

Research Article

## Health Literacy: How is it Related to Body Mass Index of Patients with Diabetes Mellitus?

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### ABSTRACT

This study aimed to assess the level of health literacy and determines the association between health literacy and Body Mass Index (BMI) among Type 2 Diabetes Mellitus (T2DM) patients in Hospital Universiti Sains Malaysia (HUSM). A cross-sectional study was conducted among 96 patients with T2DM. Health literacy was measured using the Malay version of the European Health Literacy Survey Questionnaire 16 (HLS-EU-Q16). Information about sociodemographic, weight, height, and body mass index were obtained. The majority of the participants had sufficient health literacy (60.4%), whereas the mean BMI of patients was 28.59 kg/m<sup>2</sup>. A significant association was found between BMI with health literacy levels. The median BMI value of the sufficient health literacy group was significantly higher, 28.38 (6.02) than the problematic health literacy group, 25.38 (7.52) using Kruskal Wallis test. This indicates that health literacy may be a predictor of BMI. Or maybe, the other way around is true, increased BMI may result in increased awareness on health. Still, other stronger determinants besides health literacy such as income and dietary intake which were not included in this study might influence the BMI of T2DM patients.

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## INTRODUCTION

The prevalence of diabetes has risen significantly throughout the years. Around 462 million people were diagnosed with Type 2 Diabetes Mellitus (T2DM) in 2017, representing 6.28% of the global population or a prevalence rate of 6,059 cases per 100,000 and this figure is expected to rise to 7,079 individuals per 100,00 by 2030 (Khan *et al.* 2020). T2DM affects around one in every eleven adults worldwide, with Asia serving as the epicentre of the global T2DM epidemic (Zheng *et al.* 2018). Similarly, Malaysia's overall diabetes prevalence has increased from 11.2% in 2011, 13.4% in 2015, to 18.3% in 2019 (Institute for Public Health 2020). T2DM patients are exposed to the possibility of several complications owing to multifaceted and interrelated processes such as hyperglycemia, insulin resistance, inflammation, and atherogenesis (Schlienger 2013).

In order to halt the disease progression, health literacy is required in patients with T2DM to practice multiple tasks. Multiple tasks of patients with T2DM, namely monitoring their blood glucose level, adherence to medication or diabetic diet, and appointment with a doctor, require good health literacy. Health literacy is related to literacy and requires the knowledge, motivation, and ability of individuals to access, comprehend, and apply health information in order to make judgments and decisions about healthcare, disease prevention, and health promotion to sustain or improve the quality of life throughout life (Sørensen *et al.* 2012). High health literacy is linked with greater diabetes related knowledge, self-efficacy and self-care behaviours (Bailey *et al.* 2014). Thus, health literacy is crucial to be assessed in patients with T2DM, so that improvement can be made in the lacking aspect for recovery from diabetic-related health outcomes of patients.

Overweight and obesity have been recognized as a global concern worldwide for the past years. Besides, T2DM was four times more prevalent in obese patients constituting approximately one-half of cases compared to people with normal Body Mass Index (BMI) (Abbasi *et al.* 2017). In addition, overweight and obesity are prevalent among patients with metabolic diseases such as T2DM. Higher BMI may contribute to poor glycaemic control and risk of cardiovascular disease. Besides, high BMI is also related to a poorer health-related quality of life (Wong *et al.* 2013).

Poor health literacy is generally linked with poor health behaviours and health outcomes. Based on a systematic review, recent evidence suggests that low health literacy is one of the contributors of obesity and, more importantly, maybe a significant factor in obese people's inability to lose weight (Michou *et al.* 2018). There is limited study on the association between health literacy and BMI among T2DM patients. Physical inactivity and unhealthy dietary behaviour are examples of factors that can contribute to high BMI and excessive weight gain and further deteriorate health outcomes. Based on a Danish population-based study, 30.7% of the participants are physically inactive. The study found that diabetes patients with low health literacy are more likely to be physically inactive (Friis *et al.* 2016). A framework illustrating association between health literacy with BMI (intermediate outcomes) through physical activity and nutrition/diet (self-care behaviours) has been postulated. Low numeracy skills, which is one of the components of health literacy assessed using the Rapid Estimate of Adult Literacy in Medicine (REALM) is also associated with high BMI (Huizinga *et al.* 2008). Meanwhile, another study found no association between health literacy and BMI among T2DM African American population (Al Sayah *et al.* 2015). Even though there is a mixed review on the association of health literacy with BMI among T2DM patients, it is beneficial to consider the level of health literacy of patients when developing interventions, in order to improve patient's health outcome. Therefore, the objectives of this study are to assess the level of health literacy, assess the mean BMI, and determine the relationship between health literacy and body mass index among T2DM participants in Hospital Universiti Sains Malaysia (HUSM).

