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Association between Physical Activity Level with Depression, Anxiety, and Stress in Dyslipidaemia Patients

Naleena Devi Muniandy[1]*, Noor Alicezah Mohd Kasim[2], Laila Hawariy Abd Aziz[1]

[1]Faculty of Health Sciences, Universiti Teknologi MARA Cawangan Selangor, Kampus Puncak Alam, 42300 Puncak Alam, Selangor, Malaysia

[2]Faculty of Medicine, Universiti Teknologi MARA Cawangan Selangor, Kampus Sungai Buloh, 47000 Jalan Hospital, Sungai Buloh, Selangor, Malaysia

**Corresponding Author's Email: naleena@uitm.edu.my*

ABSTRACT

Background: Dyslipidemia is a significant risk factor for cardiovascular and cerebrovascular events globally. Current findings have linked dyslipidemia with mental health. Since physical activity level (PAL) is a modifiable risk factor associated with CVD and depression risk, it is worth knowing if the level of PA among dyslipidaemia patients does affect their mental health. **Objective:** Hence, the main objective of this study was to determine the association between depression, anxiety, and stress and physical activity among lipid-lowering drug (LLD)-treated dyslipidaemia patients. **Methods:** This was a cross-sectional study that was conducted among dyslipidaemia patients receiving LLD treatment from the Lipid Clinic in Hospital Al-Sultan Abdullah UiTM (HASA) and the Clinical Training Centre (CTC) in Sungai Buloh. Mental health was assessed using the Depression Anxiety Stress Scale (DASS-21), physical activity was assessed using the International Physical Activity Questionnaire (IPAQ-SF), and sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). **Results:** Most participants fell into the low physical activity level (60.5%), 34.8% fell into the moderate category, and only 4.8% fell into the high physical activity group. A multiple regression model to identify the association between sociodemographic factors, PAL, and sleep quality with depression, anxiety, and stress revealed that low PAL is negatively associated with stress (B = -0.794; OR (95% CI) = 0.45 (0.21 - 0.99);(p = 0.046) but was not significantly associated with depression and anxiety. **Conclusions:** Although PAL was only associated with stress in this study, interventions should target increasing physical activity, which is an important modifiable risk factor that can reduce the risk of developing depression, anxiety, and stress.

Keywords: Depression; Dyslipidaemia; Mental Health; Physical Activity

INTRODUCTION

Dyslipidaemia is a significant risk factor for cardiovascular diseases (CVD), which are a leading cause of global mortality and morbidity (Wong *et al.*, 2016). A report by the National Health and Morbidity Survey in Malaysia indicated that the prevalence of hypercholesterolemia in Malaysian adults was 38.1% (Ministry of Health, 2019). Dyslipidaemia includes high levels of total cholesterol, low-density lipoprotein (LDL) cholesterol, and triglyceride (TG), as well as low levels of high-density lipoprotein (HDL) cholesterol (Lin *et al.*, 2018).

Recent studies have ventured beyond the association between hyperlipidemia and CVD. Current findings have linked hyperlipidaemia with an increased incidence of mental health issues such as depression, anxiety, and stress due to the increased circulating levels of C-reactive protein and proinflammatory cytokines (Chuang *et al.*, 2014). Depression is prevalent in CVD patients and has been identified as one of the critical cardiovascular risk factors leading to poor prognosis among patients with myocardial infarction (Fioranelli *et al.*, 2018; Gerber *et al.*, 2021).

Patients with undesirable lipid profiles that do not respond to lifestyle or diet changes will be started on

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oral lipid-lowering drugs (LLD). There are many kinds of LLD, such as statin, ezetimibe, bile acid sequestrants, PCSK 9, adenosine triphosphate citrate lyase (ACL inhibitors), fibrates, niacin, etc. Studies indicate that some of these LLDs, especially statins, have an antidepressant effect (De Giorgi *et al.*, 2023). Given the accelerating prevalence of mental illness worldwide and the proven association between depression and hyperlipidaemia, patients with LLD may have a protective effect over the development of mental illness.

