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Validity and reliability of a short self-efficacy instrument for hypertension treatment adherence among adults with uncontrolled hypertension

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ABSTRACT

Objective: To establish the reliability and validity of a self-report measure designed to assess self-efficacy for hypertension treatment adherence.
Methods: This investigation was embedded within a six-month randomized clinical trial (RCT), which demonstrated that a tailored, stage-matched intervention was more effective at improving hypertension control than usual care among individuals (n = 533) with repeated uncontrolled hypertension. The instrument used to assess self-efficacy for hypertension treatment adherence (SE-HTA) comprised three subscales that assessed diet self-efficacy (DSE), exercise self-efficacy (ESE), and medication self-efficacy (MSE). To determine SE-HTA validity and reliability, we assessed internal consistency using Cronbach's α coefficients, conducted exploratory factor analysis, and evaluated convergent and discriminant validity, as well as test-retest reliability using Spearman's ρ correlation coefficients.
Results: Cronbach's α (internal consistency) values for DSE, ESE, and MSE were 0.81, 0.82 and 0.74. Factor analysis and the scree plot demonstrated three distinct factors, which correspond to the three subscales contained in the SE-HTA instrument. SE-HTA possessed good convergent and discriminant validity, and moderate test-retest reliability.
Conclusion: The SE-HTA instrument containing diet, exercise, and medication adherence subscales is valid and reliable in adults with uncontrolled hypertension.
Practice implications: This SE-HTA instrument measures self-efficacy and could help facilitate behavior change in hypertension.

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1. Introduction

Of the approximately 75 million American adults (29%) with hypertension, approximately half (48.3%) have controlled blood pressure (BP) [1]. Left untreated, uncontrolled BP leads to heart failure, stroke, myocardial infarction and other serious cardiovascular complications, the most common cause of mortality in the United States [2]. Fortunately, treatment can lower BP, decrease cardiovascular disease risk, and reduce mortality [3]. Diet, exercise, and medication adherence are crucial to control hypertension and prevent cardiovascular complications [4]. Despite advances in treating hypertension, failure to adhere to recommended treatment is a significant barrier to hypertension control [5].

The concern with suboptimal treatment adherence, the high prevalence of uncontrolled hypertension, and the critical need to achieve more effective hypertension control was the basis for a randomized clinical trial (RCT) in which we evaluated the effectiveness of a telephone-delivered, Transtheoretical stage-matched intervention in Veterans with uncontrolled hypertension

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[6]. The Transtheoretical Model (TTM) describes the modification of behaviors within the context of individual decision-making, and identifies intermediate or dependent constructs that facilitate transitions through successive behavioral stages. Self-efficacy, a key TTM construct, influences this progression through the stages of change. However, even though self-efficacy has been studied extensively, a reliable, valid, and easy-to-administer instrument focusing on diet, exercise, and medication adherence to assess self-efficacy for following hypertension treatment for use with diverse participants is not available. A self-efficacy for hypertension treatment adherence instrument designed to address this need (Table 1), hereafter referred to as "SE-HTA," was evaluated. SE-HTA was designed for this hypertension study and comprised three subscales relevant to hypertension treatment: diet self-efficacy (DSE), exercise self-efficacy (ESE), and medication self-efficacy (MSE).

Self-efficacy is a well-established construct of Social Cognitive Theory, and refers to an individual's confidence that he or she can successfully engage in a specific behavior or achieve a desired goal [7]. Participant self-efficacy is a strong predictor of engagement in self-management strategies for managing chronic diseases [8–14]. Self-efficacy theory posits that an individual's belief in his or her own ability to engage in behavior change is a strong determinant of actual behavior change. Thus, quantifying participant self-efficacy is valuable for designing and assessing the effectiveness of tailored self-management programs and may be a useful predictor of other health outcomes.

While there are validated self-efficacy instruments, most are not relevant to cardiovascular disease [15–20]. Two widely used validated instruments, the MASES (Medication Adherence Self-Efficacy Scale) and the HBP SCP (High Blood Pressure Self-Care Profile), do measure self-efficacy in hypertension; however, these instruments are limited to medication self-efficacy and were validated in primarily African-American participants [10,12]. A recent meta-analysis describes nine independently validated hypertension self-efficacy instruments [21]. Unfortunately, none encompass the modifiable behaviors of diet, exercise, and medication adherence that are crucial to managing hypertension. Considering the enormous burden of hypertension, there is a pressing need for a comprehensive self-efficacy scale for hypertension treatment that specifically assesses behaviors relevant to self-management of hypertension in diverse adult populations. Thus, the objective of this study was to assess the validity and reliability of the SE-HTA instrument that was used in a RCT to control hypertension.

