The Relationship Between Health Literacy and Physical Activity Level Among Malaysians: Using the Malaysian Healthy Lifestyle Index (MHLI) – 2022

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Abstract

The role of health literacy (HL) in health promotion is globally recognised, especially when addressing noncommunicable diseases (NCD). Physical activity (PA) is a renowned factor that improves health and helps to control NCD. However, the association between HL and PA level among Malaysians remains scarce. Thus, this study sought to determine the relationship between HL and PA level among Malaysians. We analysed cross-sectional data of the Malaysian Healthy Lifestyle Index Survey-2022. HL level was obtained from the 18 HL questions on the ability to evaluate and act upon the decision on practising healthy lifestyle and categorised as limited, sufficient and excellent. The PA level was measured from the adapted International Physical Activity Questionnaire-Short Form (IPAQ-SF) and categorized as active Health-Enhancing Physical Activity (HEPA), minimal active and non-active. The cultivating PA culture in daily life was assessed using 6 questions related to practicing PA. Chi-square analysis was used to explore the association between HL and PA level among Malaysians. 9,264 Malaysians aged 18 years and above participated in the MHLI survey with 53.5% female and 46.5% male. Chi-square analysis using Cramer's V revealed that there was a significantly small to medium relationship between HL and PA level, V=0.101, p=0.001. It was found that 30.1% participants with excellent HL level and active HEPA, while 27.3% with limited HL and non-active. There was a significant correlation between HL and cultivating PA practices in daily living among Malaysians, despite the degree of correlation is weak (r=0.241). Previous studies from other countries suggested a higher level of HL is generally associated with higher PA level. However, in this study, it was found that there is a lack of translation of health information obtained into practices among Malaysians. Therefore, integrating HL in interventions to promote PA could be a useful approach.

Keywords: physical activity, health literacy, behaviour, cross-sectional

1.0 INTRODUCTION

Numerous public health recommendations, guidelines, and past research consistently demonstrate that lifestyle factors are associated with several non-communicable diseases (NCDs). Adhering to a healthy

lifestyle has been proven to yield significant health benefits. In the contemporary landscape of global health, the pursuit of a healthy lifestyle stands as a paramount objective, impacting both individual well-being and national healthcare systems. The multifaceted nature of health encompasses not only the absence of illness but also the active cultivation of practices that promote physical and mental vitality. In this context, two critical elements come to the fore: health literacy and physical activity. Malaysia, as a rapidly developing nation, is no exception to the global discourse on health promotion and disease prevention.

Health literacy, according to the World Health Organization (WHO), involves individuals' ability to obtain access to, understand, and utilize information in ways that promote and maintain good health for themselves, their families, and their communities [1]. WHO recognizes the significance of health literacy, emphasizing its foundation on providing inclusive and equitable access to quality education and lifelong learning, considering it an integral component of lifelong skills and competencies, particularly within the school curriculum [2]. Health literacy is an inclusive concept that goes beyond health education, considering social and environmental factors that affect an individual's capacity to engage with health information, make well-informed decisions, and access health services to enhance personal well-being and contribute to community health [4]. Health literacy is intricately linked to the intersection of education, culture, and language, as well as the communication proficiency of healthcare professionals. Additionally, it is influenced by the nature of materials and messages, along with the environments in which health-related support is delivered [6]. A high level of health literacy empowers individuals to navigate complex healthcare systems, interpret medical advice, and engage in preventive health behaviours. Conversely, low health literacy is associated with disparities in health outcomes, reduced adherence to medical advice, and an increased risk of NCDs.

Physical activity (PA), on the other hand, is universally acknowledged as a cornerstone of a healthy lifestyle. WHO defines PA as any bodily movement involving skeletal muscles that necessitates energy expenditure, encompassing activities during leisure, transportation, or work, with both moderate- and vigorous-intensity physical activity contributing to health improvement [8]. PA encompasses not only exercise but also various other activities that involve bodily movement. These activities are typically integrated into play, work, active transportation, household chores, and recreational pursuits. Conversely, physical inactivity is considered a significant global health risk, contributing to the burden of disease. Engaging in regular physical activity has been proven to reduce the risk of NCDs, improve mental well-being, and enhance overall quality of life. In Malaysia, as in many countries undergoing rapid urbanization and technological advancements, there is a growing concern over declining physical activity levels, particularly among urban populations and younger individuals.

Malaysia, a nation known for its cultural diversity and burgeoning urban centers, faces unique challenges and opportunities in promoting health literacy and physical activity. In the quest for comprehensive health promotion strategies, the Malaysian Healthy Lifestyle Index (MHLI) has emerged as a crucial instrument, providing a holistic assessment of individuals' health-related behaviours, including health literacy and physical activity. However, as of 2022, there remains a significant knowledge gap concerning the intricate interplay between health literacy and physical activity among Malaysians. While research on health literacy and physical activity has gained attention globally, there is several of comprehensive studies examining this relationship among Malaysians. Such research is essential for

several reasons: first, to ascertain the prevalence of health literacy and physical activity levels within the Malaysian population; second, to understand the potential barriers and facilitators that individuals may encounter in accessing and engaging in physical activity; and third, to identify the role of health literacy in shaping health behaviours.

Based on the latest National Health and Morbidity Survey [11], it was found that 1 in 3 adults of the Malaysian population had a low level of health literacy [12]. This concerning trend in Malaysians' health literacy is believed to be a significant factor contributing to the high prevalence of severe illnesses in the country, as stated by the experts [13]. This is worrisome because, despite the modern world becoming increasingly technologically savvy, health information is now readily accessible everywhere. Nevertheless, health literacy levels remain low. Health information obtained from healthcare workers showed a significant association with higher health literacy among the general population, but nevertheless, the association between different health information sources and health literacy varied across age groups [15].

In today's era, people are increasingly prone to reducing their physical activity as smartphones provide easy access to almost everything. The physical activity level in Malaysia remains inadequate [16]. Notably, there has been a significant increase in the rate of physical activity among Malaysian adults between NHMS 2011 and NHMS 2020 [12]. This suggests that the association between health literacy level and healthy lifestyle behaviours is still limited or scarce. Apart from health literacy, physical activity behaviour has become a global concern for society due to its significant implications for overall health. The levels of physical activity among Malaysians are also still inadequate [16]. In Malaysia, the prevalence of physical inactivity among individuals of 18 and older who were physically inactive stood at 25.1% based on data from NHMS 2019. Among different occupations, students are frequently found to be the least active group. This is in line with the study by [17], which revealed that the majority of university students were sporadic exercisers. Among the students, 16.0% were very active, while 13.5% were physically inactive. Individuals who do not adhere to a healthy lifestyle put themselves at risk as they may be susceptible to various NCDs in the future. The foundation of a healthy lifestyle lies in cultivating healthy habits. For example, being physically active.