Physical activity level (PAL) is a modifiable risk factor associated with CVD and depression risk. Studies indicated that physical activity helps to improve blood pressure and blood glucose levels and reduce total cholesterol and low-density lipoprotein (LDL) (Arija *et al*., 2017). Low physical activity is associated with a higher prevalence of anxiety and depression in a normal population (Li *et al.*, 2023; Pearce *et al*., 2022). Given that CPD may have a protective effect on the development of mental health issues, it is worth knowing if the level of PA among these patients does affect their mental health.

Hence, the objectives of this study were to determine the

1. Prevalence of mental health illness and physical activity level among LLD-treated dyslipidemia patients in the chosen setting

2. Association between mental illness and physical activity among LLD-treated dyslipidaemia patients.

Mental illnesses that were included for the purpose of this study were depression, anxiety, and stress.

METHODOLOGY

Research Design and Setting

This cross-sectional correlation design study was conducted among dyslipidaemia patients receiving lipid-lowering drug treatment from the Lipid Clinic in Hospital Al-Sultan Abdullah UiTM (HASA) and the Clinical Training Centre (CTC) in Sungai Buloh. Both of these locations were chosen as these settings had lipid clinics and cardiac clinics that treated dyslipidaemia patients. Participants who fell within the inclusion and exclusion criteria of the study were identified through the hospital database. Eligible participants were informed about the research procedures, and those who consented to the study were recruited. Participants' information, such as sociodemographic background, anthropometry measurements, and medical history, was obtained through the online database of the hospitals. Participants were contacted by phone to complete the mental health assessment, PAL, and sleep quality. Mental health was assessed using the Depression Anxiety Stress Scale (DASS-21) Questionnaire, physical activity was assessed using the International Physical Activity Questionnaire—Short Form (IPAQ-SF), and the sleep quality of the participants was assessed using the Pittsburgh Sleep Quality Index (PSQI).

Participants

A sample size of at least 210 patients was determined by using the Tabachnick and Fidell sample size calculation (Tabachnick & Fidell, 2013). The Tabachnick and Fidell formula recommended a sample size of at least 80, where $N > 50 + 8m$ (m is the number of predictor variables). The samples were recruited using convenience sampling according to patients' availability. This study included the patients according to the inclusion and exclusion criteria listed below:

Inclusion Criteria

1. Patients on lipid-lowering drug (LLD) from the lipid clinic and primary care clinic in Hospital Al-Sultan Abdullah UiTM (HASA) and Clinical Training Centre (CTC) Sungai Buloh Selangor, Malaysia.

2. Aged between 18 – 65 years old.

3. Patients who have been consuming LLD for more than 1 year.

Exclusion Criteria

1. Patients who have been diagnosed with mental health disorders or on psychiatric drugs.

2. Patients with chronic diseases such as cancer and gastrointestinal problems.

Measurement and Tools

Sociodemographic, Anthropometric and Medical Background

The sociodemographic background of the participants, such as their age, gender, ethnicity, marital status, employment status, working history, and family income, was taken from the hospital database after the patient consented to the study. The participant's body weight and height were used to calculate their BMI. The types of medication consumed were also retrieved from the database and confirmed again with the patients when they were contacted via phone.

Depression, Anxiety and Stress Level

The Depression Anxiety Stress Scale (DASS-21) questionnaire was used to measure symptoms of depression, anxiety, and stress. DASS-21 is a shorter version of DASS-42, where there are three subscales, with seven items in each subscale. In each item, participants were given four response choices: 0: did not apply to me at all; 1: applied to me to some degree or some of the time; 2: applied to me to a considerable degree or a good part of the time; and 3: applied to me very much or most of the time (Musa *et al.*, 2007). Scores from each subscale will be totaled and multiplied by two to interpret scores in a similar manner as the DASS-42 questionnaire. The scoring will determine the levels of depression, anxiety, and stress of the participants, ranging from normal, mild, moderate, severe, to extremely severe.