Table 1
The Self-Efficacy for Hypertension Treatment Adherence (SE-HTA)[a] Instrument.

Diet Self-Efficacy (DSE) Subscale

Please indicate how confident you are that you would regularly continue to follow the diet for better control of high blood pressure[b] if each of the following situations were to happen to you.

1. When I am eating with family or friends and no one but me is on a diet.
2. When I am traveling or on vacation.
3. When I am in a rush/hurry.
4. When I am under a lot of stress.
5. When I don't have easy access to healthy foods.
6. When the risk of going off my diet seems low to me.

Exercise Self-Efficacy (ESE) Subscale

Please indicate how confident you are that you will continue to exercise[c] if each of the following situations were to happen to you.

1. When I am under a lot of stress.
2. When I feel I don't have the time.
3. When I have to exercise alone.
4. When I don't have access to exercise equipment.
5. When I am spending time with friends or family who do not exercise.
6. When it's raining or snowing.

Medication Self-Efficacy (MSE) Subscale

Please indicate how confident you are that you will continue to take your medications as prescribed[d] if each of the following situations were to happen to you.

1. When I am under a lot of stress.
2. When I feel I don't have the time.
3. When I don't have easy access to the medications (i.e. living far from a pharmacy or not having pills with you when you need them.
4. When the risk of not taking medication seems low to me.
5. When my family or friends don't encourage me to take my medication.

[a] Participants respond on a five-point Likert scale, ranging from "1 = Not Confident at All" to "5 = Completely Confident".

[b] The dietary goal was the DASH diet pattern, which we operationalized as following the DASH diet for six or seven days per week (>80% adherence). To follow the DASH diet typically means decreasing sodium intake and increasing the intake of nutrient rich foods, such as those that contain potassium, and increasing the amount of fiber and protein in the diet. It is also important to cut back on foods that contain saturated fat and cholesterol. This diet is rich in fruits, vegetables, whole grains, and low-fat dairy foods, and must be followed according to your doctor's advice, for all meals every day.

[c] "Appropriate exercise" was defined as 20 min of moderate intensity exercise for at least three days a week.

[d] Medication adherence was defined as ≥ 80% adherence (Haynes et al., 2005) which we operationalized as taking the medication as prescribed > five days per week.

2. Methods

2.1. Study design

This evaluation was conducted within a RCT testing the effectiveness of a telephone-delivered, transtheoretical stage-matched intervention in veterans with uncontrolled hypertension [6,22]. We randomly assigned participants to one of three groups: 1) a telephone-delivered, tailored behavioral intervention, 2) a telephone-delivered, non-tailored health education intervention, and 3) the usual care standard. After a six-month intervention period, participants were followed for a six-month observation period of no intervention to assess intervention sustainability. In all three groups, we assessed systolic BP at baseline, six months, and 12 months. Other measurements included assessing adherence to the Dietary Approaches to Stop Hypertension (DASH) diet using food frequency questionnaires, aerobic exercise adherence in hours per week from the seven-day Physical Activity Recall measure, and medication adherence with the four-item Morisky Medication Adherence Questionnaire [23–25]. Stages of change for diet, exercise, and medication adherence were independently assessed using validated questions [26]. Details about each of the three SE-HTA subscale measures are contained in Table 1 and in the "Self-Efficacy Measure for Diet, Exercise, and Medication Adherence" section below.

2.2. Participants

We randomized participants to one of the three arms for six months of intervention followed by six months of observation. All participants had a follow-up assessment three months after randomization to assess transtheoretical constructs and other outcomes such as adherence to medication, diet, and exercise. Our analysis of the SE-HTA instrument utilized baseline data from the RCT and the three-month data. The study was conducted from January 2006 to September 2011 at the Veterans Affairs Medical Center clinics in Brooklyn and Manhattan. We identified patients with uncontrolled hypertension from review of electronic medical records. Research assistants approached patients during their subsequent routine clinic visit and informed them about the study. Written informed consent was obtained from interested patients who were then deemed eligible if they had uncontrolled

hypertension during formal BP assessment. Uncontrolled hypertension was defined as systolic BP ≥ 130 mm Hg or diastolic BP ≥ 80 mm Hg in patients with diabetes mellitus or chronic kidney disease, and as systolic BP ≥ 140 mm Hg or diastolic BP ≥ 90 mm Hg in all other patients (as defined by the hypertension guidelines at the time of the study) [27]. The flow of participants is shown on Fig. 1. Details are in previous study publications [6,28–30].

