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Cross-Cultural Adaptation and Psychometric Validation of the Medication Compliance Questionnaire (MCQ) for Type 2 Diabetes Mellitus Patients in Indonesia

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Abstract

Background: Medication adherence is critical for managing type 2 diabetes mellitus (T2DM). The Medication Compliance Questionnaire (MCQ) is a widely recognized tool for assessing adherence but has not been adapted for T2DM in Indonesia. This study aimed to adapt and validate the MCQ in the Indonesian socio-cultural context.

Methods: A cross-sectional study at community health centers (May–Aug 2024) involved forward/back translation, content validation using Aiken's V, and psychometric assessment among 230 patients. Exploratory Factor Analysis (EFA) assessed construct validity, including convergent, discriminant, and reliability.

Results: Aiken's V index indicated strong content validity (average = 0.881). EFA identified two dimensions—practical adherence and patient perception—explaining 49.25% of the variance. Composite Reliability (CR) values exceeded 0.70, indicating good internal consistency. While the Average Variance Extracted (AVE) was below 0.50, CR ≥ 0.70 confirmed convergent validity. No significant cross-loadings supported discriminant validity.

Conclusion: The validated Indonesian version of the MCQ consists of six items, demonstrating strong validity and reliability. The two-factor structure reflects practical adherence and patient perception, making it a valuable tool for assessing medication adherence among Type 2 Diabetes Mellitus (T2DM) patients in Indonesia.

Keywords: diabetes mellitus, Indonesia, medication adherence, psychometrics

INTRODUCTION

Diabetes mellitus (DM) is now recognized as one of the leading causes of death globally, as highlighted in the International Diabetes Federation (IDF) report of 2023.[1] Around 6.7 million people died from DM and its complications, of which more than 90% of cases were type 2 diabetes mellitus (T2DM). This increase in prevalence mainly occurs in low and middle-ranking countries, including Indonesia.[1–3] Effectively managing type 2 diabetes mellitus (T2DM) is essential for minimizing complications and mortality rates. Furthermore, it significantly alleviates the growing economic burden on national health systems due to increased healthcare costs linked to insufficient disease control.[4,5] Therefore, effectively managing T2DM is imperative and requires the decisive involvement of all stakeholders, particularly patients, who must adhere to their prescribed treatment regimens.[6]

Patient adherence to medication therapy is crucial in managing T2DM.[6] When patients do not adhere to their prescribed treatment regimen, it can lead to an increased risk of complications, a decline in quality of life, reduced productivity, and higher medical costs.[5,6] These consequences also contribute to a significant economic burden on the country's national health insurance system. [7,8] Given the significance of this issue, it is imperative to ensure precise identification and effective management of non-adherence by utilizing reliable screening tools. A constructive approach to preventing non-compliance is implementing medication adherence screenings for T2DM patients, enabling us to implement targeted interventions.

Several studies in Indonesia have tested the validity of medication adherence scales in patients with T2DM before applying them to specific populations.[9] However, most similar studies have not fully addressed this validation process, whereas validating indirect measurement instruments is considered a best practice in psychometrics.[10,11] Therefore, using validated adherence instruments tailored to populations with similar disease characteristics, socio-demographic conditions, and languages is highly recommended to enhance the accuracy of measurement outcomes.[10,11] This limitation highlights the need for an instrument that captures these broader dimensions, tailored to Indonesia's unique socio-cultural context. Validating indirect measurement instruments, particularly those adapted cross-culturally, is

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considered best practice in psychometrics to ensure measurement accuracy and contextual relevance.[10,11]

The Medication Compliance Questionnaire (MCQ) is an established tool used to assess medication adherence among diabetes patients in various studies.[12,13] Unlike prior tools, the MCQ integrates dimensions from three established adherence scales–namely, the Morisky Self-Reporting Scale, the Morisky Medication Adherence Scale, and the Hill-Bone Adherence Scale–creating a more holistic measure of adherence behaviors.[12,14,15] This multidimensional structure aligns well with the diverse barriers faced by Indonesian T2DM patients, particularly within a multi-ethnic society, making the MCQ a strong candidate for adaptation and validation. The prior validation in populations with socio-cultural similarities, such as Malaysia, reinforces its suitability for adaptation in Indonesia.