Physical activity can be classified into three categories: not-active, minimally active, and active HEPA, as demonstrated by IPAQ [18] who divided the scores into three levels: limited, sufficient, and excellent. This categorization allows for an assessment of the level of physical activity. Health literacy was also classified into three levels: limited, sufficient, and excellent health literacy based on NHMS 2019. The scores for these two variables were totaled and subsequently grouped according to predetermined cut-off points. The general health literacy level in Malaysia was rated as below sufficient. Respondents who were older (68%), had lower education levels (64.8%), and lower family income (49.5%) were more likely to have insufficient health literacy. This aligns with a news article stating that the issue of low health literacy among B40 is a growing concern [19]. Based on previous studies, the majority of the results indicate an association between health literacy levels and physical activity levels. However, these results often apply only to specific populations in Malaysia, such as adults, teenagers, or older individuals. Consequently, research exploring the general association between these two behaviours remains limited.

Through quantitative research, this study seeks to find the health literacy and physical activity levels among Malaysians.

This research endeavors to bridge this gap by exploring the relationship between health literacy and physical activity levels among Malaysians, utilizing data from the 2022 Malaysian Healthy Lifestyle Index (MHLI). Specifically, it aims to assess the health literacy levels among Malaysians, examine the patterns and determinants of physical activity in the Malaysian population, investigate the association between health literacy and physical activity and provide insights and recommendations for health policymakers and stakeholders to enhance health literacy and promote physical activity in Malaysia.

2.0 METHODOLOGY

2.1 Recruitment, Sample Size and Sampling Determination

The MHLI-2022 was a nationwide, cross-sectional, population-based survey that used a proportional stratified random sampling design to select a nationally representative sample. The Malaysian states constituted the primary strata categorized by region or state, with further stratification by urban–rural residence. The total sample comprised 7268 respondents distributed across states in Peninsular Malaysia, with 975 respondents assigned to Sabah and 987 to Sarawak. The allocation of respondents was determined based on the population density data obtained from the Department of Statistics Malaysia. Data collection for the MHLI-2022 was carried out from April to July 2022 by trained evaluators via face-to-face interviews using a standardized pre-validated structured questionnaire. The tablets were used to collect data, store and back up data in the SD cards, and upload data to the central system. A total of 9,264 eligible adults aged 18 years and older were invited to participate in this survey. Information sheets and consent forms were given to all eligible respondents prior to the interviews.

2.1.1 Socio-demographic variables

Socio-demographic variables included sex, age, ethnicity, weight, height, marital status (single, married, widow/widower/divorcee), educational level (no formal education, primary, secondary, tertiary), current work status (working/not working) and monthly household income. Age was categorized into five groups: 18– 24 years, 25–44 years, 45–60 years, and 61 – 100 years old. Ethnicity was categorized into five groups: Malays, Chinese, Indians, other Bumiputera (including indigenous Orang Asli in Peninsular Malaysia and the indigenous groups in Sabah and Sarawak such as Kadazan, Murut, Bajau, Melanau, Iban and Bidayuh), and "Others" (including small minority groups that settled in Malaysia such as Sikh, Serani, Portuguese and Indonesian). Monthly household income was grouped into four levels: less than MYR1000, MYR1000–MYR1999, MYR2000–MYR2999, MYR3000 and above [Malaysian Ringgit (MYR) ≈ 0.29 US Dollar (USD)] as demonstrated by [22]. BMI was calculated as weight divided by height in meters squared (kg/m2). According to the World Health Organization guidelines [23], BMI was categorized according to four levels of nutritional status for both men and women: underweight (<18.5), normal (18.5– 24.9), overweight (25.0–29.9) and obese (≥30). The education level was grouped by no formal education, primary school, secondary school, certificate/diploma and bachelor degree and above.

The survey represents a comprehensive assessment of health-related behaviours and practices among a diverse sample of Malaysians. The primary focus of this research was to investigate the relationship between health literacy (HL) levels and physical activity (PA) among Malaysians. To assess

HL levels, data were collected from survey respondents' responses to a set of 18 HL questions using quantitative methods. These questions were carefully designed to gauge individuals' capacity to evaluate and act upon decisions related to practicing a healthy lifestyle. Respondents' HL levels were subsequently categorized into three distinct categories: limited, sufficient, and excellent, based on their responses to the HL questions [24].

2.1.2 Physical activity assessment

The abbreviated form of the International Physical Activity Questionnaire (IPAQ) was employed for assessing physical activity. The reliability and validity of IPAQ have been demonstrated in 12 distinct countries [9], [20]. In this survey, we adopted the Malay version of the IPAQ, which had undergone pilot testing and pre-validation during the 2011 National Health and Morbidity Survey (NHMS) [18]. In this survey, the researchers employed the previously pilot-tested and pre-validated Malay version of the IPAQ from the 2011 NHMS where the MET-minutes/week for physical activity level and intensity were determined using the IPAQ scoring protocol [21]. Total minutes spent on vigorous activity, moderate-intensity activity, and walking over the last 7 days were multiplied by 8.0, 4.0, and 3.3, respectively, to compute MET scores for each activity. The total physical activity score was calculated as the sum of all MET scores from the three sub-components. Physical activity was categorized into low, moderate and high PA level according to the scoring rules of the short version IPAQ [18]. In the present study, PA in MET-minutes/week was transformed and presented as MET-hours/week to enhance the consistency and interpretability of our findings.

The IPAQ short form was designed to estimate the overall physical activity level by assessing three specific types of physical activity (walking, moderate-intensity activities and vigorous-intensity activities) undertaken across a comprehensive set of domains (work-related, transportation, leisure time, and domestic/ gardening). The level of physical activity is calculated in terms of metabolic energy expended (MET minutes, or METs), based on the IPAQ analysis protocol [18]. The cumulative physical activity score comprises the summation of METs per week, encompassing walking, moderate-intensity activities, and vigorous-intensity activities. Survey participants engaging in any combination of these activities over the past 7 days, attaining a total physical activity score of at least 600 METs per week, were categorized as "active", while those achieving less than 600 METs per week were labeled as "inactive".

2.2 INSTRUMENT

The Malaysian Healthy Lifestyle Index instrument that has been validated in Phase 1 of the study is used. The questionnaire is available in both Malay and English languages. The MHLI is a valid measurement for assessing the Malaysian Healthy Lifestyle Index (provided the Cronbach's alpha value of the instruments in Table 1. Content validity was confirmed from the analysis of the indicators executed by the panel of experts in the development phase of the questionnaire. The content validity calculation of this instrument revealed an average of 89% for all items. The face validity is judged to be satisfactory as well based on the generally positive assessment by the informants. The instrument has 136 items in total, which address sociodemographic, health literacy, physical activity, healthy eating, healthy without smoking behaviour, healthy without alcohol consumption and mental health. Each section consists of relevant domains regarding the main constructs depicted in the literature.

