Patient Preference and Adherence

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REVIEW

A Systematic Review of the Hill-Bone Compliance to Blood Pressure Therapy Scale

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Background: Poor medication adherence hampers hypertension control and increases the risk of adverse health outcomes. Medication adherence can be measured with direct and indirect methods. The Hill-Bone Compliance to High Blood Pressure Therapy (HBCHBPT) Scale, one of the most popular adherence measures, indirectly assesses adherence to hypertension therapy in three behavioral domains: appointment keeping, diet and medication adherence.

Aim: To synthesize evidence on the use of the HBCHBPT Scale, including psychometric properties, utility in diverse patient populations, and directions for future clinical use and research.

Methods: We searched electronic databases, specifically CINAHL, PubMed, PsychInfo, Embase, and Web of Science. We included original studies that used the HBCHBPT Scale or its subscales to measure a health outcome, or methodological studies involving translations and validations of the scale. We extracted and synthesized data following the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.

Results: Fifty studies were included in this review, 44 on hypertension, two on diabetes, and others on other chronic conditions. The scale was successfully translated into numerous languages and used in descriptive and intervention studies. The scale demonstrated sound psychometric properties (Cronbach's α coefficient 0.75) and sensitivity to capture intervention effects when used to evaluate the effectiveness of high blood pressure adherence interventions. The medication-taking subscale of HBCHBPT performs best and is widely used in diverse contexts to assess medication adherence for chronic conditions.

Conclusion: The HBCHBPT Scale has high versatility globally and has been used in various settings by various healthcare worker cadres and researchers. The scale has several strengths, including high adherence phenotyping capabilities, contributing to the paradigm shift toward personalized health care.

Keywords: medication adherence, treatment adherence, treatment compliance, hypertension, high blood pressure, Hill Bone Medication Adherence Scale, Hill-Bone Compliance to Blood Pressure Therapy Scale

Introduction

Hypertension, or high blood pressure, is a major risk factor for cardiovascular disease (CVD), stroke, renal disease, and dementia.[1] Controlling blood pressure requires adherence to prescribed pharmacological and non-pharmacological therapy to reduce the risk of adverse events.[2] Adherence is defined as the

> Extent to which a person's behavior–taking prescribed medication, following a diet, and/or executing lifestyle changes-corresponds with agreed-upon recommendations from a health care provider.[2]

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Poor medication adherence, a pervasive patient-level factor associated with not achieving blood pressure targets, is associated with disease progression, avoidable hospitalization, morbidity, and mortality.[1] Adherence to drug therapy lowers blood pressure, and reduces the risk for CVD and death.[3–5]

Approximately 50% to 80% of patients prescribed antihypertensive medications demonstrate suboptimal adherence[5] and 30–50% of United States (US) adults do not adhere to drug therapy. Also, 33–69% of medication-related hospitalization in the US are due to poor medication adherence, which costs almost $100 billion a year.[6] Nonadherence may occur when the patient does not initiate a new prescribed antihypertensive medication, implement therapy as prescribed by the provider, or persist with treatment as prescribed. Nonadherence undermines the benefits expected from evidence-based drug therapy and ultimately contributes to poor CVD outcomes.

Several interrelated factors influence adherence to drug therapy, including significant pill burden, complex drug regimen, cost of medications, side effects of multidrug antihypertensive regimens, poor patient-provider relationship, and clinical inertia.[7,8] Devising appropriate interventions to improve adherence to therapy first requires assessing adherence and the reasons or factors affecting adherence.[9] Clinicians often rely on clinical judgment in their assessment of adherence rather than using screening tools and validated instruments for assessing adherence.[10]

Adherence is measured with direct methods, such as directly observed therapy and measurement of drug metabolites or biomarkers, and indirect methods, such as patient self-reports, questionnaires, pill counts, rates of prescription refills, and electronic medication monitors.[6,11] Each method has advantages and disadvantages and differs in accuracy, practicality, cost, and burden.[12] There is no consensus on the gold standard for measuring medication adherence, and no single method meets all criteria. However, patient self-report is considered a simple and effective method to assess adherence.[13,14]

The Hill-Bone Compliance to High Blood Pressure Therapy (HBCHBPT) Scale is an indirect method to assess adherence to hypertension therapy via self-report.[15] It is a 14-item scale that assesses patient behaviors for three behavioral domains of hypertension treatment (ie, the three (3) sub-scales): Appointment Keeping (3 items), Diet [salt intake] (2 items), Medication Adherence (9-items).[15] The content validity of the original scale was assessed by a relevant literature review and an expert panel, which focused on cultural sensitivity and appropriateness of the instrument for low literacy.[15] Internal consistency reliability and predictive validity of the scale were evaluated using two community-based samples of hypertensive adults enrolled in clinical trials of high blood pressure care and control. The standardized Cronbach's alpha (α) for the total scale were 0.74 and 0.84, and the average interitem correlations of the 14 items were 0.18 and 0.28, respectively. In the initial study, high compliance scale scores, indicating better adherence, predicted significantly lower blood pressure levels and better blood pressure control.

This systematic review aims to synthesize evidence on the use of the HBCHBPT Scale, including psychometric properties, utility in diverse patient populations, and directions for future clinical use and research.

Materials and Methods

Search Strategy

We conducted a comprehensive literature review of databases with the help of an information specialist and according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.[16] We assessed the literature for studies that have used the HBCHBPT Scale.

A search strategy was derived from combinations of keys words that describe the HBCHBPT scales, for instance, "Hill-Bone", "Hill Bone Medication Adherence Scale", "Hill-Bone Compliance to High Blood Pressure Therapy", separated with the "OR" Boolean operator and the search was conducted in the following databases: CINAHL, PubMed, PsychInfo, Embase, and Web of Science. Final searches were conducted on May 18, 2020. We briefly assessed the articles returned at each search to make sure they were relevant and that the articles included the terms in the search strategy. Identified articles were imported into Covidence®,[17] for title and abstract screening.

