Psychometric Performance of the Mental Health Implementation Science Tools (mhIST) Across Six Low- and Middle-income Countries

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Keywords: mental health, implementation measurement, psychometrics, low- and middle-income countries

Posted Date: December 3rd, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-1075566/v1>

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Abstract

Background

Existing implementation measures developed in high-income countries may have limited appropriateness for use within low- and middle-income countries (LMIC). In response, researchers at Johns Hopkins University began developing the Mental Health Implementation Science Tools (mhIST) in 2013 to assess priority implementation determinants and outcomes across four key stakeholder groups – consumers, providers, organization leaders, and policy makers – with dedicated versions of scales for each group. These were field tested and refined in several contexts, and criterion validity was established in Ukraine. The Consumer and Provider mhIST have since grown in popularity in mental health research, outpacing psychometric evaluation. Our objective was to establish the cross-context psychometric properties of these versions and inform future revisions.

Methods

We compiled data from seven studies across six LMIC – Colombia, Myanmar, Pakistan, Thailand, Ukraine, and Zambia – to evaluate the psychometric performance of the Consumer and Provider mhIST. We used exploratory factor analysis to identify dimensionality, factor structure, and item loadings for each scale within each stakeholder version. We also used alignment analysis (i.e., multi-group confirmatory factor analysis) to estimate measurement invariance and differential item functioning of the Consumer scales across the six countries.

Findings

All but one scale within the Provider and Consumer versions had a Cronbach's alpha greater than 0.8. Exploratory factor analysis indicated most scales were multidimensional, with factors generally aligning with *a priori* subscales for the Provider version; the Consumer version has no predefined subscales. Alignment analysis of the Consumer mhIST indicated a range of measurement invariance for scales across settings (R^2 0.46 to 0.77). Several items were identified for potential revision due to participant non-response or low or cross- factor loadings. We found only one item – which asked consumers whether their intervention provider was available when needed – to have differential item functioning in both intercept and loading.

Conclusion

We provide evidence that the Consumer and Provider versions of the mhIST are internally valid and reliable across diverse contexts and stakeholder groups for mental health research in LMIC. We recommend the instrument be revised based on these analyses and future research examine instrument utility by linking measurement to other outcomes of interest.

Contributions To The Literature

- Current implementation measures have limited appropriateness outside the high-resource, Western contexts where they were developed.
- We present a set of tools for the measurement of priority implementation outcomes and determinants with consumers and providers of mental health interventions in low- and middle-income countries.
- Use of these tools has rapidly outpaced psychometric evaluation.
- Our study expands the field of implementation science by being the first, to our knowledge, to examine the psychometric performance of implementation measures across multiple low- and middle-income countries.
- We provide evidence that these measures are reliable and internally valid, and make some recommendations for improvement.

Background

Substantial progress has been made over the past two decades to build an evidence base for mental health services within low- and middle-income countries (LMIC) [1]. Due to a dearth of specialist mental healthcare providers in many LMIC, much of the growing evidence base has focused on treatment approaches delivered by lay health workers. There are now dozens of randomized controlled trials (RCTs) supporting the effectiveness of psychotherapy delivered by non-specialist health workers for depression, anxiety, posttraumatic stress, substance use and violence [2–4], with over 20 RCTs focused on the implementation of the World Health Organization's Mental Health Gap Action Programme alone [5]. Having established the effectiveness of interventions and approaches

within research contexts, a major challenge facing researchers and practitioners is the implementation of this evidence base into mental healthcare systems of LMIC.

In mental health, as in many areas of health, the gap between evidence and practice is typically greatest in LMIC [6] and implementation science has been recognized as the next step in the evolution of global mental health [7, 8]. Implementation science aims to provide researchers and practitioners with tools to support the integration of evidence-based care into routine practice. Among these tools, quantitative implementation measures enable researchers to assess key determinants of implementation effectiveness and to evaluate implementation efforts according to the outcome domains of adoption, acceptability, feasibility, appropriateness, penetration, cost, fidelity, and sustainability [9, 10]. However, valid and reliable implementation measurement remains a challenge within mental health research in all contexts, due in part to the complexity of operationalizing concepts associated with implementation determinants and outcomes [11]. A review by Lewis et al. [12] identified 104 measures relevant to implementation science for mental or behavioral health. Of these, only one measure had minimal evidence for psychometric strength across six of their psychometric criteria, which include reliability, structural validity, criterion validity, norms, sensitivity to change, and length.

