

# The Association of Health Literacy Level with Self-Care Behaviors and Glycemic Control in a Low Education Population with Type 2 Diabetes Mellitus: A Cross-Sectional Study in Iran

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**Introduction:** Promoting Health Literacy (HL) can be a priority in strategic healthcare planning of the countries. Low HL is prevalent in some societies which make barriers to successful self-care of diseases. The aim of this study was to examine the association of HL with self-care behaviors and glycemic control in a low education population with type 2 diabetes mellitus.

**Methods:** This cross-sectional study was conducted in Sarab city, Iran. The 192 participants were patients diagnosed as type 2 diabetes and with low level of education. Convenient sampling method was applied and the participants were chosen by their medical records in health-care centers. To collect data a valid and reliable tool was used based on HL dimensions and self-care behaviors. Using hierarchical logistic regression, the possible association of variables with self-care behaviors and glycemic control was assessed.

**Results:** The mean age of study participants was 58.12 ( $\pm 11.83$ ) years. A 28.8% of the variation in the self-care behaviors is explained by the HL and the demographic variables ( $R = 0.288\%$ ;  $p\text{-value} < 0.05$ ). Furthermore, decision-making was the strongest predictor of self-care behaviors ( $\beta = 0.451$ ). Approximately 80% of the variation in the HbA1c is explained by the HL, self-care behaviors, and the demographic variables ( $R = 0.804\%$ ;  $p\text{-value} < 0.05$ ).

**Conclusion:** This study revealed that the HL dimensions predicted approximately one-fourth of self-care behaviors and the self-care behaviors and HL dimensions about eight-tenths of HbA1c in this population. These findings call for the need for interventional programs on HL to improve the self-care behaviors and HbA1c control.

**Keywords:** health literacy, diabetes mellitus, hemoglobin A1c protein, self-care

## Introduction

Type 2 diabetes mellitus (T2DM) has quickly become one of the world's most prevalent non-communicable diseases, and one of the most daunting problems in public health.<sup>1</sup> According to the World Health Organization (WHO) report of 2016, there are approximately 422 million diabetic adults globally,<sup>2</sup> and it is estimated that this number would reach 438 million in 2030.<sup>3</sup> Based on the statistics reported by the studies, the overall prevalence of diabetes in the US is reported to be 10.5% in 2020.<sup>4</sup> According to the estimates, the prevalence of diabetes in Iran was approximately 2 million people in 2005 and it will double by 2025 to 7.7%.

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Diabetes caused ~4 million deaths in 2017 and cost people with diabetes over USD 727 billion, which is equal to 12.5% of the overall global health-care budget.<sup>5</sup>

Achievement of targets such as glycemic control which includes fasting blood glucose and glycosylated hemoglobin (HbA1c) is recommended to reduce diabetes-related mortality and economic costs.<sup>6</sup> HbA1c is a key predictor of glycemic control.<sup>7</sup> Lower levels of HbA1c have been correlated with decreased mortality among diabetic patients and less complications.<sup>8,9</sup> Previous studies' findings recommend that self-care behaviors,<sup>10</sup> increased diabetes knowledge,<sup>11</sup> and greater medication adherence<sup>12</sup> are related to better glycemic control.<sup>13</sup> In several studies, it is found that the main determinant of regulated HbA1c is the better self-care behaviors.<sup>14,15</sup>

Self-care for diabetes includes healthy diet, regular exercise, adherence to the medical treatment system, blood glucose regulation and tracking, as well as skills to promote health.<sup>16</sup> Many factors affecting T2DM patients' self-care behaviors have been reported to include socioeconomic positions, awareness of diabetes, health beliefs, attitude, motivation, social support<sup>17,18</sup> and the HL.<sup>19</sup>

Based on definition by the WHO, HL is

The cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health.<sup>20</sup>

HL can facilitate the self-management of T2DM,<sup>21</sup> positive involvement in diabetes treatment and interactive communication with health professionals.<sup>22</sup> Patients with low HL have difficulty in reading medication labels, understanding dosage instructions, using health-related information brochures, providing their informed consents, and interpreting medical test results.<sup>23</sup> Low HL also leads to inadequate knowledge of health records, directions, and less engagement of the patients in preventive measures. All these can lead to a late diagnosis of one's condition.<sup>24,25</sup>

Inadequate HL is independently related to poor glycemic regulation, low medication adherence and higher retinopathy rates.<sup>26</sup> More specifically, T2DM patients with high levels of HL are more likely to face with diabetes self-care problems compared to those with low HL.<sup>27</sup>

Schillinger et al<sup>26</sup> found that insufficient HL was related to poor glycemic control and higher rates of retinopathy, whereas Morris et al<sup>28</sup> found that HL was not correlated with HbA1c, blood pressure, or lipid levels.