Eligibility

For this review, we included studies that used the HBCHBPT Scale or its subscales in research. This includes original studies in which the HBCHBPT Scale was used to measure an outcome, or methodological studies involving translations

and validations of the scale. Additionally, eligible articles had to be peer-reviewed, published in English, and available in full text, although the scale could be administered in the participant's native language. Articles that only referenced the scale but did not necessarily administer the scale were excluded. Other reviews, study protocols, editorials, and commentaries were excluded.

Data Quality Assessment

The methodological quality of each article was assessed using the Quality Assessment of Diagnostic Accuracy Studies Criteria (QUADAS-2), which allows for transparent rating of bias and assessment of the applicability of primary diagnostic accuracy studies.[18] The domains include patient selection, index test, reference standard, flow, and timing. Each of the articles and risk of biased and applicability was judged as "low", "high", or "unclear". Articles were included if judged as "high" and were excluded if the judgment for both bias and applicability assessment were "high". For articles judged as "unclear", the two independent reviewers held discussions about these articles, and a third reviewer resolved final judgment and conflicting opinions.

Data Extraction and Synthesis

After title and abstract screening, we obtained full-text versions of screened articles. Two independent authors reviewed the articles for full-text eligibility based on the inclusion criteria. Eligible studies were assessed for quality using the Assessment of QUADAS-2. Data extracted included: author and publication year, country, study setting, sample size, disease, population and setting, age of participants, language, subscales used, method of administration, scoring system, and psychometric properties. Finally, we synthesized the extracted data following the PRIMSA guidelines, and summarized and presented the results in tables.

Results

Search and Study Selection

Following a systematic search in 5 literature databases, 342 articles were identified, 134 duplicates, leaving 208 de-duplicated articles. These 208 articles were assessed for title and abstract eligibility screening, and 112 records were excluded based on the eligibility criteria. We retrieved full-text versions for articles eligible for full-text review and excluded 46 articles due to the following reasons: Abstract only (n=31), Hill-Bone scale not administered (n=7), full-text not available (n=2), review articles (n=4), dissertation study (n=1), and article not published in English (n=1). Full-text eligibility review yielded 50 articles included in the qualitative narrative synthesis. The PRISMA flowchart is shown in Figure 1.

Characteristics of Studies

Fifty studies were included in this review and are presented in Table 1, together with the study design, region, population, setting, scale length (full scale versus subscale), method of administration, scoring system, and psychometric properties. A total of 14,364 participants were represented for all the included citations where the sample size ranged from 9 to 2870. Forty-four (44) studies focused on hypertension, two on type 2 diabetes mellitus (T2DM), three on mental or cognitive impairment, inflammatory bowel disease (IBD), Alzheimer's, and exacerbation of non-specified conditions. Regarding regional comparison, 22 studies were conducted in the Americas, 11 studies in Europe, eight in the Eastern Mediterranean region, five in Africa, two in Southeast Asia, and two in the Western Pacific Region. Twenty-five studies administered the HBCHBPT scale in its original language (English). The remaining studies translated the scale into Polish (n=6), Persian (n=3), German (n=2), Korean (n=2), Arabic (n=2), Chinese (n=2), Xhosa (n=2), Portuguese (n=1), Greek (n=1), Turkish (n=1), Malay (n=1), Afrikaans and Oshiwamb (n=1). All articles included adult patients; only two studies (4%) administered the instrument to caregivers. Most participants were sourced from the community setting, where data collection took place in primary care clinics, and 14 studies were conducted in hospital-based settings. Four papers did not specify a language, and these studies were conducted in countries with a non-English de facto official language.

Of 50 records, 26 were self-administered (1 computer-assisted), and 30 were interviewer-administered (2 via telephone). Additionally, 38 studies used the full scale, while the remainder used specific subscales: medication

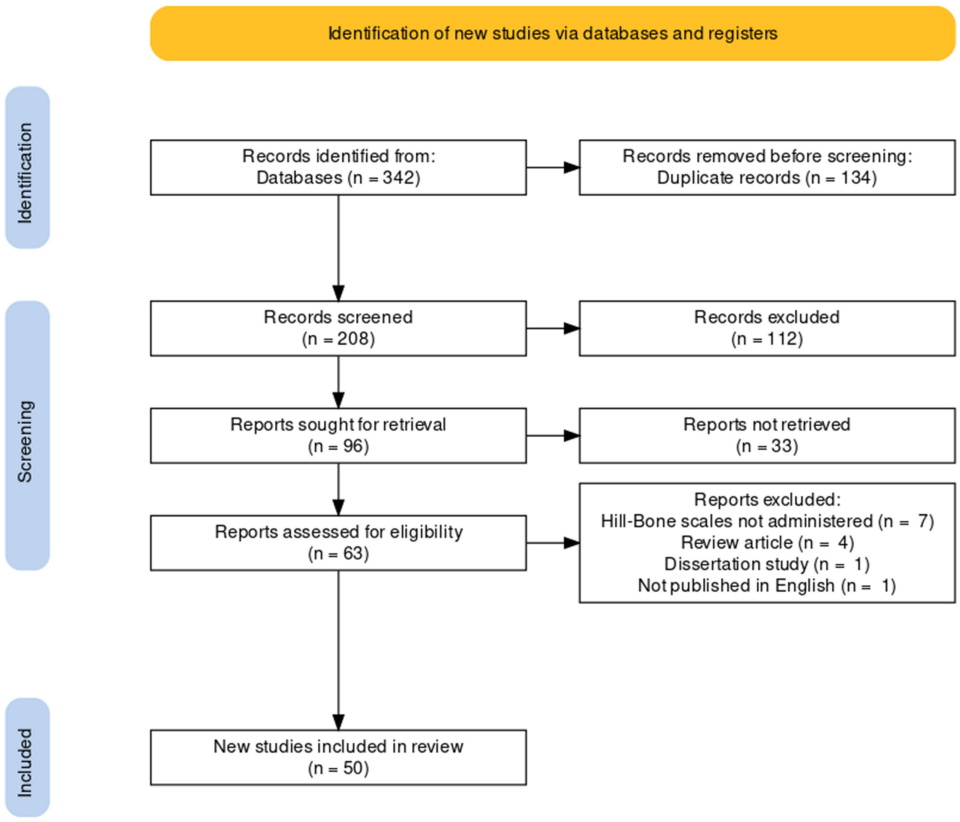

Figure 1 PRISMA flow chart.
Notes: PRISMA figure adapted from Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71. Creative Commons.[16]

taking (n=10), salt intake (n=1), and appointment keeping (n=1). Scoring systems were adapted from the original scale, where the following ranges were reported: 9–36 and 14–56. A four-point Likert scale was used in 49 studies where higher scores indicated better adherence. One study used reverse coding on a five-point Likert scoring method. The average Cronbach's α coefficient was 0.75 (range: 0.43–0.85). In the 21 cases where Cronbach's α measures were not reported, most authors endorsed internal consistency of the original scale.

