ORIGINAL ARTICLE

Predictors of Diabetes Health Literacy and Numeracy Among Urbanized Older Adults in Malaysia

Halimatus Sakdiah Minhat[1,2], Hazwan Mat Din[1], Raja Nurzatul Effah Raja Adnan[1]

[1] Malaysian Research Institute on Ageing, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[2] Department of Community health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

ABSTRACT

Introduction: Diabetes health literacy and numeracy are health indicators of increasing attention to empower diabetic self-management. This study aimed to explore the predictors of diabetes health literacy and numeracy among urbanized older adults. **Methods:** A total of 408 older adults with type 2 diabetes mellitus, aged 50 years and older were recruited using stratified random sampling from eight health clinics in Petaling district. A pre-tested questionnaire was used to measure knowledge, attitude, self-efficacy, self-care behavioral skills, diabetes health literacy and numeracy related to diabetes mellitus, as well as the sociodemographic background. Multivariable linear regression was used to understand and rank the predictors of diabetes health literacy and numeracy among the respondents. **Results:** The total mean score for diabetes health literacy was 53.74 ± 0.60, which was significantly predicted by age (β = -0.21, p=0.01), secondary (β =12.21, p<0.001) and tertiary (β = 16.37, p<0.001) education levels, non-Malays (β = -5.83, p<0.001), being employed (β = -2.77,p=0.02), have other comorbidities (β = -3.02, p=0.003), diabetes related self-efficacy (β = -0.37, p=0.02) and self-care behavioral skills (β =0.36, p<0.001). Meanwhile, the total mean score for diabetes health numeracy was 1.50 ± 0.13 and was significantly predicted by age (β=-0.15, p<0.001), secondary (β=1.09, p=0.002) and tertiary (β=2.24, p<0.001) education levels, and attitude towards diabetes (β=0.16, p<0.001). **Conclusion:** Very low diabetic numeracy was observed, which was predicted by increased age, low education and low attitude score towards managing diabetes. Hence promoting diabetic numeracy should be targeted among older adults with identified risks.
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Corresponding Author:
Halimatus Sakdiah Minhat, DrPH
Email: halimatus@upm.edu.my
Tel: +603 97692424

INTRODUCTION

Diabetes is one of the greatest health challenges globally, particularly among the rapidly ageing nations, such as Malaysia. The increasing age has contributed towards the increase prevalence of diabetes in Malaysia (1). The prevalence was projected to increase to 195.2 million by 2030 and 276.2 million by 2045 (2). Malaysia is not only experiencing a clear trend of increasing prevalence of diabetes among the adult's population, particularly among the older adults (3-5), but also the challenges related to the diabetes control and care among the older adults.

Growing scientific evidence had indicated the key role of self-management in diabetes care (6), which subsequently improves diabetes outcomes. However, the per-forming of self-care frequently involves cognitive ability to understand, appraise health information and engage in healthcare decision making, which is also known as health literacy (7,8), as well as quantitative abilities such as computing calories from nutrition labels, interpreting blood glucose levels, and calculating insulin doses (9), known as health numeracy, which is a domain of health literacy. Successful diabetes management involves multi-step problem-solving (10), which require health literacy related to diabetes knowledge, self-efficacy and self-care behaviors, as well as glycemic control.

Numerous literatures had reported on the higher prevalence of diabetes among the rural settlers in general, which maybe contributed by their accessibility not only the available services, but also diabetic knowledge, particularly among the economically disadvantaged population. Despite the lower prevalence of diabetes among the urban settlers, limited literatures have

commented on diabetes health literacy and numeracy among them. Diabetic patients commonly have limited health literacy and numeracy skills which are frequently linked with low diabetic knowledge and poor glycemic control (11). Although diabetes health literacy and numeracy (DHLN) has been reported to be significantly associated with glycemic control (12), several studies did not demonstrate a direct relationship (13,14), indicating the potential role of diabetic self-efficacy forming an indirect pathway between health literacy, general numeracy and glycemic control (15). Although, prevalence of diabetes reported to be higher in the rural areas, this study aimed to determine the predictors of diabetes health literacy and numeracy among urbanized older adults' settlers in Malaysia.

MATERIALS AND METHODS

This was an observational study, conducted among registered type 2 diabetes mellitus patients aged 50 years old and above, enrolled at the government health clinics in the district of Petaling, Selangor. Older adults were defined as those 50 years and above in this study (16). A total of 408 older adults participated in this study, which were selected using probability stratified proportional to size sampling.