Physical Activity Level (PAL)

The International Physical Activity Questionnaire—Short Form (IPAQ-SF) was used to assess the participants' physical activity level. This questionnaire has seven items with open-ended questions that gather information from the participant's 7-day recall of physical activity. Three types of physical activity were assessed: walking, moderate-intensity activities, and vigorous-intensity activities. The total duration of all three physical activities was calculated by adding the duration (in minutes) and multiplied by the frequency (in days) of the three activities assessed. The volume of physical activity was calculated by multiplying the duration of activity, in minutes, by the activity's metabolic equivalent (MET) score to yield a score in MET minutes. The total score, in MET minutes, was then categorized into three levels of physical activity: low, moderate, and vigorous.

Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) was used to assess the participants' sleep quality. It is a self-report questionnaire that measures sleep quality and disturbances over a 1-month period. There are a total of 19 items in the questionnaire, and they are classified into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. These seven components were rated with a number between 0 and 3, with higher scores indicating more serious sleep problems. The total score is calculated by summing the scores of the seven components to yield a global score, which ranges from 0 to 21. The higher the score, the lower the sleep quality.

Data Analysis

All data computations and analyses in this study were performed using IBM Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive statistics such as frequencies and percentages and inferential statistics such as chi-square tests were used to describe the demographic characteristics of the participants and classify them according to their PAL, respectively. A binary logistic regression test was used to determine the relationship between sociodemographic characteristics, PAL, and sleep quality with depression, anxiety, and stress.

Ethical Consideration

Ethical approval of this study was obtained from the Universiti Teknologi MARA (UiTM), Malaysi, Ethical Committee on 27th February 2023 with reference number FERC/FSK/MR/2023/0034. Besides, ethical approval from the Hospital Al-Sultan Abdullah UiTM (HASA), Malaysia was also obtained on 28th April 2023 with reference No: 500-PJI (18/4/46).

RESULTS

Table 1: Sociodemographic Characteristics of the Participants and the Association with PAL

Variables	Total Participants N (%)	PAL			*p*-value
		Low N (%) 127 (60.5) n (%)	Moderate N (%) 73 (34.8) n (%)	High N (%) 10 (4.8) n (%)	
Age					
Young adults (18 - 39 years old)	18 (8.6)	10 (4.8)	7 (3.3)	1 (0.5)	0.822
Middle adults (40 - 59 years old)	114 (54.3)	68 (32.4)	39 (18.6)	7 (3.3)	
Old adults (≥ 60 years old)	78 (37.1)	49 (23.3)	27 (12.9)	2 (1.0)	
Gender					
Male	103 (49.0)	62 (29.5)	36 (17.1)	5 (2.4)	0.996
Female	107 (51.0)	65 (31.0)	37 (17.6)	5 (2.4)	
Ethnicity					
Malay	200 (95.0)	121 (57.6)	69 (32.9)	10 (4.8)	0.747
Non-Malay	10 (4.8)	6 (2.9)	4 (1.9)	0 (0.0)	
Marital Status					
Single/ Divorced/ Widowed	13 (6.2)	9 (4.3)	4 (1.9)	0 (0.0)	0.638
Married	197 (93.8)	118 (56.2)	69 (32.9)	10 (4.8)	
Working Hours					
Office hours	65 (31.0)	34 (16.2)	26 (12.4)	5 (2.4)	0.175
Irregular working hours/ Shift hours	27 (12.9)	21 (10.0)	5 (2.4)	1 (0.5)	
Others/ Self-employed	118 (56.2)	72 (34.3)	42 (20.0)	4 (1.9)	
Household Income					
RM 4850 or below	123 (58.6)	80 (38.1)	41 (19.5)	2 (1.0)	0.052
RM 4851 to RM 10970	66 (31.4)	33 (15.7)	27 (12.9)	6 (2.9)	
RM 10971 and above	21 (10.0)	14 (6.7)	5 (2.4)	2 (1.0)	
Body Mass Index (BMI)					
Normal	35 (16.7)	13 (6.2)	22 (10.5)	0 (0.0)	0.000***
Overweight	83 (40.0)	30 (14.3)	44 (21.0)	9 (4.3)	
Obese	92 (43.8)	84 (40.0)	7 (3.3)	1 (0.5)	
Sleep Quality					
Good	160 (76.2)	101 (48.1)	54 (25.7)	5 (2.4)	0.093
Poor	50 (23.8)	26 (12.4)	19 (9.0)	5 (2.4)	