Randomized Controlled Trials That Measured Adherence with the HBCHBPT Scale

Table 2 features six randomized controlled trials related to hypertension and diabetes that used the HBCHBPT Scale. The results suggest that in adults with hypertension and diabetes, health behaviors and health outcomes improved specifically related to medication adherence for glycemic and BP control. A 4-arm RCT of 123 community-dwelling adults showed significant treatment compliance differences between the control and intervention groups ($P < 0.0001$).[50] Five RCTs focused on education and technology as methods for improving adherence to treatment and saw favorable outcomes in the intervention groups. Technology tools featured text messages, a self-care application, and a self-management website. The education sessions focused on two main behaviors: medication taking and diet management. Only two studies measured objective outcomes: blood pressure[36] and hemoglobin A1c.[38] The remaining four studies used psychometric scales such as the HBCHBPT to measure certain self-care behaviors. Although the educational interventions were effective, they focused more on the "medication taking" and "proper diet" items versus the "appointment keeping" domain.

Discussion

The Hill-Bone Compliance to High Blood Pressure Therapy Scale is one of the most widely used indirect measurements of adherence to hypertension therapy.[68] Our systematic review aimed to synthesize evidence on the use of the scale,

Table 1 General Characteristics of Included Studies (N=50)

Author, Year	Country	Study Design	Sample Size (N)	Disease	Population & Setting	Age (Years)	Language*	Subscale	Administration Method	Scoring system	Psychometric Properties
Abel et al, 2014[19]	USA	Cross-sectional study	80	HTN	Black women	18–60	English	8-item medication-taking subscale	In person, self-administration	Scores ranged from 9–36 (9-perfect medication adherence)	Cronbach α=0.84 Mean and range of scores: 13.1 ± 4.2 75% adherent: N= 60 25% adherent: N= 20
Al-daken and Eshah, 2017[20]	Jordan	Cross-sectional descriptive comparison design	192	HTN	Adult patients	52.8; range 20–80)	English Arabic	Full scale (14 items)	Interviews	14 items negatively worded and rated on a 4-point Likert scale Scores ranged from 14–56, (56-perfect adherence). Scores were converted to marks out of 100 to categorize patients by adherence level.	Cronbach α = 0.79 (Arabic version) The mean (SD) of total adherence to HTN was 87.27 (10.3) out of 100.
Alsolami et al, 2013[21]	Saudi Arabia	Cross-sectional study	110	HTN	Adult patients at a university hospital	53.6 ±12	Arabic	Medication adherence (9 items) and appointment keeping (3-item) subscales.	Self-administration	Nine questions with four response categories ranging from 1 = None of the time to 4 = All of the time.	Cronbach α = 0.76 (Arabic version) for 9-item medication adherence subscale)
Asadullah et al, 2018[22]	Pakistan	Cross-sectional descriptive study	401	HTN	Adult patients	45.1; range 21–95)	NR Excluded non-patients Urdu	Full scale (14 items)	Interviews and Self-administration	4-point-scale, score ranging from 9 (perfect adherence) to 36 points and dichotomized the responses in 'perfect adherence' (9 points) and 'imperfect adherence' (>9 points).	Cronbach α= NR 336 (83.4%) had imperfect adherence and 65 (16.2%) have perfect adherence. Mean score: 24.16; Median score: 25.0.
Boulware et al, 2009[23]	USA	Cross-sectional	195	HTN	Adults from 15 primary care practices	51% were 60+	English	Full scale (14 items)	Interview	Scores range from 14–56 points, Higher scores indicating poorer adherence	Cronbach α= NR Mean(±SD) Score: 17.8 (±2.6), Range 14–26
Chatziefstratiou et al, 2019[24]	Greece	Methodological study	68	HTN	Patients with and without HTN at a general hospital	Mean: 65	Greek	Full scale	Self-administration	4-point Likert-type scale (4=all the time; 1=never)	Cronbach's α = 0.76
Cheong et al, 2015[25]	Malaysia	Cross-sectional; instrument validity	262	HTN	Adults from two public primary healthcare clinics	Mean (±SD) age: 56.3 (±8.7)	Malay, but responses were in Chinese/ Tamil/Malay	Full scale (14 items)	Self-administration	4-point Likert scale. Scores ranged from 1 (all the time) −4 (none of the time). Higher scores indicated better adherence.	Cronbach α= 0.64. Cronbach's α for (items 1, 14, 10, 8, 2), (items 2, 12, 11, 9), and salt intake is 0.64, 0.55 and 0.29, respectively.

(*Continued*)

Table 1 (Continued).