Potential subjects were excluded if they had a cardiovascular disease event less than six months prior; had class III or IV heart failure; had severe psychiatric illness, AIDS, tuberculosis, lupus, end-stage renal failure, or limited life expectancy of less than one year. Other exclusions included lack of telephone access, inability to follow the study protocol, recent major surgery less than three months prior to enrollment, unavailability for follow-up (such as those living temporarily in the area), or inability to provide informed consent. IRB approval was obtained prior to study initiation and all subjects provided written informed consent.

2.3. Development of self-efficacy measure

2.3.1. Theoretical framework and constructs

Our intervention is based on the Transtheoretical Model of behavioral change [22]. We reviewed the self-efficacy instruments available for research from the University of Rhode Island Cancer Prevention Research Center [31]. Since there was no readily available instrument for diet or medication adherence, we planned to develop a self-efficacy scale for measuring adherence to hypertension treatment. We first conducted a literature search and identified comparable measures for diet and medication adherence [32,33]. Since the goal of the RCT was to test the effect of the Transtheoretical Model-based intervention on BP control, and as the existing, comparable self-efficacy measures were overly lengthy, we needed to develop a shorter instrument to reduce respondent burden while preserving fidelity to the theoretical constructs. The criterion diet, exercise, and medication adherence behaviors that are needed to achieve optimal hypertension management are well known. Thus, we built on the valid and reliable self-efficacy scales that were readily available through the Transtheoretical Model measures website, particularly the exercise subscale. Using deductive methods, we used a similar structure to the exercise subscale for our diet and medication subscales by building on the domains and the associated items from the cholesterol-lowering diet scale and the hypertension medication scale [32,33].

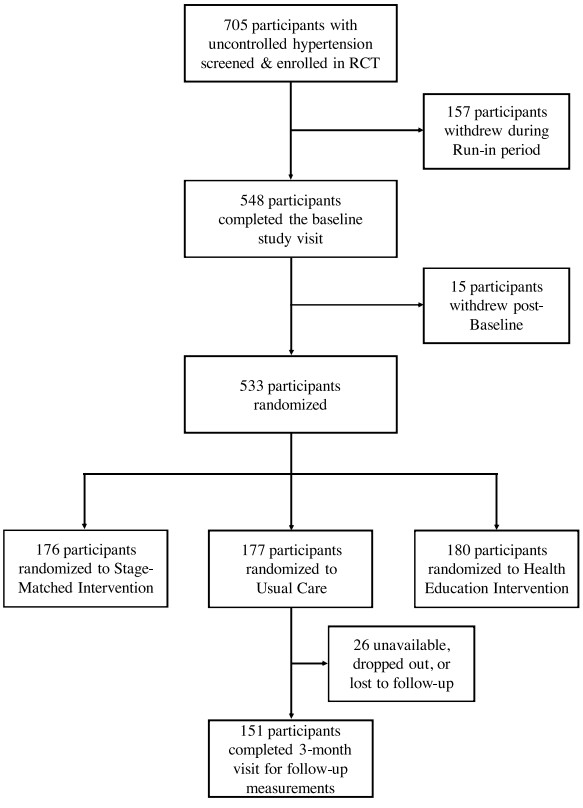

Fig. 1. Flow diagram demonstrating enrollment and participation through baseline study visit, randomization, and 3-month follow up (among Usual Care group).

