Health Literacy and Health-Related Quality of Life in Older Adults with Type 2 Diabetes: The Mediating Role of Treatment Regimen Adherence

ABSTRACT

Background and Objective: It is unclear how health literacy is associated with health-related quality of life. The aim of this study was to examine the mediating role of treatment regimen adherence between health literacy and health-related quality of life (HRQoL) in older adults with type 2 diabetes mellitus (T2DM).

Material and methods: In this cross-sectional study, a multi-stage cluster sampling method was used to recruit 300 diabetic patients aged 60 years and over with diabetes. The abbreviated version of the Test of Functional Health Literacy in Adults (S-TOFHLA) and the Swedish Health-related Quality of Life (SWED-QUAL) instrument were used to measure health literacy and HRQoL, respectively. In addition, the Morisky Medication Adherence Scale (MMAS), the diet and exercise adherence questionnaire, were used to assess treatment regimen adherence. The four steps of Baron and Kenny's procedure were implemented to test the mediation hypotheses.

Results: The mean age of the respondents was 64.92 years. In addition, the mean of the respondents' health literacy score was 52.82. The prevalence rates of the inadequate, marginal, and adequate health literacy of the respondents were 70%, 14.7%, and 15.3%, respectively. Two items of treatment regimen adherence (medication adherence and diet and exercise adherence) had a partial mediating role between health literacy and quality of life in elderly diabetes patients. The result of Baron and Kenny's procedure and Sobel's test showed a significant mediation role in medication adherence (p = 0.00, Sobel's Z = 2.77) and diet and exercise adherence (p = 0.00, Sobel's Z = 6.26) between health literacy and HRQoL.

Conclusion: Medication adherence, diet adherence, and exercise adherence are mediating factors in relationship between health literacy and HRQoL that increase the health literacy and quality of life in older adults with T2DM.

Paper Type: Research Article

Keywords: Diabetes mellitus, Frail Elderly, Health literacy, Quality of Life, Patient Compliance

Hadi kooshiar
* Department of Medical Surgical, Faculty of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran. (Corresponding Author). Kooshyarh@mums.ac.ir

Maryam Shoorvazi
Department of Medical Surgical, Faculty of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran.

Zahra Dalir
Department of Medical Surgical, Faculty of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran.

Masoud Hosseini
Department Medical Education, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

Introduction

Higher quality of life remains a major challenge for researchers in the present century (1). When the quality of life is mentioned about health and disease, it is called health-related quality of life (HRQoL) (2). Diabetes mellitus, its complications, and treatments burden older adults (3). Measuring quality of life in diabetic patients is a way to evaluate diabetes and its effects on patients (4). The rising global burden of diabetes is accompanied by the failure to achieve desired treatment results; therefore, adherence to treatment in diabetes is an issue that has been an important focus of therapists (5).

Non-adherence to a treatment regimen, especially in older adults with T2DM, is a complex and challenging issue, and it is the subject of interest of many researchers. In addition, many factors may reduce older persons' ability to adhere their medication regimens, including older adults' health literacy (6). Recognizing predictor factors of medication adherence permits practitioners to change treatment regimens to achieve patient care (7). Moreover, health literacy has been introduced as a global challenge in the 21st century. The World Health Organization introduced health literacy as one of the major determinants of health (8). Inadequate health literacy is a significant problem in many countries, and it may be the reason for undesirable and unexpected outcomes in some diabetic patients (9).

While some studies showed that health literacy impacts the quality of life among older adults with T2DM. The exact mechanism underlying this association, specifically in older people with T2DM, is unclear. The relationship between health literacy and HRQoL may sometimes occur due to indirect factors that affect HRQoL. Determining the factors contributing to HRQoL among diabetic individuals could help tailor and target interventional approaches to enhance older adults' quality of life. Hence, the current study aimed to determine the role of treatment regimen adherence as a mediator between health literacy and HRQoL in older adults with T2DM. Furthermore, this study has two hypotheses:

(1) Health literacy has a direct effect on HRQoL, and (2) treatment regimen adherence partially mediates the direct effect of health literacy on HRQoL.