## METHODS

### Design, location, and time

This study implemented a cross-sectional study design and was conducted at selected clinics and wards in Hospital USM by using purposive selection. This location was chosen because it is the place that T2DM patients get treatment for their disease. The data collection was conducted from October 2021 to January 2022. The study population was patients with T2DM who were admitted to wards (Medical Wards and Orthopaedic Wards) and attended outpatient clinics in HUSM. Patients diagnosed with T2DM for the past one year, had been on diabetes mellitus treatment (oral anti-diabetic agents or insulin or both) at least for the past four weeks, aged 18 years old and above, and able to speak and understand the Malay language were recruited in the study. The exclusion criteria of the study are participants who were diagnosed with Type 1 Diabetes Mellitus or Gestational Diabetes Mellitus, wheelchair bound patients, bed-ridden or patients in the Intensive Care Unit (ICU), having severe mental health issue and is currently under follow-up of the psychiatric and undergoing dialysis. We have only included T2DM patients in this study to obtain precise results regarding health literacy among this specific group of patients.

### Sampling

One proportion formula had been used for calculating the sample size, and the proportion value will represent the proportion of limited health literacy 65.3% among T2DM patients in Perak, Malaysia (Abdullah *et al.* 2019). With a 95% confidence level and drop-out rate of 10%, the total number of recruited T2DM patients were 96. The sampling method that was used in this research is convenience sampling. Subjects who met the inclusion criteria were included in this study.

### Data collection

Potential subjects at each medical ward and clinic were approached to participate in the study. Potential participants were screened thoroughly for only selecting those meeting the inclusion criteria. The patients who matched the inclusion and agreed to participate in the study were explained the purpose and benefits of the study. Informed consent was given by the patients prior to the start of interview. Data was collected via the

interviewer-administered method. The researcher filled in the socio-demography characteristics and health literacy part according to patients' answers, while anthropometry data (weight and height) were retrieved from medical records of patients as these data were taken almost daily in the inpatient setting or taken during each follow-up in the outpatient setting. The interview session was conducted approximately for 10 minutes.

The questionnaire had three sections namely socio-demography, anthropometry, and health literacy. As for the socio-demography section, data such as age, gender, ethnicity, marital status, educational level, employment status, household income and type of diabetes treatment (diet therapy, Oral Anti-Diabetic (OAD), and insulin) were collected through the section. Data about anthropometry measurements, including weight (kg) and height (cm) were obtained from medical records. Then, body weight and height were used to calculate the Body Mass Index (BMI). The classification of BMI followed WHO International BMI cut-off points and is as follows: BMI < 18.5 kg/m<sup>2</sup> (underweight), between 18.5–24.9 kg/m<sup>2</sup> (normal), ≥ 25 kg/m<sup>2</sup> (overweight) and ≥ 30 kg/m<sup>2</sup> (obese) (WHO Expert Consultation 2004). For older adults aged 60 years and above, a different cut-off point was used: Nutrition Screening Initiative (NSI) criteria developed in 1991 in the United States and has been validated in American older adults (Posner *et al.* 1993). The BMI for elderly is as follows: BMI < 24 kg/m<sup>2</sup> (underweight) between 25 to 26 kg/m<sup>2</sup> (normal), ≥ 27 kg/m<sup>2</sup> (overweight) and ≥ 30 kg/m<sup>2</sup> (obesity).