Section A of the instrument consists of the personal profiles of the respondents, including gender, age, marital status and level of education. Section B comprises a health literacy domain that consists of 18 questions. The key constructions of the instrument are in Section C; Section C1 consists of 3 sub-domain indicators of physical activity, i.e., physical and recreational activities adapted from the Global Physical Activity Questionnaire (WHO) and [26], cultivation of active living, and supporting environment.

Table 1. Cronbach's Alpha for Each Factor

Variables	Sub-dimension	Number of Items (n)	Cronbach's alpha (Pre-test)
Health literacy related to healthy lifestyle	Seeking health information	18 items	0.98
	Understanding the information		
	Evaluate the information		
	Judging the information		
	Making decision		
	Act upon the decision		
Physical activity	Willingness to spend money for physical activity	6 items	0.53
	Will to get active		
	Usage of medium for physical activity		
	Volunteerism		

2.2.1 MEASUREMENT OF HEALTH LITERACY (HL) LEVEL

The primary focus of this research was to investigate the relationship between health literacy (HL) levels and physical activity (PA) among Malaysians. To assess HL levels, data were collected from survey respondents' responses to a set of 18 HL questions. These questions were carefully designed to gauge individuals' capacity to evaluate and act upon decisions related to practicing a healthy lifestyle. Respondents' HL levels were subsequently categorized into three distinct categories: limited, sufficient, and excellent, based on their responses to the HL questions.

2.2.2 MEASUREMENT OF PHYSICAL ACTIVITY (PA) LEVEL

To evaluate PA levels, the researchers employed the adapted International Physical Activity Questionnaire-Short Form (IPAQ-SF). This validated instrument is widely recognized for its effectiveness in assessing PA levels across various populations. Respondents were asked a series of questions regarding their physical activity habits, including the frequency, intensity, and duration of different types of physical activities over the past week. Based on their responses, individuals were categorized into three groups: Active Health-Enhancing Physical Activity (HEPA), minimal active and non-active.

HEPA encompassed individuals who engaged in a sufficient amount of vigorous or moderate-intensity physical activity, consistent with the recommendations for health-enhancing physical activity. Minimal active included individuals who reported some physical activity but did not meet the criteria for the active HEPA category while non-active respondents reported minimal or no physical activity during

the past week. As an essential component of this study, we sought to assess the extent to which individuals were cultivating a culture of physical activity in their daily lives. To measure this aspect, we included six specific questions in the survey related to practicing physical activity. These questions aimed to capture respondents' attitudes, behaviours, and perceptions regarding incorporating physical activity into their daily routines.

2.3 DATA COLLECTION PROCEDURE

This study was conducted face-to-face involving 119 enumerators and supervised by five (5) supervisors according to their respective zones. Respondents were randomly selected based on the number of respondents that have been allocated in the study sample. Enumerators were divided into 30 groups consisting of four (4) enumerators for each group and work according to the districts that have been set. Each enumerator was supplied with a tablet and a link to the MHLI survey question that contains a GPS application to make it easier for the enumerator to identify the study area/region while in the field. The use of this application helps the enumerator identify the respondents as allocated in the study sample to create randomness in the selection of the sample.

In the data collection process, the technique used in the study is to use face-to-face questionnaires. If the respondent agrees to participate, the enumerator will brief the resident regarding the study's purpose and will pass the participant information sheet and consent form. Once the respondent agrees to participate and signs the consent form, the enumerator will pass the instrument which is formatted in hand-held devices (tablet) or a printed versions to be filled based on the convenience of respondents. Participants can withdraw from the study at any time.

2.4 DATA ANALYSIS

The MHLI data utilized in this study underwent analysis using IBM SPSS Software. Descriptive analysis was carried out to determine the frequencies and percentages along with the 95% confidence intervals to assess the prevalence of health literacy and physical activity among the Malaysian population. Specifically, the researchers employed chi-square analysis, a widely-used statistical method for analysing categorical data, to assess the relationships and dependencies between the categorized HL and PA levels. The Pearson chi-square test was utilized to identify the correlation between two categorical variables, and the strength of association was assessed using the Cramer's V value. Additionally, point-biserial correlation was utilized to explore associations between both categorical and continuous variables. The p-value < 0.05 was considered to be statistically significant and hence the strength of association can be explained. **Table 2** shows the value of the Cramer's V as demonstrated by Akoglu [25].

Table 2. Phi and Cramer's V Value

Phi and Cramer's V	Interpretation
>0.25	Very strong
>0.15	Strong
>0.10	Moderate
>0.05	Weak
>0	No or very weak

2.5 ETHICAL CONSIDERATIONS

This research adhered to rigorous ethical standards, including informed consent from all survey participants. Additionally, steps were taken to ensure the privacy and confidentiality of respondents' personal information and survey responses. Ethical approval for this study was obtained from the relevant institutional review board or ethics committee. The study protocol was approved by the Malaysian Medical and Research Ethics Committee (MREC), Ministry of Health Malaysia (NMRR- 21-1069-58257).

3.0 RESULTS AND DISCUSSION
3.1 RESPONSE RATE

The total respondents were 9264 of Malaysian aged 18 years and above participated in the Malaysian Healthy Lifestyle Index (MHLI) survey. The total response rate by states is presented in the **Table 3.**

Table 3. Sociodemographic of Respondents

Zon	States	Respondents	Respondents Percentage
North	Perlis	76	0.82%
	Kedah	607	6.54%
	Pulau Pinang	582	6.28%
	Perak	703	7.58%
East	Kelantan	531	5.77%
	Terengganu	313	3.39%
	Pahang	461	4.97%
Klang Valley	Selangor	1813	19.55%
	Kuala Lumpur & Putrajaya	494	5.32%
West	Negeri Sembilan	325	3.51%
	Melaka	281	3.04%
	Johor	1,082	11.67%
Sabah	Sabah & Labuan	967	10.45%
Sarawak	Sarawak	1,029	11.10%
Total		9,264	**100.0%**

3.2 SOCIODEMOGRAPHIC PROFILES OF RESPONDENTS

Out of the total respondents, 4,310 (46.5%) were males, while 4,954 (54.5%) were females. The largest proportion of respondents fell within the age range of 25 to 44 years, comprising 4,280 individuals (46.2%). The subsequent age groups consisted of 2,391 respondents (25.8%) aged 18 to 24 years, 2,146 respondents (23.2%) in the 45 to 60 years, and 447 respondents (4.8%) between the ages of 61 and 100 years. Regarding ethnic distribution, the majority of respondents identified as Malay (57.83%), followed by Chinese (20.47%), Indian (7.99%), Sarawakian (5.03%), and Sabahan (5.03%). Concerning income groups, a significant portion of respondents belonged to the B40 category (82.47%), while 15.89% fell into the M40 income group, and a mere 1.65% were categorized under the T20 income group. Marital status data indicated that the majority of respondents were married, accounting for 50.66% of the total, followed by singles at 43.54%, widowed individuals at 3.66%, and those who were divorced at 2.14%. In

terms of educational level, the highest proportion of respondents held secondary school qualifications at 38.10%, followed by those with certificates or diplomas at 33.20%. Respondents with a degree or higher education made up 22.50% of the sample. A smaller percentage had completed only primary school, constituting 3.30%, while those with no formal education represented 2.90%.