There is currently no self-report scale for medication adherence that has been translated, cross-culturally adapted, and psychometrically validated specifically for T2DM patients following international guidelines.[16,17] Therefore, this research aims to fill this gap by ensuring that the MCQ is socio-culturally relevant, reliable, and valid for Indonesian T2DM patients. This study is expected to contribute to controlling the burden of type 2 DM in Indonesia by improving the quality of medication adherence measurements.

METHODS

This study employed a cross-sectional approach to assess the validity and reliability of the Indonesian version of the MCQ at a single point in time, without any repeated measurements on the same subjects.[18] Over four months, from May to August 2024, a series of research procedures proposed by Cruchinho *et al*. and Ortiz-Gutiérrez and Cruz-Avelar (2018) were implemented.[16,17] The process began with the translation and cross-cultural adaptation of the MCQ self-reporting adherence instrument, followed by a pre-field test and psychometric validation (Figure 1).

The population was divided into three groups: 1) the population of the research site, 2) the pre-test population, and 3) the population of respondents for the psychometric test. All populations were determined using purposive sampling techniques to ensure socio-cultural representation in primary health care.[18] The selection of the Health Center as the research site was based on its coverage of service areas in both urban and rural contexts, ensuring wider accessibility within the socio-cultural framework.[16] The Health Centers involved in the study included four facilities in Banyumas Regency: Purwokerto Utara I Health Center, Kembaran I Health Center, Rawalo Health Center, and Purwojati Health Center. Three Health Centers from Purbalingga Regency were included: Purbalingga Health Center, Padamara Health Center, and Kutasari Health Center. During the pre-field test phase, MCQ version 4 was administered to 20 T2DM patients from health centers. However, these respondents were excluded from the psychometric testing process.[16,17]

The psychometric test population was determined using the item-to-respondent ratio of 1:10, thus requiring at least 70 respondents for the seven-item questionnaire.[19] However, a larger sample is required to minimize sampling bias, improve the reliability of factor analysis, and ensure the identification of latent variables.[18] Therefore, the target population included 487 T2DM patients actively receiving care at selected Community Health Centers using an online sample size calculator with a 5% margin of error and a 95% confidence level; the minimum required sample was 216 respondents (available at www.calculator.net, accessed May 2024). To account for potential dropouts, 10% was added, resulting in a final sample size of 238 participants. This number meets the standard for psychometric testing.[18,19] The inclusion criteria for this study were: (1) patients actively receiving T2DM treatment at the participating Community Health Centers, (2) ability to read and understand Indonesian, (3) age ≥18 years, and (4) willingness to participate in the study. Patients with cognitive impairment or severe comorbidities were excluded from participation.

The Medication Compliance Questionnaire (MCQ) was adapted and validated according to established guidelines.[17] It includes seven items to assess different aspects of patient adherence and underwent a rigorous validation process for content validity, construct validity, and reliability among Indonesian patients with T2DM.[20–23] The original 4-point Likert scale was maintained: "never" = 4; "sometimes" (1–4 times per month) = 3; "often" (more than 5 times per month or more than twice per week) = 2; and "always" (every day) = 1. The MCQ information provided to respondents was adapted for consistency in scoring and interpretation, including a clear explanation of the four-point Likert scale. This resulted in a global adherence score from 7 to 28, where higher scores indicate better adherence. However, the main goal was to assess the psychometric properties of the Indonesian-adapted MCQ, not to classify adherence levels.[12]

The cross-cultural translation and adaptation followed a structured 10-step process, grouped into three main phases (Figure 1). Ethical approval was obtained from the Health Research Ethics Committee of Muhammadiyah University of Purwokerto (KEPK/UMP/281/VI/2024). All respondents gave written informed consent before participation.[24] Permission to translate, cross-culturally adapt, and validate the MCQ in Indonesian was obtained from the original developer via e-mail. Supporting documentation from the original author was used to ensure consistent interpretation of item content throughout the adaptation process.[16,17]