The Malay version of The European Health Literacy Survey Questionnaire 16 (HLS-EU-Q16) was used to assess health literacy (Duong *et al.* 2017). The HLS-EU-Q16 Malay version consists of 16 items and has three sub-domains: health care, disease prevention, and health promotion. Response for selected items from this questionnaire were analysed. The HLS-EU-Q16 Malay version's internal consistency is strong, with Cronbach's alpha ranging from 0.775 for the disease prevention domain, to 0.779 and 0.795 for the health care domain and health prevention domain, respectively (Baharum *et al.* 2020). The HLS-EU-Q16 measures each item by using 4 points Likert scale scoring from 1 (very difficult); 2 (fairly difficult); 3 (fairly easy) and 4 (very easy). For the scoring purpose, scores 1 and 2 were categorized as 0, while scores 3 and

4 were given value of 1. Thus, scores range from a minimum score of 0 to a maximum score of, 16 created from summation of all the 16 questions. The level of health literacy was classified into three categories, namely "inadequate" when the health literacy score was between 0–8, "problematic" and "sufficient" when the health literacy scores were between 9–12 and 13–16, respectively. The scoring had been done based on the guidelines from previous study by Mekhail *et al.* 2022.

The process of data collection was conducted when ethical approval from the Human Research Ethics Committee USM (USM/JEPeM/21060451) and permission from the Director of Hospital USM were obtained.

### **Data analysis**

Data analysis was conducted using IBM Statistical Package for the Social Sciences (SPSS), version 26.0. Descriptive statistics were used to summarize the socio-demographic characteristics of subjects and the response given for some selected items in The European Health Literacy Survey Questionnaire 16 (HLS-EU-Q16). The data was presented using number (n) and percentage (%) for categorical data. Mean (SD) or Median (IQR) represented numerical/continuous data based on their normality distribution. The association between health literacy (categorical variable) and BMI (numerical variable) was tested using Kruskal Wallis Test, as the data were not normally distributed. Mann-Whitney Test was used to check which pairs of health literacy levels are significant with BMI value. The significance level was set at 0.05 and 95% confidence interval.

## **RESULTS AND DISCUSSION**

### **Socio-demographic and clinical characteristics**

The socio-demographic and clinical characteristics of T2DM patients in Hospital USM were shown in Table 1. The mean age of patients was 60.0 years old (SD=9.65). The majority of the patients were female, 77 (89.2%) and were predominantly Malay (n = 92, 95.8%). Majority of patients (n=50, 52.1%) were unemployed (housewife) and has less than RM2000 household income (n=56, 58.3%) or around 424 USD. Regarding the type of diabetes treatment, 42 (43.8%) of patients were using only OAD, while 26 (27.1%) and 28 (29.2%) were using an insulin regime and both OAD and insulin, respectively.

**Table 1. The socio-demographic and clinical characteristics of type 2 diabetes mellitus patients**

Variables	Mean±SD	Frequency (n), n=96	%
Age of patients (years)	60.01±9.65		
Gender			
Male			
Female		19	19.80
Ethnicity		77	80.20
Malay		92	95.8
Chinese		3	3.1
Punjabi		1	1.0
Marital status			
Single		3	3.1
Married		92	95.8
Widow		1	1.0
Educational level			
Illiterate		4	4.2
Primary		20	20.8
Secondary		49	51.0
Tertiary		23	24.0
Employment status			
Government sector		12	12.5
Private sector		4	4.2
Self-employed		6	6.3
Retired		24	25.0
Unemployed		50	52.1
Household income			
<MYR 2,000		56	58.3
MYR 2,000–3,899		20	20.8
MYR 3,900–6,619		13	13.5
>MYR 6,620		7	7.3
Type of diabetes treatment			
OAD		42	43.8
Insulin regime		26	27.1
Both OAD & insulin		28	29.2

OAD: Oral Anti-Diabetic Agent; MYR: Malaysian Ringgit  
SD: Standard Deviation

**Health literacy level**

Table 2 demonstrated the distribution of participants' health literacy score based on each item in the questionnaire. Meanwhile, Table 3 reported the specific score of each item

