ORIGINAL ARTICLE

Total Cholesterol Level and Its Associated Factors among Hospitalized Elderly: A Cross-sectional Study

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ABSTRACT

Introduction: The total cholesterol level of hospitalized elderly should be monitored as the long-term consequence of hypercholesterolemia is the development of cardiovascular diseases. This study aimed to determine the total cholesterol level among hospitalized elderly and its associated factors in Hospital Serdang, Selangor. **Methods:** A total of 115 hospitalized elderly aged 60 and above have participated in the study. Data on socio-demographic characteristics, medical backgrounds, anthropometric measurements, biochemical, dietary intake, malnutrition risk, lifestyle, and total cholesterol level were obtained through face-to-face interviews and physical examination. Dietary intake was assessed using the two-day diet history. Mini Nutritional Assessment (MNA-SF) was used to determine the malnutrition risk of the subjects. **Results:** The prevalence of hypercholesterolemia among the subjects was 29.6% with a mean value of 4.08 ± 1.51 mmol/L. Comorbidities specifically dyslipidemia (χ^2=14.291, p≤0.0005), and other comorbidities (χ^2=7.843, p=0.005), waist circumference (r=0.199, p=0.033), LDL-C (r=0.455, p≤0.0005), triglyceride (r=0.459, p≤0.0005), fasting blood glucose (r=0.386, p≤0.0005), carbohydrate (r=-0.333, p≤0.0005), fat (r=0.327, p≤0.0005), saturated fat (r=0.304, p=0.001), PUFA (r=0.275, p=0.003), MUFA (r=0.327, p≤0.0005), sodium (r=0.211, p=0.024), and duration of physical activity (r=-0.287, p=0.002) were found to be significantly associated with the total cholesterol level. Meanwhile, other variables were found not to be associated. **Conclusion:** Current study reported the prevalence of hypercholesterolemia of 29.6%. Comorbidities specifically dyslipidemia and other comorbidities, waist circumference, LDL-C, TG, fasting blood glucose, carbohydrate, fat, saturated fat, PUFA, MUFA, sodium, and duration of physical activity were significantly associated with the total cholesterol level. Meanwhile, other variables were not significantly associated.

Keywords: Dyslipidemia, Hypercholesterolemia, Elderly

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INTRODUCTION

Cholesterol is an important molecule that has roles for functioning cells (1). However, it may possess harmful effects on the body if it reaches abnormal blood concentrations (1). According to CPG Management of Hypertension (2018), high cholesterol ranked 5th in the mortality attributed to risk factors in 2008 (2). Moreover, hypercholesterolemia is classified as one of the major modifiable risk factors for atherosclerotic cardiovascular disease (CVD) (3). Data from the previous National Health and Morbidity Survey (NHMS) in the years 2011 and 2015 showed an increasing trend for hypercholesterolemia. The prevalence of hypercholesterolemia was from 35.1% (2011) to 47.7% (2015) (4,5). Recent data showed that overall prevalence among adults aged 18 years and above reduced to 38.1% (6). Although hypercholesterolemia was a health problem in adults, the prevalence of hypercholesterolemia was also high among the Malaysian elderly population. The prevalence of elderly screened for hypercholesterolemia in the past 12 months was 75.5% (7). A rural community study among subjects aged 55 years and above in Sarawak reported a 63.1% prevalence of hypercholesterolemia (8). From previous studies, the gap exists as most of the studies were conducted among the elderly in community settings which might give different results in hospital settings. Also, previous studies lack in terms of assessment of the dietary intake and malnutrition risk. Therefore, this study was conducted to determine the association between socio-demographic characteristics, medical backgrounds, anthropometric measurements, biochemical data, dietary intake, malnutrition risk, and lifestyle with the total cholesterol level among hospitalized elderly in Hospital Serdang, Selangor. The identification of associated factors will provide an insight into health-related policymakers to develop

suitable intervention programs to improve the current public health especially hospitalized elderly patients.