The data were collected using a pre-tested questionnaire, consisting of seven sections namely sociodemographic factors (age, gender, ethnicity, religion, marital status, educational level, occupation and income level), knowledge, attitude, self-efficacy, self-care behaviors, diabetes literacy and diabetes numeracy. Knowledge was measured using multiple choice questions with three to four answer options, containing 14 items related to general information on diabetes and also on insulin use. Meanwhile, attitude was measured using 5-point likert scale, ranging from 0 to 4 (strongly disagree = 0, disagree = 1, neutral = 2, agree = 3 and strongly agree = 4) on 10 items related to managing diabetes which include statements on compliance, perceived severity of illness, complications and impact of the illness on patients' life.

Self-efficacy (7 items) and self-care behavior skills (29 items) were also measured using the same range of 5-point likert scale (0 to 4) (17). The 29 items used to measure self-care behavior skills consist of statements related to diet, medications, physical activities and self-monitoring activities related to diabetes control.

On the other hand, the tool to measure diabetes health literacy and numeracy was adapted from the Diabetes Literacy and Numeracy Education Toolkit (DLNET) which was initially composed of 24 interactive modules, covering standard diabetic care issues that can be tailored to patient needs and used by all multidisciplinary diabetes care team. For this study, diabetes health literacy was assessed based on the ability of the respondents to pronounce a list of 60 items divided into three sections, giving a total score of 60. The scores were categorized into two groups, 0–54: low literacy level and 55–60: high literacy level, assuming that these patients would be capable of reading most of the patient education materials (18). Meanwhile, diabetic numeracy contains six items with 11 numerical answers related to direct and indirect diabetic indicators, with a score range between 0 and 11. Similarly, the scores were divided into two categories, 0-5: low level and 6-11: high level of diabetes numeracy.

Face validity was performed among 10 respondents of similar background to ensure understandability, clarity and simplicity of the questionnaire. Two panel experts from the field of endocrinology and public health were involved as content experts to check for content validity. Pilot study was also conducted to pre-test the questionnaire among a convenient sample of 30 diabetic patients to ensure its reliability. The reliability of all the sections with likert scale (attitude, self-efficacy and self-care behavior) was reflected by the Cronbach alpha coefficients, which were ranging between 0.65 to 0.86. Other factors were also measured including sociodemographic factors.

Data entry and statistical analysis was performed using IBM Statistical Package for Social Science (SPSS) version 25.0. Continuous variables were reported as mean and standard deviation. Categorical data were reported in frequencies and percentages. Multiple linear regression analysis was performed to determine the predictors for diabetes health literacy and numeracy. The statistical significance level was set at $p < 0.05$.

The present study was conducted according to the guidelines of the Declaration of Helsinki and approved by the National Medical Research Register (IRB No.: NMRR-18-3700-42947).

RESULTS

Characteristics of the respondents

Table I shows the descriptive analysis reflecting the background characteristics of the respondents. The sample was dominated by those elderly age group (52.2%), female (58.1%), received secondary education (71.3%), married (91.9%), Malay ethnic (60.3%), unemployed (63.2%), did not live alone (96.3%), and has other comorbidities (66.2%). The mean score for diabetes health literacy was 53.74 (0.60), which was under the low-level category. Meanwhile, the mean score for the diabetes numeracy score was 1.50 (0.13), which was under the low-level category.

Predictors of diabetes health literacy and numeracy

Factors predicting the diabetes health literacy total score was shown in Table II. A unit increase in age ($\beta = -0.21$; 95% CI: -0.37,0.05; p-value = 0.01), non-Malay ethnic

Table I: Descriptive statistics (N=408)

Variable	Frequency (%)	Mean (SD)
Age		60.85 (0.34)
Pre-elderly	195 (47.8)	
Elderly	213 (52.2)	
Gender		
Male	171 (41.9)	
Female	237 (58.1)	
Education level		
Primary or below	51 (12.5)	
Secondary	291 (71.3)	
Tertiary	66 (16.2)	
Marital status		
Single	33 (8.1)	
Married	375 (91.9)	
Race		
Malay	246 (60.3)	
Non-Malay	150 (36.8)	
Employment status		
Unemployed	258 (63.2)	
Employed	150 (36.8)	
Living arrangement		
Living alone	15 (3.7)	
Not living alone	393 (96.3)	
Duration of diabetes (Years)		9.26 (0.35)
Presence of other comorbidities		
No	138 (33.8)	
Yes	270 (66.2)	
Knowledge on diabetes mellitus (0-14)[a]		11.66 (0.14)
Attitude towards diabetes mellitus (5-50)[a]		42.62 (0.27)
Self-efficacy towards managing diabetes (0-28)[a]		27.54 (0.18)
Self-care behavioral skills (0-116)[a]		114.08 (0.58)
Diabetic health literary (0-60)a		53.74 (0.60)
Diabetic numeracy (0-11)[a]		1.50 (0.13)

