Received: 17 July 2017 | Revised: 29 August 2017 | Accepted: 3 September 2017

DOI: 10.1111/jch.13137

ORIGINAL PAPER

WILEY

Developing an adherence in hypertension questionnaire short version: MUAH-16

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The Maastricht Utrecht Adherence in Hypertension (MUAH) questionnaire provides clinicians with information about the causes of a patient's poor adherence to antihypertensive drugs. In this study, the authors aimed to develop and validate a short version of the MUAH questionnaire. After an exploratory factor analysis, the number of MUAH items was reduced. The original MUAH questionnaire (model 1) was compared with the 16-item MUAH short version (model 2). Next, this short version of MUAH (MUAH-16) with all factors correlated (model 2a) was compared with the short version of MUAH with four subscales that contribute to a global factor of adherence (model 2b). Model 1 had a poor fit to the data ($\chi^2$269 = 663.41, P < .001, comparative fit index = 0.695, root mean square error of approximation = 0.06), and model 2 had a very good fit to the data ($\chi^2$100 = 171.07, P < .001, comparative fit index = 0.92, root mean square error of approximation = 0.04). When comparing model 2a with model 2b, the chi-square difference of the model ($\Delta\chi^2$2 = 4.06; P = .067) revealed that the fits of both models were not significantly different. These findings suggest that MUAH-16 better represents a patient's adherence to antihypertensive medication than the original MUAH questionnaire.

1 | INTRODUCTION

Medication adherence is one of the factors most responsible for therapeutic success in cases of hypertension.[1–3] Researchers have come to prioritize classifying patients as nonadherent and to develop and implement strategies for improving adherence and blood pressure control.

In the past decade, several interventions have been performed to enhance a patient's adherence to antihypertensive medication with ambiguous results. Schroeder and colleagues[4] systematically reviewed some motivational strategies and complex interventions, which, while promising, still lack sufficient evidence. In a systematic review by Haynes and colleagues,[5] the effects of simple interventions were inconsistent from study to study, with fewer than half of the studies showing benefits. Similar conclusions were obtained by Nieuwlaat and colleagues,[6] who critiqued the current methods of improving medication adherence for chronic health problems as being mostly complex and not very effective, thus thwarting the full benefits of treatment.

This lack of evidence may be attributable to the absence of individually tailored interventions. Adherence is a complex concept that includes several dimensions, such as patient-related factors, social/economic factors, health system factors, therapy-related factors, and condition-related factors.[7] Currently, a patient is simply classified as adherent or nonadherent to a drug therapy; however, if the reasons for their nonadherence were better understood, intervention design to improve adherence could be more targeted, more optimized, and thus more successful.

Among the several self-report instruments designed to assess adherence to medication, the Maastricht Utrecht Adherence in Hypertension (MUAH) questionnaire[8] provides valuable information about the reasons for a patient's poor adherence. The MUAH,

developed in 2006, is a patient-oriented questionnaire that addresses cognitive and behavioral factors to assess adherence problems in patients taking antihypertensive drugs. MUAH measures four adherence-related dimensions: positive attitude toward health care and medication, lack of discipline, aversion toward medication, and active coping with health problems. Prior studies have found a good internal consistency for each scale (Cronbach α: 0.75, 0.80, 0.63, and 0.76, respectively).

However, probably because of the comparison of different adherence assessment methods and the difficulties in methodologically implementing them, data on convergent validity is difficult to interpret, with results falling below expectations. Primarily, these findings have not yielded significant associations between the sum scores of the four MUAH scales and electronic monitoring or pharmacy records. In addition, the MUAH contains a large number of items, making its use difficult in clinical practice. Furthermore, the MUAH does not have a global score, disabling a patient's adherence classification. The creation of a shorter version of MUAH, with the same adherence dimensions but also the ability to obtain an overall score, would classify the causes of nonadherence and the level of adherence, thus improving its applicability.

The objectives of this study were to develop a short version of the MUAH questionnaire and compare its construct validity and factorial structure with a confirmatory factor analysis, as well as estimate its convergent validity.

2 | METHODS

This cross-sectional study was approved by the ethics committee of the Faculty of Medicine at the University of Coimbra (registration number: CE_105.2013). Study aims and procedures were explained to all potentially eligible patients. Study inclusion was validated for each patient after receiving their written informed consent.

2.1 | Data collection

Questionnaires were administered between March 2014 and September 2015 in a convenience sample of seven community pharmacies located in the central region of Portugal.