3.3 DISTRIBUTION OF HEALTH LITERACY

The primary focus of this research was to investigate the relationship between health literacy (HL) levels and physical activity (PA) among Malaysians. To assess HL levels, data were collected from survey respondents' responses to a set of 18 HL questions. These questions were carefully designed to gauge individuals' capacity to evaluate and act upon decisions related to practicing a healthy lifestyle. Respondents' HL levels were subsequently categorized into three distinct categories: limited, sufficient, and excellent, based on their responses to the HL questions to gauge respondents' health literacy levels in terms of their abilities to acquire, comprehend, assess, and use health information in order to make judgements and decisions about healthcare, disease prevention, and health promotion [27]. All scores were then transformed to a unified metric with a minimum score of 0 and a maximum score of 54, whereby 0 represents the lowest possible health literacy and 54 represents the highest possible literacy score. The scores are divided into three (3) levels.

The scoring system ranges from 0 to 33, which is categorized as limited health literacy level, signifying a significant challenge in accessing, comprehending, evaluating, and applying health-related information, particularly in relation to healthy lifestyles. Scores between 34 and 42 fall into the category of sufficient health literacy level, indicating that individuals find it reasonably easy to access, comprehend, evaluate, and apply health-related information across the three domains that encompass an individual's capacity or ability to acquire, process, comprehend, and utilize health information and services for making appropriate health decisions. Scores above 43 to 54 are classified as excellent health literacy level, denoting that individuals can easily access, understand, evaluate, and apply health-related information related to healthy lifestyles within the three domains of healthcare. The majority of respondents demonstrated sufficient health literacy, totaling 4,943 individuals (53.4%). Following this group, there were 2,415 respondents (26.1%) who exhibited excellent health literacy and 1,906 (20.6%) respondents having limited health literacy.

Table 4. Descriptive Statistics of General Health Literacy Level by Socio-Demographic Characteristic.

Demographic Characteristics	Level of Health Literacy		
	Limited Health Literacy Level (Score 0 – 33)	Sufficient Health Literacy Level (Score 34-42)	Excellent Health Literacy Level (Score 43 – 54)
		Percentage (95% CI)	
Overall	**20.6 (27.43, 27.93)**	**53.4 (36.64, 36.75)**	**26.1 (49.21, 49.54)**
Sex			
Male	18.9 (27.50, 28.26)	53.6 (36.68, 36.84)	27.5 (48.97, 49.43)
Female	22.0 (27.21, 27.86)	53.1 (36.57, 36.72)	24.8 (49.32, 49.77)

Education Level			
No formal education	38.5 (23.46, 26.41)	48.9 (36.25, 36.89)	12.6 (48.07, 50.99)
Primary School	29.8 (24.88, 27.65)	44.3 (36.32, 36.96)	25.9 (49.97, 51.83)
Secondary School	24.9 (26.94, 27.67)	50.8 (36.58, 36.77)	24.4 (48.89, 49.43)
Certificate/Diploma	18.4 (28.29, 29.04)	56.0 (36.64, 36.83)	25.7 (48.66, 49.22)
Bachelor Degree and above	12.9 (27.76, 29.00)	55.8 (36.59, 36.81)	31.3 (49.69, 50.31)
Age Group			
18-24	18.6 (27.72, 28.70)	51.1 (36.70, 36.93)	30.4 (49.14, 49.74)
25-44	17.8 (27.78, 28.48)	57.5 (36.58, 36.73)	24.7 (49.01, 49.50)
45-60	25.4 (26.65, 27.59)	49.0 (36.58, 36.81)	25.6 (49.11, 49.77)
61-100	34.9 (24.76, 27.14)	46.5 (36.24, 36.75)	18.6(49.07, 50.81)

3.4 DISTRIBUTION OF PHYSICAL ACTIVITY

There were various PA questionnaires used to quantify physical activity. For this research, IPAQ was used initially which contains 7 items including questions on PA over the previous seven days, including participation in vigorous physical activities, moderate-intensity physical activity, walking activity, and sitting time as well as the amount of time spent on each activity. The questionnaires' second sub-domain inquiries about the respondents' efforts to instill a culture of active living in their daily life, and the third sub-domain, includes four inquiries regarding an environment supportive of an active way of life.

The assessment of physical activity (PA) levels in this study utilized the adapted International Physical Activity Questionnaire-Short Form (IPAQ-SF) and categorized respondents into three groups: active Health-Enhancing Physical Activity (HEPA), minimally active, and non-active. The integration of physical activity into daily life was evaluated through a set of six questions concerning PA practices. The findings revealed that the majority of respondents, specifically 4,565 individuals (49.3%), were classified as having an active HEPA level. Following this group, 3,002 respondents (32.4%) fell into the category of being minimally active HEPA, while a smaller proportion of 1,697 respondents (18.3%) reported not engaging in active HEPA.

Table VI. Descriptive Statistics of Physical Activity Level by Socio-Demographic Characteristic.

Demographic Characteristics	Level of Physical Activity		
	Not Active	Active Minimal	Active Hepa
	Percentage (95% CI)		
Overall	**18.3 (14.37, 14.57)**	**32.4 (15.17, 15.33)**	**49.3 (15.58, 15.71)**
Sex			
Male	16.7 (14.56, 14.88)	34.5 (15.27, 15.51)	48.8 (15.76, 15.96)
Female	19.8 (14.16, 14.41)	30.5 (15.00, 15.22)	49.7 (15.37, 15.55)
Education Level			
No formal education	28.1 (13.33, 14.23)	38.9 (13.50, 14.02)	33.0 (14.86, 15.77)
Primary School	19.7 (13.43, 14.71)	34.4 (14.51, 15.45)	45.9 (14.79, 15.56)
Secondary School	17.8 (1 4.11, 14.44)	30.3 (14.77, 15.04)	51.9 (15.40, 16.61)

Certificate/Diploma	18.1 (14.38. 14.73)	32.7 (15.35, 15.63)	49.2 (15.54, 15.78)
Bachelor Degree and Above	18.1 (14.66, 15.07)	34.4 (15.51, 15.85)	47.6 (15.81, 16.12)
Age Group			
18-24	14.3 (14.88, 15.33)	34.8 (15.46, 15.78)	50.9 (15.86, 16.13)
25-44	18.8 (14.46, 14.73)	31.1 (15.35, 15.58)	50.1 (15.57, 15.77)
45-60	19.4 (13.73, 14.13)	31.1 (14.47, 14.80)	49.5 (15.14, 15.41)
61-100	30.2 (13.40, 14.14)	38.0 (13.83, 14.60)	31.8 (14.62, 15.35)
Environment Facilities			
Yes	16.1 (14.36, 14.56)	37.8 (14.60, 15.84)	46.1 (15.72, 16.62)
No	18.4 (14.42, 15.71)	32.3 (15.17, 15.34)	49.3(15.56, 15.70)

3.5 ASSOCIATION BETWEEN HEALTH LITERACY AND PHYSICAL ACTIVITY

The association between respondents' health literacy and physical activity levels revealed a statistically significant relationship ($p < .05$). The relationship between these two variables falls within the small to medium range (V = 0.101). A higher health literacy level corresponds to a higher physical activity level, indicating a close and positive correlation.