Powell et al reported that low HL levels in patients with T2DM have been associated with poor HbA1c and poor diabetes knowledge.<sup>27</sup> Also, a systematic review study found a relationship between HL and HbA1c.<sup>29</sup> Some studies showed that a high level of HL had been correlated with better HbA1c.<sup>30</sup> In addition, other studies showed that HL had an indirect impact on HbA1c, and that there was not a direct relationship between them.<sup>31,32</sup>

Understanding the process of relationships between HL, self-care behaviors, and HbA1c could provide useful knowledge to improve evidence-based interventions in diabetes patients. The purpose of this study was to examine the association of HL with self-care behaviors and the glycemic control in a low education population with T2DM. We hypothesized that HL in this population would be separately associated with self-care behaviors and glycemic control.

## Methods

### Study Area and Study Design

The current cross-sectional study was conducted in Sarab city, East Azerbaijan province, northwest of Iran. This 5-month study took place from September 2019 to February 2020. Based on the *t*-test exam from the test family, and from the "correlation: point biserial model" in the statistical test, in the G\*Power software the input parameters were two tail hypothesis, effect size= 0.245,  $\alpha$  error probability= 0.05, power (1-  $\beta$  error probability= 0.95), respectively. Sample sized calculated to be 205<sup>33</sup> of which 192 agreed to participate in the study (Response rate= 93.7%).

According to the Iranian health system, the health information of all residents is documented in the health centers. Therefore, information from the health centers records were obtained and convenient sampling method was applied to select the participants. After stating study goals and obtaining informed consent from the study participants, face to face interview was used by the trained interviewers to complete the questionnaires. The interviews lasted 20 to 25 minutes.

Inclusion criteria were having a medical record as a T2DM patients in the health centers of Sarab city, being aged  $\geq 30$  years, controlled or uncontrolled diabetes, with or without complications, and having low education (secondary school and less). Exclusion criteria included having psychotic disorder, dementia, blindness, and refusal to participate in the study.

## Ethical Consideration

The study protocol was approved by the Sarab Faculty of Medical Sciences Institutional Review Board. Each participant was given an oral description of the study and signed a consent form prior to attendance.

## Measurement

The self-administered anonymous questionnaires including demographic characteristics, HL questionnaire, and self-care questionnaire were used to collect data.

## Demographic Characteristics

The covariates in the models were sociodemographic characteristics which were also collected in the survey as well, including age (years), sex, job (employed, unemployed, and housewife), and marital status (single, married).

## HL

The independent variable of the study was the HL, which was assessed by a valid and reliable instrument that was developed by Montazeri et al to assess HL among Iranian adults.<sup>34</sup> Briefly, this tool is composed of five subscales with 34 items and the Cronbach's alpha coefficient between 0.72 and 0.89. Details of the HL instrument are described as follows:

### Reading Health Information

Reading health information was assessed by a four-item subscale on a five-point Likert-type scale ranging from 1 to 5 (1= completely difficult through 5=completely easy). An example of this dimension was: "reading health education materials (booklet, pamphlet, and educational brochures) was easy for me". Cronbach's alpha for this subscale was estimated at 0.72. The total possible scores ranged from 4 to 20, higher the score, the greater the reading abilities.

### Understanding Health Information

Seven items were used to measure understanding health information (e.g., "I can acquire the required health and medical information from different sources"). Each item was rated on a 5-point scale from 1 to 5 (1= completely difficult through 5=completely easy). Cronbach's alpha for this subscale was 0.86. For this subscale, theoretical range was 7–35, the higher the scores, the more ability to understand health information.