Patients were invited to participate in this study if they met the following criteria: attended one of the participating pharmacies, were older than 18 years, and were currently taking at least one antihypertensive drug. For qualified participants, data on personal and family history were collected and 8-item Morisky Medication Adherence Scale (MMAS-8) and Measure of Treatment Adherence (MAT) instruments were administered.

2.2 | MUAH questionnaire

The MUAH[8] is a 25-item questionnaire scaled according to a seven-point Likert scale ranging from "totally disagree" (1 point) to "totally agree" (7 points). The questions are grouped into four factors: factor I, positive attitude toward health care and medication; factor II, lack of discipline; factor III, aversion toward medication; and factor IV, active coping with health problems.

After obtaining permission from the authors, the MUAH was translated and back-translated to Portuguese, according to international guidelines.[9,10]

2.3 | The MMAS-8 test

The MMAS-8[11] consists of seven dichotomous items scored on a five-point Likert scale. Questions were formulated to avoid a "yes-saying" or acquiescence bias. The last question is necessary to standardize the code (0–4), and the score is obtained by dividing by four. Patients are classified according to the score obtained as low adherent (score <6), medium adherent (score 6 to <8), and high adherent (score=8).

2.4 | The MAT test

The MAT[12] is a Portuguese instrument that consists of seven items scaled according to a six-point Likert scale, ranging from "always" (1 point) to "never" (6 points). The level of adherence is obtained by adding the values of each item and then dividing by the total number of items. Higher scores indicate a greater level of adherence. The classification of patients as adherent or nonadherent is made according to scores near the median values.

2.5 | Statistical analysis

Data were analyzed using IBM SPSS version 20.0 and IBM AMOS version 20.0. Missing values were low (<2%) and replaced by the mean of the score of the item factor of each patient.

The development of the short version of the MUAH was based on statistical and theoretical decisions. The conceptual organization of the MUAH, consisting of four factors, was maintained. The reduction of the items was based on eliminating items with a weaker influence on each factor. Therefore, we examined the factor loadings of each item in its subscale by conducting an exploratory factor analysis for each subscale and extracting just one factor. These analyses and the theoretical importance of each item substantiated the decision regarding which items were kept in MUAH-16.

Next, the original version of the MUAH (model 1) was compared with the MUAH-16 (model 2) using the confirmatory factor analysis procedure. Finally, the MUAH-16 with all factors correlated (model 2a) was compared with the MUAH-16 with four subscales that contribute to a higher order factor, a global factor of adherence (model 2b) (Figure).

Convergent validity was assessed by evaluating the association between the MUAH-16 global score and MMAS-8 and MAT, two other adherence measures.