Table VII. The Association between Health Literacy and Physical Activity Level

		Physical Activity Level	Physical Activity Score
Health Literacy Level	Pearson Chi-Square	188.189	0.241
	Cramer's V	0.101	-

3.6 ASSOCIATION PHYSICAL ACTIVITY AND ENVIRONMENRAL FACILITIES AND GENDER

There is a correlation between the respondents' health literacy and their physical activity levels, which falls within the small to medium range. The point biserial correlation, a specialized form of Pearson correlation, was employed to assess the relationship between health literacy levels and the average score of the physical activity. Consequently, a weak positive correlation exists between health literacy and physical activity. Conversely, there is no discernible association between physical activity levels and the availability of environmental facilities. In terms of gender and physical activity levels among respondents, a very weak association is observed.

This implies that an elevated level of health literacy leads to an increase in the physical activity levels among respondents. As health literacy rises, there is a minimal correlation observed in the physical activity scores. Notably, the physical activity level shows no significant connection with the availability of environmental facilities. Additionally, gender does not exert a substantial impact on this relationship.

Table 5. The chi-square and p-value for domains and sociodemographic

Association of	Pearson Chi-Square	p-value	Cramer's V	p-value
Health Literacy and Physical Activity Level	188.189	0.000*	0.101	0.000*
Health Literacy Level and mean Physical Activity Score	0.241	0.000*	-	-
Physical activity level and environment facilities	0.254	0.881	0.005	0.881
Physical activity level and gender	23.913	0.000*	0.051	0.000*

(Note: * indicate significant values)

3.7 DISCUSSION

Promoting overall well-being hinges on the pivotal roles of both health literacy and physical activity. When intertwined, these factors actively contribute to cultivating a healthier lifestyle, positively influencing an individual's quality of life. The capacity to understand health information empowers individuals to make knowledgeable choices about their well-being, while consistent involvement in physical activity remains a cornerstone of preventive healthcare. Research indicates that health literacy and physical activity levels may vary based on sociodemographic factors and lifestyle. The objective of this research is to examine the association between health literacy and physical activity among respondents who participated in the Malaysian Healthy Lifestyle Index survey. The leading global cause of death is non-communicable diseases, posing a growing threat to global health. The incidence of NCDs and associated fatalities has risen in low- and middle-income countries (CDC, n.d.). Research revealed that lifestyle factors were linked with several NCDs, and adherence to a healthy lifestyle was associated with a lower risk of NCDs and mortality [30], [31] [32], [33]. The results are highly significant and consistently observed across individuals from diverse continents, racial groups, and socioeconomic backgrounds [34]. The World Health Organization (WHO) defines health literacy (HL) as an individual's capacity to acquire and comprehend health-related information and services, and to utilize this knowledge for making informed health decisions [35].

According to this survey, a significant portion of the Malaysian population possesses health literacy skills ranging from sufficient (53.4%) to excellent (26.1%), indicating that Malaysia maintains a commendable level of health literacy. Interestingly, this study also found that males exhibit a higher prevalence of health literacy than females. It is essential to acknowledge that there exist variations in health literacy levels when compared to other nations. For instance, in the Hong Kong population, over 50% of the general public demonstrated limited health literacy, with a slightly higher prevalence among women [36]. The average health literacy score for the Malaysian population in this study was 38.15, placing it within the sufficient range. This result aligns with a study conducted by [37], which also indicated that Malaysians, on average, possess a sufficient level of health literacy. These findings suggest that there is room for improvement in health literacy among Malaysians, with the potential to reach an excellent level.

Moreover, there appears to be a potential connection between educational level and age groups in relation to health literacy levels. It is noteworthy that respondents holding certificates/diplomas and bachelor's degrees or higher exhibit a higher prevalence of having sufficient health literacy levels when compared to those with lower educational qualifications. However, it's important to consider the findings from [38] study, which suggest that low health literacy remains a relatively prevalent issue even among individuals with a high level of education. Furthermore, when examining age groups, it becomes evident that respondents in the 61 to 100 age range having the highest number of limited health literacy, whereas those aged 18 to 24 show the greatest number of individuals demonstrating excellent health literacy. This inverse relationship can be attributed to the natural decline in the capacity to acquire new knowledge and memory as individuals age over time. Additionally, this study reveals that respondents aged 61 to 100 are more likely to be physically inactive. In alignment with these findings, [39] research highlights a significant correlation between low health literacy in older adults and compromised cognitive functioning, encompassing both present and past cognitive performance. This connection is especially prominent in areas such as memory, information processing speed, and mental flexibility, with the most robust association observed in overall cognitive functioning.

The majority of the respondents demonstrate an active HEPA (Highly-Energetic Physical Activity) level, comprising 49.3% of the sample. Following this group, there are individuals with an active minimal level at 32.4%, while the remaining 18.3% are categorized as not active. Notably, female respondents exhibit a slightly higher percentage of active HEPA physical activity levels (49.7%) compared to their male counterparts (48.8%). This study also found that the terms of gender and physical activity levels among respondents, a very weak association is observed. A study by [40] found out that elderly females exhibited higher levels of physical activity compared to their male counterparts. However, a study in Bangladesh by [41] has proved that women tend to be less physically active than men in that context. In the Malaysian population, women appear to possess a heightened awareness of the importance of physical activity for maintaining good health. This awareness could potentially lead to women reporting higher levels of physical activity, even in cases where their health literacy levels may be limited.

The study's findings indicate that individuals with higher educational attainment tend to engage in more HEPA compared to those with lower levels of education. This observation aligns with [42] research, which revealed that individuals with a higher level of education (specifically, those surpassing the median years of education) reported higher levels of leisure-time physical activity. Additionally, they registered a greater quantity of aerobic steps per day but fewer total steps per day in comparison to their peers with lower educational backgrounds. This suggests that well-educated individuals may possess a more comprehensive understanding of how to integrate physical activity into their daily routines and exhibit greater knowledge of exercise options and techniques.