Material and methods

This paper presents a correlational cross-sectional study in older adults with T2DM who were referred to health centers in Mashhad (Iran). The multi-stage cluster sampling method was used. Initially, five health centers were considered cluster heads. Then, half of the older adult care units of these centers were randomly selected as a cluster. At the final stage, we selected all older adults with T2DM in these centers who met the inclusion criteria. The sample size was calculated using the pilot study and calculating the correlation between health literacy and HRQoL. In this study, 36 respondents were excluded, and the final sample size was 300 older adults with T2DM. We selected interviews as the main method of data collection. According to the Helsinki Declaration, this study received ethics approval from the ethics committee at Mashhad University of Medical Sciences (code 91205).

The short version of the Test of Functional Health Literacy in Adults (S-TOFHLA) was used to measure health literacy (10). The score of the S-TOFHLA instrument consists of reading comprehension and numeric calculations. The total score of the S-TOFHLA is between 0 and 100, as categorized on three levels: inadequate health literacy (0–53), marginal health literacy (54–66), and adequate health literacy (67–100) (11). In this study, the internal consistency of the

33

Health Literacy and Health-Related Quality of Life in Older Adults...

S-TOFHLA was measured by Cronbach's alpha coefficients for reading comprehension and the calculating parts were 0.71 and 0.77, respectively. Reisi et al. (2012) reported the internal reliabilities of the S-TOFHLA were 0.79 and 0.88 for the numeracy and the reading comprehension sections, respectively (12). The validity of this instrument was confirmed by Javadzade (13).

In this study, HRQoL was measured by a Swedish HRQoL (SWED-QUAL) instrument. (14,15). The SWED-QUAL is scored on a 0-100 scale, with higher scores indicating better quality of life (14). This instrument includes three dimensions: physical, psychological, and social. The Persian version of SWED_QUAL is a valid and reliable tool. The validity of this instrument was confirmed in a previous study by Darjani (16). Reliability was estimated for all dimensions of QOL were70%, 90%, 95%, 84%, 89%, 78%, and 91% for

physical function, pain, daily activities, feeling, sleep, overall health, and relationship with relatives , respectively (17).

We used the Morisky Medication Adherence Scale (MMAS) and the Diet and Exercise Adherence Questionnaire to assess treatment regimen adherence. The MMAS consists of eight items with a scoring scheme of "yes" = 1 and "no" = 0 for the first seven items, except for question 5 (which has reverse scoring). A score lower than 6 demonstrates a low medication adherence, scores between 6 to 8show moderate medication adherence, and a score over 8 reveals a high medication adherence. The internal consistency determined by Cronbach's alpha coefficient was 0.83 for the MMAS items (18). Ghanei Gheshlagh et al., confirmed the validity of the Persian version of MMAS.

(19). This questionnaire consist 26 questions on a 4-point Likert scale ("never," "rarely," "often," and "always") to assess diet and exercise

adherence, and its internal consistency level based Cronbach's alpha was 0.88, it was suitable and acceptable level.

Statistical analysis

Statistical analyses were conducted using SPSS version 21. Results were adjusted by potential confounding variables such as age, marital status, social support, HbA1C, insurance status, duration of diabetes, treatment regimen types, family history of diabetes, and attendance of diabetes education programs.

The four steps of Baron and Kenny's procedure were used to test mediation effect based research hypotheses (20). A Sobel test was also used to determine the significance effect of the mediator by testing the hypothesis that there is no difference between the total effect (path c) and the direct effect (path c'). The indirect effect of the mediator is the product of path ab, which is equivalent to (c–c'), as illustrated in Fig 1.
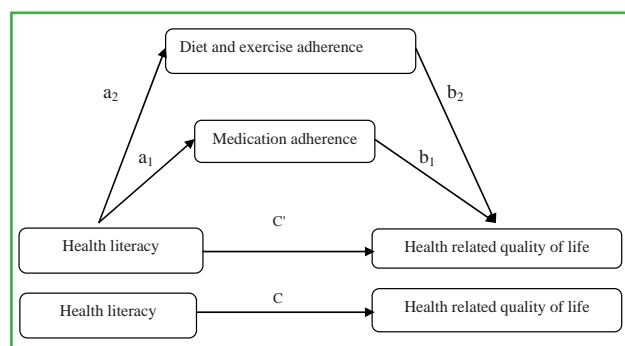
Figure 1. The pathway of mediating effect model showing association between health literacy, treatment regimen adherence, and HRQoL.