### Appraisal of Health Information

Appraisal of health information was measured by applying four items (eg, "I can get information about healthy

nutrition"). Each item was rated on a five-point Likert-type scale that ranged from 1 (never) to 5 (always). Cronbach's alpha for this subscale was 0.77. The total possible score on this index could range from 4 to 20. A high total score showed a high level of appraisal of health information.

### Ability to Access Health Information

This subscale was assessed by six items (e.g., "I can obtain information about my illness"). A five-point Likert-type scale was used (always= 5, most of the time= 4, sometimes= 3, seldom= 2 and never= 1). Cronbach's alpha for this subscale was 0.86. The total possible scores ranged from 6 to 30 in which the higher the score, the more ability to access health information.

### Decision Making

Decision making was a twelve-item subscale that was developed to measure the ability to decide health-related behaviors. Sample of items is: "I avoid doing things or taking materials that might increase my weight" even if the symptoms of the disease would be disappeared. The items were rated on a five-point Likert-type scale ranging from 1 to 5 (always= 5, most of the time= 4, sometimes= 3, seldom= 2 and never= 1). Cronbach's alpha for this subscale was 0.89. The higher the score, the better decision making was concluded.

### Diabetes Self-Care Behavior

Self-care behavior was assessed with the 12-item summary of diabetes self-care activities scale,<sup>35</sup> which had been validated and its reliability was verified by Didarloo et al, in Iran.<sup>36</sup> The instrument measures frequency of self-care behaviors in the last 7 days for four parts of: diet (6 items), glucose monitoring (2 items), medications (2 items) and exercise (2 items). The Cronbach's alpha was estimated at 0.74 for this instrument. The total possible score on this index may range from 0 to 84 in which higher scores indicated the higher self-care behaviors adopted by the patients.

### Glycemic Control

The outcome variable was patients' most recent HbA1c value; the new HbA1c value was derived from the medical record for patients and used as a glycemic control measure. The level of glycemic control was categorized with 7% HbA1C according to The American Diabetes Association (ADA) Standards of Medical Care in Diabetes.<sup>37</sup>

## Data Analysis Procedure

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 21 (SPSS, Inc., Chicago, IL). The quantitative characteristics of the participants were described using mean, standard deviation and the qualitative ones with frequency (percent). The Pearson correlation coefficient was used to quantify the linear relationship between HL score and self-care behaviors and the HbA1c. Researchers often want to check theoretical hypothesis and examining sequentially at the effect of several predictor variables, so that the relative important of a predictive can be measured on the basis of how much it contributes to the estimation of a criterion, beyond what other important predictors may account for. A common goal in stepwise and simultaneous regression, a common focus is to determine the “optimal” set of predictors by limiting the number of predictors without reducing the R2 coefficient significantly. Nevertheless, in hierarchical regression the emphasis is on the change in predictability correlated with later entered predictor variables in the analysis above and beyond that caused by predictor variables entered in the analysis earlier. In our study, we wanted to know the extent to which measures of positive expectations about HL predict the self-care behavior outcome. The socioeconomic variables were entered into the analysis first, followed by positive expectations about self-care behaviors and then HL constructs were entered into the analysis to determine whether newly added variables show a significant improvement in R2 (the proportion of explained variance in dependent variable by the model).

Using the enter approach, a hierarchical logistic regression analysis was applied in two steps. The first model

(Model 1) typically included demographic information such as age, sex, job, and marital status. In the next step (Model 2), we added the HL and the self-care behaviors variables in this line of research. P-value of 0.05 or less determined as statistical significance in all analysis.

## Results

The demographics variables of the participants are shown in Table 1. The mean age of subjects was  $58.12 \pm 11.83$  years. Participants were mainly male (55.2%, n= 106) and married (82.3%, n= 158). Approximately 20% (n= 38) of the participants were unemployed. No statistically significant difference was found in demographic variables by self-care behaviors. As it is displayed in Table 1, a statistically significant association was found in HL by the age of patients (p-value= 0.002). The table demonstrates that the scores of HL was lower among unemployed people (p-value= 0.001).

Table 2 presents the bivariate correlations for HL dimensions and self-care behaviors. Applying Pearson correlation coefficient test, we found that self-care behaviors had statistically significant correlations with all HL dimensions (p-value<0.05) except for reading health information (p-value>0.05).