Mental health implementation research in LMIC is also impeded by the limited applicability of existing measures for use outside high-income contexts. Most implementation measures originate in Western high-income countries and rely on assumptions about healthcare that do not necessarily hold globally, often reducing their appropriateness for use within LMIC or lower-resource contexts within high-income countries [12, 13]. There are important differences in health system structures and financing, particularly the role of insurance and payment mechanisms, between high-income countries and LMIC [14]. Mental health services in LMIC are frequently provided by non-specialist health workers (e.g., nurses, community health workers, peers) rather than physicians or other specialist providers [15]. Evidence-based approaches to expanding mental healthcare coverage often rely on primary care or community-based platforms for service delivery; recipients of mental health interventions may rarely have contact with secondary or tertiary mental health facilities [16, 17]. Mental health implementation measurement is also limited because of choices in scale development; most implementation measures tend to be long and focus only on a single stakeholder group (e.g., intervention providers versus recipients), making their use less pragmatic for field research. Because of these limitations, a major barrier to implementation science globally is the lack of pragmatic, accurate, and relevant implementation measurement, particularly valid and reliable implementation measures for global mental health.

In light of these challenges, researchers at Johns Hopkins University developed a series of measures to evaluate priority determinants and implementation outcomes for mental health interventions specifically in LMIC [18]. The Mental Health Implementation Science Tools (mhIST; pronounced “mist”) evaluate mental health interventions and programming according to the domains of implementation science defined by Proctor et al. [9] (Table 1). There are dedicated scale versions for each of three key stakeholder groups: 1) program consumers, 2) program providers, and 3) organizational level staff and leaders. The scale developers also adapted two additional measures for use in LMIC, the Implementation Leadership Scale [19] and the Program Sustainability Assessment Tool [20], which were not evaluated in the current study.

The mhIST is designed to be pragmatic and address limitations encountered when attempting to employ implementation measures developed for high-resource contexts. The original versions were pilot tested in Iraq and Myanmar [21, 22] which informed one round of revision (i.e., v1.0 to v2.0). After this initial process, Haroz et al. [18] validated the Consumer mhIST using a mixed-methods approach in Ukraine. Their qualitative findings informed further measure adaptation and led to the inclusion of additional context-specific items in Ukraine. Their quantitative findings demonstrated good evidence for the internal reliability and criterion validity of the instrument using a vignette-based validation approach, where respondents used the mhIST to report on descriptions of high- and low-performing mental health programs. Internal consistency reliabilities of the instrument scales ranged from α 0.85 to 0.91 and test-retest reliabilities were acceptable to good for all scales (ρ : 0.61–0.79). Total scale scores significantly differed by vignette assignment (odds ratios: 2.21–5.6) and overall ratings (odds ratios: 5.1–14.47), supporting criterion validity. While these initial validation studies have been limited, several researchers have begun employing the mhIST, including within research in South Africa, Kenya, Pakistan, Sierra Leone, and recently in the United States [23–27].

Given the growing use of the mhIST, there is an urgent need to better understand its psychometric properties, particularly across diverse cultures and contexts. For this study, we evaluated the internal reliability, dimensionality, and individual item performance of the Consumer and Provider mhIST using secondary data from seven recent studies of mental health interventions in six LMIC: Colombia, Pakistan, Myanmar, Thailand, Ukraine, and Zambia. Our objective was to establish the cross-context psychometric properties of these

versions and inform future revisions. We then provide recommended revisions where individual items or scales did not perform acceptably.

Methods

Instrument development

Researchers from Johns Hopkins University populated the mhIST through four steps. First, they delineated and operationalized implementation determinants and outcomes in the context of LMIC, based on outcome domains defined by Proctor et al. [9, 10]: acceptability, adoption, appropriateness, feasibility, fidelity, reach, organizational climate, and leadership. Second, they mapped domains and constructs from two leading implementation science frameworks – the Consolidated Framework for Implementation Research [28]; and the Exploration, Preparation, Implementation and Sustainment framework [29] – to these outcomes. Third, scale developers solicited input on additional domains, constructs, content, and structure from experts in the field of international health, health systems, global mental health, and implementation science. Lastly, implementation domains and constructs were formulated into items with Likert scale response options.

The Consumer and Provider mhIST have been more commonly used in implementation research and are the focus of the present study (Tables S1 and S2). The Consumer version includes scales for the domains of Adoptability (AD; 9 items), Acceptability (AC; 17 items), Appropriateness (AP; 13 items), Feasibility (FS; 14 items), and Accessibility (RA; 8 items). The Provider version has a scale for each of these domains – Adoptability (9 items), Acceptability (13 items), Appropriateness (16 items), Feasibility (20 items), and Accessibility (9 items) – as well as scales for Organizational Climate (OC; 18 items), and General Leadership (GL; 9-items). Also included in the Provider mhIST is the Implementation Leadership Scale (12 items) [19], which was slightly modified (e.g., removal of some items, slight rewording of items) during formative work with stakeholders. Most domain scales of the Provider mhIST are further delineated into subscales, such as those distinguishing between the acceptability of the intervention and of individual professionalism within the Acceptability scale. Respondents are asked to rate each item using a four-point Likert scale with the options of “Not at all,” “A little bit,” “A moderate amount,” and “A lot.” Response options also include “Don’t know” and, when appropriate, “Not applicable”. Scales are then scored by calculating the response mean across all items for each scale. Researchers are also encouraged to review low-scoring items for potential program barriers and challenges, such as confidentiality concerns due to a lack of private space (item FS14).