*Chi-Square Test is Significant at *p < 0.05. **p <0 .01. ***p <0 .001*

A total of 210 participants were included in the analysis, and their characteristics are shown in Table 1. More than half of the participants (54.3%) were in the middle age group between the ages of 40 and 59 years old. There were about an equal proportion of male (49.0%) and female (51.0%) participants. The majority of participants were Malay (95.0%) and married (93.8%). As for working hours, more than half of the participants (56.2%) were self-employed with no fixed working hours, with 58.6% of them falling in the lower household income group of below RM4850. About the same fraction of participants were in the overweight (40.0%) and obese (43.8%) groups, while the rest were of normal BMI (16.7%). Most participants (76.2%) reported having good sleep quality, compared to 23.8% of participants whose sleep quality was poor.

PAL was assessed using the IPAQ-SF, which was categorized into three levels of physical activity: low, moderate, and high. The chi-square test showed that there was an association between BMI and PAL ($p < 0.001$); however, other characteristics such as age, gender, ethnicity, marital status, working hours, household income, and sleep quality were not significantly associated with PAL.

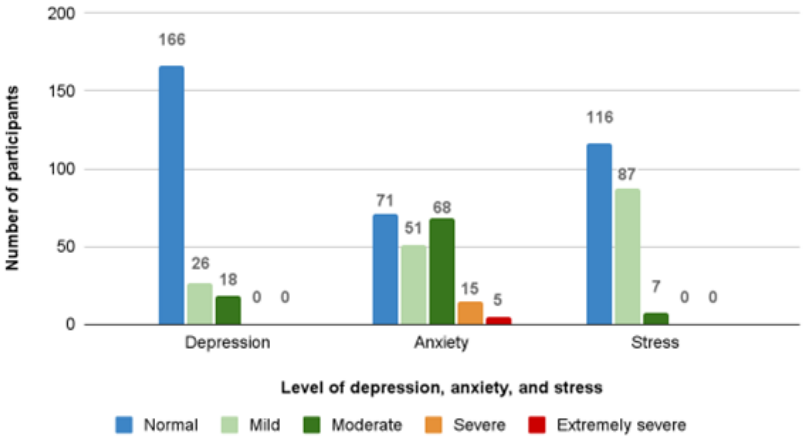

Figure 1: Distribution of Depression, Anxiety, and Stress Level among Participants

Referring to Figure 1, only a small percentage of the 210 participants had mild (n = 26) and moderate depression (n = 18), while the rest had no depression (n = 166). More participants were reported to have mild (n = 51) and moderate (n = 68) anxiety compared to severe (n = 15) and extremely severe (n = 5) anxiety. Only 7 participants reported having moderate stress, while 87 of them had mild stress, and most of them (n = 116) had no stress.

Table 2: Association Between PAL with Depression, Anxiety, and Stress

PAL	Depression, *n* =44 (21.0%)				Anxiety, *n* =139 (66.2%)				Stress, *n*=94 (44.8%)			
	Absent n (%)	Present n (%)	OR (95% CI)	*p*-value	Absent n (%)	Present n (%)	OR (95% CI)	*p*-value	Absent n (%)	Present n (%)	*OR (95% CI)*	*p*-value
Low	104 (49.5)	23 (11.0)	0.73 (0.36 - 1.48)	0.379	44 (21.0)	83 (39.5)	0.87 (0.47 - 1.60)	0.651	74 (35.2)	53 (25.2)	0.74 (0.41 - 1.31)	0.299
Moderate	56 (26.7)	17 (8.1)	Ref.		23 (11.0)	50 (23.8)	Ref.		37 (17.6)	36 (17.1)	Ref.	
High	6 (2.9)	4 (1.9)	2.20 (0.55 - 8.70)	0.263	4 (1.9)	6 (2.9)	0.69 (0.18 - 2.68)	0.592	5 (2.4)	5 (2.4)	1.03 (0.27 - 3.85)	0.968