MATERIALS AND METHODS

Study Population and Design

This cross-sectional study was conducted among hospitalized elderly aged between 60 to 81 years old in Hospital Serdang, Selangor. Ethical approval was obtained from the MREC (Medical Research and Ethics Committee) (Project reference number: NMRR-18-3027-44602). Using a purposive sampling method, surgical, medical, orthopedic, urology, cardiology, and cardiothoracic wards were selected in the study. Elderly patients who agreed to participate and met all the criteria were included in the study. The highest sample size calculated was 96 and after 20% was adjusted for the non-response rate, the study had recruited a total of 115 subjects. The inclusion criteria were Malaysian citizens aged 60 years old and above. The caregiver was included when the subjects need help to answer the questions. The exclusion criteria for this study were subjects that have a psychiatric illness. Critically ill subjects who need to be ventilated or sedated were also excluded from this study. A total of 115 (100%) patients agreed to participate in the study. Before data collection was conducted, eligible subjects signed the information sheets and consent forms. Ample time was given for subjects to understand the rules. Some selected information was retrieved from the medical record and physical examination. The data collection was conducted for 3 months from January to March 2020.

Measurements

Socio-demographic Characteristics

A face-to-face interview was conducted to obtain sociodemographic information, such as age, sex, ethnicity, education level, marital status, living area, monthly household income, source of income, living arrangement, and previous occupation.

Medical Backgrounds

The medical background of the subject was determined through medical records and/or interview sessions. Bed-head tickets were referred to when the data were not available yet in the system. Length of stay in the hospital, number and type of comorbidities, family history, the number of medications, polypharmacy status, and dietetic consultation history were recorded. The types of comorbidities were reported such as hypertension, diabetes, dyslipidemia, ischemic heart disease, or any other types of diseases. Polypharmacy was characterized by consuming 5 or more medications (9).

Anthropometric Measurements

For anthropometric measurements, the data were obtained through the medical record, interview sessions, and/or physical examinations. Anthropometry measurements obtained included current weight, previous weight, weight change, percentage weight change, height, body mass index (BMI), waist circumference, and calf circumference. Mid-upper arm and calf circumferences were measured to determine the weight for non-ambulatory subjects. Meanwhile, knee height was measured to determine the height of non-ambulatory subjects. BMI was further classified according to the classification of the World Health Organization (10). Waist circumference was compared with normal cut-off circumference for Asians for both men and women. For calf circumference, the measurements for both men and women were classified according to the indicator of muscle wasting in the elderly (11).

Biochemical Data

Biochemical data were obtained from the medical records. Data obtained consists of fasting serum lipid profile; LDL-C, HDL-C, and TG fasting glucose level, renal profile; urea, sodium, potassium, chloride and creatinine, and liver function test; total protein and albumin. Next, the value obtained was compared with the normal cut-off point used in Hospital Serdang.

Dietary Intake

The dietary intake of the subject was assessed using two days of diet history based on the diet at home which consists of one day weekdays and one day weekends through interview sessions. The caregiver may assist to help to answer the question on the dietary intake of the subject. Nutrient components of the subjects were assessed using Nutritionist Pro software (Version 2.5, Axxa System, USA). Then, all components of dietary intake such as energy, carbohydrate, fiber, protein, fat, saturated fat, polyunsaturated fat (PUFA), monounsaturated fat (MUFA), trans-fatty acid, dietary cholesterol, and sodium were compared with Medical Nutrition Therapy (MNT) for Hyperlipidemia (2001) (12). Fluid intake was also being assessed and further compared with the Clinical Practice Guideline (CPG) for dyslipidemia (13). The caloric requirement for the elderly was estimated using the quick method formula.

Malnutrition Risk

Mini Nutritional Assessment- Short Form (MNA-SF) was adopted to assess the malnutrition risk (14). It comprises of 7 items which are questions 1 to 7. Questions 1 to 5 were assessed using an interview session meanwhile question 6 and 7 were assessed using the physical examination. The score varies from 0 to 3. Questions 1 to 7 provide different options for each score depending on the questions except item 4 which only provides a score of 0 for "yes" and score 2 for "no". The maximum screening score is 14 points. 12 to 14 points indicate normal nutritional status, 8 to 11 points are at the risk of malnutrition while 0 to 7 indicate malnourished.