Results

The mean and standard deviation of the respondents' ages was 64.92±5.22 years, with a minimum of 60 and a maximum of 82 years. In this study, 197 females (65.7% of total participants) and 103 males (34.3%) were the total respondents. Most respondents (n=240; 80%) were married, and had an elementary education(n=237; 42.3%). In terms of employment status63.7% of participants

34

(n=191) were homemakers. The mean and standard deviation of the duration of diabetes in the older adults were 7.08±5.65 years. A family history of diabetes was reported by 61.3% of respondents (n=184). The results showed that the mean and standard deviation of respondents' health literacy scores were 52.82±13.25. The prevalence rates of inadequate, marginal, and adequate health literacy among the respondents were 70%, 14.7%, and 15.3%, respectively. The mean and standard deviation of respondents'HbA1c was 7.78±1.19. See Table 1.

Table 1. General characteristics of respondents (N=300)

Variables Categories		N (%)	Mean ± SD	Ranges
Social support		300(100)	46.24±19.2	1-100
incomea		125(41.66)	˜559k±332k	˜59k ± 33k
BMIb		300(100)	27.23 ±4.17	17.9 ± 38.7
Age (year)	60-74	276(92)		
	75 -85	24(8)		
HbA1cc	≤7	80 (26.7)		
	> 7	220(73.3)		
Marital status	Single	1 (0.3)		
	Married	240 (80.0)		
	Divorced	4 (1.3)		
	Widowed	55(18.3)		
LAd	Living alone	32 (10.7)		
	Living with spouse	135 (45)		
	Living with children	28 (9.3)		
	LSCe	105 (35)		
Educational status	Elementary school	138 (79.3)		
	Middle school	35(11.7)		
	Diploma	17 (5.7)		
	College and university	10 (3)		
Insurance	Yes	268 (89.3)		
	No	32 (10.7)		
Treatment method	OHAf alone	254 (84.7)		
	Injecting insulin alone	21(7)		
	OHA and injecting insulin	25(8.3)		
Housing	Tenant	20(6.7)		
	Owner	273(91)		
	other	7 (2.3)		
Duration of diabetes	≤5	167(55.5)		
	6-10	108(36)		
	11-15	19(6.3)		
	16-20	2(0.7)		
	21-25	4(1.3)		
Family history	Yes	184 (61.3)		
	No	116 (38.7)		

[a]Iran currency (Rial). [b]BMI= Body Mass Index.
[c] HbA1c=hemoglobin A1c. [d]Living arrangement.
[e]Living with spouse and children. [f]OHA= Oral Hypoglycemic Agent.

35

Health Literacy and Health-Related Quality of Life in Older Adults...

The result of student's t-test reveals that mean of HRQoL (58.18±10.83) in younger older adults, aged from 60to74, was significantly (t=2.62 P<0.05) higher compare with HRQoL (51.67±11.52) in older adult with age more than 75 years . Further information about HRQoL and the treatment regimen adherence items in older adults with type 2 diabetes was summarized in Table 2.

Table 3 displays the results of correlation analyses between health literacy, medication adherence, adherence to diet and exercise, and HRQoL. Health literacy correlated with medication adherence (r =0.44), adherence to diet and exercise (r = 0.82), and HRQoL (r = 0.70).

Table 2. Mean, standard deviation, and range of total HRQoL, the treatment regimen adherence items in older adults with T2DM.

Variables	Mean ± SD	Ranges
Total Health –related quality of life	56.59± 9.88	1-100
Medication adherence	5.11± 1.30	0-8
Diet and Exercise adherence	68.72± 8.51	26-94

Table 3. bivariate correlation among health literacy, medication adherence, adherence to diet and exercise, and HRQoL

Variables	Health literacy	Medication adherence	Diet and Exercise adherence	HRQoL
Health literacy	1	0.44**	0.82**	0.70**
Medication adherence		1	0.46**	0.45**
Diet and Exercise adherence			1	0.77**
HRQoL				1

In this study, treatment regimen adherence was measured based on medication adherence and adherence to diet and exercise. Each item was separately examined to determine the mediating role of treatment regimen adherence between health literacy and HRQoL. A variable has a mediating role when the initial variable affects indirectly the outcome variable through the mediator. In this study, the four steps of Baron and Kenny's procedure were used to demonstrate the mediating role of treatment regimen adherence between health literacy and the HRQoL in older adults with T2DM.