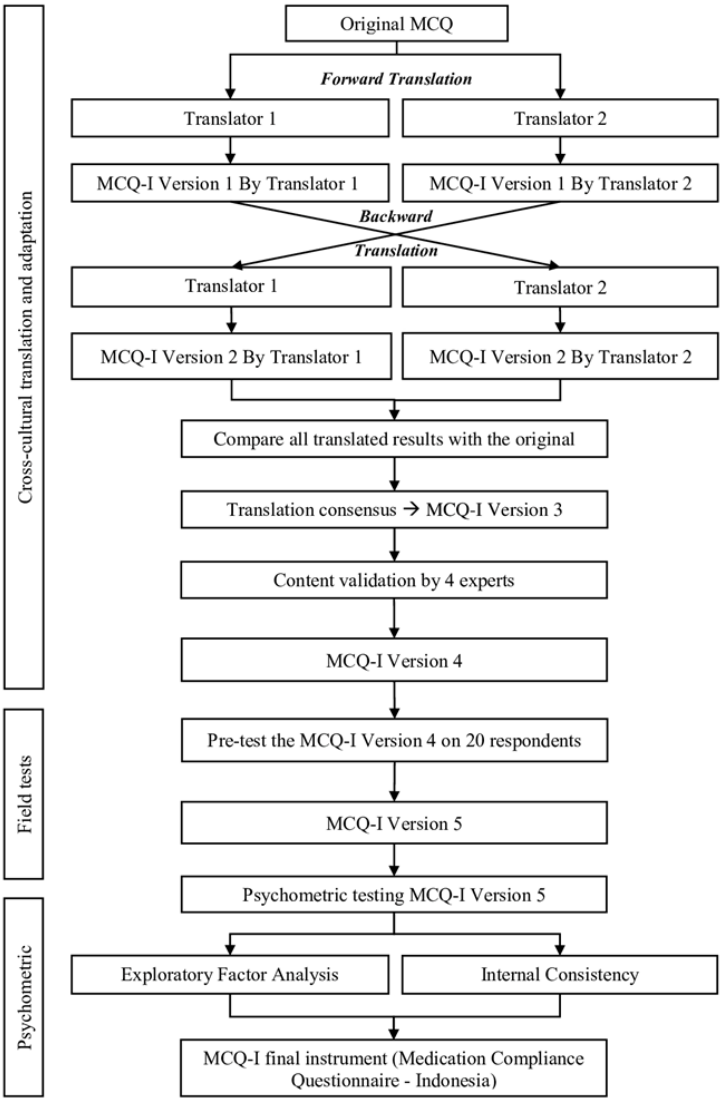

FIGURE 1. Cross-cultural adaptation and evaluation process of the Medication Compliance Questionnaire (MCQ)

Stage 1: Cross-cultural translation and adaptation

The translation process involved two independent professional translators and two bilingual health professionals fluent in English and Indonesian. The cross-cultural adaptation process followed established translation guidelines, ensuring semantic, idiomatic, conceptual, and cultural equivalence.[16,17] The first stage involves the forward translation process (from English to Indonesian), completed by two professional language translators. Each translator worked separately and produced two independent translations (Figure 1). The second stage is back-translation (from Indonesian to English) of the translations produced in the first stage. To maintain independence and avoid confirmation bias, the back-translation followed a cross-translation approach: (1) Translator 1's forward-translated MCQ-I was back-translated by Translator 2. (2) Translator 2's forward-translated MCQ-I was back-translated by Translator 1. Both back-translators worked independently and were not provided access to the original English MCQ during the process (Figure 1).[16] In the third stage, the research team evaluates both back-translations with the original English version to ensure the language is appropriate and the meaning of words fits both the syntactic and local cultural contexts. This evaluation results in Version 3 of the questionnaire, which is then validated by experts. Content validity is assessed by four experts: two pharmacists, one doctor, and one psychologist. They check the material for appropriateness, the construction of language, and the relevance of the cultural context. This

led to the creation of version 4 of the questionnaire as the final instrument, which was ready for the field-testing phase.[25–27]

Stage 2: Field testing

The pre-test stage will identify fundamental issues in MCQ version 4, such as language ambiguity, contextual relevance, or answer consistency, directly from the respondent's perspective.[27] This stage tests the clarity of each question item to evaluate the respondent's understanding of the question.[16,17] A total of 20 pre-test respondents were given the MCQ-I version 4 questionnaire to evaluate the clarity of each question item in the questionnaire. Respondents were also asked to indicate difficult-to-interpret terms and were allowed to provide qualitative feedback. The results of this test became the basis for revising question items that were too complex. The pre-field test stage produced MCQ version 5, which was used in the psychometric validation phase (Figure 1).