*Binary Logistic Regression Test is Significant at *p < .05. **p < .01. ***p < .001. Ref. = Set as Reference*

The association between PAL and depression, anxiety, and stress among the 210 participants is shown in Table 2. Depression was reported among 21.0% of the total participants and was higher (11.0%) in the low PAL group compared to the moderate and high PAL groups. Around 66.2% were reported to be anxious, and the percentage was higher (39.5%) in the low PAL group compared to the moderate and high PAL groups. Stress was reported among 44.8% of the participants and was higher (25.2%) among the low-PAL group compared to the moderate- and high-PAL groups.

A bivariate logistic regression found no significant association between PAL and depression, anxiety, or stress. However, depression has a higher likelihood of occurring in the high PAL group (OR (95% CI) = 2.20 (0.55–8.70) compared to low PAL (OR (95% CI) = 0.73 (0.36–1.48)). Anxiety, on the other hand, has a higher likelihood of occurring in the low PAL group (OR (95% CI) = 0.87 (0.47–1.60) than in the higher PAL group (OR (95% CI) = 0.69 (0.18–2.68). In contrast, stress has a higher likelihood of occurring in individuals with high PAL (OR (95% CI) = 1.03 (0.27–3.85) than in individuals with low PAL (OR (95% CI) = 0.74 (0.41–1.31).

Table 3: Association between Sociodemographic Factors, PAL, and Sleep Quality with Mental Health in Hyperlipidaemia Patients