Step One: The linear regression between the initial variable (health literacy) and the outcome variable (HRQoL) (path c) showed an association between these two variables (p<0.05).

Step Two: The linear regression between the initial variable (health literacy) and the intermediate variable (treatment regimen adherence) (path a1 and path a2) showed that health literacy has a correlation with two items of treatment regimen adherence including medication adherence, diet and exercise adherence (p<0.05).

Step Three: The linear regression was tested between the two items of the mediating variable (treatment regimen adherence) and the outcome variable (HRQoL) (path b1 and path b2) with a controlling initial variable (health literacy). The result showed medication adherence, and diet and exercise adherence have a significant correlation with HRQoL (p<0.05). However, HbA1c and BMI were not significantly associated with HRQoL (p>0.05).

Step Four: mediating variables (medication adherence, diet and exercise adherence) were individually controlled to complete mediation roles between the initial and outcome variable.

36

Then, the effect of the initial variable on the outcome variable was measured (Path c'). The values of β in these pathways were not equal to zero; therefore, the mentioned mediation was partial mediation. The coefficient related to the pathway of c (0.70) was larger than the coefficient related to the pathway of c' (0.62 and 0.33). Consequently, two items of treatment regimen adherence (medication adherence, and diet and exercise adherence) showed a partial mediating role between health literacy and HRQoL in older adults with T2DM. Steps 3 and 4 use the same regression equation. See Table 4.

Table 4. Mediator analysis of health literacy, treatment regimen adherence (medication adherence, diet and exercise adherence), and HRQoL.

Steps	Variables		B	SE B	β	p-Value
1. Path c	Outcome Predictor	HRQoL Heath Literacy	0.58	0.03	0.70	0.00
2. Path a1	Outcome Predictor	Medication adherence Heath Literacy	0.04	0.01	0.44	0.00
Path a2	Outcome Predictor	Diet and exercise adherence Heath Literacy	0.53	0.02	0.83	0.00
3&4.	Outcome Mediatorᵃ Predictor	HRQoL Medication adherence Health Literacy	1.46 0.52	0.38 0.04	0.17 0.62	0.00 0.00
	Outcome Mediatorᵃ Predictor	HRQoL Diet and exercise adherence Health Literacy	0.58 0.27	0.09 0.07	0.45 0.33	0.00 0.00

ᵃ controlled variable.

Baron and Kenny's causal steps test was used to assess the plausibility of mediation. However, the Sobel test was also used to determine statistical power to detect the true mediation effects(25).

$$\text{Sobel's Z} = \frac{a \times b}{\sqrt{(a^2 \times Se_b^2) + (b^2 \times Se_a^2)}}$$

a: unstandardized regression coefficient between the independent variable and the mediator variable

Sea: standard error between the independent variable and the mediator variable

b: unstandardized regression coefficient between the mediator variable and the dependent variable

Seb: standard error between the mediator variable and the dependent variable

The result of the Sobel test showed there were significant mediation roles of medication adherence (p = 0.00, Sobel's Z = 2.77) and diet and exercise adherence (p = 0.00, Sobel's Z = 6.26) between health literacy and HRQoL.

Discussion

The result of this study showed that the level of health literacy among older adults is very low. In line with this study, Bauer et al. (2013) reported 72% of patients had limited health literacy (21). In addition, Reisi et al. (2012) reported that around 79% of people had inadequate health literacy (12). Kosicka et al. (2020) stated that the level of general health literacy and its dimensions (health care, disease prevention, and health promotion) in older people aged 65+ was insufficient (22). Reasons for non-adherence are multifactorial and difficult to identify (23). High levels of health literacy in patients can

37

Health Literacy and Health-Related Quality of Life in Older Adults...

increase cognitive sensitivity and attention to the consequences of the illness: patients raised their awareness of all aspects of the disease and tried actively to control their disease (24).

Our findings are consistent with prior research suggesting older adults with higher level of health literacy show higher rates of medication adherence. Based on these results, it appears older people with T2DM could better control their diabetes. Medication adherence is important for diabetes management (25). Jackson et al. (2015) and Lee et al. (2020) showed there was a statistically significant correlation between health literacy and medication adherence in patients with T2DM, and improving health literacy may provide better medication adherence in older people with diabetes (26,27). People with adequate health literacy were more likely to remember to take their medications than those with poor health literacy (Hussain, Said, and Khan 2020). Song et al. (2020) found that medication adherence was moderately and positively correlated to health literacy among older adults in a rural community in South Korea (28).