2.3.2. Expert review and pilot testing the instrument

The first draft of the scale was developed and adapted by the PI, and was individually and collectively evaluated by a study team panel. This included the PI, two senior faculty behavioral science co-investigators, several physicians (a cardiologist, a geriatrician, and a primary care physician), three PhD clinical psychologists, three research coordinators and three research assistants. This panel reviewed the measures individually to ensure that each question was relevant to self-efficacy for adhering to hypertension treatment. The panel paid particular attention to the format of the items, the wording of the items, the types of responses that the question was designed to induce and whether it was relevant to hypertension management in a veteran population. The panel reached a consensus on the wording of each question within the framework of previously validated instruments. The refined instrument was then initially pilot tested among our research group for clarity, duration and face validity. Each team member provided input on the relevance of each item, and the decision to keep or eliminate items was based on the judgement of the physicians, clinical psychologists and senior behavioral scientists. The instrument was subsequently administered to the first study participants, and its performance was reviewed to confirm its relevance to their experience of managing hypertension, clarity, and production of appropriate responses.

2.3.3. Final instrument

The resulting SE-HTA instrument (Table 1) comprised three subscales that focused on relevant aspects of self-efficacy for successful hypertension management: DSE (six items), ESE (six items), and MSE (five items). Before administering the SE-HTA, research assistants defined to the participant what constituted the BP-lowering diet, exercise recommendations in hypertension and appropriate medication adherence. The dietary goal was the DASH diet [34,35], which we operationalized as following the DASH diet for > five days per week (>80% adherence). Prior to the 2008 Physical Activity Recommendations for Americans [36], the exercise goal was 20–60 min of moderate to high-intensity exercise performed ≥ three times a week [37]. Since the majority of study participants were over the age of 60 with other comorbidities in addition to hypertension; in the interest of safety, we conservatively defined “appropriate exercise” as 20 min of moderate intensity exercise for at least three days a week. Finally, we defined medication adherence as ≥ 80% adherence [38], which we operationalized as taking the medication as prescribed > five days per week. In these three subscales, each item presents a different situation that could present a challenge for adhering to one of these three health behaviors. Participants were asked to rate their confidence in maintaining their diet, exercise, or medication adherence in each situation, on a five-point Likert scale, ranging from “1 = Not Confident at All” to “5 = Completely Confident”. The total score for each subscale is therefore an assessment of each participant’s self-efficacy in the context of each respective health behavior.

2.4. Analyses

After calculating descriptive statistics, analyses were independently performed for the three subscales (diet, exercise, and medication adherence) of the SE-HTA instrument. Internal consistency was determined by calculating the Cronbach's α coefficient, wherein a value > 0.70 is considered to be internally consistent [39,40]. Test-retest reliability was assessed using the Spearman's ρ correlation coefficient using baseline and three-month data. Convergent validity for the DSE, ESE, and MSE subscales was assessed by calculating the Spearman's ρ correlation coefficient for each of the three subscales with the corresponding criterion measure. DSE was compared to the DASH score from Willett food frequency questionnaires, which consists of scores ranging from eight to 40 with higher scores corresponding to improved dietary adherence [25]. ESE was compared to aerobic exercise measured in hours per week from the Sallis seven-day physical activity recall, which specifically assesses hours per week of moderate aerobic exercise [24]. MSE was compared to medication adherence determined from the four-item Morisky Scale, which consists of scores ranging from zero to four with higher scores representing greater medication adherence [26]. Discriminant validity was examined using psychosocial support for diet (encouragement) or psychosocial support for exercise participation measures [41]. These measures are 6-item and 12-item instruments that assess varying levels of support for diet encouragement and exercise participation respectively. We chose Spearman's ρ coefficient rather than Pearson's r coefficient because it is more conservative and requires fewer assumptions. Factor Analysis was performed on all 17 items of the SE-HTA instrument using baseline data and examined using a Cattell Scree Plot. All analyses were conducted with SAS 9.4 (SAS Institute Inc., Cary, North Carolina).

3. Results

Our analysis utilized baseline data measurements (n = 533) as well as data from the three-month follow-up in the usual care group (Fig. 1). Study participants were primarily unemployed and unmarried older men; approximately equal numbers were white or black (Table 2).

The DSE and ESE subscales included six items each (maximum score 30), while the MSE subscale included five items (maximum score 25). The mean (standard deviation) for the DSE subscale was 18.41 (4.94), for ESE 20.09 (5.27), and for MSE 19.85 (3.49). The median (lower quartile, upper quartile) for the DSE subscale was 18 (15,21), ESE 20 (16,24), and MSE 20 (18,22). In general, MSE scores were relatively high with the greatest consistency, while DSE and ESE scores were lower with greater variability relative to MSE.

