



# Validity and reliability of the health belief model questionnaire for dietary patterns and physical activity in prediabetes

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## Abstract:

**BACKGROUND:** The health belief model (HBM) questionnaire for dietary patterns and physical activity is important for assessing behavior in prediabetes subjects. Assessing health behavior important to design intervention that can control development of prediabetes. The study aimed to examine the validity and reliability of the HBM questionnaire for dietary patterns and physical activity in prediabetes.

**MATERIALS AND METHODS:** A descriptive method was used comprising validity and reliability tests; specifically, the content validity was assessed by 10 panelists of nutrition in public health and education experts. Meanwhile, face validity and reliability tests were performed by 10 and 30 respondents, respectively. Content validity was conducted quantitatively with the content validity index (CVI), kappa statistics score, along with qualitative assessment. The reliability test was carried out based on Cronbach's alpha.

**RESULTS:** The results showed that CVI analysis and kappa statistics obtained values between 0.77–1 and -5.24–0.99, respectively. The face validity analysis produced a value >1.5, while the reliability test obtained Cronbach's alpha value of 0.821. The final questionnaire was based on the recommendations of the panelists as well as the results of validity and reliability tests including 47 HBM item statements.

**CONCLUSIONS:** The HBM questionnaire was found to be valid and reliable for assessing behavior about dietary patterns and physical activity in prediabetic. This instrument could be used by healthcare providers in studies and clinical practice to measure behavior dietary patterns and physical activity as well as to develop interventions for prediabetes.

## Keywords:

Areliability, health belief model, prediabetes, validity

## Introduction

Prediabetes is a pathological condition before diabetes that characterized by hyperglycemia.<sup>[1]</sup> This condition increases the risk of diabetes mellitus approximately by 70%,<sup>[2]</sup> and the awareness of self-management is relatively low.<sup>[3]</sup> Self-management of prediabetes important to improve dietary pattern and physical activity that can control the progression of prediabetes. Meanwhile, the Health Belief

Model (HBM) plays an important role in improving behavior change, particularly in the context of prediabetes management.<sup>[4]</sup>

The health belief model is a theory of behavior change with an approach to the perception of risk vulnerability, severity, benefits, barriers, self-efficacy, and cues to action practice dietary management and physical activity.<sup>[5]</sup> The HBM approach has an effect in controlling HbA1c in diabetes mellitus patients.<sup>[6]</sup> There was a correlation between HBM and diet

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quality and physical activity in the working group population.<sup>[7]</sup> The HBM questionnaire included the components related to dietary patterns and physical activity with the answers about statement items using Likert scale and has been developed on different subjects and target populations.<sup>[6,8–16]</sup>

The development of the HBM questionnaire is important to measure health behavior. A good questionnaire must have optimal validity in measuring the components under investigation.<sup>[17]</sup> Therefore, this study aimed to evaluate validity and reliability of the HBM questionnaire specifically to assess dietary patterns and physical activity in a population with prediabetes.

## Materials and Methods

### Study design and setting

This descriptive study was conducted from July to September 2023 among participants with high risk of prediabetes. The HBM questionnaire for dietary patterns and physical activity validity test was evaluated with content and face validity as well as reliability test.

### Study participants and sampling

Content validity was carried out by 10 panelists consisting of four community nutrition specialists as well as six education and behavior change specialists. Although the minimum standard recommendation was five panelists, a total of 10 were used to minimize the possibility of an accidental agreement.<sup>[18]</sup> The reliability test was carried out by 30 adults determined based on recommendations for a cognitive interview questionnaire ranging from 5 to 15 participants and the minimum sample size to estimate alpha coefficient.<sup>[17,19,20]</sup> Every participant filled out an informed consent form for approval to participate in the study after receiving an explanation about the research method, purpose, procedure, potential risks, and benefits for the study participants.

The inclusion criteria for panelists in content validity were (a) practitioners and academics background in health science and (b) experience working in the field for at least 5 years. Meanwhile, the inclusion criteria for participants in the face validity and reliability test were (a) adults aged 30–55 years and (b) willing to complete questionnaire. Both panelists and participants were asked to rate the clarity of the questionnaire items and assess their relevance to measuring dietary patterns and physical activity.