This study also showed that older adults who had a higher level of health literacy showed the higher rates of diet and exercise adherence. Consistent with this study Mehrtak., et al (2018) found that health literacy is effective on diet and exercise adherence (29). Empowerment has a mediating role between health literacy with diet and exercise adherence. It means higher health literacy causes people to feel healthier and confident, and those with higher empowerment were more likely to eat healthy foods and doing exercise (30). In line with this study, Tang et al. (2017) found a strong relationship between health literacy with functional exercise adherence in patients with radical mastectomy (31) . Although participating in exercise and sports had obvious benefits, and adherence to long-term exercise

programs can vary between 10 and 80%, specifically in the long term (32). In contrast with our result Yeh et al. (2018) found adherence behavior has a weak association with health literacy in chronic disease management (33).

The results of this study revealed that older adults who had a higher level of health literacy had lower levels of HbA1c. Different studies showed varying results regarding the association between health literacy and glycemic control, and this heterogeneity did not permit the estimation of an overall effect (10). An association between higher levels of health literacy with better glycemic control was demonstrated by some studies (34–36). Some studies showed there were direct and statistically significant relationships between health literacy and blood glucose control (the amount of HbA1c). The patients with better health literacy had lower HbA1c levels and more control over their disease (35–38). This result is inconsistent with the results obtained by Huang et al. (2018) that health literacy was not correlated with medication adherence and glycemic control (HbA1c) among patients with type 2 diabetes. (39) . Osborne et al. (2010) found that health literacy did not directly affect knowledge about diabetes, self-care activity, or blood glucose control. However, health literacy had an indirect effect on the blood glucose control and self-care activities of diabetic patients through social support (40).

This study also showed direct and indirect relationships between health literacy and HRQoL in older adults with T2DM. The finding that older adults with T2DM who had adequate health literacy had higher HRQoL is consistent with previous studies. In line with this study, Gaffari-fam and colleagues (2020) found HRQL of the T2DM is low, and about two-thirds of the HRQL of diabetic patients is explained by health literacy (41). Study findings of Code et al.

38

(2020) and Salari et al. (2017) also demonstrated that health literacy significantly correlated with quality of life in older adults (42,43). Reisi et al. (2012) found low levels of health literacy led to poorer control of diseases, which was observed through frequent and unnecessary doctor visits, prolonged hospital stays, and increased costs, which subsequently reduce the patient's quality of life (12). On the other hand, Lee et al. (2016) found, although, there is no direct effect between health literacy and HRQoL in older adults with T2DM, health literacy did exert an indirect effect on HRQoL via self-care activities (44).

This study found medication adherence and diet and exercise adherence had a partial mediating role between health literacy and HRQoL among older adults with T2DM. In line with this study Song et al.'s (2017) study results showed the health literacy was indirectly linked with the quality of life by two mediation pathways, including reading drug labels, and understanding prescription instructions. These pathways explained the links between health literacy and medication adherence, and quality of life. Lower health literacy appears to be correlated with lower medication adherence and poor quality of life (45). Lee et al. (2016) found that health literacy had an only indirect effect on HRQOL through self-care activities (44).

This study has some limitations. The first major limitation of this study is its cross-sectional design due to time and budget limitations; a longitudinal design would be better for this kind of study. Secondly, the respondents were recruited from city health care centers so they may not be representative of rural older adults and therefore the findings cannot be generalized. Finally, respondents of this study were drawn from older people who were able to visit health care centers and therefore excluded older people living in nursing homes.

Conclusions

In summary, the present study found some associations between health literacy and HRQoL in older adults with T2DM. In addition, medication adherence, and diet and exercise adherence had a partial mediating role between health literacy and HRQoL. Therefore, further studies are needed to identify other variables and factors that mediating role mediate in relationship between health literacy and HRQoL among older diabetic patients.