Variables	n (%)	Depression			Anxiety			Stress		
		B	OR (95% CI)	*p*-value	B	OR (95% CI)	*p*-value	B	OR (95% CI)	
Age										
Young Adults (18 - 39 years)	18 (8.6)	**Ref.**			**Ref.**			**Ref.**		
Middle Adults (40 - 59 years)	114 (54.3)	- 0.669	0.51 (0.14 - 1.91)	0.320	- 0.327	0.72 (0.22 - 2.36)	0.590	- 0.474	0.62 (0.20 - 1.95)	0.416
Old Adults (≥ 60 years)	78 (37.1)	- 0.063	0.94 (0.20 - 4.45)	0.937	- 0.476	0.62 (0.16 - 2.47)	0.499	- 0.251	0.78 (0.21 - 2.91)	0.709
Gender										
Male	103 (49.0)	**Ref.**			**Ref.**			**Ref.**		
Female	107 (51.0)	1.119	3.06 (1.37 - 6.84)	0.006**	0.892	2.44 (1.28 - 4.65)	0.007**	1.086	2.96 (1.59 - 5.54)	0.001**
Ethnicity										
Malay	200 (95.2)	**Ref.**			**Ref.**			**Ref.**		
Non-Malay	10 (4.8)	- 0.047	0.95 (0.14 - 6.42)	0.962	- 0.853	0.43 (0.11 - 1.70)	0.227	- 0.345	0.71 (0.17 - 2.99)	0.638
Marital Status										
Single/Divorced/ Widowed	13 (6.2)	**Ref.**			**Ref.**			**Ref.**		
Married	197 (93.8)	- 0.162	0.85 (0.18 - 4.13)	0.841	- 0.238	0.79 (0.21 - 3.02)	0.728	- 0.256	0.77 (0.22 - 2.73)	0.691
Working Hours										
Office hours	65 (31.0)	**Ref.**			**Ref.**			**Ref.**		
Irregular hours/ Shift hours	27 (12.9)	- 0.525	0.59 (0.14 - 2.49)	0.474	- 0.458	0.63 (0.24 - 1.68)	0.359	- 0.067	0.94 (0.34 - 2.58)	0.898
Others/ Self-employed	118 (56.2)	- 0.051	0.95 (0.33 - 2.70)	0.924	0.304	1.36 (0.57 - 3.21)	0.489	- 0.226	0.80 (0.35 - 1.83)	0.593
Household Income (MYR)										
≤ 4850	123 (58.6)	**Ref.**			**Ref.**			**Ref.**		
4851 – 10970	66 (31.4)	- 0.123	0.89 (0.38 - 2.07)	0.778	0.305	1.36 (0.64 - 2.87)	0.424	0.242	1.27 (0.64 - 2.55)	0.495
≥ 10971	21 (10.0)	- 1.425	0.24 (0.04 - 1.39)	0.111	- 0.434	0.65 (0.22 - 1.87)	0.423	- 0.845	0.43 (0.14 - 1.32)	0.140
Body Mass Index (BMI)										
Normal	35 (16.7)	**Ref.**			**Ref.**			**Ref.**		
Overweight	83 (39.5)	1.061	2.89 (0.79 - 10.52)	0.108	- 0.293	0.75 (0.29 - 1.92)	0.542	0.077	1.08 (0.43 - 2.70)	0.869
Obese	92 (43.8)	1.045	2.84 (0.71 - 11.32)	0.138	0.296	1.34 (0.50 - 3.65)	0.562	0.974	2.65 (0.99 - 7.12)	0.054
PAL										
Low	127 (60.5)	- 0.416	0.66 (0.26 - 1.71)	0.391	- 0.315	0.73 (0.34 - 1.59)	0.427	- 0.794	0.45 (0.21 - 0.99)	0.046*
Moderate	73 (34.8)	**Ref.**			**Ref.**			**Ref.**		
High	10 (4.8)	0.649	1.91 (0.39 - 9.34)	0.422	- 0.318	0.73 (0.16 - 3.25)	0.678	- 0.082	0.92 (0.22 - 3.92)	0.911
Sleep Quality										
Good	160 (76.2)	**Ref.**			**Ref.**			**Ref.**		
Poor	50 (23.8)	1.685	5.40 (2.34 - 12.44)	0.000***	-0.001	1.00 (0.47 - 2.11)	0.998	0.475	1.61 (0.79 - 3.27)	0.188

*Binary logistic regression test is significant at *p < .05. **p < .01. ***p < .001. Ref. = set as reference*

Multiple regression models were performed to identify the association between sociodemographic factors, PAL, and sleep quality with depression, anxiety, and stress among the 210 participants. The following variables were selected in the model: age, gender, ethnicity, marital status, working hours, household income, BMI, PAL, and sleep quality (Table 3). The model shows that females have higher odds of having depression (B = 1.119; OR (95% CI) = 3.06 (1.37 - 6.84); p = 0.006), anxiety (B = 0.892; OR (95% CI) = 2.44 (1.28 - 4.65); p = 0.007), and stress (B = 1.086; OR (95% CI) = 2.96 (1.59 - 5.54); p = 0.001) compared to males, and these associations are all positive, as indicated by the p-values. Poor sleep quality is positively associated with depression (B = 1.685; OR (95% CI) = 5.40 (2.34–12.44); $p < 0.001$), while low physical activity is negatively associated with stress (B = -0.794; OR (95% CI) = 0.45 (0.21–0.99); p = 0.046).