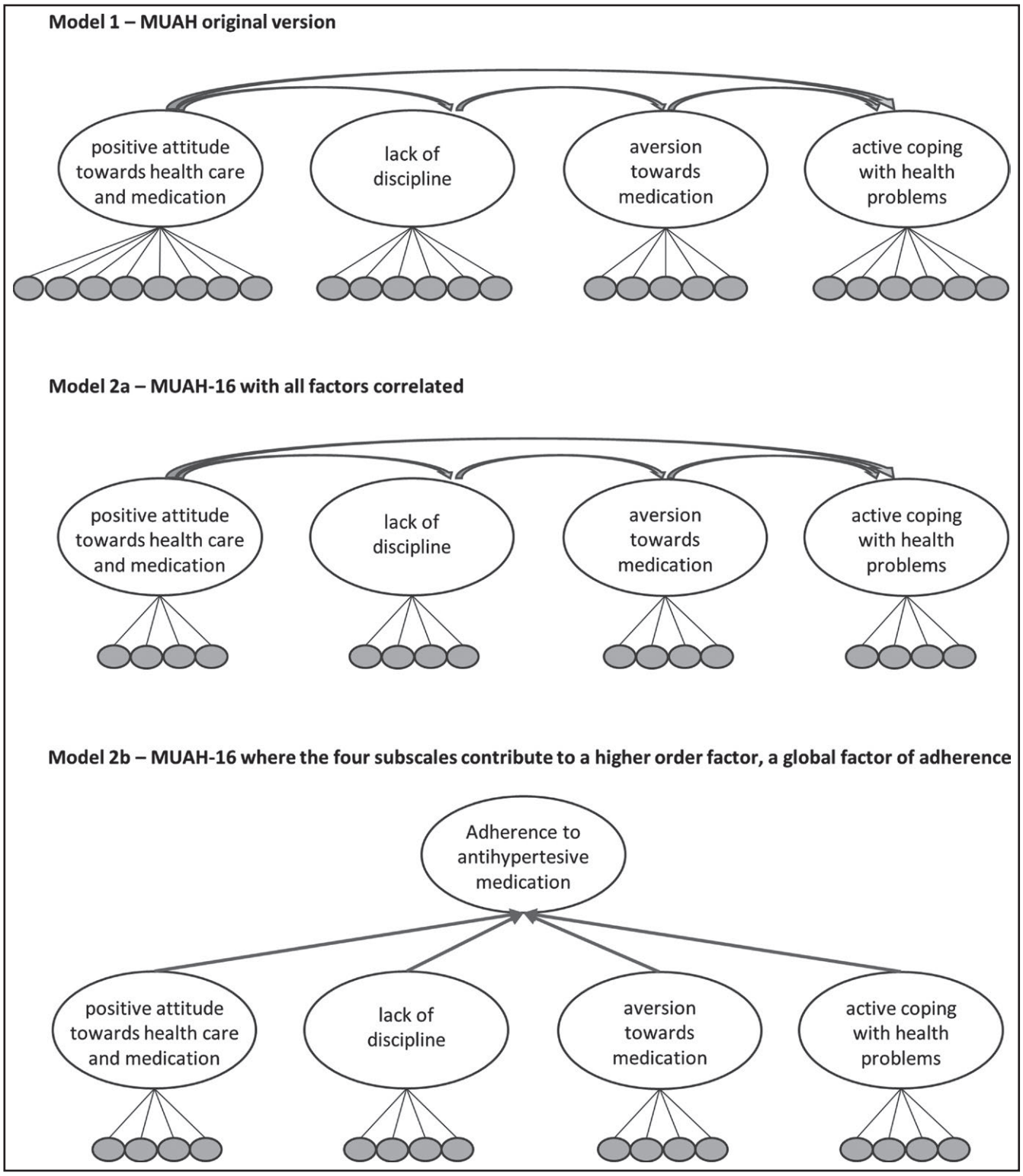

FIGURE Maastricht Utrecht Adherence in Hypertension (MUAH) models tested with confirmatory factor analysis procedure

3 | RESULTS

A sample of 423 patients participated in this study, with a mean age of 68.16±10.53 years and 225 (53.2%) women.

3.1 | Development of the MUAH-16

To develop the MUAH-16, we examined the loadings of all items in each subscale. These results are reported in Table 1.

TABLE 1 Factor loadings of original version of the Maastricht Utrecht Adherence in Hypertension questionnaire

Item	Factor loadings			
	1	2	3	4
Subscale 1: positive attitude towards health care and medication				
3_I feel better taking medication every day	0.42	–	–	–
5_If I take my medication every day, I feel confident that my blood pressure is under control	0.59	–	–	–
7_The pros of taking medication weigh up against the cons	0.50	–	–	–
32_The information that my general practitioner gave me about taking my medication was satisfactory	0.24	–	–	–
33_The information the pharmacy gave me about taking my medication was satisfactory	0.17	–	–	–
34_I do not worry too much about my blood pressure if I take my medication every day	0.19	–	–	–
35_I think I contribute to the improvement of my blood pressure when I take my medication every day	0.43	–	–	–
43_When I worry too much about my health, I will try to find something to take my mind off it	0.03	–	–	–
Subscale 2: lack of discipline				
18_I have persons in my surroundings that help me to take my medication	–	−0.33	–	–
23_It happens that I am not sure whether I have taken my tablets	–	0.26	–	–
24_I have a busy life; that is why I sometimes forget to take my medication	–	0.44	–	–
25_I tend to forget my medication because I am not aware of having a high blood pressure	–	−0.59	–	–
26_During holidays or weekends I sometimes forget to take my medication	–	0.29	–	–
36_I find it hard to stick to my daily regimen of medication taking	–	0.45	–	–
Subscale 3: aversion towards medication				
9_When my blood pressure is under control during my medical checkups, I want to take less medication	–	–	0.69	–
11_I prefer homeopathic medication to lower my blood pressure	–	–	0.59	–
13_I dislike taking medication every day	–	–	0.49	–
14_I am afraid of side effects	–	–	0.35	–
16_I think it is not healthy for your body to take medication every day	–	–	−0.28	–
Subscale 4: active coping with health problems				
20_I take special care to do enough exercise to reduce the risk of getting cardiovascular diseases	–	–	–	0.86
21_I eat less fat in order to avoid cardiovascular diseases	–	–	–	0.85
22_I eat less salt in order to avoid cardiovascular diseases	–	–	–	0.23
37_When I intend to live a healthy life, I almost always succeed on doing this	–	–	–	0.16
39_I gather information about possibilities to solve health problems	–	–	–	0.12
40_I am goal-oriented when solving health problems	–	–	–	0.08