**Table 2. Distribution of health literacy scores according to each item in the HLS-EU-Q16**

Question	Very difficult n (%)	Fairly difficult n (%)	Faily easy n (%)	Very easy n (%)
Q1	23 (24.0)	14 (14.6)	11 (11.5)	48 (50.0)
Q2	2 (2.1)	3 (3.1)	8 (8.3)	83 (86.5)
Q3	1 (1.0)	6 (6.3)	19 (19.8)	70 (72.9)
Q4	0 (0.0)	1 (1.0)	18 (18.8)	77 (80.2)
Q5	3 (3.1)	7 (7.3)	14 (14.6)	72 (75.0)
Q6	1 (1.0)	17 (17.7)	29 (30.2)	49 (51.0)
Q7	0 (0.0)	7 (7.3)	13 (13.5)	76 (79.2)
Q8	30 (31.3)	14 (14.6)	16 (16.7)	36 (37.5)
Q9	1 (1.0)	7 (7.3)	13 (13.5)	75 (78.1)
Q10	1 (1.0)	1 (1.0)	14 (14.6)	80 (83.3)
Q11	22 (22.9)	24 (25.0)	24 (25.0)	26 (27.1)
Q12	19 (19.8)	22 (24.0)	23 (22.9)	32 (33.3)
Q13	25 (26.0)	22 (22.9)	11 (11.5)	38 (39.6)
Q14	5 (5.2)	6 (6.3)	11 (11.5)	74 (77.1)
Q15	15 (15.6)	9 (9.4)	13 (13.5)	59 (61.5)
Q16	0 (0.0)	4 (4.2)	18 (18.8)	74 (77.1)

HLS-EU-Q16: European Health Literacy Survey Questionnaire 16

according to the domains. In the domain of health care, almost 38.5% of the participants reported that they had difficulties finding information about the illness that concerns them. In addition, almost 47.9% of the patients had lack of ability

**Table 3. Summary of the HLS-EU-Q16 scores according to each domain**

Questions	Very difficult to fairly difficult n (%)	Fairly to very easy n (%)
<b>Health Care</b>		
Q1	37(38.5)	59 (61.5)
Q2	5 (5.2)	91 (94.8)
Q3	7 (7.3)	89 (92.7)
Q4	1 (1.0)	95 (99.0)
Q5	10 (10.4)	86 (89.6)
Q6	18 (18.8)	78 (81.3)
Q7	7 (7.3)	89 (92.7)
<b>Diseases prevention</b>		
Q8	44 (45.8)	52 (54.2)
Q9	8 (8.3)	88 (91.7)
Q10	2 (2.1)	94 (97.9)
Q11	46 (47.9)	50 (52.1)
Q12	42 (43.8)	54(56.3)
<b>Health promotion</b>		
Q13	47 (49.0)	49 (51.0)
Q14	11 (11.5)	85 (88.5)
Q15	24 (25.0)	72(75.0)
Q16	4 (4.2)	92 (95.8)

HLS-EU-Q16: European Health Literacy Survey Questionnaire 16

to determine the accuracy of the health-related information in the social media. Another 49.0% of the patients reported that they had difficulties to find activities to improve their mental well-being.

The mean total health literacy score is 12.7(3.0). Analysis according to domain demonstrated higher mean value for the domain of health care,6.1(1.1). The majority of the participants (n=58, 60.4%) had sufficient (13–16) health literacy (Table 4).

Majority of the participants (86.5%) find it very easy to "get professional help when they are ill," whereas 83.3% of the participants felt it very easy to "understand why they need health screenings". This indicates that the participants may have fewer problems in obtaining and comprehending health information, which contributed to a higher health literacy level

**Table 4. The scores of healthy literacy according to domains and health literacy level among type 2 diabetes mellitus patients**

Variables	Mean±SD	Frequency (n)	%
<b>Health literacy domains</b>			
Health care	6.1±1.1		
Disease prevention	3.5±1.3		
Health promotion	3.1±1.1		
<b>Health literacy level</b>			
Inadequate (0–8)		10	10.4
Problematic (9–12)		28	29.2
Sufficient (13–16)		58	60.4

SD: Standard Deviation

among the participants. Moreover, they routinely and willingly come to the hospital for follow-up appointments with their doctor or dietitian, indicating the rate of appointment compliance is high. Compliance with doctor's appointments is indeed helping the participants to access and understand health information, as delayed care and not having seen a doctor in the previous year are the behaviours that are likely to be observed in low health literacy individuals (Levy & Janke 2016). Furthermore, frequently taking blood sugar tests and blood pressure at the hospital may facilitate the participants' understanding of the importance of health screening. On the other hand, information search on the ways to manage mental health problems and performing tasks that improves mental health is very challenging. It is understandable that the participants felt mental health information is difficult to obtain as negative stereotypes commonly accompany mental health. T2DM patients with mental health comorbidities such as depression, anxiety, or schizophrenia had a 24% higher risk of 4-year mortality, because these comorbidities affected quality of life and ability to perform self-care activities (Guerrero Fernández de Alba *et al.* 2020). Thus, mental health literacy may need significant consideration when managing T2DM patients.