Table 3 also shows that middle-aged people have higher odds of having depression (OR (95% CI) = 0.51 (0.14–1.91) and stress (OR (95% CI) = 0.62 (0.20–1.95), while older people have higher odds of having anxiety (OR (95% CI) = 0.62 (0.16–2.47) than younger people. Being non-Malay also means having lower odds of having depression (OR (95% CI) = 0.95 (0.14 - 6.42)), anxiety (OR (95% CI) = 0.43 (0.11 - 1.70)), and stress (OR (95% CI) = 0.85 (0.18 - 4.13)). Being married also indicated lower odds of having depression (OR (95% CI) = 0.79 (0.21–3.02), anxiety (OR (95% CI) = 0.77 (0.22–2.73), and stress (OR (95% CI) = 0.71 (0.17–2.99)) than people who are single, divorced, or widowed. Both irregular working hours or shift hours (OR (95% CI) = 0.59 (0.14–2.49) and other working hours arrangements or being self-employed (OR (95% CI) = 0.95 (0.33–2.70)) have low odds of causing depression; however, irregular working hours or shift hours are less likely to lead to depression than other working hours arrangements or being self-employed. The same goes for stress, except that other working-hour arrangements or being self-employed (OR (95% CI) = 0.80 (0.35–1.83) is less likely to lead to stress than irregular working hours or shift hours (OR (95% CI) = 0.94 (0.34–2.58). On the other hand, having other working hours arrangements or being self-employed has higher odds of having anxiety (OR (95% CI) = 1.36 (0.57–3.21) than having irregular working hours or shift hours (OR (95% CI) = 0.63 (0.24–1.68). However, age, ethnicity, marital status, and working hours showed no significant association with depression, anxiety, or stress.

Moreover, both middle (OR (95% CI) = 0.89 (0.38–2.07)) and high income groups have low odds of having depression, with the higher income group being less likely to have depression (OR (95% CI) = 0.24 (0.04–1.39)). However, the middle-income group has higher odds of having anxiety (OR (95% CI) = 1.36 (0.64–2.87) and stress (OR (95% CI) = 1.27 (0.64–2.55) compared to the high-income group (anxiety: OR (95% CI) = 0.65 (0.22–1.87); stress: OR (95% CI) = 0.43 (0.14–1.32)). Both overweight and obese individuals have high odds of having depression. (overweight: OR (95% CI) = 2.89 (0.79–10.52); obese: OR (95% CI) = 2.84 (0.71–11.32); and stress (overweight: OR (95% CI) = 1.08 (0.43–2.70); obese: OR (95% CI) = 2.65 (0.99–7.12), while overweight individuals have lower odds of having anxiety (OR (95% CI) = 0.75 (0.34–1.59) than obese individuals (OR (95% CI) = 1.34 (0.50–3.65)). Both household income and BMI are also not significantly associated with depression, anxiety, and stress. High PAL have higher odds of causing depression (OR (95% CI) = 1.91 (0.39–9.34), while low PAL have lower odds of causing depression (OR (95% CI) = 0.66 (0.26–1.71), but both do not reach statistical significance with depression. The odds of having anxiety are the same in good and poor sleep quality groups, but there is no significant association. Poor sleep quality also has higher odds of causing stress (OR (95% CI) = 1.61 (0.79–3.27)) but is not significantly associated with stress.

DISCUSSION

Dyslipidaemia is a significant risk factor for cardiovascular diseases (CVD), which is a leading cause of death globally, resulting in 17.9 million deaths annually (WHO, 2023). Dyslipidemia increases inflammatory markers in the body, resulting in an increased risk of depression and other mental health issues (Chuang *et al.*, 2014; Han, 2022). The prevalence of mental health issues such as depression, anxiety, and stress are on the rise in the world, and Malaysia is witnessing the same trend. The recent national health and morbidity survey reported that 29.9% of Malaysian adults experienced mental health issues such as depression and anxiety (Institute for Public Health (IPH), 2015).

On the other hand, physical activity is a modifiable risk factor for CVD, and the national guidelines for

hyperlipidaemic patients recommend 150 to 300 minutes a week of moderate-intensity exercise or 75–150 minutes of vigorous-intensity aerobic exercise in healthy adults for CVD prevention (Shephard & Aoyagi, 2014). The literature suggests lipid-lowering drugs (LLD), mostly statins, may have an anti-depressive effect on the consumer (Chuang *et al*., 2014; De Giorgi *et al.*, 2023; Molero *et al.*, 2020). However, this study was designed to investigate if physical activity remains a significant predictor of depression, anxiety, and stress in patients who were on LLD.