3.1. Internal consistency

Internal consistency was determined by calculating Cronbach's α coefficients using baseline data. The three subscales (DSE, ESE, and MSE) each measure self-efficacy of a different factor influencing hypertension control and were examined independently. Internal consistency for the three subscales varied slightly. The six-item DSE scale demonstrated good internal consistency (Cronbach α = 0.81). Similarly, the six-item ESE scale also demonstrated good internal consistency (Cronbach α = 0.82). The five-item MSE scale demonstrated slightly lower but acceptable internal consistency (Cronbach α = 0.74).

3.2. Test-retest reliability

Self-efficacy is a psychological construct that varies over time and not permanently static [42]. This can result in variation in measurements over time, which may affect test-retest reliability. Furthermore, test-retest reliability is highly dependent on the length of time between assessments. In this RCT, participants returned for a short three-month visit to capture medication adherence and to assess behavioral constructs. While this is longer than ideal for test-retest, which is typically about two weeks [43], we took this practical opportunity to examine test-retest reliability at three months. Test-retest reliability was assessed using a Spearman's ρ correlation coefficient in participants from the usual care arm (n = 177 at baseline, n = 151 at three months, 14.7% attrition) since the other two arms received interventions that may have increased self-efficacy. Test-retest reliability was 0.58 ($p < 0.0001$) for DSE, 0.57 ($p < 0.0001$) for ESE and 0.49 ($p < 0.0001$) for MSE assessed from the 151 participants with both baseline and three-month assessments.

3.3. Convergent validity

Construct validity quantifies the extent to which inferences can be made from the study. To determine construct validity, convergent validity was first examined. A Spearman's ρ coefficient was calculated for each of the three SE-HTA scales to examine convergent validity. Baseline measurements for each respective self-efficacy scale were correlated to the relevant criterion measure (Table 3). DSE was compared to the DASH score, from Willett food frequency questionnaires, for a Spearman coefficient of 0.17 ($p = 0.0004$). ESE was compared to aerobic exercise in hours per week, from the Sallis seven-day physical activity recall, for a Spearman coefficient of 0.27 ($p < 0.0001$). MSE was compared to medication adherence, from the four-item Morisky Scale, for a Spearman coefficient of 0.24 ($p < 0.0001$).

3.4. Discriminant validity

Discriminant Validity contributes to construct validity by demonstrating lack of correlation between self-efficacy and unrelated measures. Baseline measurements for each of the three self-efficacy subscales were compared to psychosocial support for diet (encouragement) or psychosocial support for exercise participation measures, and Spearman's ρ coefficient for each of the three subscales was calculated (Table 3). Psychosocial support for diet encouragement was compared to DSE, ESE, and MSE for Spearman coefficients of −0.065 ($p = 0.13$), −0.051 ($p = 0.23$), and −0.047 ($p = 0.28$) respectively. Psychosocial support for exercise participation was compared to DSE, ESE, and MSE for Spearman coefficients of 0.059 ($p = 0.18$), 0.07 ($p = 0.11$), and 0.001 ($p = 0.97$) respectively.

3.5. Exploratory factor analysis

Common factor analysis was performed by using the oblique rotation and the squared multiple correlation as estimating communalities from the baseline data. We used all 17 items from the instrument for the factor analysis. We extracted three factors based on the scree plot (Fig. 2), which demonstrated a natural bend at four factors within the structure. Furthermore, total variance that was explained along with eigenvalues verified the structure to contain three factors. Total variance explained by factors I, II, and III were 76.3%, 18.9%, and 12.6%, respectively. Eigenvalues were 4.9, 1.2, and 0.8, respectively. The presence of these three distinct factors suggests that the SE-HTA instrument examines three different constructs, i.e. the three different subscales. The factor loadings (Table 4) corresponded to the conceptualized three-construct design of the SE-HTA instrument. The first factor

Table 2
Characteristics of Participants from the Hypertension Control Trial (n = 533).