Stage 3: Psychometric validation

The final stage is the psychometric validation process of the MCQ-I in a population of T2DM patients taken from seven health centers. Respondents were asked to complete the MCQ-I questionnaire using paper and writing instruments during a monthly health check.[28] Researchers or the patient's family accompanied the process if the respondents could not read/understand the questions.[16,17]

During the translation stage, the research team thoroughly analyzed and compared all versions, including the original, forward translation, and back translation, to evaluate their accuracy, fluency, sensitivity, and cultural appropriateness.[16] The translations were meticulously examined both lexically and grammatically to identify potential ambiguities, gaps in perception, and variations in translation quality.[16] Any discrepancies were resolved through in-depth discussions among experts and translators, leading to a consensus translation of MCQ-I Version 2.

A descriptive statistical analysis was conducted on the test respondent population's sociodemographic data, including frequency and percentage. Additionally, a descriptive analysis was performed on the distribution of the respondents' answers (Table 3), which included the average score and standard deviation of their responses. In the final stage of cross-cultural translation and adaptation, the content validity of MCQ Version 3 was assessed through expert evaluation using Aiken's V index.[27] This index demonstrated analytical content validity based on expert ratings using a Likert scale from 1 to 4, with a 5% error limit ($p < 0.05$).[23,25,29] Furthermore, the evaluation of the trial results focused on testing the clarity of the question items and the ease of understanding and interpretation of the instrument. Data analysis at this stage involved assessing clarity based on the following criteria: an average score of 1.0–1.5 indicated "very clear" (no revision needed); a score of 1.6–2.5 indicated "quite clear" (may require minor revisions); and a score of 2.6–4.0 indicated "unclear" (needs major revision).[23,25,29]

The psychometric validation process utilized exploratory factor analysis to assess construct validity, specifically convergent and discriminant validity. This approach was selected to identify the underlying structure of the adapted MCQ-I, particularly in the absence of existing data on how items might be grouped in the Indonesian context—the original MCQ combined elements from three validated instruments, placing its construct in an exploratory stage. Therefore, EFA was justified in this cultural adaptation phase.[12,30] This analysis starts with the Kaiser-Meyer-Olkin (KMO) test (KMO ≥ 0.50), Bartlett's test ($p \leq 0.001$), and the Measures of Sampling Adequacy (MSA) test (MSA ≥ 0.5), followed by the Eigenvalue test. Factors were extracted using eigenvalues ≥ 1 and scree plot analysis.[30,31] Convergent validity was assessed via Average Variance Extracted (AVE) and Composite Reliability (CR), while discriminant validity was examined by identifying cross-loading patterns.[21,30] Convergent validity was assessed via Average Variance Extracted (AVE) and Composite Reliability (CR), while discriminant validity was examined by identifying cross-loading patterns.[21,30] All statistical analyses were performed using SPSS version 26.0, while supporting calculations (Aiken's V, AVE, CR) were completed in Microsoft Excel 2019.[25,30,32]

TABLE 1. Original Medication Compliance Questionnaire (MCQ) domains and translation consensus

Item	Original MCQ Domain	Translation Consensus in Indonesian
1.	Forgetfulness	Seberapa sering Anda lupa minum obat Anda?
2.	Intentional non-adherence	Seberapa sering Anda memutuskan untuk tidak minum obat Anda?
3.	Perceived Health Status	Seberapa sering Anda melewatkan minum obat karena sudah merasa lebih baik?
4.	Dose Reduction	Seberapa sering Anda memutuskan untuk mengurangi obat yang Anda minum?
5.	Severity of Side Effects	Seberapa sering Anda menghentikan minum obat karena Anda merasa sakit akibat efek samping obat?
6.	Preparedness	Seberapa sering Anda lupa membawa obat saat bepergian jauh dari rumah?
7.	Medication Supply Management	Seberapa sering Anda tidak minum obat karena kehabisan obat di rumah?

RESULTS

From March to August 2024, 487 patients with T2DM actively participated in periodic treatment through the Chronic Disease Management Program across seven health centers involved in the study. A total of 238 respondents were selected for the psychometric validation study. However, eight respondents were excluded due to incomplete responses, resulting in a final sample of 230 participants.