References

1. Bowling A, Windsor J. Towards the Good Life: A Population Survey of Dimensions of Quality of Life. J Happiness Stud. 2001;2(1):55-82. https://doi.org/10.1023/A:1011564713657

2. Khaleghi M, Amin Shokravi F, Peyman N. The Relationship Between Health Literacy and Health-Related Quality of Life in Students. Iranian Journal of Health Education and Health Promotion. 2019;7(1):66-73. https://doi.org/10.30699/ijhehp.7.1.66

3. Ghoreishi M-S, Vahedian-Shahroodi M, Jafari A, Tehranid H. Self-care behaviors in patients with type 2 diabetes: Education intervention base on social cognitive theory. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2019;13(3):2049-56. https://doi.org/10.1016/j.dsx.2019.04.045 PMid:31235135

4. Lee GK, Chronister J, Bishop M. The effects of psychosocial factors on quality of life among individuals with chronic pain. Rehabil Couns Bull. 2008;51(3):177-89. https://doi.org/10.1177/0034355207311318

5. Chan YM, Molassiotis A. The relationship between diabetes knowledge and compliance among

39

Health Literacy and Health-Related Quality of Life in Older Adults...

Chinese with non-insulin dependant diabetes mellitus in Hong Kong. J Adv Nurs. 1999;30:431-8. https://doi.org/10.1046/j.1365-2648.1999.01098.x PMid:10457246

6. Kocurek B. Promoting medication adherence in older adults...and the rest of us. Diabetes Spectr. 2009;22(2) https://doi.org/10.2337/diaspect.22.2.80

7. . Bahati R, Guy S, Gwadry-sridhar F. Analysis of Treatment Compliance of Patients with Diabetes. 2012;108-16. https://doi.org/10.1007/978-3-642-27697-2_8

8. Mellor D, Russo S, McCabe MP, Davison TE, George K. Depression training program for caregivers of elderly care recipients: implementation and qualitative evaluation. J Gerontol Nurs. 2008;34(9):8-15. https://doi.org/10.3928/00989134-20080901-09 PMid:18795560

9. Noroozi M, Madmoli Y, Derikvand M, Saki M, Moradi kalboland M. Investigating Health Literacy Level and Its Relation with Some Factors in Patients with Type 2 Diabetes in Ahvaz -2018. Journal of Health Literacy. 2019;4(1):43-52. https://doi.org/10.22038/jhl.2019.39813.1049

10. Al Sayah F, Majumdar SR, Williams B, Robertson S, Johnson J a. Health literacy and health outcomes in diabetes: a systematic review. J Gen Intern Med. 2013 Mar;28(3):444-52. https://doi.org/10.1007/s11606-012-2241-z PMid:23065575 PMCid:PMC3579965

11. Kirk JK, Grzywacz JG, Arcury T a, Ip EH, Nguyen HT, Bell R a, et al. Performance of health literacy tests among older adults with diabetes. J Gen Intern Med. 2012 May;27(5):534-40. https://doi.org/10.1007/s11606-011-1927-y PMid:22095571 PMCid:PMC3326106

12. Reisi M, Javadzade S, Mostafavi F, Sharifirad G, Radjati F, Hasanzade A. Relationship between health literacy, health status, and healthy behaviors among older adults in Isfahan, Iran. J Educ Health Promot. 2012;1(31):1-7. https://doi.org/10.4103/2277-9531.100160 PMid:23555134 PMCid:PMC3577376

13. Javadzade SH, Sharifirad G, Tavassoli E, Rajati F. Health Literacy among Adults in Isfahan, Iran. J Heal Syst Res. 2013;9(5):540-9.

14. Brorsson B, Ifver J, Hays RD. The Swedish health-related quality of life survey (SWED-QUAL). Qual Life Res. 1993;2(1):33-45. https://doi.org/10.1007/BF00642887 PMid:8490616

15. Wändell PE, Brorsson B, Åberg H. Quality of life in diabetic patients registered with primary health care services in Sweden. Scand J Prim Health Care. 1997;15(2):97-102. https://doi.org/10.3109/02813439709018495 PMid:9232711

16. Darjani A, Ghanbari A, Sayadi Nejhad A, Golchay J, Sadr Eshkevari S, Alizadeh N, et al. Comparison the Health-Related Quality of Life of Patients Suffering from Pemphigus with Healthy People. J Guilan Univ Med Sci. 2009;67:1-9.