Lifestyle status

The components of lifestyle evaluated were smoking

status, alcohol consumption, and physical activity level. For smoking, the subject was asked about the amount, type, and status of smoking. The same question was asked regarding the alcohol in which the subject reported the amount, type, and status of alcohol consumption. For physical activity, components of frequency, intensity, and time were being asked (15). The determination of moderate-intensity physical activity is based on the following: brisk walking, dancing, gardening, walking a dog (16). Meanwhile, vigorous-intensity physical activities consist of swimming, cycling, playing football, jogging, and playing basketball (16). Smoking status and physical activity were compared with standard recommendations based on 5th Edition Clinical Practice Guideline (CPG) Management of Dyslipidemia (CPG Dyslipidemia, 2017) (13)) while alcohol intake was compared with the Medical Nutrition Therapy (MNT) of Hyperlipidemia (MNT Hyperlipidemia, 2001) (12).).

Total Cholesterol Level

The total cholesterol level was obtained through medical records. The value was then being compared according to the definition of hypercholesterolemia in which is a value greater than or equals to 5.2 mmol/L and/or use of cholesterol-lowering medication (17) indicates hypercholesterolemia.

Statistical Analysis

Data analysis was conducted using the IBM SPSS Version 22 with the level of significance at $p<0.05$. The normality of the data distribution was checked before the analysis started. Data were presented in frequency, percentage, mean, standard deviation, minimum, and maximum value. Categorical variables were analyzed using the Chi-square test while continuous variables were analyzed using Pearson's product-moment correlation. For the Chi-square test, when the assumptions have been violated, Fisher's exact test was used to determine the significance between the variables.

RESULTS

Table I shows the socioeconomic and medical characteristics of the subjects. Based on the demographic information, 60% were male and 40% were female with the mean age of 66.97 ± 5.41 years. Most of the subjects were Malay (51.3%), live in urban areas (78.3%), and secondary school leavers (45.2%). More than half (79.1%) of the respondents are married and live with their spouse and family (52.2%). Most subjects have an income ranging from RM500-RM1000 per month (31.3%). Most of the subjects (45.2%) received money from their family and used to work in the private sector (48.7%).

The average length of stay of subjects in the ward was 4.03 ± 4.19 days. The highest number of comorbidities was 9 while 4.3% of the subjects did not have any comorbidities. As for the number of medications, the subjects consumed up to 27 types of medications. More than half of the subjects were practicing polypharmacy. The current finding shows that less than 10% of the subjects have records of dietetic consultation. Most of the subjects had hypertension, diabetes, dyslipidemia, and ischemic heart disease. Another 49.6% have diseases other than hypertension, diabetes, dyslipidemia, and

Table I: Socioeconomic and medical characteristics of the subjects (n=115)

Characteristics	*n (%)*	*Mean SD*
Age (Years)		66.97 ± 5.41
Monthly household income (RM)		1510.14 ± 1498.07
Sex		
Male	69 (60.0)	
Female	46 (40.0)	
Ethnicity		
Malay	59 (51.3)	
Chinese	28 (24.3)	
Indian	26 (22.6)	
Others	2 (1.7)	
Residence		
Rural	25 (21.7)	
Urban	90 (78.3)	
Education level		
No formal education	13 (11.3)	
Primary level	31 (27.0)	
Secondary level	52 (45.2)	
Pre-university	4 (3.5)	
University	15 (13.0)	
Marital status		
Single	3 (2.6)	
Married	91 (79.1)	
Divorced	5 (4.3)	
Widowed	16 (13.9)	
Monthly household income		
Less than RM 500	31 (27.0)	
RM 500 – RM 1000	36 (31.3)	
RM 1001 – RM 1500	9 (7.8)	
RM 1501 – RM 2000	14 (12.2)	
More than RM 2000	25 (21.7)	
Source of income		
Salary	3 (2.6)	
Pension fund	21 (18.3)	
EPF	2 (1.7)	
Charity aid	37 (32.2)	
Family	52 (45.2)	
Living arrangement		
With spouse only	30 (26.1)	
With spouse and family	60 (52.2)	
Others	25 (21.7)	
Previous occupation		
Self-employed	21 (18.3)	
Government	22 (19.1)	
Private	56 (48.7)	
Unemployed	16 (13.9)	
Length of stay (days)		4.03 ± 4.19
Number of comorbidities		2.90 ± 1.52
Number of medications		7.97 ± 5.96
Record met with the dietitian	7 (6.1)	
Comorbidities (Hypertension)	82 (71.3)	
Comorbidities (Diabetes)	74 (64.3)	
Comorbidities (Dyslipidemia)	44 (38.3)	
Comorbidities (IHD)	37 (32.2)	
Comorbidities (Others)	57 (49.6)	
Family history (Dyslipidemia)	17 (14.8)	
Family history (Others)	98 (85.2)	
Polypharmacy	77 (67.0)	