This study found that 21% of the total participants had depression, 66% were anxious, and 45% were stressed. Only 5% of the participants reported being extremely anxious, and no participant fell into the criteria of being extremely depressed or stressed. The low prevalence of mental health issues among the participants might be due to the consumption of LLD. The literature suggests that LLD, especially statins, helps reduce inflammation and the risk of developing mental health issues such as depression (De Giorgi *et al.*, 2023; Molero *et al.*, 2020).

A poor prevalence of physical activity was identified in the study population, in which the majority of the participants fell below the low PA level (60.5%). The significant association between BMI and PAL of participants in this study is supported by a systematic review that concluded high PA is associated with a lower risk of developing obesity, CHD, and diabetes in adults (Cleven *et al.*, 2020). Thus, the American Heart Association has recommended PA as a first-line defense for those with elevated blood pressure and cholesterol (Barone Gibbs *et al.*, 2021).

Females were found to have a significantly higher likelihood of having depression, anxiety, and stress. These findings were consistent with other studies that also reported the higher tendency of women to have higher depression, anxiety, and stress scores compared to men. One possible explanation was the low energy levels in the females compared to the males. (Maslakçı & Sürücü, 2022; Zheng *et al.*, 2023). The study also indicated that those with poor sleep quality had a significantly higher likelihood of developing depression compared to those with good sleep quality. These findings were similar to other studies among the adult population that reported a positive association between poor sleep and depression. However, a plausible explanation for why poor sleep may contribute to depression remains inconclusive (Hu *et al.*, 2020; Liu *et al.*, 2019).

Although no significant association was found between physical activity and depression, anxiety, or stress in the general model, the corrected model found a significant association between physical activity and stress after controlling for selected cofounders. In the corrected model, there was no significant association found between physical activity and depression and anxiety in the participants. However, the study found 60% of the participants fell into the category of low physical activity, and nearly 80% of participants were overweight or obese. Furthermore, weight management initiatives should be offered to individuals who are overweight, enabling them to work towards their desired weight (Ahmad *et al.*, 2023). This explains the significant association found between physical activity and the BMI of the participants in this study. This study found that participants who fell into the lower physical activity group were more likely to be stressed than those in the moderate physical activity group. This result is contrary to a previous study that reported an association between preferred and moderate physical activity and lower perceived stress, and high physical activity was associated with high perceived stress (Cao *et al.*, 2021).

Studies have shown consistent findings on the positive association between physical activity and mental illness. Physical inactivity is linked to a higher likelihood of having mental illness, especially depression (Marconcin *et al.*, 2022; Singh *et al.*, 2023; Wang *et al.*, 2023). However, this study only found a significant association between stress and physical activity, although there was a high proportion of participants who fell into the low physical activity group. These results may be linked with the use of LLD, as these drugs have an antidepressant effect (De Giorgi *et al.*, 2023; Köhler-Forsberg *et al.,* 2017).

Limitation

The methodological aspects of this study may have influenced the findings. Firstly, the small number and

lack of diversity of participants may have affected the overall findings. Secondly, the nature of the data collection, in which certain data was obtained online or via phone, may have influenced the results. Given these limitations, future studies should be conducted on a larger scale in several settings to investigate the association between physical activity and depression, anxiety, and stress.

CONCLUSION

This study was conducted to determine the association between physical activity and mental illnesses such as depression, anxiety, and stress in hyperlipidaemic patients on lipid-lowering drugs. Overall, the study found 21% of the total population were depressed, 66.2% had anxiety, and 45% had stress. The study revealed no association between physical activity and depression or anxiety. However, there was a significant association between physical activity and stress among hyperlipidaemic patients. The low prevalence of moderate and high physical activity levels in the target population should be noted, and interventions should target increasing physical activity among hyperlipidaemic patients, as physical activity is an important modifiable risk factor that can improve lipid profile, the outcome of a CVD event, and also the risk of developing depression, anxiety, and stress.

Conflict of Interest

The authors declare that they have no competing interests.

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