The four items that had higher loadings in their respective subscale were maintained. For the subscale I (positive attitude toward health care and medication), four factors clearly had a better contribution to the subscale (items 3, 5, 7, and 35). All items had loadings higher than 0.20. For the subscale II (lack of discipline), all items had adequate loadings. However, to increase consistency between the items, we chose to maintain the items that contributed to the subscale in the same direction (items 23, 24, 26, and 36).

For the subscale III, (aversion toward medication), the same criteria was followed, ie, we retained the items that influenced the final subscale score in the same direction (items 9, 13, 14, and 16). Finally, for the subscale IV (active coping with health problems), the four items with the highest loadings were retained (items 20, 21, 22, and 39). Item 39 had a loading below the recommended cutoff (0.16), but, after examining its content, we decided that the item was an important item for its subscale and kept it in the MUAH-16.

The final version of the MUAH had 16 items, divided by four subscales, with two of them (subscales I and IV) assessing positive factors toward adherence to hypertensive medication and two of the them (subscales II and III) assessing negative factors toward adherence. As such, the theoretical structure of the questionnaire was maintained similarly to the original version. The factor loadings of the MUAH-16 are reported in Table 2.

3.2 | Original MUAH vs MUAH-16

We compared the original version of the MUAH with the MUAH-16 using confirmatory factor analysis. The original version of the MUAH was identified as model 1 and MUAH-16 as model 2.

Model 1 had a poor fit to the data ($\chi^2 269 = 663.41$, $P < .001$, comparative fit index = 0.695, root mean square error of approximation = 0.06). Model 2 had a very good fit to the data ($\chi^2 100 =$

TABLE 2 Factor loadings of Maastricht Utrecht Adherence in Hypertension short version (MUAH-16)

Item	Factor loadings			
	1	2	3	4
Subscale 1: positive attitude towards health care and medication				
3_I feel better taking medication every day	0.39	–	–	–
5_If I take my medication every day, I feel confident that my blood pressure is under control	0.51	–	–	–
7_The pros of taking medication weigh up against the cons	0.59	–	–	–
35_I think I contribute to the improvement of my blood pressure when I take my medication every day	0.42	–	–	–
Subscale 2: lack of discipline				
23_It happens that I am not sure whether I have taken my tablets	–	0.31	–	–
24_I have a busy life; that is why I sometimes forget to take my medication	–	0.47	–	–
26_During holidays or weekends I sometimes forget to take my medication	–	0.20	–	–
36_I find it hard to stick to my daily regimen of medication taking	–	0.47	–	–
Subscale 3: aversion towards medication				
9_When my blood pressure is under control during my medical checkups, I want to take less medication	–	–	0.39	–
13_I dislike taking medication every day	–	–	0.67	–
14_I am afraid of side effects	–	–	0.47	–
16_I think it is not healthy for your body to take medication every day	–	–	0.61	–
Subscale 4: active coping with health problems				
20_I take special care to do enough exercise to reduce the risk of getting cardiovascular diseases	–	–	–	0.22
21_I eat less fat in order to avoid cardiovascular diseases	–	–	–	0.82
22_I eat less salt in order to avoid cardiovascular diseases	–	–	–	0.89
39_I gather information about possibilities to solve health problems	–	–	–	0.15

171.07, *P*<.001, comparative fit index=0.92, root mean square error of approximation = 0.04). The comparison of the chi-square of both models ($\Delta\chi^2$169=492.34; *P*<.001) revealed that model 1 and model 2 were significantly different, with model 2 reporting a better fit to the data.

3.3 | Model fit for the MUAH-16

Considering the importance of a global score of adherence, we compared the fit of the model of the MUAH-16 with all factors correlated (model 2a) to the MUAH-16 with a higher order factor, a global score of adherence, accounted for the variance of the four subscales (model 2b) (Figure). A chi-square difference of the model ($\Delta\chi^2$2 = 4.06; *P* = .067) revealed that the fit of both models were not significantly

TABLE 3 Comparison of the model fit for the MUAH-16 with correlated factors (model 2a) and with MUAH-16 with a higher order factor (model 2b)

	Model 2a	Model 2b
χ^2	167.01	171.07
Degrees of freedom	98 *P* < .001	100 *P* < .001
CFI	92	92
RMSEA (CI)	0.41 (0.30-0.51)	0.41 (0.30-0.51)
SRMR	0.05	0.05

Abbreviations: CFI, comparative fit index; CI, confidence interval; MUAH-16, Maastricht Utrecht Adherence in Hypertension short version; RMSEA, root mean square error of approximation; SRMR, standardized root mean squared residual.