Hierarchical multiple linear regressions were performed on HL dimensions and self-care behaviors, as the outcome variable. As there is presented in Table 3, in step 1, demographic variables were not significant predictors of self-care behaviors (p-value>0.05, R2 total= 0.003). In step 2, when the HL dimensions were included in the model, reading health information (p-value= 0.01), appraisal of health information (p-value= 0.008), and decision-

**Table 1** Demographic Characteristics of the Study Participant and Their Association with Self-Care Behaviors and HL

Variables		F (%)	Self-Care Behaviors	p-value	HL	p-value	HbA1C	p-value
			Mean $\pm$ SD		Mean $\pm$ SD		Mean $\pm$ SD	
Age groups (years) *	50>	53 (27.6)	43 $\pm$ 10.17	0.580	94.01 $\pm$ 23.80	0.002	7.27 $\pm$ 1.11	0.867
	50 $\leq$	139 (72.4)	43.50 $\pm$ 10.08		83.85 $\pm$ 18.64		7.24 $\pm$ 1.02	
Gender *	Male	106 (55.2)	43.88 $\pm$ 10.17	0.793	88.84 $\pm$ 22.79	0.161	7.21 $\pm$ 1.05	0.590
	Female	86 (44.8)	43.50 $\pm$ 10.08		84.33 $\pm$ 17.50		7.29 $\pm$ 1.06	
Job **	Employed	77 (40.1)	44.20 $\pm$ 9.49	0.305	93.20 $\pm$ 23.01	0.001	7.18 $\pm$ 1.07	0.542
	Unemployed	38 (19.8)	41.44 $\pm$ 12.10		79.39 $\pm$ 20.98		7.41 $\pm$ 1.04	
	Housewife	77 (40.1)	44.33 $\pm$ 9.60		83.70 $\pm$ 15.76		7.23 $\pm$ 1.03	
Marital status *	Married	158 (82.3)	43.77 $\pm$ 10.41	0.848	87.25 $\pm$ 19.99	0.388	7.25 $\pm$ 1.07	0.976
	Single	34 (17.7)	43.41 $\pm$ 8.71		83.88 $\pm$ 23.57		7.27 $\pm$ 0.97	

Notes: \*p-value-based Independent T-test, \*\*p-value-based one-way ANOVA test.

**Table 2** Bivariate Correlation Between HL Dimensions, Self-Care Behaviors and HbA1c

Variables	1	2	3	4	5	6	7	Mean ± SD
1= Reading health information	1							7.48 ± 4.10
2= Ability to access health information	0.688*	1						15.02 ± 5.35
3= Understanding health information	0.725*	0.747*	1					17.98 ± 5.11
4= Appraisal of health information	0.618*	0.746*	0.680*	1				10.51 ± 3.08
5= Decision-making	0.386*	0.732*	0.647*	0.520*	1			35.65 ± 7.27
6= Self-care behaviors	0.041	0.208*	0.244*	0.315*	0.461*	1		43.71 ± 10.11
7= HbA1c	-0.048	-0.209*	-0.201*	-0.324*	-0.348*	-0.884*	1	7.25 ± 1.05

Note: \*Correlation is significant at the 0.05 level (two-tailed).

**Table 3** Hierarchical Linear Regression of Self-Care Behaviors Onto Demographic Characteristics, HL

Step/Variables	$\beta^{**}$ (Step 1)	p-value*	$\beta^{**}$ (Step 2)	p-value*
(1) Age groups	0.031	0.658	0.069	0.312
Gender	0.074	0.608	0.098	0.433
Job	0.070	0.633	0.157	0.224
Marital status	0.017	0.818	0.005	0.932
(2) Reading health information			0.260	0.010
Ability to access health information			0.042	0.714
Understanding health information			0.044	0.728
Appraisal of health information			0.277	0.008
Decision-making			0.451	0.001
R <sup>2</sup>	0.003	0.961	0.288	0.001

Notes: \*p<0.05, \*\* $\beta$  is standardized coefficient.

making (p-value= 0.001) were significant predictors of self-care behaviors R<sup>2</sup>= 0.288, that is, approximately 28.8% of the variation in the self-care behaviors is explained by the HL and the demographic variables. Among the variables, decision-making was the strongest predictor of self-care behaviors.