### Data collection

The HBM questionnaire for dietary patterns and physical activity was developed based on the knowledge, attitudes, and practices prediabetes assessment questionnaire (KAP-PAQ) and the

instruments of the risk perception survey for developing diabetes (RPS-DD).<sup>[6,8,9,21]</sup> The questionnaire was translated as the initial step for organizing item statements.<sup>[22]</sup> The results determined the included components including perceived susceptibility, severity, benefit, barrier, and self-efficacy as well as cues to action for dietary patterns and physical activity based on balanced nutrition guidelines and adaptation eating behavior alongside socioculture.<sup>[23,24]</sup> The measurement of the components was performed using a scale ranging from 1 (very disagree) to 4 (strongly agree) and then averaged into the total score. Higher scores reflect greater health beliefs in managing dietary patterns and physical activity. The HBM components for dietary patterns and physical activity are shown in Table 1.

The analysis of content validity used content validity index (CVI) and multirater kappa statistics.<sup>[25]</sup> The panelists were asked to determine whether the question items were clear and relevant to the basic theory of HBM for dietary patterns and physical activity in prediabetes. Assessments were given 4 scales to evaluate clarity and relevance, including 1 (unclear) to 4 (very clear) and 1 (irrelevant) to 4 (very relevant).

The CVI value was adjusted with multirater kappa statistics to eliminate the possibility of increasing values due to the accidental agreement of each expert panelist.<sup>[25]</sup> The probability of change agreement (Pc) was calculated by  $Pc = [N! / A! (N - A)!] \cdot 0,5^N$  where N was the total number of experts and A was the number of experts who agreed that the item was relevant or clear. After

**Table 1: Components of health belief questionnaire for dietary patterns and physical activity in prediabetes**

Behavior changes	Nutrition education application (management dietary patterns and physical activity)
Perceived susceptibility	The perception of susceptibility to prediabetes based on self-characteristics and high risk of diabetes triggers awareness that prediabetes increases the risk of diabetes and other degenerative diseases.
Perceived severity	The perception of prediabetes severity is based on the description prediabetes problem and its complications. Prediabetes triggers diabetes and degenerative diseases causes long-term health problems, and increases risk morbidity and mortality.
Perceived benefit	The perceived benefits about the positive effect when adjusting diet (consumption of balanced nutrition, fiber, and low glycemic index, reducing sweet sugar beverages) and regular practice of physical activity.
Perceived barriers	The perception of barriers about obstacles that can occur when practicing diet and physical activity regularly.
Cues to action	Actions and behaviors that have been influenced by information on regulating consumption dietary patterns and physical activity.
Self-efficacy	Build self-confidence to manage dietary patterns and physical activity regularly.

calculating Pc, the Kappa score was obtained by using the formula  $K = (I-CVI - Pc) / (1 - Pc)$ .<sup>[26]</sup>

The face validity test identified item statements for measurement based on the HBM component. The test was conducted both qualitatively and quantitatively,<sup>[9,27]</sup> specifically, qualitative assessment was carried out by conducting interviews to determine the understanding of the respondents in relation to items and the complexity of the language statements. In this context, we corrected an item when participants found it complex and difficult to understand. Quantitative assessment was carried out by asking participants to assess the importance of statements based on personal experience, while scoring was based on five scales including 1 (not important) to 5 (very important). We used the assessment to evaluate the impact score of each statement.<sup>[28]</sup>

The reliability test of questionnaire was measured by assessing the internal consistency reflecting the domain construction among similar prediabetes subjects. Cronbach's coefficient alpha (CCA) was used to assess the association between item statements and answers based on the Likert scale.<sup>[29]</sup>

### Ethical consideration

The study received ethical approval, and participants signed a written informed consent to participate in the study.