Author, Year	Country	Study Design	Sample Size (N)	Disease	Population & Setting	Age (Years)	Language*	Subscale	Administration Method	Scoring system	Psychometric Properties
Chudiak et al, 2017[26]	Poland	Cross-sectional	300	HTN	Patients at a University Clinical Hospital	Mean (± SD: 71.75 (±7.79)	Polish	Full scale (14 items)	NR	Scores range between 14 and 56 points; higher scores=poorer adherence	Cronbach α= NR **Full scale** (Range: 14–34). **Mean** (±SD) score: 20.75 ±4.11. **Salt Intake subscale** (Range: 3–12; Mean (±SD) score: 4.79 (±1.17). **Appointment Keeping subscale** (Range: 2–8; Mean (±SD) score: 3.47 (±1.09). **Medication Taking subscale** (Range: 9–36); Mean (±SD) score: 12.49 (±3.3)
Chudiack et al, 2018[27]	Poland	Analytical cross-sectional study	300	HTN/ Cognitive impairment	Adults with HTN on admission at a University Teaching Hospital	Mean age: 71.8 ±7.8	Polish	Full scale	Self-administration	4-point Likert-type items (1=none of the time, 2=some of the time, 3=most of the time and 4=all the time)	Cronbach α = 0.851 Range of scores: 14–34. Adherence level: 63% of the participants
Dennison et a, 2007[28]	South Africa	Cross-sectional	403	HTN	Black patients in public and private primary care sites	Mean age=52 (range: 35–65)	Xhosa	10-item, 3- point Likert-type Hill-Bone Compliance Scale	Interview	Not reported	Cronbach α= 0.77
Dharan & Moly, 2017[29]	India	Cross-sectional	150	HTN	Adult patients in a tertiary care hospital	Mean (± SD): 55 (±15)	English	Full scale (14 items)	Interview	Four-point Likert scale. Scores ranged from 14–56. Score of 14–28 =good compliance, 29–42 =average, and 43–56=poor compliance.	Cronbach α= NR
Etebari et al, 2019[30]	Iran	Cross-sectional study	254	HTN	Adults with HTN attending a family medicine clinic	Mean (± SD): 58.16 ± 10.54	Persian	Full scale	Self-administration	5-point 'reversed' Likert scale: 5 considered as "I never forget", and the score of 1 determined as "I always forget".	Cronbach α = 0.71. Scores ranged from 14–51. Mean overall patient score was 35.96 ± 9.17. Mean (SD) scores for dietary subsection: 7.84 ± 1.94; Medication: 19.6 ± 5.86; Appointment: 8.52 ± 2.68

Fleig et al, 2018[31]	Germany	Prospective observa-tional	1770	HTN	Adult patients in practices of 614 internists, general practitioners and cardiologists	Mean (± SD): 60.0 ± 13.4	German	Medication subscale (9 items)	NR	Four-point Likert scale. Scores ranged from 9–36 (9 = perfect medication adherence)	Cronbach α= NR
Fongwa et al, 2015[32]	USA	Validation study	70	HTN	African American women from a federally funded inner-city clinic	Mean (± SD): 54 (±8) years, Range: 37–75 years	English	Full scale (14 items)	Interview	14-item Hill-Bone Compliance Scale uses a 4-point Likert scale.	Cronbach α= NR Internal consistency reliability coefficients were reported to be 0.74 and 0.84.
Gerber, 2010[33]	USA	Cross-sectional	450	HTN	African American and White Medicare recipients aged 65 + in a city	Mean (± SD): 77±6.65	English	Medication- subscale (9 items)	Face-to-face interviews; computer-assisted survey	Four-point Likert scale. 9–36 (9 reflecting perfect medication adherence)	Cronbach α= 0.68
Glasgow, 2012[34]	USA	Three-arm RCT	463	Type 2 Diabetes	Range: 25–75 years, Dx with DM II, (BMI) of 25 kg/m2 or greater, and at least one other risk factor for heart disease	Mean (± SD): 58.4±9.2	English	Medication- subscale (9 items)	Not reported	Dichotomized adherence scores 1 = perfect adherence, 0 = other levels of adherence	Cronbach α= NR
Greer & Abel, 2017[35]	USA	Mixed methods, Cross-sectional quantitative arm	20	HTN	African-American women	Mean (± SD): 54 ± (11.6)	English	Full scale (14 items)	Self-administration	4-point Likert scale; Score ranged from 14–56. Higher scores =poorer adherence.	Cronbach α= 0.81
Greer & Ostwald, 2015[36]	USA	Randomized controlled trial	60	HTN	African-American women	Mean (± SD): 57.98 ± (12.37)	English	Full scale (14 items)	Self-administration	Scores ranged from 14 (perfect adherence-56. A cutoff score of 22 was used to distinguish high and low adherence.	Cronbach α=NR
Han et al, 2014[37]	USA	Validation study	213	HTN	Adults in an inner city	Mean (± SD): 68.6 ± (12.3)	English	Full scale (14 items)	Self-administration	Four-point Likert scale. Scores ranged from 9–36 (9 = perfect medication adherence)	Cronbach α= 0.70 Pearson's correlation coefficients of HBP SCP-Behavior with existing HBP self-care instruments were moderately strong (r = −0.493 with the Hill-Bone scale; P <0.001 for all correlation coefficients), indicating concurrent validity

(*Continued*)

Table 1 (Continued).

Author, Year	Country	Study Design	Sample Size (N)	Disease	Population & Setting	Age (Years)	Language*	Subscale	Administration Method	Scoring system	Psychometric Properties
Hill-Briggs et al, 2006[38]	USA	Randomized controlled trial	65	Diabetes	Adult urban African Americans	Mean (± SD): 59.5±11.6	English	Full scale (14 items)	Self-administration	4-point Likert scale; Scores range from 4 to 36, higher scores = higher medication adherence.	Cronbach α=Not reported Mean (± SD): score: 33.1 (±3.9)
Hsu et al, 2010[39]	USA	Cross-sectional	94	HTN	Chinese American elders from three Chinese churches and one community center	Mean (± SD): 75 ± 12.5	Chinese	Medication- subscale (9 items)	Interview	4-point Likert scale; Scores ranged from 9 to 36; The higher the scores, the lower the compliance	Cronbach α= Not reported The scores ranged from 9 to 22. Mean (± SD): 10.63 (±2.53)
Ingram and Ivanov, 2013[40]	USA	Descriptive correlational design.	121	HTN	Community - African American community members	Mean (± SD)59.75 (± 7.94) Range 50–87	English	Full scale (14 items)	Self-administration	4-point Likert scale; 14–56 higher scores indicating less adherence.	Cronbach α = 0.73. Mean: 24, and 50% non-adherent
Karademir et al, 2009[41]	Turkey	Validation study	200	HTN	Primary health clinic- Adult patients	58% of partici-pants were >61 y/o	Turkish	Full scale (14 items)	Interview	4-point Likert scale; lower scores= better adherence	**Full scale**: Cronbach α = 0.72 **Medication subscale**: (Cronbach α =0.83 **Salt intake subscale**: (Cronbach α= 0.62
Kim et al, 2007[42]	USA	Cross-sectional	208	HTN	Community - Korean Americans in a metropolitan area	Mean (± SD): 52.6 ± 5.6	English and Korean	Medication subscale (4 items)	Interview	4-point Likert scale; lower scores= better adherence	**Medication subscale**: Cronbach α =0.74 53.8% of participants endorsed at least 1 type of nonadherent behavior.
Kosachack et al, 2010[43]	Germany	Comparison and validation study	353	HTN	General practice - Adults attending 23 German general practices	Mean (± SD): 64 ± 11	German	Full scale (14 items)	Telephone interview	4-point Likert scale; low score = better adherence, dichotomized the responses in "perfect adherence" (9 points) and "imperfect adherence" (>9 points)	Cronbach α = 0.73.