There appears to be no discernible connection between the presence of environmental facilities and the physical activity levels of the respondents. Interestingly, respondents residing in areas lacking such facilities appear to be more physically active than those who do have access to them. This phenomenon could be attributed to the fact that respondents are more motivated to engage in physical activity when there are limited recreational amenities available in their residential surroundings.

There is a correlation between the level of health literacy and physical activity, which aligns with the findings of [43]. In the research, a statistically significant relationship (p < .05) between health literacy and physical activity was also established. The correlation coefficient of 0.101 suggests a modest to moderate association, consistent with the results of [44], both of which observed a positive but weak relationship between health literacy and physical activity levels. Individuals with higher health literacy levels tend to be more knowledgeable about how to maintain their health and are aware of the potential consequences of physical inactivity on their well-being. Hence, this study reaffirms that HL serves as a significant predictor of an active lifestyle, in line with the findings of [45] study. Additionally, the HL level and the mean score of the physical activity also yield the same result where there is a positive weak relationship between the variables. The mean score for the physical activity is 2.62 ± 0.52.

These findings indicate that the Malaysian government should proactively work towards elevating health literacy to an excellent level while sustaining the physical activity levels of the Malaysian population. Implementing promotional campaigns and health education initiatives is essential to enhance Malaysians' understanding of the importance of health literacy and physical activity in cultivating a healthy lifestyle. However, it is vital for authorities to tailor their strategies based on the specific sociodemographic profiles of the respondents, as different approaches may yield varying results depending on these profiles. Furthermore, environmental facilities play a crucial role, not only for young people but also for older individuals. The presence of walkable cities and numerous recreational parks can serve as motivating factors for elderly individuals to engage in physical activity. This aspect also warrants further research to determine its significance in promoting physical activity readiness among Malaysians. Future research is needed to improve the clarity of the findings.

The analysis employed Chi-square analysis with Cramer's V as a measure of the strength of association, revealing a statistically significant but modest relationship between health literacy and physical activity levels (V = .101, p=.001). Further examination of the data revealed that 30.1% of participants with excellent health literacy levels reported being physically active at a high level (meeting HEPA guidelines), while 27.3% of those with limited health literacy levels reported being non-active. Additionally, a correlation analysis indicated a statistically significant but weak positive correlation (r = .241) between health literacy and the cultivation of physical activity practices in daily living.

The observed small to medium relationship (V = .101) between health literacy and physical activity levels aligns with existing literature that highlights the multifaceted nature of health behaviours [7]. While the relationship is statistically significant, the magnitude of the association suggests that other factors, beyond health literacy, may influence individuals' physical activity behaviours. This finding underscores the importance of considering various determinants and barriers that individuals may face when engaging in physical activity, such as environmental factors, social support, and personal motivations (Kohl et al., 2012).

The discrepancy in physical activity levels between participants with excellent and limited health literacy levels (30.1% vs. 27.3%) highlights the role of health literacy as a potential influencing factor in promoting physical activity engagement. Individuals with higher health literacy levels may possess better knowledge and comprehension of the health benefits associated with physical activity, leading to a greater

inclination to adopt and maintain active lifestyles. Conversely, individuals with limited health literacy may face challenges in accessing and understanding health information, potentially hindering their engagement in physical activity. The observed weak positive correlation ($r = .241$) between health literacy and cultivating physical activity practices in daily living suggests that, while not a robust predictor, health literacy contributes to the adoption of a physically active lifestyle among Malaysians. This correlation reinforces the notion that health literacy is one of several contributing factors to physical activity behaviour. It is essential to consider health literacy in conjunction with other determinants, tailoring interventions to address the diverse needs and barriers faced by individuals [3].

The implications of these findings are noteworthy for public health interventions in Malaysia. To promote physical activity and improve health outcomes, interventions should adopt a comprehensive approach that addresses not only health literacy but also environmental, social, and motivational factors. Tailored health education and communication strategies designed to enhance health literacy can improve individuals' comprehension of the advantages of physical activity, enabling them to make informed decisions about their health. In conclusion, this study provides valuable insights into the relationship between health literacy and physical activity levels among Malaysians. While a statistically significant association exists, the modest magnitude of the relationship suggests the need for multifaceted interventions that consider various determinants of physical activity behaviour. By addressing health literacy alongside other factors, public health initiatives can more effectively promote physical activity and contribute to improved health outcomes in Malaysia.

4.0 CONCLUSION

In general, the health literacy level among Malaysians is currently deemed sufficient, and they are actively engaged in High-Energetic Physical Activity (HEPA) in their physical activity levels. In conclusion, our study highlights a significant but moderately sized relationship between health literacy and physical activity levels among Malaysians. While health literacy programs can play a role in promoting physical activity, it is clear that addressing physical inactivity necessitates a more comprehensive approach. The weak yet significant correlation between health literacy and cultivating physical activity practices underscores the importance of considering both health literacy and environmental factors in public health interventions. Ultimately, the findings from this study can inform strategies aimed at enhancing health literacy and promoting physical activity, contributing to improved health outcomes in Malaysia.

Moving forward, future research should prioritize delving deeper into the impact of environmental amenities on physical activity levels across diverse age groups and sociodemographic profiles. Additionally, there is a need to explore various facets of health literacy and physical activity to comprehensively evaluate the overall levels among respondents. This comprehensive approach will aid in understanding which specific domains should be assessed to elevate Malaysian health literacy and physical activity levels to an excellent standard.

4.1 The Discrepancy with International Findings

The study's findings deviate from previous research conducted in other countries, which often suggested a positive association between higher HL levels and increased PA engagement [46]. These international

studies have emphasized the pivotal role of HL in shaping health behaviours and have commonly regarded it as a facilitator of informed decision-making regarding PA participation.

However, within the Malaysian context, this study reveals a somewhat contradictory picture. Despite a statistically significant association between HL and PA, the magnitude of this relationship was modest (V = .101), highlighting that other factor, beyond HL, contribute significantly to PA engagement among Malaysians. This finding resonates with the assertion that health behaviours, including PA, are influenced by a multitude of factors, such as environmental, sociocultural, and personal determinants [47].

4.2 The Gap Between Knowledge and Practice

One prominent observation from this study is the apparent gap between health knowledge, as reflected in HL levels, and the translation of this knowledge into actual PA practices. The finding that participants with excellent HL levels did not consistently engage in higher levels of PA suggests that merely possessing health information does not guarantee health behaviour change. This gap may be attributed to various factors, including motivational factors, environmental constraints, or cultural norms, which act as barriers to the application of health knowledge into daily practices.

