mass index, WHR = Waist to Hip ratio

The dominant weight range was 50-55 kg, accounting for21% (n=21) of the sample, while the mostfrequent height bracket was 150-152 cm, observed in 12% (n=12) of participants. Interms of Body Mass Index (BMI), the mean for females was 21.2, which was not statistically different from the mean for males, 20.7 (p=0.447). Utilizing the World Health Organization (WHO) classification criteria for Asian populations, 15% (n=15) were categorizedas overweight and 14% (n=14) as obese. The majority (45%, n=45) fell within the normal BMI range, whereas 26% (n=26) were underweight. When abdominal obesity is defined by using International Diabetes Federation (IDF) suggested cut- off values for waist circumference (WC) for Asians, 12% (n=12) exhibited abdominal obesity (9% in males and 3% in females). A notably higher prevalence (65%) of abdominal obesity (35% in males and 30% in females) was observed when using the waist-to-hip ratio (WHR) specific to Asians (>0.95 in males and >0.8 in females) to define obesity. Fasting plasma glucose (FPG) levels spanned from 70 to 108 mg/dL, and impaired fasting glycaemia (IFG) was reported in 3% of the study population.

Lifestyle and dietary habits

Lifestyle and basic dietary habits are demonstrated in Table 2. The majority consume three main meals per day though some of the participants (36%, n=36) skipped their main meals; lunch (47%, n=17), breakfast (45%, n=16) and dinner (8%, n=3). The majority (72%,n=72) had less than seven hours of continuous sleep at night because theyspent time watching movies, studying, and participating in clinical training program. Smoking was relatively uncommon, and the significant majority, 73% (n=73) reported a lack of regular physical exercise.

Table 3 shows the food consumption frequency among the study participants.

Table 2. Distribution of selected lifestyle characteristics among the undergraduates

Lifestyle characteristics	Frequency (%) (n=100)
Regular consumption of three main meals per day	
Yes	82 (82)
No	18 (18)
Regular skipping of any main meal	
Yes	36 (36)
No	64 (64)
Daily water intake in glasses (1 glass~200 mL)	
>10	21 (21)
8 – ≤10	39 (39)
<8	40 (40)
Daily number of sleep hours at night	
≥7hrs	28 (28)
<7hrs	72 (72)
Alcohol consumption †	
Never	73 (73)
Occasional	23 (23)
Infrequent	02 (2)
Frequent	02 (2)
Daily	00 (0)
Smoking	
Non-smoker	92 (92)
Ex-smoker	03 (3)
Current smoker	05 (5)
Regular exercise/physical activities	
Yes	27 (27)
No	73 (73)

†*Daily = Everyday, Frequent = 3- 4 days/week, Infrequent = Less than 3 days/week, Occasional = 1-2 days/month*

Table 3. Distribution of consumption of food items among the undergraduates

Food item	Daily	Frequently (3-4 days/ week)	Sometimes (1-2 days/ week)	Rarely (2-3 days/ month)	Not at all
	Percentages (%) (n=100)				
Cereals and starchy foods	100	0	0	0	0
Pulses/ fish/ eggs/ lean meat	27	26	28	13	6
Vegetables	100	0	0	0	0
Fruits	2	13	48	37	0
Fresh milk and its fermented products	2	9	28	44	17
Nuts/ oily seeds	5	8	31	46	10
Salty foods (salty snacks, instant noodles, chips etc.)	22	27	38	11	2
Sugary food items (biscuits, cakes, sweets etc.) and beverages	31	36	29	4	0
Junk/fast foods	13	18	50	12	7
Supplements	7	2	6	8	77
Energy drinks	0	1	8	19	72

All the participants consumed cereals, starchy foods, and vegetables daily. A nearly equal number of participants consumed pulses/fish/eggs/ lean meat daily, frequently, and 1-2 days per week. Most of the participants (48%, n=48) had fruits 1-2 days per week. Most of the participants consumed fresh milk and its fermented products and nuts/oily seeds rarely, 2-3 days per month. This reflected that their daily diet is not planned according to the food-based dietary guidelines. Some of the participants consumed high-salt food (22%, n=22), and sugary food items (31%, n=31) daily. Most of them (77%, n=77) did not consume nutritional supplements (multivitamins, minerals, proteins/ amino acids, essential fatty acids etc.) and energy drinks (72%, n=72). Among them 50% of the participants tend to consume junk foods, 1-2 days per week.

Association between anthropometric parameters and FPG

Significant positive correlation was observed between FPG and selected anthropometric parameters/indices except WHR (Table 4), though the correlations were weak.