### Statistics analysis

Descriptive statistics were presented as frequency and percentages. Microsoft Excel was used for CVI and Kappa statistical analysis, while Spearman and CCA correlation tests for reliability were analyzed with SPSS version 16. The CVI was tested based on relevant criteria including 1-CVI for clarity and relevance, with a recommended minimum score of 0.78.<sup>[30]</sup> The multirater kappa statistics were classified into values  $>0.74$  (very good),  $0.60-0.74$  (good), and  $0.40-0.49$  (sufficient).<sup>[26]</sup> When the assessment of impact score for each statement was equal to or greater than 1.5 then the question item was retained in the instrument.<sup>[28]</sup> The recommended minimum limit for the coefficient reliability was 0.7.<sup>[31]</sup> When reliability coefficient value was below 0.7, the question with the highest Cronbach value would be deleted until the value reached the minimum limit.<sup>[29]</sup>

## Results

### Panelist and participant characteristics

The content of validity test involved 10 panelists, with the majority of 80% a women. The reliability test characteristics of the total participants ( $n = 30$ ) are presented in Table 2. The highest age group category was 40–44 years, while a significant proportion were

**Table 2: Analysis of participant characteristics**

Characteristics	Amount	
	<i>n</i>	%
Marital status		
Married	29	96,7
Divorce	1	3,3
Education		
Elementary school	12	40,0
Junior high school	8	26,7
Senior high school	8	26,7
University	2	6,7
Occupation		
Work in private and public sector	8	26,7
Housewife	22	73,3
History of gestational diabetes		
Yes	2	6,7
Not	28	93,3
History of hypertension		
Yes	9	30,0
Not	21	70,0
History CVD		
Yes	4	13,3
Not	26	86,7
Family history of diabetes		
Yes	1	3,3
Not	29	96,7
Family history NCD		
Yes	5	16,7
Not	25	83,3

married, attended elementary school, and working as housewives with income levels below the regional minimum wage (RMW). Several participants had a history of gestational diabetes, hypertension, and cardiovascular disease (CVD). The majority also had a history of noncommunicable diseases (NCDs) such as diabetes mellitus.

### Validity of questionnaire

The content validity test on the HBM questionnaire for dietary patterns, and physical activity was involved 10 panelists. The validity test consisted of content and multirater kappa statistics, as described in Table 3. The results of the CVI analysis on content validity by ten panelists showed I-CVI score between 0.77 and 1. Two item statements had CVI value  $<0.78$  in the clarity aspect, while five statements had CVI  $<0.78$  in the relevance aspect. After analysis of the content validity test, the number of item statements was reduced with only 47 proceeding to the face validity and reliability tests.

The questionnaire was comprised of 48 HBM items for dietary patterns and physical activity, consisting of statements related to perceived susceptibility (9 items), severity (5 items), benefit (6 items), barrier (7 items), self-efficacy (13 items), and cues to action (8 items). Table 4 shows only a few item statements on

**Table 3: Validity test of HBM questionnaire for dietary patterns and physical activity**

Item	Number of clarity item agreement	I-CVI*	Pc**	Kappa statistic	Number of relevant item agreement	CVI	Pc	Kappa statistic	Interpretation
Perceived severity									
1	8	0,88	0,00879	0,87	8	0,88	0,00879	0,87	Excellent
2	8	0,88	0,00879	0,87	9	1	0,00098	0,99	Excellent
4	9	1	0,00098	0,99	8	0,88	0,00879	0,87	Excellent
Perceived susceptibility									
6	8	0,88	0,00879	0,87	9	1	0,00098	0,99	Excellent
7	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
8	9	1	0,00098	0,99	7	0,77	0,1406	0,49	Good
11	7	0,77	0,1406	0,49	6	0,66	2,9531	-5,24	Low
13	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
Perceived benefit									
16	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
18	8	0,88	0,00879	0,87	8	0,88	0,00879	0,87	Excellent
19	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
Perceived barrier									
21	7	0,77	0,1406	0,49	7	0,77	0,1406	0,49	Good
24	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
26	9	1	0,00098	0,99	8	0,88	0,00879	0,87	Excellent
Self-efficacy									
28	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
34	8	1	0,00098	0,99	7	0,77	0,00879	0,49	Excellent
35	7	1	0,00098	0,99	7	0,77	0,00879	0,49	Excellent
39	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
40	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
Cues to action									
41	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
44	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent
47	9	1	0,00098	0,99	9	1	0,00098	0,99	Excellent