We used Hierarchical multiple linear regression to predict of HbA1c. According to Table 4, in step 1, demographic variables were not significant predictors of HbA1c (p-value<0.05, R<sup>2</sup> total= 0.002). In step 2, when the HL dimensions and self-care behaviors were included in the model, decision-making (p-value= 0.001), diet (p-value<0.001), exercise (p-value<0.001) and medications (p-value= 0.013) were significant predictors of HbA1c R<sup>2</sup>= 0.804, that is, approximately 80.4% of the variation in the HbA1c is explained by the HL and the demographic variables. Among the variables, diet was the strongest predictor of HbA1c ( $\beta$ = -0.679).

**Table 4** Hierarchical Linear Regression of HbA1c Onto Demographic Characteristics, HL and Self-Care Behaviors

Step/Variable	$\beta^{**}$ (Step 1)	p-value*	$\beta^{**}$ (Step 2)	p-value*
(1) Age groups	-0.002	0.975	-0.035	0.342
Gender	0.084	0.565	0.054	0.435
Job	0.052	0.719	0.030	0.666
Marital status	0.001	0.991	0.003	0.930
(2) Reading health information			-0.029	0.641
Ability to access health information			-0.020	0.755
Understanding health information			-0.007	0.921
Appraisal of health information			-0.096	0.921
Decision-making			0.118	0.024
Diet			-0.679	0.001
Exercise			-0.379	0.001
Glucose monitoring			0.065	0.112
Medications			-0.088	0.013
R <sup>2</sup>	0.002	0.980	0.804	0.001

Notes: \*p<0.05, \*\* $\beta$  is standardized coefficient.

## Discussion

This study was conducted aiming at examining the influence of HL dimensions on self-care behaviors and HbA1c control among low education patients with T2DM in Sarab city, Iran. Having a good knowledge on self-care behaviors and identifying their influential factors may be helpful in addressing those factors through educational interventions.

The study results showed significant differences in HL by the patient's employment status. Similar with finding of the present study, Bohanny et al<sup>38</sup> and Rafiezadeh et al<sup>39</sup> reported that HL level was significantly higher in those who had a job compared to those who were unemployed.<sup>38</sup> This could be because community outreach services and campaigns for diabetes screening often mostly target the

working population because of their accessibility and leave out unemployed patients with diabetes.<sup>38</sup> Such results indicate that health-care providers should focus on providing appropriate education to unemployed patients.

According to results of the present study, younger age is associated with possessing a higher level of HL. The results of similar studies confirm these findings. For example, Bohanny et al<sup>38</sup> in the Marshall Islands and Schillinger et al<sup>30</sup> in US among patients with T2DM indicated that older patients had lower HL. One of the possible reasons may be that older people have less cognitive ability, and this could have affected measurements of HL. Therefore, it is recommended that when designing educational interventions aiming at HL promotion the older people should be considered as a priority. Use of certain approaches such as picture and video with local language may be effective among this population.

In the present study, it was found that all HL dimensions, except reading health information, are positively associated with self-care behaviors. Furthermore, HL dimensions accounted for 28.8% of the total variation in self-care behaviors. The appraisal of health information and decision-making are important to influence the self-care of patients with T2DM. However, the factor of decision-making was found to account for more total variation in the dimension of HL than the factor of appraisal of health information. This has also been found in previous studies.<sup>40,41</sup> Pawlak considered the information technology to be one of the determinants of HL.<sup>42</sup> Ease of gathering information would certainly increase the search for and gathering of information by respondents even further. The study conducted by Santosa<sup>43</sup> showed that one factor affecting the HL is access to health information. It is vital that patients with diabetes have an understanding of the signs and symptoms of hypoglycemia, hyperglycemia, and how to properly self-administer medications correctly to manage diabetes.<sup>44</sup> Understanding of the positive (positive history of hyperglycemia) and negative factors (socio-demographic variables) associated with diabetes HL is necessary for implementing preventive measures.<sup>45</sup> In the study conducted by Pokhrel, those patients who had a better understanding of diabetic complications and their management showed fair glycemic control.<sup>46</sup>