Subjects and settings

We pooled data from seven studies to evaluate the performance of the mhIST within and across multiple LMIC (Table 2). Data included responses from consumers and providers of mental health interventions from most study sites. Only provider data are included from Lee et al. [22] because study authors made substantive changes to the Consumer mhIST given their target intervention recipients (i.e., consumers) were children. For the two in Zambia, one administered the mhIST only to providers [30] while another administered the mhIST only to intervention recipients [31].

Myanmar & Thailand: Adults

From 2011-2013, researchers from Johns Hopkins University conducted an RCT of the Common Elements Treatment Approach (CETA) among adult refugees and informal migrants from Myanmar in Mae Sot, Thailand [32]. CETA is a transdiagnostic adaptive treatment approach for mental and behavioral disorders developed to be delivery by lay counselors in settings with few mental health professionals [33]. Following the trial, Lee et al. [21] used the mhIST to study continued CETA implementation in Mae Sot as well as expand to Yangon and Karen State in Myanmar. A total of 198 participants across three sites completed the Consumer version, with all but one having fully completed the intervention at the time of response. Thirty-four lay mental health providers from the implementing organizations also completed the provider version. At the time of data collection, providers had completed an average of 48 CETA cases.

Myanmar: Youths

Lee et al. also led a study of the adaptation and implementation of CETA for internally displaced youths in Kachin State, Myanmar [22]. Their research was motivated by concerns from stakeholders about youth mental health and requests for child-focused services from community-based organizations in northeastern Myanmar [34]. Lay health workers provided an adapted version of CETA to youths in six camps for displaced persons who had been exposed to conflict, violence, or other types of trauma and who met criteria for moderate to severe psychological distress. Eighteen providers from two implementing organizations who had been trained in CETA and received

ongoing supervision for the duration of the study period completed the Provider mhIST. At the time of data collection, providers had completed an average of six CETA cases.

Ukraine

Murray et al. [35] conducted an RCT comparing brief and standard versions of CETA among those affected by conflict between pro-Russian separatists and Ukrainian loyalists. Intervention recipients were adults who were internally displaced persons, military and para-military veterans, and others affected by conflict; all participants initially reported elevated symptoms of depression or post-traumatic stress and functional impairment. The mhIST were adapted through a qualitative study and previously validated in the study setting [18]. In the current study, 77 recipients completed the Consumer mhIST, with all but five having completed the intervention. Thirty providers who were Ukrainian psychologists, social workers, and lay health workers completed the Provider mhIST. At the time of data collection, providers had been delivering CETA for an average of 22.5 months and had an average of 11.1 years of experience working in mental health.

Colombia

Marsch et al. [36] conducted a modified stepped-wedge implementation study of integrating mental health services for depression and alcohol use disorder into 6 primary care systems in Colombia. Their integration strategy relied on digital tools to detect, manage, and deliver services for depression and alcohol use disorder within primary care. Services provided during the study relied on elements of behavioral activation, problem solving therapy, and cognitive behavioral therapy delivered via digital platform, and included pharmacotherapy when indicated [36]. At the time of data collection, mhIST had been administered to 117 consumers at 6- and 12-months after being exposed to the mental health care model. Thirty nonspecialist primary care workers completed the Provider mhIST at the time they launched the mental health care model at their site and every 6 months thereafter for up to 2 years. We used available data from the most recent survey administration from each respondent in the present study.

Pakistan

Hamdani et al. [37] conducted an effectiveness implementation-hybrid randomized controlled trial of the World Health Organization Parents Skills Training program [38] in rural Pakistan. Caregivers of children with developmental delays received either skills training or enhanced treatment as usual, the latter including provider training in the detection and management of developmental disorders. One-hundred sixty-six caregivers completed the Consumer mhIST six months after program implementation. Providers were caregivers of children with developmental disorders who volunteered to be trained by trainers and provide skills training throughout the duration of the program; 10 providers completed the Provider mhIST six months after program implementation.