IHD. From the result, more than 80% of the subjects have a family history of various diseases while the rest have a family history of dyslipidemia.

The anthropometric measurements and biochemical data of the subjects are shown in Table II. Most of the subjects have no change in weight for the past 3 months. About 29.6% of the subjects experienced weight loss while 17.4% experienced weight gain. It is shown that most of the subjects have normal BMI classification (38.3%), followed by overweight (29.6%), underweight and obese class I (13.0%), obese class II (5.2%), and obese class III (0.9%). For the waist and calf circumferences more than half of the subjects fell under the normal classification. Most of the subjects have a normal range of biochemical data except for fasting blood glucose and creatinine. More than half of the subjects have an abnormal range of fasting blood glucose (57.4%) and creatinine (52.2%). The prevalence of hypercholesterolemia was 29.6% with a mean cholesterol level of 4.08 ± 1.51 mmol/L.

The nutrients based on the dietary intake are shown in Table III. The mean energy intake for the subjects is 1581 ± 560 kcal. More than half of the subjects did not meet the energy requirement, and some exceeded the energy requirement. For carbohydrates, a big proportion of the subjects had exceeded the recommendation while only 5.7% had insufficient carbohydrates in their dietary intake. For protein, fat, saturated fat, PUFA, dairy products, and fluid, almost a quarter of the subjects meet the recommendation while more than half had insufficient nutrients. The subjects either meet or had insufficient intake of MUFA. For trans fatty acids, all subjects had met the recommendation. On the other hand, all subjects did not meet the recommendation for fiber. All subjects have sufficient intake of dietary cholesterol and sodium and some had exceeded the requirement.

The malnutrition risk and lifestyle of the subjects are shown in Table IV. The mean score obtained was 12.04 ± 2.38 with a minimum value of 5 and a maximum value of 14. The total score was further classified into three categories. More than half (66.1%) of the subjects have normal nutritional status. For smoking status, more than half of the subjects are smoking (75.7%). The common type was the normal cigarette which accounts for more than 90% of the subjects. The least popular type in the study was the electronic cigarette and other types like "rokok daun" with 3.6%. In contrast with smoking status, the percentage of subjects who did not drink alcohol is much higher (94.8%). Beer is more commonly consumed (83.3%) as compared to wine (16.7%) among subjects who are alcohol drinkers. In terms of physical activity, more than half of the subjects had some activities recorded. Among subjects who carried out physical activity, most of the subjects carry out a moderate-intensity activity (54.3%) between 20 minutes to 60 minutes per day. Despite the time spent and physical activity recorded, only 31.3% had met the recommendation.

Table II: Anthropometric measurements and biochemical data of the subjects (n=115)