Table 2 presents the sociodemographic and clinical characteristics of the respondents. Among the 230 participants, 63.91% were female, and 46.52% were 65 years or older. Additionally, 90.00% lived with family members, and 69.57% lived within 5 kilometers of a community health center. Regarding education, 42.61% had elementary education or less, 22.17% had completed middle school, 20.87% had graduated from high school, and 8.26% had a college degree. Additionally, 64.35% of respondents reported being unemployed.

TABLE 2. Sociodemographic and clinical characteristics of respondents (N = 230)

Characteristics	N	%
Gender		
Male	83	36.09
Female	147	63.91
Age (years)		
≤ 45	14	6.09
45–54	35	15.22
55–64	74	32.17
≥ 65	107	46.52
Occupation		
Working	82	35.65
Not working	148	64.35
Level of education		
No school	14	6.09
Elementary school	98	42.61
Middle school	51	22.17
High school	48	20.87
College	19	8.26
Distance from home to health center		
≤ 5 km	160	69.57
≥ 5 km	70	30.43
Living with family		
Yes	207	90.00
No	23	10.00
Duration of suffering from T2DM		
≤ 5 years	135	58.70
6–10 years	66	28.70
11–20 years	24	10.43
> 20 years	5	2.17
Number of T2DM medications		
1	58	25.22
2	96	41.74
3	48	20.87
> 3	28	12.17

T2DM: type 2 diabetes mellitus; km: kilometers

The original MCQ was developed from 3 previous questionnaires and outlined domains of patient adherence to medication (Table 1). Overall, there was good agreement between the translator and the researcher when comparing the original English version and the back translation. Some minor changes were made to simplify the language of instructions for respondents; for example, the word "How" was translated to *"seberapa"* instead of *"berapa"* or "take" was translated to *"minum"* instead of *"mengonsumsi."*

Content validity was evaluated by four experts using Aiken's V index, as shown in Table 3. All items exceeded the recommended threshold (Aiken's V ≥ 0.80), with an average score of 0.881 ($p < 0.05$). These results demonstrate strong agreement among experts regarding each item's relevance to the measured construct.[27] No items were flagged for major revision, suggesting that the translation preserved semantic and contextual equivalence.[25,27] However, minor refinements may be needed to develop MCQ-I Version 4 for further testing in the pre-test phase.

The MCQ-I Pre-test clarity evaluation results, as detailed in Table 3, show that most items were rated as very clear, with average clarity scores below 1.5. Two items received average clarity scores between 1.6 and 2.5, suggesting minor wording refinements could improve clarity. No items required major revision, indicating a high linguistic clarity and readability level in MCQ-I Version 4. These results suggest that the translated items were well-understood by respondents; however, further assessments are required to confirm full cultural equivalence.[10,16,17] These findings also reaffirm the content validity, as confirmed by the expert panel, which agreed that no revisions were needed for the items in the MCQ-I.

The analysis of respondents' answers in the psychometric test indicated that the average rating for each item was above 3.0 on a four-point Likert scale, with standard deviation (SD) values ranging from 0.59 to 0.64 (Table 3). The standard deviation (SD) values indicate relatively low response variability, suggesting that participants tended to provide similar ratings for each item. However, low SD does not necessarily confirm construct relevance, as it may also result from response tendencies such as social desirability bias.[33,34] This could lead to overestimating positive responses, affecting variability across groups and influencing adherence to self-reports.[33,34] To establish the validity and reliability of the MCQ-I, further psychometric analyses, including factor analysis and reliability testing, are necessary in the next step.

TABLE 3. Content validity, pre-test clarity, and response distribution of the Medication Compliance Questionnaire (MCQ-I)

Item	Content Validity (Aiken's)	MCQ-I Pre-test – Clarity Ratings			Distribution of Respondents' Answers	
		Total Clarity Score	Average clarity score*	Interpretation	Avg rating	SD
1	0.917	26	1.30	Very clear (no revision needed)	3.15	0.604
2	0.833	27	1.35	Very clear (no revision needed)	3.59	0.590
3	0.917	25	1.25	Very clear (no revision needed)	3.57	0.621
4	0.917	29	1.45	Very clear (no revision needed)	3.53	0.638
5	0.917	35	1.75	Self-explanatory (may need minor revision)	3.51	0.611
6	0.833	41	2.05	Self-explanatory (may need minor revision)	3.59	0.640
7	0.833	30	1.50	Very clear (no revision needed)	3.52	0.604
Avg	**0.881**	**30.43**	**1.52**	**Very clear (no revision needed)**	**3.49**	**0.615**