4.3 Implications for Interventions

The presence of this gap between HL and PA behaviour highlights the potential utility of integrating health literacy-focused interventions into strategies aimed at promoting physical activity among Malaysians. Such interventions should go beyond the mere dissemination of health information and focus on equipping individuals with the skills and self-efficacy needed to translate this knowledge into action [48]. Additionally, interventions should take into account the cultural diversity and socioeconomic disparities present within the Malaysian population, tailoring approaches to address specific contextual challenges and barriers to PA engagement.

4.4 The Need for Holistic Approaches

To bridge the gap between knowledge and practice, holistic approaches to promoting physical activity in Malaysia are warranted. These approaches should encompass multi-level interventions that consider individual-level factors, such as HL, alongside community-level and policy-level determinants [49]. Creating supportive environments for PA, fostering a culture of physical activity, and implementing policies that facilitate access to recreational spaces are essential components of such a strategy.

In conclusion, this study contributes to our understanding of the relationship between health literacy and physical activity among Malaysians. While the findings suggest a significant association, the modest effect size and the observed gap between knowledge and practice emphasize the complexity of health behaviours in the Malaysian context. Integrating health literacy-focused interventions into comprehensive strategies to promote physical activity may hold promise in addressing this gap and fostering a healthier, more physically active population in Malaysia.

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REFERENCES

1. "Health Promotion." Accessed: Nov. 16, 2023. [Online]. Available: https://www.who.int/teams/health-promotion/enhanced-wellbeing/ninth-global-conference/health-literacy

2. W. H. Organization, "Shanghai declaration on promoting health in the 2030 Agenda for Sustainable Development," *Health Promot Int*, vol. 32, no. 1, pp. 7–8, 2017, doi: 10.1093/heapro/daw103.

3. K. Sørensen *et al.*, "Health literacy and public health: A systematic review and integration of definitions and models," *BMC Public Health*, vol. 12, no. 1, p. 80, 2012, doi: 10.1186/1471-2458-12-80.

4. A. A. Azlan, M. R. Hamzah, J. S. Tham, S. H. Ayub, A. L. Ahmad, and E. Mohamad, "Associations between health literacy and sociodemographic factors: A cross-sectional study in Malaysia utilising the HLS-M-Q18," *Int J Environ Res Public Health*, vol. 18, no. 9, 2021, doi: 10.3390/ijerph18094860.

5. C. Coleman, S. Kurtz-Rossi, J. McKinney, A. Pleasant, I. Rootman, and L. Shohet, "The Calgary charter on health literacy: Rationale and core principles for the development of health literacy curricula," *The Center for Literacy of Québec*, no. November, pp. 1–4, 2008.

6. IPH, *Non-Communicable Diseases, Risk Factors & Other Health Problems*, vol. II, no. 3. 2015.

7. N. D. Berkman, S. L. Sheridan, K. E. Donahue, D. J. Halpern, and K. Crotty, "Low health literacy and health outcomes: An updated systematic review," *Ann Intern Med*, vol. 155, no. 2, pp. 97–107, 2011, doi: 10.7326/0003-4819-155-2-201107190-00005.

8. "Physical activity." Accessed: Nov. 16, 2023. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/physical-activity

9. H. W. Kohl *et al.*, "The pandemic of physical inactivity: Global action for public health," *The Lancet*, vol. 380, no. 9838, pp. 294–305, 2012, doi: 10.1016/S0140-6736(12)60898-8.

10. C. J. Caspersen, K. E. Powell, and G. M. Christenson, "Physical Activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research CARL," Centers for Disease Control and Prevention. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1424733/pdf/pubhealthrep00100-0016.pdf

11. NHMS 2019, *National Health and Morbidity Survey 2019 Non-communicable diseases, healthcare demand, and health literacy*, vol. 20. 2019. doi: 10.18356/be4d1601-en.

12. I. for P. H. IPH, N. I. of H. NIH, and M. of H. Malaysia, *National Health and Morbidity Survey (NHMS) 2019: NCDs - Non-Communicable Diseases: Risk Factors and other Health Problems*, vol. 1. 2019.

13. A. Shah and I. M. Iskandar, "Malaysia's health literacy rate low," *TheStar*, 2022.

14. Y. B. Liu, L. Liu, Y. F. Li, and Y. L. Chen, "Relationship between health literacy, health-related behaviors and health status: A survey of elderly Chinese," *Int J Environ Res Public Health*, vol. 12, no. 8, pp. 9714–9725, 2015, doi: 10.3390/ijerph120809714.

15. N. Buawangpong, W. Sirikul, C. Anukhro, M. Seesen, A. La-Up, and P. Siviroj, "Health Information Sources Influencing Health Literacy in Different Social Contexts across Age Groups in Northern Thailand Citizens," *Int J Environ Res Public Health*, vol. 19, no. 10, 2022, doi: 10.3390/ijerph19106051.

16. N. M. Nik-Nasir *et al.*, "Physical Activity in Malaysia: Are We Doing Enough? Findings from the REDISCOVER Study," *Int J Environ Res Public Health*, vol. 19, no. 24, 2022, doi: 10.3390/ijerph192416888.

17. Z. A. Bakar, H. Ibrahim, and Z. M. Ashaari, "Physical activity among malaysian university students: The motives," *Indian J Public Health Res Dev*, vol. 10, no. 6, pp. 1305–1308, 2019, doi: 10.5958/0976-5506.2019.01476.1.

18. I. P. A. Q. (IPAQ), "Guidelines for data processing and analysis of the IPAQ-short and long forms," *Med Sci Sports Exercise*, no. April, p. https://www.physio-pedia.com/images/c/c7/Quideline, 2004.

19. A. Ibrahim, "Low health literacy among B40 a growing concern," *New Strait Times*, 2022.

20. C. L. Craig *et al.*, "International physical activity questionnaire: 12-Country reliability and validity," *Med Sci Sports Exerc*, vol. 35, no. 8, pp. 1381–1395, 2003, doi: 10.1249/01.MSS.0000078924.61453.FB.

21. Y. Y. Chan *et al.*, "Physical activity and overweight/obesity among Malaysian adults: Findings from the 2015 National Health and morbidity survey (NHMS)," *BMC Public Health*, vol. 17, no. 1, pp. 1–12, 2017, doi: 10.1186/s12889-017-4772-z.

22. Y. Y. Chan *et al.*, "Lifestyle, chronic diseases and self-rated health among Malaysian adults: results from the 2011 National Health and Morbidity Survey (NHMS)," *BMC Public Health*, vol. 15, no. 1, pp. 1–12, 2015, doi: 10.1186/s12889-015-2080-z.

23. WHO, "A healthy lifestyle - WHO recommendations." [Online]. Available: https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations

24. N. Jaafar *et al.*, "Malaysian Health Literacy: Scorecard Performance from a National Survey," *Int J Environ Res Public Health*, vol. 18, no. 11, p. 5813, Jun. 2021, doi: 10.3390/IJERPH18115813.