Characteristics	*n (%)*	*Mean SD*
Weight (kg)		66.18 ± 13.85
Previous weight (kg)		67.55 ± 13.54
Weight change (kg)		2.73 ± 4.47
Percentage weight change (%)		4.17 ± 6.94
Height (cm)		162.32 ± 9.06
BMI (kg/m^2)		25.13 ± 5.36
Waist circumference (cm)		82.17 ± 16.27
Calf circumference (cm)		33.69 ± 4.13
The trend of weight change		
Positive (weight gain)	20 (17.4)	
Negative (weight loss)	34 (29.6)	
No change (weight maintain)	61 (53.0)	
BMI classification		
Underweight (<18.5 kg/m^2)	15 (13.0)	
Normal (18.5-24.9 kg/m^2)	44 (38.3)	
Overweight (25.0-29.9 kg/m^2)	34 (29.6)	
Obese I (30.0-34.9 kg/m^2)	15 (13.0)	
Obese II (35.0-39.9 kg/m^2)	6 (5.2)	
Obese III (≥40 kg/m^2)	1 (0.9)	
Waist classification		
Normal	61 (53.0)	
Abnormal	54 (47.0)	
Calf classification		
Normal	101 (87.8)	
Abnormal	14 (12.2)	
Total cholesterol level (mmol/L)		4.08 ± 1.51
Total cholesterol classification		
Normal (<5.2 mmol/L)	81 (70.4)	
Abnormal (≥5.2 mmol/L)	34 (29.6)	
LDL-C classification		
Normal (0-3.37 mmol/L)	100 (87.0)	
Abnormal	15 (13.0)	
HDL-C classification		
Normal (1.04-1.55 mmol/L)	80 (69.6)	
Abnormal	35 (30.4)	
Triglyceride classification		
Normal (0-1.7 mmol/L)	98 (85.2)	
Abnormal	17 (14.8)	
Fasting blood glucose classification		
Normal (<5.6 mmol/L)	49 (42.6)	
Abnormal	66 (57.4)	
Urea classification		
Normal (3.2-9.2 mmol/L)	76 (66.1)	
Abnormal	39 (33.9)	
Sodium classification		
Normal (136-145 mEq/L)	79 (68.7)	
Abnormal	36 (31.3)	
Potassium classification		
Normal (3.5-5.1 mmol/L)	96 (83.5)	
Abnormal	19 (16.5)	
Chloride classification		
Normal (98-107 mEq/L)	66 (57.4)	
Abnormal	49 (42.6)	
Creatinine classification		
Normal (62-115 µmol/L)	55 (47.8)	
Abnormal	60 (52.2)	
Protein classification		
Normal (64-83 g/L)	93 (80.9)	
Abnormal	22 (19.1)	
Albumin classification		
Normal (35-50 g/L)	74 (64.3)	
Abnormal	41 (35.7)	

Table III: Dietary intake of the hospitalized elderly (n=115)

Nutrients	*n (%)*			*Mean SD*
	Meet	*Exceed*	*Insufficient*	
Energy (kcal)	24 (20.9)	14 (12.2)	77 (67.0)	1581.37 ± 560.67
Carbohydrate (%)	4 (11.4)	29 (82.9)	2 (5.7)	62.42 ± 8.81
Protein (%)	32 (27.8)	17 (14.8)	66 (57.4)	13.74 ± 3.64
Fat (%)	29 (25.2)	26 (22.6)	60 (52.2)	24.09 ± 7.72
Saturated fat (%)	27 (23.5)	10 (8.7)	78 (67.8)	4.47 ± 3.34
PUFA (%)	16 (13.9)	24 (20.9)	75 (65.2)	3.70 ± 3.47
MUFA (%)	7 (6.1)	-	108 (93.9)	4.18 ± 3.77
Trans fat (%)	115 (100.0)	-	-	0.00 ± 0.00
Fiber (g)	-	-	115 (100.0)	6.25 ± 3.98
Dairy products (serving)	26 (22.6)	3 (2.6)	86 (74.8)	-
Dietary cholesterol (mg)	55 (47.8)	60 (52.2)	-	99.93 ± 130.05
Sodium (mg)	85 (73.9)	30 (26.1)	-	2019.10 ± 1102.90
Fluid (cups)	34 (29.6)	3 (2.6)	78 (67.8)	4.30 ± 2.06

Table IV: Malnutrition risk and lifestyle of the hospitalized elderly (n=115)