17. Ghanbari A, Yekta ZP, Roushan ZA, Lakeh NM. Assessment of Factors Affecting Quality of Life in Diabetic Patients in Iran. Public Health Nurs. 2005;22(4):311-22. https://doi.org/10.1111/j.0737-1209.2005.220406.x PMid:16150012

18. Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive Validity of A Medication Adherence Measure in an Outpatient Setting. J Clin Hypertens (Greenwich). 2008 May;10(5):348-54. https://doi.org/10.1111/j.1751-7176.2008.07572.x PMid:18453793

19. Ghanei Gheshlagh R, Ebadi A, Veisi Raygani A, Nourozi Tabrizi K, Dalvandi A, Mahmoodi H. Determining Concurrent Validity of the Morisky Medication Adherence Scale in Patients with Type 2 Diabetes. Iran J Rehabil Res Nurs. 2015;1(3):24-32.

20. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. J Pers Soc Psychol. 1986;51(6):1173. https://doi.org/10.1037/0022-3514.51.6.1173

21. Bauer AM, Schillinger D, Parker MM, Katon W, Adler N, Adams AS, et al. Health literacy and antidepressant medication adherence among adults with diabetes: the diabetes study of Northern California (DISTANCE). J Gen Intern Med. 2013 Sep;28(9):1181-7. https://doi.org/10.1007/s11606-013-2402-8 PMid:23512335 PMCid:PMC3744297

22. Kosicka B, Deluga A, Bąk J, Chałdaś-Majdańska J, Bieniak M, Machul M, et al. The Level of Health Literacy of Seniors Living in Eastern Region of Poland. Preliminary Study. Healthcare. 2020;8(3):277. https://doi.org/10.3390/healthcare8030277 PMid:32824553 PMCid:PMC7551014

23. García-Pérez L-E, Alvarez M, Dilla T, Gil-Guillén V, Orozco-Beltrán D. Adherence to therapies in patients with type 2 diabetes. Diabetes Ther. 2013 Dec;4(2):175-94. https://doi.org/10.1007/s13300-013-0034-y PMid:23990497 PMCid:PMC3889324

24. Tol A, Pourreza A, Tavasoli E, Rahimi Foroshani A. Determination of knowledge and health literacy among women with type 2 diabetes in teaching hospitals of TUMS. Hosp (Lond 1886). 2012;11(3):45-52.

25. Huang YM, Pecanac KE, Shiyanbola OO. "Why Am I Not Taking Medications?" Barriers and Facilitators of Diabetes Medication Adherence Across Different Health Literacy Levels. Qual Health Res. 2020;30(14):2331-42. https://doi.org/10.1177/1049732320945296 PMid:32723206

26. Jackson IL, Adibe MO, Okonta MJ, Ukwe C V. Medication Adherence in Type 2 Diabetes Patients in Nigeria. Diabetes Technol Ther. 2015;17(6):398-404. https://doi.org/10.1089/dia.2014.0279 PMid:25749392

27. Lee Y-M, Yu HY, You M-A, Son Y-J. Impact of health literacy on medication adherence in older people with chronic diseases. Collegian. 2017;24(1):11-8. https://doi.org/10.1016/j.colegn.2015.08.003 PMid:29218957

28. Song MS, Park S. Comparing two health literacy measurements used for assessing older adults' medication

adherence. J Clin Nurs. 2020;29(21-22):4313-20. https://doi.org/10.1111/jocn.15468 PMid:32865257

29. Mehrtak M, Hemmati A BA. Health Literacy and its Relationship with the medical , dietary Adherence and exercise in Patients with Type II Diabetes mellitus. J Heal Literacy. 2018;3(2):137-44.

30. Shin KS, Lee EH. Relationships of health literacy to self-care behaviors in people with diabetes aged 60 and above: Empowerment as a mediator. J Adv Nurs. 2018;74(10):2363-72. https://doi.org/10.1111/jan.13738 PMid:29893030

31. Tang W, Li Z, Tang C, Wang X, Wang H. Health literacy and functional exercise adherence in postoperative breast cancer patients. Patient Prefer Adherence. 2017;11:781-6. https://doi.org/10.2147/PPA.S127925 PMid:28458522 PMCid:PMC5402901

32. Praet SFE, van Loon LJC. Exercise therapy in type 2 diabetes. Acta Diabetol. 2009;46:263-78. https://doi.org/10.1007/s00592-009-0129-0 PMid:19479186 PMCid:PMC2773368