Table 4. Association between anthropometric parameters and the FPG

Measurement	r	p
Weight	0.312	0.002
Height	0.251	0.012
BMI	0.234	0.019
Waist circumference	0.288	0.004
Hip circumference	0.169	0.092
WHR	0.144	0.153

Pearson correlation coefficient was used in the analysis. BMI = Body mass index, r = Pearson correlation coefficient, p = p value WHR = Waist / hip ratio

DISCUSSION

Basic characteristics and lifestyle factors

According to the present study, 3% of the participants in the age ranged between 20-28 years old had impaired fasting glycaemia, though there was no diabetes mellitus. However, the estimated regional prevalence of IFG among South-East Asians by the IDF is to be 9.2% (between 20-79 years old adults) in 2021 is expected to rise up to 9.4% by 2045 (IDF,2021). The difference in the prevalence of prediabetes may be due to the wider age range considered by IDF.

Katulanda *et al*. showed sex and sector (urban and rural) standardized prevalence of IFG and undiagnosed DM of 2.3% and 1.3% respectively in the age range of 20-29 years (Katulanda et al., 2008). Though the two studies demonstrated closely similar results for the prevalence of prediabetes, the variation in theprevalence of diabetes may be due to the difference in the type of population and the smaller sample in the current study restricted to undergraduates.

According to the findings of the current study, the majority of the participants (60%) drink adequate amounts of water, more than 8 glasses (>2000 mL) per day. A study done to determine the diet and lifestyle among university students in Brunei showed that nearly 58% of them drink ≥ 2 L of water (Yun, Ahmad and Quee, 2018). In line with the findings of the current study, an Indonesian study revealed that most of the college students tend to drink ≥ 8 glasses of water (54%) (Djannah and Matahari, 2020). Sri Lankan FBDGs recommend drinking 8-10 glasses (one glass~200 mL) of water for ahealthy adult to keep the hydration. Water is preferred over any other beverages as it does not contain any added sugar, sweeteners and calories. But herbal drinks, coconut water/king coconut water, fresh fruit juices (without added sugar or salt), tea and coffee (without milk and sugar) can be taken other than the water (Ministry of Health, 2021).

Though the diet is not healthy, most of them (82%, n=82) had three main meals daily in the present study. Among those who skip meals (18%, n=18), skipping breakfast and lunch is commoner than dinner. The main reason for skipping breakfast was to prevent getting late to attend to the clinical training. In addition, the low-income level of the family and the increased expenditure on food might have an adverse impact on their lifestyle, because about half of them are from families with an income level of less than 50000 LKR. It was revealed that they share food/meals with their colleagues rather than consuming a balanced diet.

A previous study done among (n=250) undergraduates of Eastern University of Sri Lanka shows that 36% of students skip their breakfast. The main reason for skipping breakfast was lack of time (68.1%). Other possible reasons they found were low appetite in the morning (18.7%), absence of a variety of foods (25.3%), unavailability of foods (9.9%) and other reasons (18.7%) (Handuwala et al., 2022). A systematic review revealed lack of time and hunger, weight control, lack of money, religious/fasting behavior and poor cooking skills as possible reasons for meal skipping among young adults (Pendergast et al., 2016).

The majority of the participants in the present study (72%, n=72) do not sleep seven or more than seven hours continuously in the night due to various reasons such as involvement in studying, clinical training, and watching movies showing sleep deprivation. According to the national guidelines seven or more hours of sleep per night is recommended for the age range of 20 -60 years (Ministry of Health, 2021). It is necessary to make them aware of the importance of having adequate quality sleep and on time management which allows for finding adequate time for sleep. Sleep is an important requirement for tissue repair, productivity improvement and to maintain overall good health (Elkhenany et al., 2018; Hosker, Elkins and Potter, 2019). In addition, sleep is involved in theregulation of metabolism that affects the physiological processes (Grandner et al., 2016) and lack of sleep increases insulin resistance (CDC, 2022). A Pakistan study done among medical students showed negative impact of poor sleeping quality on academic performance. Most of the students with lower average GPA had bad sleep duration (<5-7 hrs.) (Maheshwari and Shaukat, 2019). A cross-sectional study done among undergraduates at the Faculty of Medicine and Allied Health Sciences, Rajarata University, Sri Lanka showed that 25.9% of students (168/649) had bad sleep quality according to the Pittsburgh Sleep Quality Index (Gunathilaka et al., 2020).