Characteristics	*n (%)*	*Mean SD*
MNA-SF score		12.04 ± 2.38
Classification		
Normal nutritional status (12-14 points)	76 (66.1)	
At the risk of malnutrition (8-11 points)	33 (28.7)	
Malnourished (0-7 points)	6 (5.2)	
Lifestyle; Smoking status		
Yes	28 (24.3)	
No	87 (75.7)	
Smoking (type)		
Cigarette	26 (92.9)	
Electronic	1 (3.6)	
Others	1 (3.6)	
Smoking (pieces/day)		3.92 ± 8.74
Alcohol status		
Yes	6 (5.2)	
No	109 (94.8)	
Alcohol (type)		
Wine	1 (16.7)	
Beer	5 (83.3)	
Alcohol (unit/day)		0.06 ± 0.33
Physical activity status	70 (60.9)	
Yes	45 (39.1)	
No		
Physical activity (intensity) n=70		
Light	25 (35.7)	
Moderate	38 (54.3)	
Vigorous	7 (10.0)	
Physical activity (min/day) n=70		
Less than 20 min/day	16 (22.9)	
20-60 min/day	38 (54.3)	
More than 60 min/day	16 (22.9)	
Physical activity (meet recommendation) n=70		
Yes	36 (31.3)	
No	79 (68.7)	
Physical activity (min/week)		171.48 ± 325.34

Table V: Pearson correlation between socio-demographic, medical background, anthropometric, biochemical, dietary intake, malnutrition risks, lifestyle and stress level with total cholesterol level among hospitalized elderly (n=115)

Variables	*r*	*p*
Age (year)	-0.088	0.348
Length of stay (days)	-0.070	0.458
Number of comorbidities	-0.032	0.732
Number of medications	0.107	0.253
Weight (kg)	-0.014	0.885
Previous weight (kg)	-0.043	0.650
Weight change (kg)	-0.161	0.085
Percentage weight change (%)	-0.150	0.110
Height (cm)	-0.052	0.581
BMI (kg/m^2)	0.009	0.927
Waist circumference (cm)	0.199	0.033*
Calf circumference (cm)	0.043	0.650
LDL-C (mmol/L)	0.455	0.000*
HDL-C (mmol/L)	0.049	0.602
Triglyceride (mmol/L)	0.459	0.000*
Fasting Blood Glucose (mmol/L)	0.386	0.000*
Urea (mmol/L)	-0.034	0.719
Sodium (mEq/L)	-0.027	0.774
Potassium (mmol/L)	0.089	0.344
Chloride (mEq/L)	-0.080	0.398
Creatinine (µmol/L)	0.012	0.902
Protein (g/L)	-0.080	0.397
Albumin (g/L)	0.053	0.574
Energy (kcal)	0.111	0.239
Carbohydrate (%)	-0.333	0.000*
Protein (%)	0.128	0.172
Fat (%)	0.327	0.000*
Saturated fat (%)	0.304	0.001*
PUFA (%)	0.275	0.003*
MUFA (%)	0.327	0.000*
Trans fat (%)	-	-
Fiber (g)	0.142	0.131
Dietary cholesterol (mg)	0.129	0.168
Sodium (mg)	0.211	0.024*
Fluid (cups)	0.076	0.420
MNA-SF score	0.017	0.855
Smoking (pieces/day)	0.159	0.090
Alcohol (unit/day)	0.010	0.913
Physical activity (min/week)	-0.287	0.002*

*p<0.05

Pearson correlation and Chi-square tests in Table V and Table VI showed that comorbidities specifically dyslipidemia (χ^2=14.291, p≤0.0005), and other comorbidities (χ^2=7.843, p=0.005), waist circumference (r=0.199, p=0.033), LDL-C (r=0.455, p≤0.0005), triglyceride (r=0.459, p≤0.0005), fasting blood glucose (r=0.386, p≤0.0005), carbohydrate (r=-0.333, p≤0.0005), fat (r=0.327, p≤0.0005), saturated fat (r=0.304, p=0.001), PUFA (r=0.275, p=0.003), MUFA

Table VI: Chi-Square test between socio-demographic characteristics, medical background, malnutrition risk with total cholesterol level among hospitalized elderly (n=115)