33. Yeh JZ, Wei CJ, Weng SF, Tsai CY, Shih JH, Shih CL, et al. Disease-specific health literacy, disease knowledge, and adherence behavior among patients with type 2 diabetes in Taiwan. BMC Public Health. 2018;18(1):1-15. https://doi.org/10.1186/s12889-018-5972-x PMid:30143020 PMCid:PMC6108149

34. Ishikawa H, Yano E. The relationship of patient participation and diabetes outcomes for patients with high vs. low health literacy. Patient Educ Couns. 2011 Jul 9;84(3):393-7. https://doi.org/10.1016/j.pec.2011.01.029 PMid:21388773

35. Hussain N, Said ASA, Khan Z. Influence of Health Literacy on Medication Adherence Among Elderly Females With Type 2 Diabetes in Pakistan. Int Q Community Health Educ. 2020;41(1):35-44. https://doi.org/10.1177/0272684X19896724 PMid:31886737

36. Souza JG, Farfel JM, Jaluul O, Queiroz MS, Nery M. Association between health literacy and glycemic control in elderly patients with type 2 diabetes and modifying effect of social support. Einstein (São Paulo). 2020;18:1-9. https://doi.org/10.31744/einstein_journal/2020AO5572 PMid:33295425 PMCid:PMC7690930

37. Brega AG, Ang A, Vega W, Jiang L, Beals J, Mitchell CM, et al. Mechanisms underlying the relationship between health literacy and glycemic control in American Indians and Alaska Natives. Patient Educ Couns. 2012;88(1):61-8. https://doi.org/10.1016/j.pec.2012.03.008 PMid:22497973

38. Van der Heide I, Uiters E, Rademakers J, Struijs JN, Schuit AJ, Baan CA. Associations among health literacy, diabetes knowledge, and self-management behavior in adults with diabetes: results of a Dutch cross-sectional study.

J Health Commun. 2014;19 Suppl 2(October):115-31. https://doi.org/10.1080/10810730.2014.936989 PMid:25315588

39. Huang YM, Shiyanbola OO, Smith PD. Association of health literacy and medication self-efficacy with medication adherence and diabetes control. Patient Prefer Adherence. 2018;12:793-802. https://doi.org/10.2147/PPA.S153312 PMid:29785094 PMCid:PMC5953319

40. Osborn CY, Bains SS, Egede LE. Health literacy, diabetes self-care, and glycemic control in adults with type 2 diabetes. Diabetes Technol Ther. 2010 Nov;12(11):913-9. https://doi.org/10.1089/dia.2010.0058 PMid:20879964 PMCid:PMC3000637

41. Gaffari-fam S, Lotfi Y, Daemi A, Babazadeh T, Sarbazi E, Dargahi-Abbasabad G, et al. Impact of health literacy and self-care behaviors on health-related quality of life in Iranians with type 2 diabetes: a cross-sectional study. Health Qual Life Outcomes. 2020;18(1):1-10. https://doi.org/10.1186/s12955-020-01613-8 PMid:33148266 PMCid:PMC7640476

42. Code L. Health-Related Quality of Life in Older Adults: Its Association with Health Literacy, Self-Efficacy, Social Support, and Health-Promoting Behavior. Quality. 2020;8(4):407. https://doi.org/10.3390/healthcare8040407 PMid:33081352 PMCid:PMC7712387

43. Salari R, Salari R, Medicine C. Electronic Physician (ISSN : 2008-5842). Electron Physician. 2017;9(January):3592-7. https://doi.org/10.19082/3592 PMid:28243411 PMCid:PMC5308499

44. Lee EH, Lee YW, Moon SH. A Structural Equation Model Linking Health Literacy to Self-efficacy, Self-care Activities, and Health-related Quality of Life in Patients with Type 2 Diabetes. Asian Nurs Res (Korean Soc Nurs Sci). 2016;10(1):82-7. https://doi.org/10.1016/j.anr.2016.01.005 PMid:27021840

45. Song S, Lee SM, Jang S, Lee YJ, Kim NH, Sohn HR, et al. Mediation effects of medication information processing and adherence on association between health literacy and quality of life. BMC Health Serv Res. 2017;17(1):1-12. https://doi.org/10.1186/s12913-017-2598-0 PMid:28915814 PMCid:PMC5602864