TABLE 4 Correlation between MUAH-16 and MMAS-8 and MAT

	MMAS-8	MAT
Subscale 1: positive attitude towards health care and medication	0.28*	0.23*
Subscale 2: lack of discipline	0.44*	0.40*
Subscale 3: aversion towards medication	0.32*	0.32*
Subscale 4: active coping with health problems	0.12	0.10
Global MUAH-16 score	0.45*	0.41*

Abbreviations: MAT, Measure of Treatment Adherence; MMAS-8, 8-item Morisky Medication Adherence Scale; MUAH-16, Maastricht Utrecht Adherence in Hypertension short version.
*P < .001, and all other values P<.05.

different. All other fit indices were also equivalent (Table 3). Therefore, both models were found to have a good fit to the data.

3.4 | Internal consistency

Internal consistency measured by Cronbach α for all items of a global scale was 0.64, and the item total correlation coefficient for the 16 items ranged from 0.08 to 0.39.

Considering the four subscales, Cronbach α was 0.53, 0.36, 0.59, and 0.51 for subscales I, II, III, and IV, respectively.

3.5 | Convergent validity

The global mean score of MUAH-16 was 5.49±0.82. Regarding other adherence questionnaires administered, the mean MMAS-8 score was 6.36±1.61 and the mean MAT score was 5.74±0.33.

Convergent validity was estimated by correlating both the global score and the four subscales of MUAH-16 with MMAS-8 and MAT. Both the global score and all of the subscales of MUAH-16 correlated positively and significantly with the MMAS-8 and MAT scores (Table 4).

4 | DISCUSSION

After performing an exploratory factor analysis together with theoretical decisions, we obtained a short version of MUAH with 16 items that maintained the original conceptual organization in four subscales. Reducing the length of this questionnaire may facilitate its use in clinical practice. Although several instruments for assessing self-reported medication adherence exist, the original MUAH and its short version, the MUAH-16, also allow clinicians to identify the causes of nonadherence.

5 | STUDY STRENGTHS AND LIMITATIONS

The MUAH-16 presents a lower internal consistency than the original version[8] (Cronbach α for MUAH-16 subscales I, II, III, and IV: 0.53, 0.36, 0.59, and 0.51, respectively; Cronbach α for MUAH subscales I, II, III, and IV: 0.75, 0.80, 0.63, and 0.76, respectively). This limitation was expected as a result of the reduction of the number of items for each subscale. Another limitation of this analysis was the impact of test length on the Cronbach α value.[13–15] In shorter scales, measures of unidimensionality, as factor analysis, are equally important to Cronbach α for homogeneity assessment of the instrument. Indeed, internal consistency is a necessary but insufficient condition for measuring homogeneity in a sample of test items.[13] Thus, by reducing the number of items in each subscale to four, a reduction in α values was expected. Nevertheless, the evaluation of confirmatory factor analysis for both models shows that MUAH-16 is a better fit than the original. This finding suggests that MUAH-16 better represents each adherence dimension.

The original version of MUAH does not provide a global score. Higher scores obtained in each subscale indicate higher positive attitudes toward health care and medication, stronger discipline, lower aversion toward medication, and more active coping with health problems.[8] The authors found correlations between adherence and subscale II (lack of discipline) and between adherence and subscale I (positive attitude toward health care and medication). Thus, a higher score in subscale II suggests a higher probability of a patient being poorly adherent. Alternately, patients with a higher score on subscale I had a significantly lower probability of being poorly adherent. To obtain a global score of adherence, we hypothesized a model in which subscales I and IV contribute positively to adherence (eg, "I feel better taking medication every day"), and subscales II and III are negatively associated with adherence (eg, "I find it hard to stick to my daily regimen of medication taking"). Thus, in the statistical analysis, the score obtained in subscales II and III was reversed (items 9, 13, 14, 16, 23, 24, 26, and 36 were reverse scored: "totally disagree," 7 points; "totally agree," 1 point). After comparing the fit of the model of MUAH-16 with all factors correlated to the fit of the model of MUAH-16 with a global score of adherence, the chi-square difference of the model revealed that the fit of both models were not significantly different and that all other fit indices were also equivalent. Thus, both models have a good fit to the data, suggesting MUAH-16 successfully assesses a patient's adherence.