Characteristic	Percent	Mean (SD)	Median	Lower Quartile	Upper Quartile
Age, years		66.1 (0.46)	64.6	59.0	74.9
Men	98.7				
Race					
White (non-Hispanic)	39.8				
Black	39.8				
Hispanic origin (any race)	15.2				
Other	5.3				
Married	36.9				
High School Graduate or below	46.5				
Employed	20.6				
Manhattan Campus	54.2				
Comorbidities					
Diabetes	44.1				
IHD (heart attack)	12.8				
Revascularization	16.2				
Hyperlipidemia	24.1				
EGFR		81.3 (1.58)	79.0	61.0	94.0
Hypertension control	42.6				
Systolic BP, mmHg		136.7 (0.67)	135.7	126.3	146.7
Diastolic BP, mmHg		75.52 (0.50)	75.7	67.3	83.83
Aerobic exercise in hours/week		4.9 (0.29)	2.8	1.0	6.25
DASH score		23.8 (0.25)	24.0	20.0	27.0
Medication Adherence by Morisky scale		3.3 (0.04)	4.0	3.0	4.0
Number of antihypertensive medications		2.7 (0.06)	3.0	2.0	4.0
Proportion (%) in action or maintenance[a]					
Diet	38.7				
Exercise	64.3				
Medications	93.6				

RCT Randomized Clinical Trial; BP Blood Pressure; DASH Dietary Approaches to Stop Hypertension; EGFR, Estimated Glomerular Filtration Rate; IHD, Ischemic Heart Disease.
[a] Stages of change were determined using validated questions (Nigg et al., 1999). These include precontemplation (no plans to adhere in <6 months), contemplation (plans to adhere in 1–6 months), preparation (plans to adhere within 1 month), action (adherence for <6 months), and maintenance (adherence for ≥6 months).

Table 3
Analyses demonstrating Convergent and Discriminant Validity.

	DASH score (Willett food frequency questionnaires)	Aerobic exercise (Sallis seven-day physical activity recall)	Medication adherence (four-item Morisky scale)	Psychosocial support for diet encouragement	Psychosocial support for exercise participation
Diet Self Efficacy	0.17**	–	–	−0.065 ns	0.059 ns
Exercise Self Efficacy	–	0.27**	–	−0.051 ns	0.07 ns
Medication Self Efficacy	–	–	0.24**	−0.047 ns	0.001 ns

** $p < 0.001$.
ns No significant difference ($p >$ or = 0.05).

included all six questions belonging to the ESE subscale, the second factor consisted of all six questions for the DSE subscale, and the third factor contained all five questions from the MSE subscale. Although the eigenvalue for the third factor was less than one, the item was retained since it was composed of all the medication-taking items on the SE scale.

4. Discussion

We evaluated the validity and reliability of a self-efficacy for hypertension treatment adherence instrument, the SE-HTA. We found the SE-HTA instrument to be a sufficiently valid and reliable tool for assessing self-efficacy for diet, exercise, and medication adherence in adults with uncontrolled hypertension. The Cronbach's α coefficients for each instrument subscale support high internal consistency and the test-retest correlations suggest moderate reliability. When the values for DSE, ESE, and MSE were compared to DASH scores, aerobic exercise in hours per week, and medication adherence, the correlations supported convergent validity. The lack of correlation between self-efficacy scores and psychosocial support for diet or exercise confirmed discriminant validity. Moreover, exploratory factor analysis demonstrated that three distinct factors could be attributed to the DSE, ESE, and MSE subscales. The three factors were determined from the scree plot, which demonstrated a distinct natural bend at factor four. Factor loadings attribute three distinct factors to the structure of our self-efficacy instrument that correspond to the three subscales.

Successful self-management of chronic disease is behaviorally dependent. Individuals who possess high self-efficacy are more likely to make necessary changes in lifestyle and maintain newly adopted healthy behaviors. Thus, having a valid and reliable methods to assess and ultimately improve self-efficacy is desirable for optimizing behaviors for sustained hypertension control. The SE-HTA instrument was designed to examine self-efficacy in participants with uncontrolled hypertension and is unique in measuring this construct in a diverse population of adults with hypertension. It is both appropriately narrow in scope and comprehensive in its simultaneous examination of diet, exercise, and medication adherence self-efficacy. Its comprehensive nature did not compromise practicality, as study participants responded well to the instrument. The instrument was designed to be used in a large RCT and was evaluated as part of the study.