*Score 1.0–1.5: Very clear (no revision needed); Score 1.6–2.5: Self-explanatory (may need minor revision); Score 2.6–4.0: Unclear (needs major revision); Avg rating: mean response score (Likert scale: 1–4); SD: standard deviation (response variability)

TABLE 4. Exploratory factor analysis and internal consistency of the MCQ-I

Item MCQ – I	Factor loading 1			Factor loading 2**		
	MSA	Comp 1	Comp 2	MSA	Comp 1	Comp 2
1.	0.698	0.108	0.664*	0.692	0.139	0.688*
2.	0.680	0.027	0.770*	0.694	0.002	0.762*
3.	0.720	0.663*	0.236	0.685	0.684*	0.262
4.	0.689	0.735*	0.006	0.686	0.738*	0.004
5.	0.762	0.199	0.552*	0.733	0.208	0.565*
6.	0.712	0.401	0.335		NA	
7.	0.731	0.641*	0.101	0.695	0.650*	0.120
CR	-	0.709	0.704	-	0.733	0.714
AVE	-	0.388	0.446	-	0.478	0.458
KMO		0.712			0.696	
Significance		< 0.001			< 0.001	
Explained variance		44.55%			49.25%	
Total Cronbach's Alpha		0.613			0.582	

*Factor loading ≥ 0.5; **Factor loading after removing item 6 | NA: Not available; MSA: Measures of Sampling Adequacy; Comp: Component; CR: Composite Reliability; AVE: Average Variance Extracted; KMO: Kaiser-Meyer-Olkin

Table 3 summarizes the results from three analyses: (1) content validity using Aiken's V index, (2) clarity ratings from a pre-test, and (3) response distribution from psychometric validation. The Total Clarity Score is the sum of clarity ratings from all respondents for each item, while the Average Clarity Score is the mean rating on a 4-point scale (1 = "Very clear," 4 = "Unclear"). The Average Rating in the response distribution analysis is based on a 4-point Likert scale (1 = "Always," 4 = "Never"), and the Standard Deviation (SD) indicates the variability in responses among participants.

Psychometric validation was conducted in two stages. In Stage 1, all seven items of the MCQ-I were included. In Stage 2, Item 6 was excluded due to low factor loadings on both components ($\lambda \leq 0.500$). This indicated a limited contribution to the overall construct.[31,32] After removing this item, the factor structure remained stable. The results suggest that the instrument maintained adequate psychometric properties with six items, as reflected in improved construct reliability and clearer factor groupings (Table 4).[30,31] These findings provide a solid foundation for further exploration of the indicators measured by the MCQ-I.[31,32]

Discriminant validity was evaluated by analyzing the cross-loadings between factors in the MCQ-I, as shown in Table 4.[30]. This analysis identified two distinct components: Component 1, which includes item 3, item 4, and item 7, and Component 2, which consists of item 1, item 2, and item 5 (Table 4). In a subsequent analysis that excluded item 6, each question item displayed a dominant loading on only one component, resulting in no significant cross-loadings. These findings are further supported by the Scree Plot, which indicates an inflection point at the second position, marked by a change in the slope. This reinforces the results of the rotated component analysis, which confirms the existence of two components that describe the factor structure of the MCQ-I, thereby satisfying the criteria for discriminant validity.[31,32]

Convergent validity was assessed using the Average Variance Extracted (AVE) value, which reflects the average variance captured by the construct indicators.[30,31] The removal of item 6, which had low loading values on both components (Component 1 = 0.401 and Component 2 = 0.335) (Table 4), positively affected the instrument's validity and reliability. Following this adjustment, the AVE value increased, nearing the minimum recommended threshold of 0.50.[32] Additionally, the variance explained also improved, approaching the ideal threshold of 50%. This indicates that the remaining items are more effective in capturing the primary constructs measured by the instrument.[30,32]

The internal reliability of the MCQ-I was evaluated using CR and Cronbach's Alpha values.[30,32] After item 6 was deleted, the CR values on both factors increased (Table 4) and exceeded the minimum threshold (CR ≥ 0.70). [30,32] However, Cronbach's Alpha value decreased slightly, which is still acceptable in the context of developing a relatively new instrument.[10,35] The Cronbach's Alpha value after deleting item 6 is in the moderate category ($0.50 < \alpha \leq 0.70$), so the MCQ-I remains reliable for consistent and stable measurements.