This study revealed that 60.4% of the participants had sufficient health literacy. The health literacy level in this study is inconsistent with the results reported in Yi and Ismail (2020), which stated the overall prevalence of low health literacy among patients visiting a government

health clinic was 83.1%, respectively. The discrepancies in the health literacy level among T2DM patients across several studies are due to the multiple measuring tools that report psychometric features in different ways, making it difficult to compare final results (Abdullah *et al.* 2019).

### Nutritional status of participants

Based on Table 5, the mean weight of participants was 70.68 kg (SD=16.14), whereas the mean height was 157.08 cm (SD=7.63). Furthermore, the mean BMI of patients was 28.59 kg/m<sup>2</sup> (SD=6.17), which was within the overweight category.

### Association between health literacy with education level and body mass index

Table 6 revealed the relationship between health literacy with education level and BMI among 96 T2DM patients in Hospital USM. Subjects with secondary and tertiary education had sufficient health literacy level as compared to those who are illiterate (51.7%) and with primary education (37.9%).

Kruskal-Wallis test (non-parametric test) revealed a statistically significant difference in the median BMI of participants with three health literacy levels ( $p=0.01$ ). After post-hoc test were conducted by doing comparison analysis with separate pairs using the Mann Whitney test and Bonferroni's correction, it was found that the significant different BMI value was contributed by the comparison between problematic and sufficient health literacy groups ( $p=0.009, <0.05$ ). The median BMI value of the sufficient health literacy group (median=28.38, IQR=6.02) was significantly higher than the problematic health literacy group (median=25.38, IQR=7.52).

**Table 5. Nutritional status of type 2 diabetes mellitus patients in Hospital USM**

Variables	Mean±SD	Minimum	Maximum
Weight (kg)	70.68±16.14	39.00	131.00
Height (cm)	157.08±7.63	141.00	195.00
BMI (kg/m <sup>2</sup> )	28.59±6.17	19.48	58.22

BMI: Body Mass Index; SD: Standard Deviation; USM: Universiti Sains Malaysia

The current study found that health literacy is significantly associated with level of education. Participants who are illiterate and with primary education had very low level of sufficient health literacy score as compared to those with secondary and tertiary education ( $p<0.05$ ) (not reported in table). Level of education is indeed one of the factors that influence health literacy. Study by Ueno *et al.* (2019) found that there is an association between educational level and health literacy among T2DM patients. Participants with greater education level will engage in health-seeking behaviour and have greater access to health-related websites and resources, resulting in improved health literacy (Bayati *et al.* 2018).

This study demonstrated that health literacy is associated with BMI among T2DM patients in Hospital USM and further post-hoc analysis revealed significant association between the problematic and sufficient health literacy groups. It was assumed that the median BMI of problematic health literacy groups would be higher than the sufficient groups. This is because individuals with low health literacy will have difficulties maintaining a healthy weight as they lack the necessary skills to obtain, comprehend, appraise and utilize the health information appropriately (James *et al.* 2015). However, our results showed otherwise. This study is consistent with Mashi *et al.* (2019) study, which also reported that the BMI value of the adequate health literacy group among T2DM patients was slightly higher than the marginal and inadequate health literacy group. Previous studies regarding the association between health literacy and BMI showed mixed results. Enomoto *et al.* (2020) revealed no significant association between level of health literacy and BMI. A systematic review by Michou *et al.* (2018) confirmed the association between health literacy and BMI. However, those studies suggested that the lower the health literacy level, the higher the BMI, which is contrary to our study, which found high BMI in the high health literacy level group. Therefore, it was believed that higher BMI among the sufficient health literacy group might be due to other stronger factors such as poor knowledge on carbohydrate counting, lack of physical activity, or poor socioeconomic status that have more impact on the BMI of T2DM patients. Low health numeracy skills related to weight management, such as monitoring calorie intake, interpreting food labels, and tracking daily steps, may also contribute to higher BMI

**Table 6. Relationship between health literacy with education level and BMI among type 2 diabetes mellitus patients**

Variables	Inadequate	Problematic	Sufficient	Kruskal-Wallis H (df)	p*
Health literacy level n (%)					
Illiterate	2 (20.0)	2 (7.1)	0 (0.0)		
Primary	6 (60.0)	8 (28.6)	6 (10.3)		
Secondary	2 (20.0)	17 (60.7)	30 (51.7)		
Tertiary	0 (0.0)	1 (3.6)	22 (37.9)		
Health literacy level n (%)					
BMI	10	28	58	9.14 (2)	0.01
Median (IQR)	28.73 (6.11)	25.38 (7.52)	28.38 (6.02)		