Medication adherence measured by the Morisky Scale was relatively high. We attribute this to the fact that our participants were predominantly elderly men obtaining care at Veterans Affairs Medical Center clinics. Medication adherence tends to be higher in

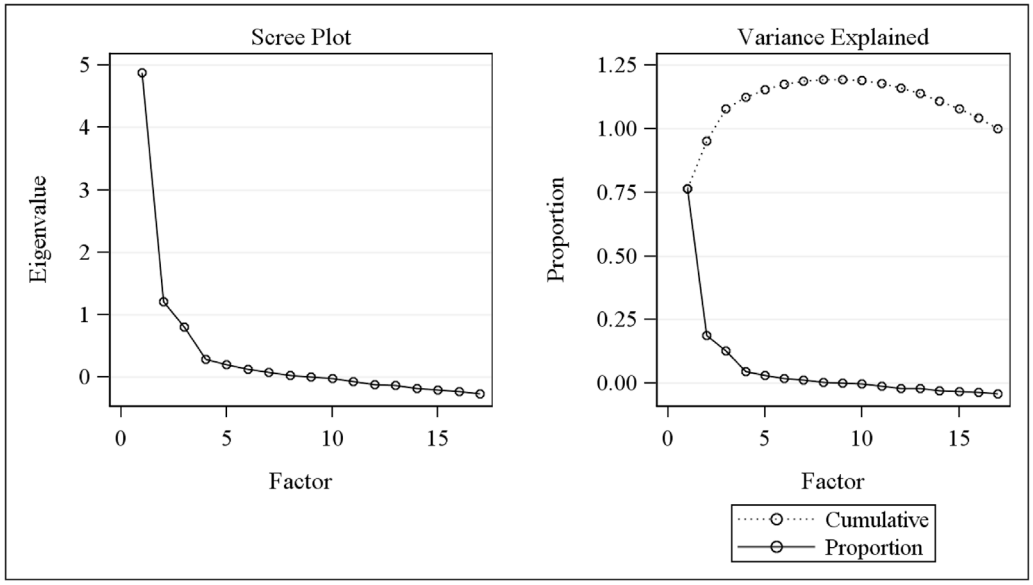

Fig. 2. Exploratory Factor Analysis of the 17 Self-Efficacy Questions from the SE-HTA Instrument.

Table 4
Rotated Factor Pattern of SE-HTA Instrument with Standardized Regression Coefficients.

Item Number	Factor 1	Factor 2	Factor 3
Diet Self-Efficacy 1	−0.04691	0.71891	0.04146
Diet Self-Efficacy 2	−0.00449	0.73798	−0.01129
Diet Self-Efficacy 3	0.10666	0.71396	−0.00864
Diet Self-Efficacy 4	0.03054	0.68871	0.09259
Diet Self-Efficacy 5	0.03054	0.68715	−0.07868
Diet Self-Efficacy 6	0.01352	0.66252	0.01099
Exercise Self-Efficacy 1	0.75087	0.08062	−0.08212
Exercise Self-Efficacy 2	0.73915	0.00932	−0.02591
Exercise Self-Efficacy 3	0.76926	−0.06416	0.02814
Exercise Self-Efficacy 4	0.65449	0.04346	0.07596
Exercise Self-Efficacy 5	0.68117	0.05617	0.12927
Exercise Self-Efficacy 6	0.68015	−0.01903	−0.04919
Medication Self-Efficacy 1	0.07754	−0.00039	0.62807
Medication Self-Efficacy 2	0.09022	−0.03259	0.78029
Medication Self-Efficacy 3	−0.02749	0.12043	0.53953
Medication Self-Efficacy 4	−0.14263	0.06716	0.75198
Medication Self-Efficacy 5	0.05119	−0.10870	0.71836

this setting because: a) patients receive their medication at the pharmacy at little or no cost, b) medication renewals are convenient and c) patients obtain their care in patient-centered medical homes where they have good access to their providers and are well educated regarding their medications. Furthermore, the distribution of scores across the three subscales was generally high. There are three reasons for this: First, the instrument comprised self-reported assessments demonstrating a participant's self-efficacy in maintaining health behaviors, in a study population consisting of older veterans who are generally adherent to instructions. Second, this study was performed as part of a RCT examining telephone-delivered behavioral interventions. Third, the RCT included a run-in period, where participants with lower levels of adherence may have dropped out before randomization.