Krousel-Wood et al, 2005[44]	USA	Cross-sectional survey	239	HTN	Community - Patients attending the hypertension section of the Internal Medicine Clinic in a large multispecialty group practice	Mean: 69; Men Mean (± SD): 68.3 ±11.2, Women Mean (± SD): 69.8 ± 13.0	English	Full scale (14 items)	Self-administration	4-point Likert scale; higher scores= poor adherence	**Full scale**: Cronbach α = 0.43. **Medication subscale**: Cronbach α=0.68 Salt intake subscale: Cronbach α= 0.49
Krousel-Wood et al, 2008[45]	USA	Cross-sectional survey	210	HTN	Community - patients attending the HTN section of an established urban multispecialty group practice after Hurricane Katrina	Mean: 63.6	English	Medication subscale (9 items)	Self-administration	4-point Likert scale; higher scores= poor adherence	Cronbach α = NR 46% of the patients had less-than-perfect adherence to antihypertensive medications in the year following Hurricane Katrina.
Krousel-Wood et al, 2013[46]	USA	Cross-sectional survey, prospective cohort study	394	HTN	Adults > 65 years from a large managed care organization	Mean (± SD): 76.6 ± 5.6	English	Medication subscale (9-items)	Self-administration	4-point Likert scale, higher scores= poor adherence	Cronbach α = NR Concordance statistic = 0.66 (95% CI 0.622–0.674)
Lambert et al, 2006[47]	South Africa	Validation study	98	HTN	Community Patients from peri-urban community health centers or a government work site in	Mea n (± SD): 52 ± 7.6	Xhosa	Full scale (14 items); 10-item adapted scale	Interview	4-point Likert scale; lower scores= higher adherence	**10-item scale**: Cronbach α = 0.79 **Salt-intake subscale**: Cronbach α = 0.41. **Medication subscale** (8-items): Cronbach α=0.76
Mafutha and Wright, 2013[48]	South Africa	Cross-sectional	101	HTN	Primary health clinic - Patients living in a city and attending one of the three primary healthcare clinics	Range 20–80	English	Full scale (14 items)	Interviewer-assisted (face-to-face interviews with fieldworkers fluent in local languages)	4-point Likert scale; higher scores= better compliance label 80% and above as good compliance, between 70% and 79.9% as moderate compliance and 69.9% and below as poor compliance	Good compliance = 70% Moderate compliance = 23% Low compliance = 7%
Manze et al, 2015[49]	USA	Prospective cohort	819	HTN	Hospitalized adults at an urban safety-net hospital	Mean: 59.6	English	Salt-intake subscale	Self-administration	Higher score indicates worse diet, range 1–12	Cronbach α = NR

(*Continued*)

Table 1 (Continued).

Author, Year	Country	Study Design	Sample Size (N)	Disease	Population & Setting	Age (Years)	Language*	Subscale	Administration Method	Scoring system	Psychometric Properties
Maslakpak and Safaie, 2016[50]	Iran	Randomized controlled clinical trial study with a pretest-posttest design	123	HTN	Community-dwelling adults in a city	Control group: 50.54 (mean) ±8.14, Text message group: 53.68 (mean) ± 6.94, Reminder card group: 50.29 (mean) ± 10.51	Not specified	Full scale (14 items)	Interviewer administered	1 = never, 2 = occasionally, 3 = often, and 4 = always	Cronbach α = NR
Maslakpak et al, 2018[50]	Iran	Single-blind randomized, parallel-group controlled trial	100	HTN	Adult patients referred to a clinical-educational center	18–60 years	Persian	Full scale	4-point Likert scale: never (1), occasionally (2), often (3) and always (4)	Cronbach α = 0.87, 0.94, 0.79, 0.88, respectively for total treatment, medication, low sodium regimen and medical appointments adherence.	4-point Likert scale: never (1), occasionally (2), often (3) and always (4)
Mutneja et al, 2020[51]	India	Observational cross-sectional study	452	HTN	Patients prescribed antihypertensives attending cardiology and geriatrics outpatient clinics	Mean ± SD: 54.6 ± 13.7 years	Not Specified	Full scale	Self-administration	4-point Likert-type scale (1=never, 4=always)	Cronbach's α: overall = 0.7; Subscales: Salt intake = 0.7; appointment keeping = 0.8; medication adherent = 0.7 Mean inter-item correlation: 0.341; Kaiser-Meyer-Olkin (KMO): 0.591
Nashilongo et al, 2017[52]	Namibia	Descriptive cross-sectional observational study/ validation study	120	HTN	Primary health clinic - Adults from public primary health clinics in four sub-urban townships	Mean (± SD): 47.3 ± 11.1	Afrikaans and Oshiwamb	Modified 12-item Namibian version (items 6 and 12 from original scale removed)	Interview	4-point Likert scale; Lower scores=better compliance. Replies to questions with a mean score > 2 indicated poor compliance.	Cronbach α = 0.695
Ndumele et al, 2010[53]	USA	Cross-sectional survey	141	HTN	Primary health clinic - African American (AA) and Non-Hispanic White patients	AA median = 64 (59–73 range), White median = 67 (57–71 range)	English	Full scale(14-items)	Interviewer administered	4-point Likert scale; lower scores=better adherence.	Cronbach α = NR