In this study, decision-making was the strongest predictor of self-care behaviors ( $\beta = 0.451$ ). Self-care decision making in chronic illness seems warranted so that the complexities inherent in this process can be more fully understood.<sup>47</sup> Of course, compliance is considered as good

decision making, and non-compliance is considered problematic decision-making.<sup>48</sup> People with low literacy may face challenges in writing and communication, in particular, they are less likely to initiate and maintain successful diabetes care, which requires interactive communication and participatory decision-making.<sup>49</sup> True self-care is a decision-making process requiring the cognitive ability to learn, perceive, interpret, reason, and respond.<sup>50</sup>

It is difficult to equate the results of this study directly with previous findings to comparison between these studies because of the use of various measures of health literacy. The study provides that the HL has negative significant correlation with the HbA1c levels, which is consistent with previous study conducted by Osborn et al<sup>51</sup> in the US. However, another study conducted in the US found that the association between HL and the HbA1c levels was not significant.<sup>19</sup> The relationship between HL and glycemic control may differ with patient populations and clinical settings.<sup>52</sup> These findings indicated that to clarify the relationship, the studies require international comparisons between HL and glycemic control. Also, several observational studies found that HL is directly associated with self-care behaviors in diabetes patients,<sup>53,54</sup> whereas some others observed no such direct association.<sup>38,55</sup> These findings concluded that further studies are required to understand how HL is related to diabetes-related outcomes. However, some studies suggest that low HL contributes to lack of self-care knowledge and skills,<sup>56</sup> lower rate of glycemic control<sup>57</sup> and higher HbA1c levels in diabetic sufferers.<sup>58</sup>

The results also support the strong negative relationship between self-care behaviors and HbA1c found in previous studies.<sup>32,59</sup> Self-care behaviors together with HL dimensions explained 80.4% of the variance in HbA1c. Of the factors, diet and exercise are the most important factors associated with glycemic control. Therefore, strategies to improve patients' self-care behaviors especially healthy diet should be developed in the design of diabetic patients' education for controlling HbA1c among T2DM patients. Several studies found the protective association between adherence to the diet and improved diabetes control.<sup>60,61</sup> Evidence from the European Prospective Investigation of Cancer and Nutrition (EPIC-Norfolk) study has shown that 1% increase in HbA1c level increased risk of death due to all causes by 28%.<sup>62</sup>

Another study result did not show a significant association between self-care activities and HbA1c. This may

explain why health literacy is indirectly related (combined or separately as an individual component) through self-care on A1c was not significant.<sup>63</sup> Medication adherence could be a key factor impacting the relationship between health literacy and glycemic control. Moreover, there are other factors that could mediate the relationship between health literacy and health outcomes, including individual-level factors, patient-provider interaction, as well as system-level factors.<sup>63</sup> Brega et al<sup>64</sup> demonstrated that the relationship between health literacy and glycemic control has been influenced by information about diabetes.

## Limitation

Firstly, although present study suggests causal effect between variables, the cross-sectional design of the data precludes causal inference and can only refer to correlations at a single point in time between constructs observed. Secondly, majority of the participants were in age group 50 years and higher, an age in which people's cognitive status may be declined. The measurements in this study were self-reported and, thus, may not be perfect; nevertheless, self-reporting is the most common method for measuring psychosocial variables in primary care research.<sup>65</sup> The potential social desirability bias must be considered, and the results must be cautiously interpreted. Also, another limitation in this study was lack of income data of the patients. Since majority of the patients did not answer the question of income level, the item excluded from analysis.

## Conclusion

Our results suggest that the favorable effect of HL on the self-care behaviors may contribute to control of HbA1c among type 2 diabetes patients with low education. Therefore, the study highlights the importance of strengthening efforts to increase the level of HL across all patients with T2DM. Health-care professionals should be conscious that insufficient HL is correlated with poor self-care behaviors and high HbA1c, which pose a barrier to effective care, and they should take this into consideration during all advices. Improving HL and promoting self-care behaviors would not only better the outcomes of diabetes but also it has economic benefits to the individual and the health system.

## Ethical Approval

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or

national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethical approval to perform the study was obtained from the Ethics Committee in Sarab Faculty of Medical Sciences.

## Informed Consent

Informed consent was obtained from all individual participants included in the study.

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## Disclosure

The authors declare that they have no competing interests.

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