DISCUSSION

This study has successfully translated, cross-culturally adapted, and validated the MCQ into the Indonesian Cultural context for use in patients with type 2 DM. The cross-cultural validity of the MCQ was carefully ensured through a rigorous cross-cultural adaptation methodology process.[16,17] The involvement of a panel of experts and a relatively large sample size of the test respondent population have met the standard requirements of the process. The MCQ-I's choice of words and sentence sequences ensures readability, understanding, and sensitivity to local culture. Examples of translation analysis that often appear include the word "How" being interpreted as "seberapa" rather than "berapa." The word "seberapa" is associated with numbers or amounts, while "seberapa" is associated with the level or size of something, so the MCQ-I uses the diction "seberapa".[36] The translation procedure was carried out lexically and grammatically so that MCQ-I showed good acceptance from the expert panel. Other researchers also adjusted several items to align with the Indonesian language and culture.[37]

The translation results demonstrate a high content validity value, and the average pre-test score for the clarity of the MCQ-I has been categorized as very clear. These two indicators are important bases for determining whether a translation requires improvement, ensuring its semantic, idiomatic, and conceptual equivalence for measuring patient medication adherence.[16,17] An instrument must accurately measure what it intends to do and possess psychometric characteristics that indicate its reliability and validity. Therefore, following the recommended methodological strategies is essential to avoid questionable research results and incorrect conclusions.[38,39] This process represents a crucial step in expanding the application of the MCQ-I instrument and ensuring its reliability in various cultural contexts, particularly in Indonesia.

This study extends previous evidence on the application of MCQ in diabetes patients in various countries such as Malaysia and Cameroon.[12,13] Using a structured approach in translation and cultural adaptation, this study confirms that MCQ can be modified to reflect the cultural values and mindsets of patients in Indonesia. This can be seen from several validity tests that meet standard criteria, such as content validity with an average value of Aiken's V = 0.881, indicating that experts have agreed that the items in the MCQ-I are relevant to the measured construct.[25] This finding supports the importance of expert panel participation in the content validation to ensure a strong theoretical representation of the MCQ-I.[25]

Exploratory factor analysis in the first psychometric testing stage found significant cross-loading on item 6. Hence, the researchers decided to delete it to improve the factor analysis results.[30,32] The second stage factor analysis, after deleting item 6, did not find any significant cross-loading. These findings suggest that each item is only relevant to each dimension, so discriminant validity is well met.[30,32] The removal of item 6, which has low loading on both factors, indicates that this instrument needs further adjustment to improve its reliability and construct validity. Furthermore, the decision to remove item 6 was also supported by Indonesian contextual considerations. Item 6, which refers to the frequency of forgetting to bring medication when traveling far from home, may not accurately capture medication adherence behavior in the Indonesian public healthcare setting. The majority of respondents in this study were elderly (≥ 65 years old) individuals with limited travel habits and received treatment at local Puskesmas located close to their homes (≤ 5 km). As such, non-adherence due to traveling is likely rare and not a significant factor in this population's medication-taking behavior. Including such an item may introduce noise measurement rather than meaningful variance. Hence, psychometric evidence and contextual irrelevance supported the decision to exclude item 6 from the final instrument.