\*I-CVI: Item-Content validity index, \*\*Pc: Probability of change agreement

**Table 4: Revision statement component of HBM questionnaire for dietary patterns and physical activity**

Statement	Identify ease of understanding and simplicity of language	Revision of statements
Irregular eating habits (not eating breakfast) can lead to prediabetes	The statement is difficult to understand	Statement deleted
I am supported by my family to make dietary arrangements that can control the condition of prediabetes	The statement is not simple and difficult to understand	My family supports me in making dietary arrangements that can control the condition of prediabetes
I find it very difficult to be able to eat a balanced diet that can control blood sugar	The statement is not simple and difficult to understand	I find it very difficult to be able to eat a balanced diet consisting of staple foods, protein, vegetables, and fruit
To maintain my health status, I will practice physical activity regularly	The statement is not simple	I will do regular physical activity to maintain my health status
My family always helps me in making dietary arrangements as recommended	The statement is difficult to understand and not clear	My family always helps me in making dietary arrangements such as eating three times and snacking two times a day
My friend always reminds me to do physical activity based on recommendation	The statement is not simple and not clear	My friend always reminds me to do at least 30 minutes of physical activity a day

questionnaire representing the overall description of the contents.

The panelists conducted qualitative assessments by giving comments about item statements that needed improvement to enhance the quality of questionnaire. For example,

suggestions included reducing redundancy among similar questions and ensuring each statement adequately represents all components of HBM. The number of item statements was revised to assess the face validity of the target group of participants. Table 4 provides an overview of the redaction changes made to each item statement sentence.

Face validity tests were carried out on 10 adults to assess qualitative and quantitative validity, with the impact score presented in Table 5. The quantitative analysis showed a score >1.5, suggesting that the question item could be retained (48).

In the face validity test, a total of 47 item statements were assessed as one was excluded due to low score and based on recommendations from the panelists. The item statement was "Irregular eating habits (skipping breakfast) can cause prediabetes (perceived susceptibility)" with a kappa statistic score <0.40. The qualitative study in the aspect related to panelist recommendations, suggesting that the number of statements should be reduced. The adult group participants classified the 47-item statements as easy to understand.

### The reliability of questionnaire

The reliability test on 47 item statements was conducted on 30 participants, and the results are presented in Table 6. The Pearson correlation test showed 27-item statements ( $P$  value <0.05), while 18-item

statements ( $P$  value > 0,05) had Cronbach's alpha of 0.821, indicating strong reliability.

## Discussion

Analysis of content validity aimed to determine whether the instrument developed could assess the content component of the phenomenon under investigation.<sup>[32]</sup> The validity the HBM questionnaire was used to measure the component of HBM included perceived susceptibility, severity, benefits, barriers, as well as self-efficacy and cues to action for regulating dietary patterns and physical activity in adult women that can control prediabetes. The validity of the questionnaire is important to standardized tool in measuring HBM as a basic to develop intervention in behavior changes.

The item statements on questionnaire were developed based on several literature reviews related to dietary patterns and physical activity in prediabetic and diabetic patients.<sup>[6,8,9]</sup> Differences were observed in the characteristics of respondents and sociocultural