% = Percentage; SD = Standard deviation; ()[a] score range

group (β = -5.83; 95% CI: -7.83, -3.83; p-value <0.001), being still employed (β = -2.77; 95% CI: -5.15, -0.39; p-value = 0.02), had other comorbidities (β = -3.02; 95% CI: -5.04, -1.01; p-value = 0.003), and a unit increase in diabetes related self-efficacy (β = -0.37; 95%CI: -0.69, -0.06; p-value = 0.02) are associated with significant reduction of diabetes health literacy total scores when other variables were adjusted. Meanwhile, those who received secondary (β =12.21; 95% CI: 9.16, 15.26; p-value <0.001) and tertiary education (β = 16.37; 95% CI: 12.49, 202.25; p-value<0.001) were predicted to have increase in health literacy total scores. Additionally, increase in self-care behavioral skills (β =0.36; 95%CI: 0.23, 0.49; p-value<0.001) was associated with increase in health literacy score.

Table II: Predicting factors of diabetes health literacy (N=408)

Variable	β (SE)	95% CI	P-value
Age	-0.21 (0.08)	-0.37, -0.05	0.01*
Gender			
Male	Reference	-	-
Female	-1.40 (1.14)	-3.64, 0.83	0.22
Education level			
Primary or below	Reference	-	-
Secondary	12.21 (1.55)	9.16, 15.26	<0.001*
Tertiary	16.37 (1.97)	12.49, 20.25	<0.001*
Marital status			
Single	Reference		
Married	3.65 (2.01)	-0.31, 7.60	0.07
Race			
Malay	Reference	-	-
Non-Malay	-5.83 (1.02)	-7.83, -3.83	<0.001*
Employment status			
Unemployed	Reference	-	-
Employed	-2.77 (1.21)	-5.15, -0.39	0.02*
Living arrangement			
Living alone	Reference	-	-
Not living alone	2.64 (-2.80)	-2.86, 8.14	0.35
Duration of diabetes (Years)	-0.01 (0.08)	-0.16, 0.13	0.86
Presence of other comorbidities			
No	Reference	-	-
Yes	-3.02 (1.03)	-5.04, -1.01	0.003*
Knowledge on diabetes mellitus	0.44 (0.30)	-0.14, 1.02	0.14
Attitude towards diabetes mellitus	-0.04 (0.19)	-0.41, 0.32	0.82
Self-efficacy towards managing diabetes mellitus	-0.37 (0.16)	-0.69, -0.06	0.02*
Self-care behavioral skills	0.36 (0.07)	0.23, 0.49	<0.001*

* Significant at p<0.05; β = Regression coefficient; 95% CI = 95% Confidence interval.

Meanwhile, Table III shows the factors predicting diabetic numeracy. Increase of age (β=-0.15; 95% CI: -0.18, -0.12; p-value<0.001) was associated with reduced health numeracy score, whereas those who received secondary (β=1.09; 95% CI: 0.41, 1.77; p-value = 0.002) and tertiary (β=2.24; 95% CI: 1.55, 3.29; p-value<0.001) education were expected to have increase diabetic numeracy scores. Furthermore, increase in attitude score (β=0.16; 95% CI: 0.09, 0.24; p-value<0.001) was associated with increase in numeracy score.

DISCUSSION

The current study reflects considerably satisfactory mean score for diabetes health literacy as it is in the higher range of the low level, but very low mean score for diabetes health numeracy, which was predicted by age, education level and attitude, with tertiary education level being the strongest predictor of higher diabetes health numeracy. While diabetes health literacy involves exchange of

Table III: Predicting factors of diabetic numeracy (N=408)

Variable	β (SE)	95% CI	P-value
Age	-0.15 (0.02)	-0.18, -0.12	<0.001*
Gender			
Male	Reference	-	-
Female	-0.09 (0.24)	-0.55, 0.39	0.72
Education level			
Primary or below	Reference	-	-
Secondary	1.09 (0.35)	0.41, 1.77	0.002*
Tertiary	2.42 (0.44)	1.55, 3.29	<0.001*
Marital status			
Single	Reference	-	-
Married	-0.49 (0.42)	-1.32, 0.33	0.24
Race			
Malay	Reference	-	-
Non-Malay	-0.33 (0.22)	-0.77, 0.10	0.13
Employment status			
Unemployed	Reference	-	-
Employed	0.16 (0.25)	-0.24, 0.65	0.54
Living arrangement			
Living alone	Reference	-	-
Not living alone	0.52 (0.58)	-0.62, 1.67	0.37
Duration of diabetes (Years)	0.02 (0.02)	-0.01, 0.05	0.28
Presence of other comorbidities			
No	Reference	-	-
Yes	-0.06 (0.22)	-0.48, 0.36	0.79
Knowledge on diabetes mellitus	0.07 (0.06)	-0.05, 0.19	0.26
Attitude towards diabetes mellitus	0.16 (0.04)	0.09, 0.24	<0.001*
Self-efficacy towards managing diabetes mellitus	0.01 (0.03)	-0.05, 0.08	0.73
Self-care behavioral skills	0.001 (0.01)	-0.03, 0.03	0.92
Diabetes health literacy	-0.02 (0.01)	-0.04, 0.001	0.06