This fact was also supported by convergent validity analysis, in which MUAH-16 global score of adherence was correlated with MMAS-8 and MAT, two other adherence instruments.

The convenience sample of seven pharmacies hampered any inference from the descriptive data. Because we used this convenience sample only to assess the psychometric characteristics of the MUAH-16, any generalization is not appropriate.

6 | CONCLUSIONS

The MUAH-16 measures adherence-related dimensions and global adherence to antihypertensive medication. This measure can be easily applied in a clinical setting, giving health professionals more extended information about the patient's reasons for poor adherence and

allowing the development of more targeted interventions to improve adherence to antihypertensive medication.

ACKNOWLEDGMENTS

The authors would like to acknowledge the contribution of Mariana Moura-Ramos for all the statistical analyses of this study. The authors wish to thank Donald E. Morisky, who gave the permission for use of the MMAS-8 for this study. The use of the MMAS© is protected by US copyright laws. Permission for use is required. A license agreement is available from Donald E. Morisky, ScD, ScM, MSPH, Professor, Department of Community Health Sciences, UCLA School of Public Health, 650 Charles E. Young Drive South, Los Angeles, CA 90095-1772; all translations of the MMAS-8 are copyrighted intellectual property and must be obtained from the developer/owner.

CONFLICT OF INTEREST

There are no conflicts of interest to disclose.

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REFERENCES

1. DiMatteo MR, Giordani PJ, Lepper HS, Croghan TW. Patient adherence and medical treatment outcomes: a meta-analysis. *Med Care*. 2002;40:794-811.
2. Holland N, Segraves D, Nnadi VO, Belletti DA, Wogen J, Arcona S. Identifying barriers to hypertension care: implications for quality improvement initiatives. *Dis Manag*. 2008;11:71-77.
3. World Health Organization. A global brief on hypertension–silent killer, global public health crisis. Geneva, Switzerland; WHO: 2013.
4. Schroeder K, Fahey T, Ebrahim S. Interventions for improving adherence to treatment in patients with high blood pressure in ambulatory settings. *Cochrane Database Syst Rev*. 20042;CD004804.
5. Haynes RB, Ackloo E, Sahota N, McDonald HP, Yao X. Interventions for enhancing medication adherence. *Cochrane Database Syst Rev*. 2008;(2):CD000011.
6. Nieuwlaat R, Wilczynski N, Navarro T, et al. Interventions for enhancing medication adherence. *Cochrane Database Syst Rev*. 2014;11:CD000011.
7. Horne R, Berber N, Elliott R, Myfanwy M. *Concordance, adherence and compliance in medicine taking: a conceptual map and research priorities*. National Institute for Health Research Service Delivery and Organisation R&D; 2006.
8. Wetzels G, Nelemans P, van Wijk B, et al. Determinants of poor adherence in hypertensive patients: development and validation of the "Maastricht Utrecht Adherence in Hypertension (MUAH)-questionnaire." *Patient Educ Couns*. 2006;64:151-158.
9. Guillemin F, Bombardier C, Beaton D. Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines. *J Clin Epidemiol*. 1993;46:1417-1432.
10. Wild D, Grove A, Martin M, et al. Principles of good practice for the translation and cultural adaptation process for patient-reported outcomes (PRO) measures: report of the ISPOR task force for translation and cultural adaptation. *Value Health*. 2005;8:94-104.
11. Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting. *J Clin Hypertens (Greenwich)*. 2008;10:348-354.
12. Delgado A, Lima ML. Contributo para a validação concorrente de uma medida de adesão aos tratamentos. *Psicologia, Saúde & Doenças*. 2001;2:81-100.
13. Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ*. 2011;2:53-55.
14. Schmith N. Uses and abuses of coefficient alpha. *Psychol Assess*. 1996;8:350-353.
15. Dunn TJ, Baguley T, Brunsden V. From alpha to omega: a practical solution to the pervasive problem of internal consistency estimation. *Br J Psychol*. 2014;105:399-412.

How to cite this article: Cabral AC, Castel-Branco M, Caramona M, Fernandez-Llimos F, Figueiredo IV. Developing an adherence in hypertension questionnaire short version: MUAH-16. *J Clin Hypertens*. 2018;20:118–124. https://doi.org/10.1111/jch.13137