In the present study, the majority of undergraduates were non-alcoholic (73%, n=73). A previous study done among 193 Sri Lankan veterinary undergraduates showed that alcohol consumption (n=6) and smoking (n=2) were rare among them (Rita et al., 2014). A previous study done in Myanmar among university students showed 20.3% prevalence of alcohol consumption (males: 36.0%, females: 10.8%). The majority of the participants were non-smokers (92%, n=92), only 5% of participants were current smokers while only 3% were ex-smokers showing that smoking is not popular among the current study group. In contrast to that, a previous study done among the students of the University of Tuzla, Bosnia and Herzegovina in 2012/2013 (Ibisevic et al., 2015) showed that 22.8% were current smokers and 7.8% were ex-smokers and there was no gender difference. A study in Yemen showed a prevalence of 33.1% of smokers among students in Hodeidah University (Nasser and Zhang, 2019). They found a significant association between smoking and increasing age, year of study and family income. Differences between the results in this study and the others may be due to cultural differences of the populations.

The majority of participants (73%, n=73) do not engage in regular exercise. Engaging in regular exercise/physical activities is considerably low among the participants of the current study, which needs to be improved. At least a 150-300 minutes of moderate-intensity physical activities per week is recommended to improve health and prevent most ofhealth-related issues (Ministry of Health Sri Lanka,2021). A Sri Lankan study done to determine physical inactivity among physiotherapy undergraduates at the University of Colombo in 2013 (Ranasinghe et al., 2016) showed a high

percentage of participants were inactive (48.7%) according to the International Physical Activity Questionnaire categorical score. They found lack of time, not having support and motivational encouragement, limited facilities, and lack of accessibilities to engage in sports or physical activities, and low self-efficacy as causes for them withdrawing from engaging in sports and physical activities. Asians show decreased physical activities and increased rate of obesity, and increased insulin resistance are as the major factors of the increasing prevalence of T2DM among Asians at younger ages (Ramachandran, 2012). A national survey done among students at University of Kansas (Huang et al., 2003) showed that most of the college students failed to meet the physical activity guidelines.

Food consumption in relation to the guidelines

According to the current study except the starchy food consumption, their diet is not according to the recommendations of food-based dietary guidelines for Sri Lankans. However, the present study indicated the frequency of the consumption of different food items, it neither showed the details about the portion sizes according to FBDGs (Ministry of Health, 2021) nor the amount of nutrition intake.

A cross-sectional study conducted among the undergraduates of Eastern University, Sri Lanka showed a significant difference in the consumption of individual food categories between males and females (Karthijekan and Anthony, 2020). They used 11 food items and the frequency of consumption was recorded using a self-administered questionnaire. Most of the food items were consumed equally by both sexes including rice, grains, vegetables, fish and sea foods, sweets, hot beverages and dried fish while red meat, fruits, and fast foods were consumed more by males. They have shown that males tend to eat sugary items more thanfemales. The current study also shows a considerable number of participants consuming sugary foods daily (31%), 3-4 days per week (36%) and 1-2 days per week (29%). According to the FBDGs for Sri Lankans, sugary food items (biscuits, cakes and other sweets) and beverages should be avoided as much as possible. The daily consumption of total sugar should be less than that of 30g/6 teaspoon (tsp.) by a person from all sources (Ministry of Health, 2021). WHO also recommends reducing the intake of sugar in view of reducing the risk of NCDs (WHO, 2018).

Avoidance of salty foods like pickles, cheese, sauce (e.g.:- ketchup/ soy sauce), processed meats (e.g.:- sausage/ ham/ bacon), salty snacks, instant noodles, chips, salted nuts are recommended. The recommended amount of iodized salt per person per day is less than 5 g (one tsp.) (Ministry of Health, 2021). High sodium intake (1tsp contains 2300 mg of sodium) is associated with high blood pressure and cardiovascular diseases (World Health Organization (WHO), 2018). The current study shows a considerable number of participants consuming salty foods daily (22%), 3-4 days per week (27%), and 1-2 days per week (38%) respectively. They also tend to eat foods like salty snacks, instant noodles, chips, salted-roasted nuts, pickles and other ready-to-eat meals. Consumption of these food items containing considerable amounts of hidden salt and fat could have long-term health effects and increase the risk of NCDs (Strazzullo et al., 2009). However, the amount of salt intake was not estimated using laboratory-based methods in this study.

A previous study done among undergraduates of Bangladesh University of Health Sciences, Dhaka (Biswas et al., 2020) shows an increasing trend of consuming salty fast foods and they had the habit of adding salts in the table.