Nguyen et al, 2009[54]	USA	Cross-sectional	235	Inflammatory Bowel Disease (IBD)	Primary health clinic - IBD patients from outpatient clinic	Mean (± SD): 41.2± 14.2	English	10 items along with 2 behavior domains: medication-taking and prescription refill (8 items), and appointment keeping (2 items)	Telephone interview	4-point Likert scale; Scores ranging from 10 (most adherent/least non-adherent) to 40 (least adherent/most non-adherent). Adherence was also dichotomized with a threshold score of less than 16 reflecting adherence versus non-adherence.	Cronbach α = NR
Nogueira-Silva et al, 2016[55]	Portugal	Validation study	One group with 9 people	HTN	Clinic - Adults in HTN clinic	Not reported	Portuguese	Full scale (14 items)	Self-administration	4-point Likert scale; 1 = Always, 4 = Never. Lower scores=better adherence	Cronbach α = NR
Rose et al, 2014[56]	USA	Descriptive correlational design	98	Serious Mental Illness	Community - Psychiatric Treatment program	Mean (± SD): 51.84 ± 8.79, 31–75 (range)	English	Full scale	Interview	4-point Likert scale; Lower scores=better adherence	Cronbach α = NR Mean (± SD): score = 21.21 (± 4.41)
Sarfo et al, 2018[57]	Ghana	Cross-sectional design	2870	HTN and/or Type 2 DM	5 Hospitals - participants with HTN with or without diabetes	Mean (± SD): 58.9 ± 16.6	English	Full scale (14 items)	Interview	4-point Likert scale; 1=none of the time, 4=all of the time; higher scores=poorer adherence	Cronbach α = NR
Shawler et al, 2019[58]	USA	Longitudinal predictive	51 dyads Analysis of Hill-Bone scale of 18 hypertensive mother-daughter dyads.	HTN	Older mother-adult daughter dyads recruited from 4 senior citizen centers in an urban area	Mean: mothers; 781; daughters: 52.5.	English	Full-scale	Interviews	Not reported	Cronbach's α = 0.69 and 0.68 at baseline and follow-up, respectively Mean scores: At baseline: Mothers: 52.0 ± 2.6 Daughters: 48.5 ± 4.0 At 6-month follow-up: Mothers 52.4 ± 2.5. Daughters: 49.2 ± 2.5
Song et al, 2011[59]	USA	Validation study	525	HTN	Community - Korean Americans from two community-based HTN intervention trials	Mean (± SD): 52.5 ± 5.42	Korean	8-item modified medication subscale	Face-to-face interviews with bilingual interviewers	4-point Likert scale; 1=none of the time, 4=all of the time; Lower scores=better adherence	Cronbach α = 0.76

(*Continued*)

Table 1 (Continued).

Author, Year	Country	Study Design	Sample Size (N)	Disease	Population & Setting	Age (Years)	Language*	Subscale	Administration Method	Scoring system	Psychometric Properties
Uchmanowicz et al, 2016[60]	Poland	Validation study	117	HTN	Private medical center	Mean (± SD): 60.7 ± 12.41	Polish	Full scale (14 items)	Self-administration	4-point Likert scale; 1=none of the time, 4=all of the time; Lower scores=better adherence	**Full Scale** Cronbach α = 0.851. **Medication subscale** Cronbach α = 0.78
Uchmanowicz et al, 2018[61]	Poland	Prospective, cross-sectional, and analytical study	186	HTN	Hypertensive elderly patients at the hypertension clinic	Mean age: 71.05 ±7.47 years	Polish	Full-scale	Interview	Not reported	Overall mean score= 20.39±4.31 points. Mean score in the subscale analyses: reduced sodium intake =4.75±1.33 Appointment keeping = 3.45±1.07 Medication taking = 12.19±3.46
Uchmanowicz et al, 2018[62]	Poland	Cross-sectional study	150	HTN	Hypertensive adult patients at the University Clinical Hospital	Mean: 72.1 ±8.0	Polish	Full scale	Interviews	4-point scale: "none of the time=1", "some of the time=2", "most of the time=3", and "all the time=4"	Cronbach α = 0.851. Scores ranged from 14 to 32 points. The median was 19 points. The first and third quartiles were 17 and 22. Mean overall score: 20.19 ±4.05. Subscale analysis: Reduced sodium intake: 4.82 ±1.09; Appointment keeping: 3.33 1±19; medication taking: 12.05 ±3.08.
Uchmanowicz et al, 2019[63]	Poland	Cross-sectional study	160	HTN	Adult patients hospitalized at the Hospital in a city	65–78, Mean, 72.09 ±7.98	Polish	Full scale	Self-administration	Modified scale: "none of the time", "some of the time", "most of the time", "all the time", "not applicable", and "do not know".	Cronbach α = NR Scores ranged from 14 to 32 points. Mean overall score: 20.24 ±4.01. Median score: 19.5.
Wang et al, 2015[64]	USA	Cross-sectional correlation study	45	Alzheimer's	Adult caregivers and Alzheimer's patients at university geriatric clinics and local communities in a large city.	*Patients*: Mean (± SD): 81.3 ± 7.9 *Caregivers*: Mean (± SD): 66.8 ± 10.5	English	6-item version of the full scale	Interview	5-point Likert-type scale (1 = never, 5 = all the time), responses to both measures were reverse coded; higher scores = higher adherence to medications and appointments	Cronbach α = 0.88.