**Table 5: Face validity (impact score) analysis of HBM questionnaire for dietary patterns and physical activity**

Item	n score 4 and 5	Mean	Impact score	Interpretation
Perceived severity				
1 The problem of prediabetes is a serious health problem	4,6	10	4,6	Items retained
2 Overweight and obesity will increase the complications of prediabetes	3,9	8	3,1	Items retained
4 The habit of lack of exercise can cause an increase in blood sugar	4	8	3,2	Items retained
Perceived susceptibility				
6 If I have a high blood sugar concentration, then I am at risk of developing diabetes	4,4	9	3,9	Items retained
7 If my parents have diabetes then I have a risk of having diabetes because of heredity	4,2	9	3,7	Items retained
9 The habit of consumption of sweet foods and drinks increases the risk of prediabetes	3,6	6	2,1	Items retained
12 Less physical activity can increase the risk of obesity and prediabetes	4	8	3,2	Items retained
Perceived benefit				
15 Choosing food sources of complex carbohydrates such as brown rice and corn rice has a good impact on blood sugar control	3,9	8	3,1	Items retained
17 I am supported by my family to make dietary arrangements that can control prediabetes	3,8	8	3,0	Items retained
18 Regular physical activity every day has a good impact on blood sugar	3,8	7	2,6	Items retained
Perceived barrier				
20 I find it very difficult to be able to eat a balanced diet that can control blood sugar	4,1	8	3,2	Items retained
23 I don't have time to be able to do sports activities	4,1	9	3,6	Items retained
25 I don't have any friends that can do sports	4	8	3,2	Items retained
Self-efficacy				
27 I am sure that I can make dietary patterns with main meals 3 times a day and snacking meals 2 times a day	3,7	7	3,0	Items retained
33 To maintain my health status, I will routinely do physical activity	4,1	9	3,6	Items retained
35 I am sure that I can choose and consume food ingredients such as brown rice, corn rice, and boiled bananas good for blood sugar control	3,9	7	2,7	Items retained
38 I believe that I can process food ingredients by boiling/steaming rather than frying/ stir-frying	4,2	9	3,7	Items retained
39 I should read the food labels related to sugar, salt, and fat on the packaging foods I'm going to buy	4,2	9	3,6	Items retained
Cues to action				
40 My family always helps me in making dietary arrangements as recommended	4,1	8	2,5	Items retained
43 My friend always reminds me to do physical activity based on recommendation	4	8	3,2	Items retained
46 I have a guide that can help me to make dietary management	4	9	3,6	Items retained



**Table 6: Analysis of interconsistency reliability of HBM questionnaire for dietary patterns and physical activity**

Item	R-Item*	Significance (Two Tailed)	Cronbach's Alpha	Cronbach's Alpha If Item Is Eliminated	Reliability
Perceived severity					
1	0,434	0,017	0,821	0,815	Reliable
2	0,565	0,001	0,821	0,810	Reliable
4	0,377	0,040	0,821	0,816	Reliable
Perceived susceptibility					
6	0,371	0,044	0,821	0,817	Reliable
7	0,375	0,041	0,821	0,817	Reliable
9	0,417	0,022	0,821	0,815	Reliable
12	0,487	0,006	0,821	0,813	Reliable
Perceived benefit					
15	0,298	0,109	0,821	0,819	Reliable
17	0,243	0,196	0,821	0,819	Reliable
18	0,394	0,031	0,821	0,816	Reliable
Perceived barrier					
20	0,444	0,014	0,821	0,814	Reliable
23	0,302	0,104	0,821	0,818	Reliable
25	0,031	0,872	0,821	0,826	Reliable
Self-efficacy					
27	0,360	0,051	0,821	0,817	Reliable
33	0,376	0,040	0,821	0,817	Reliable
35	0,385	0,036	0,821	0,816	Reliable
38	0,407	0,025	0,821	0,816	Reliable
39	0,098	0,606	0,821	0,823	Reliable
Cues to action					
40	0,378	0,040	0,821	0,816	Reliable
43	0,448	0,013	0,821	0,814	Reliable
46	0,165	0,382	0,821	0,821	Reliable

\*Pearson correlation

backgrounds requiring adjustments to the local aspects of the community. Therefore, modifications of a few item statements were made to develop questionnaire. The development of questionnaire was used to identify the predisposition of HBM components in people with prediabetes, which formed the basis for formulating interventions. These interventions can help improve blood glucose and HbA1c in people with diabetes mellitus.<sup>[33]</sup> A positive correlation was found between the HBM intervention approach to controlling HbA1c and significantly increasing physical activity such as regular walking.<sup>[6,34]</sup> Dietary regulation, physical activity, and weight control are important the management of nutrition therapy for prediabetes.<sup>[35]</sup>