\*Tested using Kruskal Wallis Test; \*Post hoc with Bonferroni's correction; Inadequate vs. Problematic; p-value=0.183; Inadequate vs. Sufficient; p-value=3.00; Problematic vs. Sufficient; p-value=0.009; BMI: Body Mass Index

in the adequate health literacy group because patients with limited numeracy abilities may be unable to successfully interpret or use typical weight management counselling (Huizinga *et al.* 2008). T2DM patients with a higher BMI did not meet HbA1c targets, ate sweeter foods, had less physical activity, and were more likely to skip breakfast (Al-Mountashiri *et al.* 2017).

The findings of this study demonstrated that the BMI of the patients were in the overweight category with mean BMI of 28.59kg/m<sup>2</sup>. Maintaining BMI within the optimal range is essential for diabetic patients well being as abnormal increase in BMI leads to changes in blood glucose, blood pressure, and serum lipid profile (Hu *et al.* 2021). Gray *et al.* (2015) mentioned that weight control is critical for preventing diabetes mellitus-related complications because a high BMI increases risk of complications. Hence, weight-loss management, including dietary, exercise, and behavioural interventions, is essential in the long term and may result in better diabetic outcomes.

Most health outcomes are unlikely to be influenced directly by health literacy; rather, health outcomes are likely to be influenced by various mediating mechanisms, called health actions (Wallace 2010). This revealed that health literacy does not solely influence health outcomes. That study also suggests that motivational processes will ultimately influence an individual to perform health actions, as an individual may already have some knowledge about physical activity and health screening. Still, the knowledge is only a force to form intentions about health

actions. However, motivation alone is not the only predictor of adopting a health action. Self-efficacy and social support can mediate the association between health literacy and BMI (Squiers *et al.* 2012). For example, an individual may understand that excessive energy intake may cause high BMI but may not have the social support or self-efficacy to control their food intake. Social support is important to make changes, as people with diabetes who have received positive support from their relatives and friends are more likely to adhere to self-care behaviours (healthy dietary patterns and exercise) (Mohebi *et al.* 2018).

The current study determines the relationship between health literacy and BMI among T2DM patients in Hospital USM. The association of health literacy and BMI will provide insights into ways to improve the health outcomes of T2DM patients. Health literacy is a study area that is gaining attention at the moment. Therefore, this study will also contribute to Malaysia's health literacy data. In this regard, this study will help healthcare professionals better understand the overall health literacy scenario. The fact that there are still 39.6% of the participants with low health literacy cannot be overlooked. Hence, this finding could help policymakers create better educational programmes and help healthcare providers pay greater attention to their communication style with patients to improve health literacy.

This study was performed in a single hospital in Malaysia, thus the findings of this study are not generalizable to all T2DM population in Malaysia. Moreover, the data was collected in an

area where Malay is the majority ethnicity, so the majority of the participants were Malay, which cannot be generalised to Malaysian population settings. As a result, future studies should use a better sampling approach that can balance participants of varying ethnicities. Besides, we recruited study participants using the purposive sampling technique without randomization. As a result, the study's generalizability and reliability are limited. Since the health literacy level and BMI were assessed cross-sectionally, the causal associations could not be discovered.

### CONCLUSION

It can be concluded that the majority (60.4%) of patients with T2DM in Hospital USM have sufficient health literacy. The most probable reason for this finding is that more than half of our study participants have good educational backgrounds, with 51.0% and 24.0% of the participants at secondary and tertiary levels, respectively. Besides, it was found that most of the participants were within the overweight category. Other than that, we found a statistically significant relationship in the median BMI of participants according to the three health literacy level ( $p=0.01$ ). The significant difference BMI value was contributed by the comparison between problematic and sufficient health literacy groups. The median BMI value of the sufficient health literacy group was significantly higher than the problematic health literacy group. This revealed that the interaction between health literacy and BMI is more multifaceted than just direct one way effect, which may be influenced by dietary behavior, physical activity, numeracy skills, motivation, and social support. Nevertheless, this study is able to contribute to the knowledge of the relationship between health literacy with BMI among T2DM patients in Hospital USM.

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### DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest.

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