* Significant at p<0.05; β = Regression coefficient; 95% CI = 95% Confidence interval

complex health information on diabetes knowledge, self-efficacy, self-care behaviors and glycemic control between health organizations and patients or the family members (10), diabetes health numeracy is the key skills needed to ensure successful diabetes self-care care and treatment adherence (19). Diabetic patients with limited health literacy and numeracy have increased likelihood towards poorer diabetes knowledge, particularly on symptom recognition, poorer glycemic control, greater difficulty interpreting food labels and estimating portion sizes, lower self-efficacy or confidence in diabetes management and self-management behaviors (20). Therefore, effective diabetes management involves the application of numeracy skills (10) in monitoring the blood glucose, administering medications, and appropriately modifying dietary intake (8).

The low diabetic numeracy in this study could be explained by the study population, which were among those of older age. The inverse relationship between age and health numeracy has been consistent in previous research (11,12,21), indicating the reduced ability to deal with numerical tasks and effectively manage their diabetes, as patients grow older (22). Available scientific evidence had also reported on the consistent relationship between lower diabetes-related numeracy and worse knowledge, self-efficacy, and self-management, and make worse medical decisions (9). In this study, age was also found to be negatively associated with diabetes health literacy, which was also supported by previous study (23) and contributed by the increasing risk of cognitive decline with age (24).

The significant positive relationship between higher education level (11,25), as well as attitude (26) and diabetes numeracy were consistently reported in previous literatures, with poor numeracy individuals tend to leave full-time education at the earliest opportunity and usually without qualifications (27). This is because health numeracy is not just the ability to understand and use basic arithmetic skills in daily life, but a broader perspective encompassing the ability to understand, interpret, and apply quantitative, graphical, biostatistical, and probabilistic health information (9). Better education will ensure diabetes patients correctly interpret and apply dietary information, which is a crucial part of diabetes care. Erroneous interpretation of food labels was not uncommon among diabetes patients, which include wrong application of portion size, and incorrect calculations of calories (20). Furthermore, having adequate health literacy does not ensure adequate numeracy abilities, because numeracy skills often lagged behind (20), highlighting the importance of numeracy skills as a separate patients' factor that needs to be tackled accordingly. Similarly, higher education level is also significantly predicted to have better health literacy (28-32), due to the capacity to receive and assess health information effectively and act accordingly (33).

There has been limited evidence on the relationship between health numeracy and attitude, with more emphasis given on the association between attitude and health literacy. A study exploring the knowledge, attitude and behavior on healthy snacks selection indicated the role of knowledge on attitude, with the level of knowledge on nutrition and food safety influenced the attitudes and behavior in the selection of food purchased (34). While ignorance towards the food ingredients may lead to wrong selection of food, the lack of nutritional knowledge will cause indifference to certain foods (34). Nevertheless, knowledge is not a significant predictor for either diabetes health literacy or numeracy in this study, reflecting the minimal role of attitude on diabetes numeracy and none on literacy.

Nevertheless, the empirical results reported herein should be considered in the light of some limitations. The utilization of a valid and reliable questionnaire, as well as probability sampling that enable certain degree of generalization of the findings to population of similar sociodemographic backgrounds. However, this research is also subject to several limitations, such as the selected study design that does not allow temporal relationship. Hence, the findings need to be interpreted

and generalized with caution.

CONCLUSION

The current study indicates a very low score for diabetes numeracy despite the satisfactory level of health literacy, which may contribute towards poor understanding on good diabetic control indicators, as well as diabetic self-management among older adults. Age and education level were found to consistently predict health literacy and numeracy among the urban settlers' older adults participated in this study.

Clinical consultations among diabetic patients and plan of action to promote better self-management of diabetes among older adults, should consider active identification of patients with low diabetes numeracy, particularly those older and low education back-ground, with consideration on individualized education approach. Clarifying their understanding on the certain critical values related to diabetes management such as fasting blood sugar, BMI or even how to read calories values should be assessed periodically either during follow up or dietician review. Further exploration on the effective approach to improve diabetes numeracy among these targeted older adults is also necessary.

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