Zabihi et al, 2012[65]	Iran	Descriptive study	120	HTN	Hospital clinics - Adults attending clinics affiliated with the hospitals	40–60 (range), 64.2% >51 y/o	Not reported	Full scale (14 items)	Interview	NR To classify adherence scores, scores of patients in each subscale were calculated, divided by the total score of the same subscale, and finally multiplied by 100	Cronbach α = 0.71.
Zare et al, 2019[66]	Iran	Matched RCT	101	HTN	Outpatients referred to two heart clinics	Mean (range): Intervention: 43.17 (26–60); Control: 44.24 (27–58)	Persian	Full scale	Self-administration during clinic visits	Not Reported	Cronbach α = 0.71
Zwar et al, 2017[67]	Austra-lia	Pretest posttest	47	HTN	Adults at general practices	Mean (± SD): 62.5 ± 19.2	English	Full scale (14-items)	Interview	NR	Cronbach α= NR

Notes:*Languages scales were translated into or administered in, if applicable.
Abbreviations: HTN, Hypertension; DM, Diabetes Mellitus; RCT, Randomized Controlled Trial; NR, Not Reported; HBP, High Blood Pressure.

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Table 2 Randomized Controlled Trials Measuring Adherence in Hypertension (n=4) and Diabetes (n=2) Treatment

Author	Condition	Purpose	Intervention	Effect Size (Cohen's d)	Medication Adherence/Clinical Outcome
Glasgow et al, 2012[34]	Diabetes	To address 3 self-management behaviors for adults with diabetes: medication adherence, exercise, and food choices, using the diabetes self-management website.	My Path/Mi Camino, a computer-assisted diabetes self-management (CASM) intervention vs a CASM plus human support (CASM+) condition.	*d* for Medication adherence=0.12 at 4 months, 0.13 at 12 months comparing CASM vs CASM+	Internet conditions improved health behaviors significantly vs usual care over the 12-month period (d for effect size = 0.09–0.16)
Greer & Ostwald, 2015[36]	Hypertension	To improve outcomes for 60 African American women with hypertension.	90-minute educational sessions offered once a week for 6 weeks to groups of 8 to 12 women. Participants randomized to a wait-list control group received only usual care from their healthcare provider. After data collection, participants in the wait-list group were offered the classes, and 11 of 30 women enrolled, were shown a DVD, and received the lecture materials, pamphlets, and handouts.	–	A significant favorable overall main effect (time) was found for systolic blood pressure (F3, 174 = 11.104, P = 0.000) and diastolic blood pressure (F3, 174 = 4.781, P = 0.003) for both groups.
Hill-Briggs et al, 2006[38]	Diabetes	To examine, in a sample of urban African Americans with type 2 diabetes, the association of social problem-solving with glycemic control and health behaviors.	Participants underwent standardized interviews, physical assessment, and laboratory testing. They also received additional assessments of health behaviors and psychosocial factors.	–	Difference between mean A1C for the Above Average avoidant style group, as compared to the Below Average avoidant style group, was 2.2 (p = 0.03, 95% CI = 0.20–4.31), indicating significantly worse glycemic control in the Above Average group. Linear regression showed that for every 1.62 increase in A1C in the Avoidant group, there was a –0.95 decrease in medication adherence.
Maslakpak & Safaie, 2016[50]	Hypertension	To compare the effectiveness of short message service (SMS) to reminder cards about medication adherence in patients with hypertension.	3-month intervention with three groups: the control group received the standard education; SMS groups were sent 6 messages a week and the reminder card group. Also, all the patients were asked to visit the clinical center 6 times.	–	Medication adherence for three groups: control (46.63±2.99), SMS (57.70±2.75) and the reminder cards (57.51±2.69) after the intervention.

Maslakpak et al, 2018[50]	Hypertension	To evaluate the effectiveness of family involvement in patient education on hypertension management.	The participants in the control group were given routine education. The control group received the paper-based educational materials and all participants completed the Hill-Bone Scale and their blood pressure was measured at the end of the intervention.	–	Mean medication adherence scores: control group: 21.72 ± 2.20, family-oriented group: 13.44 ± 3.26, patient-oriented group: 16.64 ± 2.59 and patient and family-oriented group: 12.36 ± 2.36; $p < 0.0001$. Treatment compliance was best in the patient and family-oriented groups compared to other groups after the intervention.
Zare et al, 2019[66]	Hypertension	To evaluate the effect and acceptance of an educational self-care application.	The control group participants received the routine care and underwent no interventions. The patients in the intervention group were asked to use the application for eight weeks. They were also asked to measure and save their BP in the application every two weeks.	–	There was a significant difference between the intervention and control groups regarding the mean score of self-care behaviors (4.13 ± 0.23 versus 3.18 ± 0.27, $p < 0.001$). Additionally, a significant difference was observed between the two groups concerning the mean scores of the two subscales of self-care behaviors, including "medication taking" and "proper diet".

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including its psychometric properties and utility in various patient populations. Although the majority of the articles in this systematic review applied HBCHBPT scales to patients with hypertension, the scales have also been used with other disease conditions such as diabetes, Alzheimer's' disease, and inflammatory bowel disease. The Cronbach's α for studies that reported this statistic ranged from 0.62 to 0.88. In addition, we observed variation in the use of the 14-item scale or the 9-item medication adherence subscale. The HBCHBPT scales have also been used in randomized clinical trials to measure improvements in medication adherence and the prediction of improved blood pressure measurements and control. The high predictive validity of the scale is a distinct strength of this scale and the reason for its popularity.