Although the original MCQ has been validated in prior studies, this study employed EFA rather than Confirmatory Factor Analysis (CFA) due to its focus on cultural adaptation and the need to explore how the underlying factor structure manifests in a new linguistic and cultural context.[30,32] Given the distinct characteristics of the Indonesian healthcare environment and patient population, EFA ensured that no assumptions were made regarding the data structure. Nevertheless, using CFA

would be a valuable follow-up method to confirm the structure identified in this study and recommend its use in future validation efforts.[30,32]

Convergent validity is an essential part of construct validity, measuring the extent to which indicators within a construct account for its variance through Average Variance Extracted (AVE) and Composite Reliability (CR) values.[18,32] After item 6 was removed, the CR value continued to meet the recommended minimum standard (CR ≥ 0.70), while the AVE value increased, although it remained below the minimum threshold (AVE ≥ 0.5) (Table 4). Despite the AVE not reaching the minimum requirement, this outcome is acceptable if the CR value is ≥ 0.70.[30–32] This indicates that the MCQ-I meets the minimum standards for convergent validity. Additionally, the CR value is used to assess the reliability of the MCQ-I in providing consistent results over time. A CR value of ≥ 0.70 indicates that the research instrument can be depended upon to yield stable and consistent results.[30–32] Reliability was further evaluated using Cronbach's Alpha, which produced moderate results ($0.50 < \alpha \leq 0.70$) after item 6 was removed. Both reliability assessments suggest that the MCQ-I construct demonstrates good internal consistency, with its indicators consistently measuring the same construct.[10,35]

The MCQ-I identifies two dimensions of medication adherence through various indicators. The first dimension includes practical aspects and patient readiness to comply with treatment, as indicated by Perceived Health Status (Item 3), Dose Reduction (Item 4), and Medication Supply Management (Item 7). The second dimension focuses on patient perceptions related to treatment, identified through indicators of Forgetfulness (Item 1), Intentional non-adherence (Item 2), and the severity of side effects (Item 5) (Table 4). These two dimensions support previous research indicating that medication adherence is multi-dimensional and can vary within populations.[11] Together, these dimensions can be used to identify medication adherence in T2DM patients and reduce the economic burden of diabetes in Indonesia.[6–8] The MCQ-I can be used as a routine evaluation tool in primary healthcare facilities to identify medication non-adherence in T2DM patients. The MCQ-I enables health workers to design more focused and effective interventions by covering practical and patient perception dimensions. Furthermore, the Indonesian version of the MCQ can serve as a model for adapting similar instruments in other countries with similar sociodemographic characteristics.

This study's relatively large sample size is a key strength, as demonstrated by the favorable results from the KMO, Bartlett's Test, and MSA tests, which indicate sufficient values to support the factor structure.[40] This substantial sample size enhances the stability of the statistical tests. It allows for identifying hidden variables, as evidenced by the cross-loading evaluation that reveals the emergence of two dimensions within the MCQ-I construct.[19] Additionally, the comprehensive methodology for cross-cultural adaptation and several validity criteria yield in-depth results that can serve as a reference for similar instrument adaptation research. To our knowledge, this study represents the first validation of the MCQ in diabetic patients in Indonesia, achieving validity and reliability that meet scientific standards.

One limitation of this study is the lack of a test-retest reliability assessment, which is crucial for evaluating the temporal stability of the MCQ-I. Test-retest reliability ideally involves administering the same test to the same participants at two different points and correlating the scores to determine consistency.[22,41,42] However, logistical challenges, such as coordinating participant availability for a second assessment and difficulties in follow-up due to unpredictable patient return rates at healthcare facilities, pose significant challenges.[22] These factors limited our ability to re-administer the MCQ-I within the necessary timeframe to assess test-retest reliability accurately. Future research should consider using a longitudinal design or a repeated-measures approach to evaluate the stability of MCQ-I scores over time and confirm their reliability at different measurement points.

In addition, the generalizability of the MCQ-I results may be limited by the specific characteristics of the study population. Most respondents were elderly individuals, had relatively low levels of formal education, and resided near public primary health centers. These characteristics may not represent all patients with type 2 diabetes in Indonesia, particularly those receiving care in private settings or urban tertiary hospitals. Therefore, future research should explore using MCQ-I in more diverse populations to assess its applicability across different demographic and healthcare settings. With further adjustments, the Indonesian version of the MCQ could become a reliable measurement instrument to support global health research, especially within the context of Indonesian culture.

CONCLUSIONS

The final six-item Indonesian version of the MCQ demonstrates strong content and construct validity, and satisfactory internal consistency. The two-factor structure effectively captures practical adherence and patient perception. This adapted instrument can be considered reliable for evaluating medication adherence among Indonesian patients with type 2 diabetes mellitus and has potential utility in clinical and public health research settings.

CONFLICT OF INTEREST

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