Variables	X^2	p^c
Sex Male Female	1.002	0.317
Ethnicity Malay Non-Malay	0.998	0.318
Living area Urban Rural	2.823	0.093
Education level No formal education Received formal education		0.752[a]
Marital status Not married Married		1.000[a]
Monthly household income ≤ RM 2000.00 > RM 2000.00	0.091	0.763
Source of income Family Other sources	0.024	0.878
Living arrangement With spouse and family Others	1.670	0.196
Previous occupation Unemployed Employed		0.556[a]
Record met with the dietitian Yes No		0.672[a]
Comorbidities (Hypertension) Yes No	0.630	0.427
Comorbidities (Diabetes) Yes No	0.819	0.365
Comorbidities (Dyslipidemia) Yes No	14.291	0.000*
Comorbidities (IHD) Yes No	3.156	0.076
Comorbidities (Others) Yes No	7.843	0.005*
Family history (Dyslipidemia) Yes No		0.233[a]
Polypharmacy Yes No	0.111	0.740
Malnutrition risk classification Normal nutritional status At the risk of malnutrition/malnourished	1.193	0.275

[a]*Fisher's Exact test;* [c]*Chi-square test*

(r=0.327, p≤0.0005), sodium (r=0.211, p=0.024), and duration of physical activity (r=-0.287, p=0.002) were found to be significantly associated with the total cholesterol level. Meanwhile, other variables were found not to be associated.

DISCUSSION

This study showed that there was no significant association between sociodemographic characteristics with total cholesterol levels (p>0.05). Similarly, some studies showed that there was no association between age and lipid profile which may reflect the differences in lifestyle and particularly in nutrition (18,19,20). A previous study found that the prevalence of dyslipidemia was significantly higher in men (21). The value of total cholesterol is also significantly higher in female subjects (22). This can be explained as menopause leads to changes in hormonal status and lipid profile in women (23). A previous study which is inconsistent with current findings found a higher serum total cholesterol in Malays, compared with Chinese subjects (20). The difference was due to polymorphism of lipoprotein called apolipoprotein E (apoE) which differ the lipoprotein between population (24). Consistent with the current study, no association was found between marital status and total cholesterol levels (25). This is because the need for companion/support does not significantly lead to poorer health status (26)

Past literature has found an association between higher socioeconomic status and dyslipidemia (27). This is related to a wider choice of food selection which leads to a better lipid profile. Comorbidities specifically dyslipidemia and other comorbidities were found to be significantly associated with total cholesterol level (p<0.05). Contrary to past studies, the finding of this study found that diabetes and hypertension did not significantly influence the total cholesterol level. In the past, a study conducted among subjects aged 18-90 years old north, middle, and south regions of Jordan found that diabetes and hypertension were the risk factors for total cholesterol levels (28). About 30-60% of patients with Type 2 diabetes have dyslipidemia (29). As a result of poor glycemic control, the serum lipid profile will increase (30). Besides, it is suggested that dyslipidemia is the effect of critical hypertension as elevated blood pressure causes certain disturbances in lipoprotein metabolism (31).

Dyslipidemia is found to be significantly associated with total cholesterol in the current study. Past studies also revealed that the changes in the value of total cholesterol were affected by the other lipid indicators (31). Findings from this research found that other types of comorbidities were significantly associated with total cholesterol. Based on the questionnaires, common comorbidities besides diabetes, hypertension, and ischemic heart disease were kidney disease. Consistent with the previous study, it is shown that people who have kidney disease experienced some changes in the metabolism of lipoprotein (32). Therefore, the lipid profile altered in the presence of kidney disease.

Waist circumference was significantly associated with total cholesterol levels (p<0.05). Consistently, a study conducted among subjects aged 65 and over on the factors of dyslipidemia among the elderly found that abdominal obesity is strongly associated with

abnormal lipid profiles (31). Prior studies ascertained the association of abnormal waist circumference with poor control of serum lipids (33). Besides that, a meta-analysis study among the Asian population found that the measure of central obesity is a better predictor for detecting cardiovascular risk factors like dyslipidemia (34).