Hypertension is a leading independent risk factor for cardiovascular diseases, renal disease, stroke, and death.[1] Self-report measures of hypertension are strongly associated with adverse cardiac events, including myocardial infarction, coronary heart disease death, and stroke.[69] However, there are limitations, such as recall bias and social desirability. One of the most important factors associated with hypertension control is medication non-adherence, which increases the risk of severe cardiovascular disease and death from 50–80%.[70] About half of the persons with cardiovascular diseases or major risk factors (ie, hypertension) have poor adherence,[71] and only about half of persons with hypertension achieve blood pressure control. The HBCHBPT scale was developed as an indirect method of measuring hypertension medication adherence, including items on medication adherence, appointment keeping, and diet. The brief instrument, which can be administered by self-administration or interview in less than five minutes, is designed to augment care in the clinical setting by assessing for self-reported adherence to hypertension therapy, facilitating the planning of individualized hypertension care, and research design adherence interventions.[15]

A subsequent version of the original scale, the Hill-Bone Medication Adherence Scale (HBMAS), has recently been derived from the full scale to specifically measure medication adherence.[72] The newer instrument includes 9 items assessing medication adherence in the original HBCHBPT scale. Several studies have demonstrated the reliability of the 9-item medication adherence subscale.[21,33,73,74]

This systematic review revealed that the scales' utility has expanded from assessing adherence to hypertension and/or cardiovascular disease medication to include other conditions such as diabetes, Alzheimer's, and inflammatory bowel disease. This is important as medication non-adherence is equally vital in chronic conditions such as stroke, diabetes, and Alzheimer's disease. For instance, medication adherence in patients with stroke is 64%,[75] and about 45% in patients with diabetes,[76] about 17–100% in older adults with Alzheimer's dementia.[77] In inflammatory bowel disease, non-adherence has been found to range from 7%-72%[78] and varies between 17–74% for chronic kidney disease.[79]

The reproducibility of the scales in various settings and populations is notable This review showed that the scale was administered in different populations, including adults with various chronic diseases, cognitive impairments, older adults, and African American and Asian populations. Based on these diverse populations, the lowest Cronbach's α observed among the studies validating the scales in other populations was 0.62, while the highest was 0.88. This range of Cronbach's α is desirable as extremely high internal consistency ≥ 0.95 reduces sensitivity and room for capturing changes due to an intervention, hence a less desirable feature of an intervention evaluation measure.[80,81] This range of Cronbach's α was compared to that of the full HBCHBPT scale, which was 0.74 and 0.84, and the average interitem correlations of the 14 items of 0.18 and 0.28, respectively.[15] In this review, although studies have reported relatively high reliability, validation studies are needed to assess the scales' appropriateness in various other populations. Additionally, the dearth of data on the optimal recall period limits and the lack of a gold-standard self-report measure limits the process of selecting a medication adherence scale,[71] including the HBCHBPT scale. Beyond the HBCHBPT scale, the most widely used validated scales to measure medication adherence are the Morisky Medication Adherence Scale (MMAS-8),[82] the Morisky-Green-Levine test,[83] the Medication Adherence Self-Efficacy Scale (MASES)[84] and The Brief Medication Questionnaire.[85]

There are various reasons to choose the Hill-Bone scales for use in research and practice. The ease of use and brevity of the scales may have contributed to their administration in various settings. This review showed that the HBCHBPT scales were used in primary health centers, specialty clinics, hospitals, and community health centers. This has significant implications for the clinical use of the scales. Its performance in this myriad of clinical settings suggests stability in its ability to accurately estimate self-reported medication adherence regardless of clinical setting or patient population.

Furthermore, the HBCHBPT scale demonstrated adequate sensitivity to capture any change due to intervention with varying degrees of intensity. The early investment in efforts to establish the predictive validity of the scale by the original developers resulted in valuable measures in both descriptive and intervention research settings.

In addition, the scale permits self-administration; in this review, most of the articles reported self-administration, and fewer were interviewer-administered. This has significance for using these scales in low- and middle-income countries (LMICs) where medication adherence is notably lower due to various factors, including weaker health infrastructure and healthcare access inequality. Thus, there is a need to evaluate medication adherence appropriate to LMICs where the burden of chronic diseases is increasing, and challenges with medication utilization are higher.[86] Finally, the scale may be obtained free of charge upon request for permission for their use; this would further improve the scales' utility, particularly in low-resource settings. This paper offers a global perspective on the use of the scales and how they contribute to addressing global healthcare challenges related to treatment adherence, hamper optimal healthcare outcomes. In particular, this review highlights the usability, translatability, and scalability of the HBCHBPT scales across multiple countries, populations, and cultures. This review also shows that the HBCHBPT scales can be administered by various healthcare work cadres, such as community health workers, etc., among diverse populations and in low resources healthcare settings; thus, presenting important evidence that the scales have been used globally to aid clinical decision-making.

Another major strength of the scale is its high clinical utility in personalized care; the scales have been used to guide personalized intervention based on individual adherence types (intentional vs non-intentional). For instance, educational intervention can be provided to people who are intentionally not taking medications due to myths or insufficient knowledge.[74] For people who are missing medications due to unintentional reasons (eg, cognitive decline, busy schedule), habit forming (cognitive-behavioral) intervention was applied.[74] The HBCHBT scale has an adequate number of items that allow researchers and clinicians to identify the causes of their adherence barriers. Given that the field is moving to precision health paradigm, the ability of the scale to phenotype adherence is critical and can be a basis for precision and personalized intervention, according to psychosocial phenotyping) to improve adherence to high blood pressure treatment regimen.

This study has revealed some weaknesses of the scale. The appointment-keeping and salt intake subscales suffer from relatively low item-to-total correlations or low Cronbach's α due to low numbers of items in those subscales. To continue to be a comprehensive adherence measure for high blood pressure self-management support programs, those subscales should be considered to add a few theoretically meaningful and behaviorally relevant items.

Conclusion

The reported validity and reliability measures for the HBCHBPT scales continue to vary slightly across settings, highlighting the need for better psychometric properties. Due to the heterogeneity of the data collection methods, analyses, and follow-up times, we could not obtain an overall effect size through a meta-analysis. Studies varied in terms of treatment groups, follow-up times, and outcomes. Moreover, few RCT studies measured medication adherence as an outcome. Despite these drawbacks, our systematic review has some strengths. To our knowledge, this is the first review providing a systematic evaluation of the use of the HBCHBPT scale across different contexts. We have provided contemporary evidence on the scales' psychometric properties in studies examining different health conditions and behaviors. Translation of the original English version of the HBCHBPT scale into 25 different languages, did not compromise the clinical utility of the scale. We have also demonstrated the versatility of the scale and reach across six different World Health Organization (WHO) regions.

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Disclosure

Ms Lauren Smulcer reports being the spouse of an active duty Army officer; her spouse receives salary from the federal government as an active duty soldier. The authors report no other conflicts of interest in this work.

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