Another study done to determine salt consumption and awareness among medical students in Angola demonstrated high salt intake and unsatisfactory behaviors towards salt consumption among them. The majority (96.7%) of them consumed more than 5g of salt per day and the average salt intake was 14.2 ± 5.1 g/ day. Though the majority were aware of the health-related consequences of high salt intake only 6.5% of participants knew about their high salt intake behavior. This shows the importance of assessing the knowledge and perception of high salt consumption and making young adults aware on health-related consequences (Magalhães et al., 2014).

According to the present study, 50% tend to consume junk foods 1-2 days per week. In contrast to a study done among students at Eastern University in Sri Lanka showed a lower intake of fast food (≤ 3 times/ week) and red meat, but males consumed more fast food than femalessignificantly (Karthijekan and Anthony,2020). Another local study revealed anincreased demand for fast food amongstudents at the Faculty of Applied Science, University of Jayewardenepura in Sri Lanka. According to them, males had the tendency to eat fast foods more than that of the females. They found the price (39%), taste (38%) and cleanliness of the outlet (12%) as the factors that they considered when buying fast food (Jayasinghe and De Silva, 2014). Undergraduates with their busy schedules tend to consume unhealthy diet which may potentially contributes to the development of NCDs in later life. This shows the requirement of improving dietary behavior in order to lead a healthy life minimizing the risk of developing NCDs in the future.

Nutritional status, association between selected anthropometric parameters and the fasting plasma glucose concentration

According to the present study, 15 (15%) were overweight and 14 (14%) were obese. Most of the participants (45%, n=45) were in the normal range of BMI while 26 (26%) of them were underweight according to the WHO classification for Asians. Among university students in Malaysia 27% were underweight while 12% were overweight. The findings are closely related to the findings of the present study (Huda and Ahmad, 2010).

The present study identified 12 (12%) students with abdominal obesity, while another study conducted among veterinary students at University of Peradeniya ofSri Lanka in 2014 identified 39 (20%) students with abdominal obesity, 19 (10%) with overweight and a single participant with global obesity. There was a higher prevalence of IFG (42%, n=82) among them compared to the present study. However, the present study showed higher rates of obesity (14%) than the mentioned study (n=1) (Rita et al., 2014). Another local study demonstrated overweight (35.2%), obesity (10.7%), underweight (8.6%) and normal weight (46%) among undergraduates at the Faculty of Health-Care Sciences, Eastern University (Karthijekan and Anthony, 2020).

Waist circumference(r=0.288) and BMI (r=0.234) had a significant positive correlation with the FPG level while hip circumference and WHR did not show a significant correlation (r=0.169) with the FPG level. In a cross-sectional study done using ADA screening guidelines for diabetes on 44 college students at an Upstate New York public college showed a significant direct correlation between the risk of developing T2DM with BMI (r=0.488). However, according to the present study the association between BMI and the plasma glucose level

(r=0.234) was weaker than the mentioned study. Similarly, they showed a significant positive correlation between FBG and waist circumference (r=0.416, p=0.005), and not with WHR (r=0.257, p=0.093) which is in line with the current study (Antwi et al., 2020). Another survey done in adult Indians demonstrated the presence of a significant positive correlation between WC and the high risk for diabetes based on the Indian Diabetes Risk Score (Nagarathna et al., 2020). In consistent with that Katulanda etal found that WC was significantly higher among those with DM and prediabetes in another cross-sectional study done on Sri Lankans aged ≥ 18 years old (Katulanda etal., 2008).

The present study plays an important role in filling the gaps in the local literature pertaining to the health and wellness of young adults. However, there are limitations identified with the study such as not analyzing the amount of food and nutrition intake, small sample size and being a single-center study.

CONCLUSIONS

This study reveals a low prevalence of impaired fasting glycaemia (IFG) among young undergraduates, with no instances of Type 2 Diabetes Mellitus reported. However, dietary habits largely deviate from the food-based dietary guidelines and meal-skipping is notably common. Although water intake is generally adequate, suboptimal engagement in regular physical activities is widespread. Furthermore, the majority of participants reported insufficient nightly sleep, even though smoking and alcohol consumption are relatively uncommon within this cohort.

These findings underscore the necessity for regular educational and awareness programs focusing on nutrition, dietary habits, and lifestyle choices. Such interventions are integral for promoting holistic well-being among undergraduates. Additionally, the data suggests an urgent need for structural changes within the academic environment to facilitate healthier lifestyle choices among students.

By offering targeted awareness and facilitating conducive environments, institutions can better equip undergraduates to make informed decisions regarding their health, thereby potentially mitigating the future onset of metabolic disorders and related health issues.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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