Both quantitative and qualitative methods can analyze content validity. The qualitative method has been widely used, even though the result is relatively subjective.<sup>[36,37]</sup> In this study, the qualitative assessment was carried out by experts giving comments, input, and indicators relevant to HBM theory, diet, and physical activity in prediabetics with a description section in each statement item on the questionnaire. On the other hand, the quantitative assessment of content validity entailed giving a score for each item statement in terms of clarity and relevance.<sup>[25]</sup> CVI is a method generally used in quantitative content

validity tests,<sup>[18,38]</sup> with the recommended minimum score set at 0.78 when the panel consists of more than six members.<sup>[30]</sup> The results showed that there were two item statements on the clarity aspect with CVI values of less than 0.78 and a kappa statistic value of 0.49. Meanwhile, five-item statements on the relevance aspect had CVI values less than 0.78, with four having kappa statistic values of 0.49 and one with -5.24. Analysis of validity showed CVI values between 0.77 and 1, included in the good category. These results were supported by a previous study about the development of HBM questionnaire in working groups, producing an average CVI value of 0.85.<sup>[7]</sup> Similarly, the development of questionnaire about the impacts of sport on CVD scales yielded a value of 0.79 (27). Kappa statistical values between 0.40 and 0.49 are considered sufficient validity, while those less than 0.40 are classified as low validity.<sup>[26]</sup> Based on the results, one item statement considered difficult to understand and without a clear intention was deleted, while others were retained after revision made based on suggestions and the determination of indicators from the panelists. Although CVI is a measurement commonly used in content validity tests, there is a possibility of increased value due to coincidence agreement among panelists during the assessment process. This underscores the need for multirater kappa statistics to eliminate the possibility of

increasing the value score due to coincidence agreement from the panelists.<sup>[25]</sup>

Face validity tests showed good acceptance by respondents; specifically, the qualitative assessment results indicated that the item statements on each questionnaire were classified as easy to understand. The questionnaire was revised based on suggestions and input by panelists during the content validity test. The simplicity and ease of understanding item statements are important components for target respondents.<sup>[39]</sup>

The questionnaire was considered strongly reliable based on the results of the 47-item statements with a Cronbach's alpha value of 0.821. These results were consistent with a previous study that obtained a Cronbach's alpha value of 0.83, falling in the good reliability category. Another study in diabetic patients with the development of HBM instruments obtained a value of 0.89. Furthermore, the Impact of Sport on the CVD Scale questionnaire based on the HBM-ISCS had Cronbach's alpha values ranging between 0.715 and 0.816, suggesting good internal consistency.<sup>[4,6,40,41]</sup> The HBM questionnaire reliability test in the working group with a value of 0.74–0.93 showed good reliability<sup>[7]</sup> to measure the components of dietary patterns and physical activity.

The HBM questionnaire was developed to assess behavioral changes in adult groups with diabetes mellitus.<sup>[6,33,42,43]</sup> Subsequent application included assessing HBM in adults with prediabetes,<sup>[16]</sup> the development of HBM-ISCS,<sup>[40]</sup> as well as measuring physical activity in adulthood,<sup>[33,42]</sup> working group,<sup>[7]</sup> and the elderly.<sup>[44]</sup> The instrument has also been used in the identification of health beliefs for the prevention of metabolic syndrome,<sup>[45]</sup> such as diabetes mellitus.<sup>[46]</sup> The HBM questionnaire for dietary patterns and physical activity developed in this study showed good validity and reliability. Based on the results, the instrument can be used to measure behavior change interventions in adult prediabetics, by observing the mediator pathways through the HBM component.

This study analyzed content and face validity, as well as reliability which was carried out directly face-to-face with panelists and respondents, but the number of samples was relatively small. The samples comprised adults representing the situation of the general population in developing countries. The validity test process provided a general idea that the questionnaire was valid and reliable for measuring HBM dietary patterns and physical activity in adults as an effort to prevent diabetes mellitus.

## Conclusions

In conclusion, the HBM questionnaire for dietary patterns and physical activity related to prediabetes in

adults showed score CVI between 0.77 and 1 and score kappa statistics between -5.24 and 0.99 in category good validity and reliability. The final questionnaire was determined based on the assessment of panelists related to aspects of content and face validity, as well as reliability tests. Furthermore, questionnaire can be used to examine dietary patterns and physical activity related to HBM components in prediabetic adults to identified the potential effective intervention in clinical settings. The limitation of study is the number of panelists and respondents relatively small, hopefully in the future study can be develop questionnaire with more respondents.

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## Conflicts of interest

There are no conflicts of interest.

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