This study has certain limitations. First, the test-retest reliability assessments occurred three months apart, which is a longer than usual for test-retest. The purpose of test-retest reliability is to measure whether an instrument can reliably replicate the result in the same situation and population. Since an individual's personal perception determines self-efficacy and may change over time [44], future assessments of SE-HTA test-retest reliability would benefit from measurements taken closer in time. The other measure of reliability, internal consistency, was high, using the typical Cronbach's α cut-off of >0.70 as well as the more contemporary threshold of >0.80 for reliability [45,46]. Second, considering that this was not a standalone project but part of a large RCT, we needed the measures ready for deployment before the RCT began, i.e., in only a few months. Consequently, more detailed patient interviews and formal analyses were beyond the scope of the project. Since prior work by others had demonstrated the essential validity and reliability of the constructs with which we were working, we did not conduct more rigorous interviews or focus groups, or formal analyses-based item reduction. Finally, it should be noted that data collection for this study was completed in 2011. Nevertheless, the primary modalities for hypertension treatment remain diet, exercise, and medications, which are the primary assessments from this instrument. While the instrument defines a criterion for diet and exercise, for medication adherence, it focuses on adherence and does not specify particular medications or class of medications. Therefore, despite data being from 2011, we believe that the instrument will have wide applicability.

Strengths of this study include an instrument that is both short and comprehensive (17 items spanning three clinically relevant subscales of diet, exercise, and medication adherence), large sample size (n = 533), and diversity (39.8% white, 39.8% black, and 15.2% non-white Hispanic). The sample is representative of urban Veterans with hypertension given that participants were primarily older men with comorbidities and were predominantly white (non-Hispanic) and black participants. Considering the substantial burden of hypertension, the increasingly common structure of "medical homes" across the country, the diverse study sample, and the high prevalence of comorbidities, these findings should be applicable to a broad range of patients with hypertension. Hypertension and cardiovascular disease are concerns for non-Veterans and among patients outside of health-maintenance organizations. The treatment of hypertension in men and women, and in patients from different community settings are not significantly different. Therefore, while the processes and outcomes from this study are directly relevant to veterans, the findings should be generalizable to patients from other settings.

Nonetheless, future studies should examine if the SE-HTA instrument employed in this study demonstrates similar properties in other studies among different patient populations and settings.

Finally, tailored interventions in hypertension show significant potential to improve self-management and enhance hypertension control. Motivating patients to initiate and maintain behavioral change is crucial to patient-centered treatment. Thus, effectively measuring self-efficacy in a clinical setting may not only benefit the quality of treatment, but may also increase overall efficiency.

4.1. Conclusion

Existing instruments for assessing self-efficacy among adults with hypertension with demonstrated validity and reliability are of limited scope and utility. The SE-HTA instrument that was developed and used in a successful hypertension RCT is valid and reliable for measuring self-efficacy for diet, exercise, and medication adherence in adults with hypertension. Additional efforts to further evaluate validity and reliability of this short self-efficacy instrument in other population subgroups would complement these findings. Moreover, future research with this instrument, or an adapted version, could provide potentially useful information regarding the effectiveness of the instrument for understanding and measuring self-efficacy in other disease states such as diabetes, dyslipidemia, or heart failure; all of which involve the challenges of changing behavior across multiple domains.

4.2. Practice implications

Self-efficacy, which is central to many behavioral theories and models, is a critical construct underlying adherence to health behaviors and is a principal focus of behavioral intervention for chronic disease self-management. A valid and reliable instrument for use among adults with hypertension can assess self-efficacy and may help facilitate behavior change for improved health. Thus, having a valid and reliable instrument for assessing and ultimately improving self-efficacy is important for optimizing behaviors for sustained hypertension control.

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CRediT authorship contribution statement

Matthew Zhao: Conceptualization, Writing - original draft, Writing - review & editing. **Maria A. Rodriguez:** Conceptualization, Methodology, Supervision, Data curation, Validation, Writing - original draft, Writing - review & editing. **Binhuan Wang:** Conceptualization, Methodology, Supervision, Data curation, Validation, Formal analysis, Writing - review & editing. **Elizabeth J. Santa Ana:** Writing - review & editing. **Jennifer Friedberg:** Data curation, Validation, Writing - review & editing. **Yixin Fang:** Formal analysis, Writing - review & editing. **John P. Allegrante:** Methodology, Writing - review & editing. **Sundar Natarajan:** Conceptualization, Methodology, Project administration, Supervision, Validation, Writing - original draft, Writing - review & editing.

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