This current study also proved that LDL-C, triglyceride, and fasting blood glucose were significantly associated with total cholesterol levels ($p<0.05$). A study that supports the current findings showed that abnormal glucose level was a risk factor for dyslipidemia as it will increase the level of total cholesterol (28). Comparing with the current study, fasting blood glucose had a significant effect might be due to a high percentage of subjects with comorbidities of diabetes. Most of the subjects with diabetes had an abnormal value of fasting blood glucose. For triglyceride, it was found that triglyceride increases the total cholesterol level particularly from the consumption of high carbohydrates food. However, in contrast with current findings, the analysis of plasma or serum total cholesterol, triglycerides, and lipoproteins showed that cholesterol levels remain constant, even though triglyceride levels fluctuate 1 to 4 hours after meals (35). The difference arises as measurements were done while the subjects are on usual diet and taking no medications that could alter blood lipid levels (35). Besides that, the evidence of the risk of lipid-lowering in elderly patients of age 75 years or older showed that uncontrolled diabetes may result in abnormalities of lipoprotein and total cholesterol (36). This is due to LDL-C builds up in the walls of arteries which leads to an increase in the total cholesterol level.

The dietary assessment showed that carbohydrate, fat, saturated fat, PUFA, MUFA, and sodium were significantly associated with total cholesterol levels ($p<0.05$). Shahrin et al. (2019) reported the health domain was the most common factor that influenced food choices besides convenience, price, sensory appeal, among others (37). It is shown that the replacement of saturated fat with PUFA or MUFA decrease total, LDL-C, and HDL-C, and thus there were improvements observed in the lipid profiles (38). Another study was conducted regarding the DASH Diet approach and the effects of blood lipids. It was found that when the subjects consumed the DASH diet, there was a noticeable improvement in the total cholesterol (39). Based on the study, it shows that sodium also has a contribution to the level of cholesterol, as the subjects were indirectly consuming a controlled amount of sodium. From food history, most of the subjects stick to common food in Malaysia like nasi lemak, roti canai, tosai, chapati, white bread, and biscuits. Traditional ethnic foods like energy-dense food and high in saturated fat food are also associated with dyslipidemia (19). This poor meal-related situation as reported by Yahya et al. (2020) can be explained by difficulties with food shopping and preparation and problems during mealtime (40).

Malnutrition risk was found to be not significantly associated with total cholesterol level. The current finding was inconsistent with the previous studies. Past studies on the relationship between malnutrition-inflammation and cholesterol among African Americans found that cholesterol levels increase significantly with the score of the screening and assessment tools (41. 33). This is because prolonged malnutrition resulted in loss of fat stores among the subjects (32). Malnutrition is prevalent among hospitalized elderly (43) and its significantly associated with a condition called hypocholesterolemia which is serum cholesterol less than 160 mg/dL (44).

It is revealed that physical activity, specifically the duration in a week was significantly associated with total cholesterol level ($p<0.05$). The current finding of the physical activity possessed a consistent result with a previous study in lack of physical activities and sedentary habits are the characteristic of dyslipidemia (31). The main reason for not meeting the recommendation for physical activity is due to the illness and mobility of the subjects. The subjects' mobility is limited in which assistance is needed when performing physical activity. The finding was consistent with the National Health Morbidity Survey (2015) (16) which found that persons aged 75 years and above have the least engagement with physical activity (59%). This may lead to poor health-related quality of life that becomes a greater concern among elderly (45-47).

The strength of our study lies in terms of assessment of the dietary intake and malnutrition risk which are lacking in the previous studies. We acknowledge several limitations in the study. First, the study has the potential for bias especially recall bias. During the interview session, the questions can either be answered by the subject or the caregiver. If the subject or caregiver did not know well or have a problem recalling the answer, misreporting might happen. Second, for the selection of the sample size, patients who consumed medications to control the total cholesterol level were not excluded in which would bias the results of the analysis towards the null hypothesis. In this study, medications to control the total cholesterol level can be addressed as a potential confounding variable.

CONCLUSION

In conclusion, the prevalence of hypercholesterolemia among hospitalized elderly was 29.6%. Comorbidities specifically dyslipidemia and other comorbidities, waist circumference, LDL-C, TG, fasting blood glucose, carbohydrate, fat, saturated fat, PUFA, MUFA, sodium, and duration of physical activity were significantly associated with the total cholesterol level. The total cholesterol level of hospitalized elderly should be regularly monitored. The elevation of total cholesterol

could lead to hypercholesterolemia. Even worse, the long-term consequence of hypercholesterolemia is the development of cardiovascular diseases. Health promotion programs can be conducted which include dietary intervention and physical activity to prevent morbidity and mortality among the elderly.

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