25. H. Akoglu, "User's guide to correlation coefficients," *Turk J Emerg Med*, vol. 18, no. 3, pp. 91–93, 2018, doi: 10.1016/j.tjem.2018.08.001.

26. J. F. Sallis *et al.*, "Metodología de evaluación de la actividad física en el Proyecto Five-City," *Am J Epidemiol*, vol. 121, no. 1, pp. 91–106, 1985.

27. E. T. Carbone and J. M. Zoellner, "Nutrition and health literacy: A systematic review to inform nutrition research and practice," *J Acad Nutr Diet*, vol. 112, no. 2, pp. 254–265, 2012, doi: 10.1016/j.jada.2011.08.042.

28. A. Terzic and S. Waldman, "Chronic diseases: The emerging pandemic," *Clin Transl Sci*, vol. 4, no. 3, pp. 225–226, 2011, doi: 10.1111/j.1752-8062.2011.00295.x.

29. "About Global NCDs | Division of Global Health Protection | Global Health | CDC." Accessed: Nov. 16, 2023. [Online]. Available: https://www.cdc.gov/globalhealth/healthprotection/ncd/global-ncd-overview.html

30. K. E. N. Petersen *et al.*, "The combined impact of adherence to five lifestyle factors on all-cause, cancer and cardiovascular mortality: A prospective cohort study among Danish men and women," *British Journal of Nutrition*, vol. 113, no. 5, pp. 849–858, 2015, doi: 10.1017/S0007114515000070.

31. N. Zhu *et al.*, "Adherence to a healthy lifestyle and all- cause and cause-specific mortality in Chinese adults : a 10-year prospective study of 0 . 5 million people," 2019.

32. A. Shankar, A. McMunn, and A. Steptoe, "Health-Related Behaviors in Older Adults. Relationships with Socioeconomic Status," *Am J Prev Med*, vol. 38, no. 1, pp. 39–46, 2010, doi: 10.1016/j.amepre.2009.08.026.

33. E. S. Ford, G. Zhao, J. Tsai, and C. Li, "Low-Risk lifestyle behaviors and all-cause mortality: Findings from the national health and nutrition examination survey III mortality study," *Am J Public Health*, vol. 101, no. 10, pp. 1922–1929, 2011, doi: 10.2105/AJPH.2011.300167.

34. Y. B. Zhang *et al.*, "Combined lifestyle factors, all-cause mortality and cardiovascular disease: A systematic review and meta-analysis of prospective cohort studies," *J Epidemiol Community Health (1978)*, vol. 75, no. 1, pp. 92–99, 2021, doi: 10.1136/jech-2020-214050.

35. D. Nutbeam and D. M. Muscat, "Health Promotion Glossary 2021," *Health Promot Int*, vol. 36, no. 6, pp. 1578–1598, 2021, doi: 10.1093/heapro/daaa157.

36. F. Zhang, P. P. L. Or, and J. W. Y. Chung, "How different health literacy dimensions influences health and well-being among men and women: The mediating role of health behaviours," *Health Expectations*, vol. 24, no. 2, pp. 617–627, 2021, doi: 10.1111/hex.13208.

37. N. Jaafar *et al.*, "Malaysian health literacy: Scorecard performance from a national survey," *Int J Environ Res Public Health*, vol. 18, no. 11, 2021, doi: 10.3390/ijerph18115813.

38. I. Van Der Heide, J. Wang, M. Droomers, P. Spreeuwenberg, J. Rademakers, and E. Uiters, "The relationship between health, education, and health literacy: Results from the dutch adult literacy and life skills survey," *J Health Commun*, vol. 18, no. SUPPL. 1, pp. 172–184, 2013, doi: 10.1080/10810730.2013.825668.

39. B. Geboers *et al.*, "Health literacy among older adults is associated with their 10-years' cognitive functioning and decline - The Doetinchem Cohort Study," *BMC Geriatr*, vol. 18, no. 1, pp. 1–7, 2018, doi: 10.1186/s12877-018-0766-7.

40. Y. H. Liao, T. W. Kao, T. C. Peng, and Y. W. Chang, "Gender differences in the association between physical activity and health-related quality of life among community-dwelling elders," *Aging Clin Exp Res*, vol. 33, no. 4, pp. 901–908, 2021, doi: 10.1007/s40520-020-01597-x.

41. M. Moniruzzaman, M. S. A. M. Ahmed, and M. M. Zaman, "Physical activity levels and associated socio-demographic factors in Bangladeshi adults: a cross-sectional study," *BMC Public Health*, vol. 17, no. 1, pp. 1–8, 2017, doi: 10.1186/s12889-016-4003-z.

42. J. T. Kari *et al.*, "Education leads to a more physically active lifestyle: Evidence based on Mendelian randomization," *Scand J Med Sci Sports*, vol. 30, no. 7, pp. 1194–1204, 2020, doi: 10.1111/sms.13653.

43. V. Valatkaitytė and V. J. Česnaitienė, "Relationship Between Health Literacy, Physical Activity, Motivation and Barriers of People Aged 30–50 Years," *Balt J Sport Health Sci*, vol. 2, no. 113, 2019, doi: 10.33607/bjshs.v2i113.787.

44. N. Uysal, E. Ceylan, and A. Koç, "Health literacy level and influencing factors in university students," *Health Soc Care Community*, vol. 28, no. 2, pp. 505–511, 2020, doi: 10.1111/hsc.12883.

45. A. Buja *et al.*, "Health Literacy and Physical Activity: A Systematic Review," *J Phys Act Health*, vol. 17, no. 12, pp. 1259–1274, 2020, doi: 10.1123/jpah.2020-0161.

46. M. K. Paasche-Orlow, R. M. Parker, J. A. Gazmararian, L. T. Nielsen-Bohlman, and R. R. Rudd, "The Prevalence of Limited Health Literacy," *J Gen Intern Med*, vol. 20, no. 2, pp. 175–184, Feb. 2005, doi: 10.1111/J.1525-1497.2005.40245.X.

47. H. W. Kohl *et al.*, "The pandemic of physical inactivity: global action for public health," *Lancet*, vol. 380, no. 9838, pp. 294–305, 2012, doi: 10.1016/S0140-6736(12)60898-8.

48. D. Nutbeam, "Health literacy as a public health goal: A challenge for contemporary health education and communication strategies into the 21st century," *Health Promot Int*, vol. 15, no. 3, pp. 259–267, 2000, doi: 10.1093/heapro/15.3.259.

49. J. F. Sallis *et al.*, "Co-benefits of designing communities for active living: An exploration of literature," *International Journal of Behavioral Nutrition and Physical Activity*, vol. 12, no. 1, pp. 1–10, Feb. 2015, doi: 10.1186/S12966-015-0188-2/TABLES/11.