Zambia: Families

Kane et al. [39] conducted an RCT of CETA compared to treatment as usual plus safety checks among heterosexual families in which the woman reported recent IPV perpetrated by her current male partner and in which the male partner had unhealthy alcohol use. The trial was ended early based on recommendation of the data and safety monitoring board due to an interim data analysis indicating a clear benefit of CETA at 12 months; participants in the control arm were then offered CETA [31]. Study investigators followed the original CETA participants for an additional 12 months for a 24 month post-baseline assessment [40]. Family members, including adolescents, in the CETA arm completed Consumer mhIST following their 12-month post-baseline assessment. Adolescent responses were included since the no substantive changes were made to the instrument for different age groups. Providers were local lay counselors with no previous formal mental health training; they did not complete mhIST.

Zambia: Youths

Murray et al. [41] completed an RCT of trauma-focused cognitive behavioral therapy compared to enhanced psychosocial counseling in reducing HIV risk behaviors among adolescents in Zambia. Intervention recipients were adolescents who were orphans or vulnerable children and who exhibited HIV risk behaviors. Providers were lay health workers who had at least a high school education and demonstrated basic communication and social skills; only one provider had previous training in mental health. Provider mhIST were administered to all 101 providers at the end of the study. Adolescent participants did not complete Consumer mhIST as a part of the study.

Analysis

Item Comparison

We first reviewed English-language versions of the instrument from each site to ensure site-specific cultural adaptations did not impede item cross-comparability. Consumer data from Lee et al. [22] were excluded at this stage because of substantive changes to the

instrument for youth respondents. We combined item responses from all sites where items were an exact or near match into a single dataset for cross-site analysis.

Factor structure

We used exploratory factor analysis (EFA) to examine dimensionality and item loadings for each domain scale separately within the Consumer and Provider versions (rather than pooling all items within each version). EFA was guided by model fit statistics and parallel analysis using an oblique Geomin rotation in Mplus [42]. We expected factors identified during EFA of the Provider mhIST domain scales to align with subscales defined during scale development (Table S2). As no additional subscales were defined for Consumer mhIST, there was no pre-specified expectations for factor structure of Consumer scales.

We calculated Cronbach's alpha (α) for each scale as measure of internal reliability. We also identified items for further review which had a high non-response rate (i.e., more than 20% of respondents selecting "Don't know" or "Not applicable"), low covariance (< 0.1), cross-loading onto multiple factors, or a factor loading less than 0.4 [43]. Prior to cross-site analysis, we conducted EFA of each Consumer scale within each site, which informed methods used during cross-site analysis and are not presented here.

Where feasible, we drew a stratified random sample of two-thirds of respondents from each study site for cross-site EFA when examining Consumer mhIST scales and used the remaining third for validation [44]. The full sample was used, rather than a split sample validation approach, due to sample size constraints for the Provider mhIST and remaining Consumer scales. Results of the cross-site EFA informed the factor structure for the alignment analysis. If an item did not load onto a factor in the EFA, it was excluded from alignment.

Alignment

Lastly, we used alignment analysis to estimate measurement invariance and differential item functioning of Consumer scales; sample sizes were underpowered for alignment analysis of the Provider mhIST. Alignment analysis, i.e., multi-group confirmatory factor analysis, allows researchers to estimate group-specific factor means and variances without requiring exact measurement invariance [45]. It also produces an estimate of parameter invariance for model parameters in each group and can be used to evaluate the performance of a measure across multiple groups or settings. An additional benefit of the alignment method is the use of pairwise – rather than listwise – comparison tests, i.e., responses from an individual are used even when some of the individual's other response data are missing. As a result, the analysis is not impeded by missing or nonresponse data to the same extent as those relying on listwise comparisons.

We identified items for further review where alignment analysis indicated measurement non-invariance in factor loading or intercept across more than one site and for which the item level non-invariance impacted variance in factor scores across sites. We also report the average item invariance for each scale using the R^2 index, where 1 indicates full scalar invariance and 0 indicates full scalar noninvariance [45]. EFA and alignment analysis were used to examine dimensionality, factor structure, and measurement invariance of the mhIST. These results were then combined with *a priori* theory from the scale development process to comment on instrument performance and potential revisions.

Ethics

This study relies on secondary data analysis and was approved by the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health (#00000287).

Results

We compiled responses to the mhIST from $N = 817$ consumers and $N = 223$ providers of mental health interventions in six countries (Table 2). Average age across studies ranged from 35.0 to 54.7 among consumers and 27.6 to 44.3 among providers. Provider qualifications differed considerably across settings. Studies in Ukraine and Colombia primarily relied on formal health workers, while those in Myanmar, Thailand, Pakistan, and Zambia used briefly trained lay health workers or peers to deliver interventions.

Consumer Version

Exploratory Factor Analysis

Each scale of the Consumer mhIST was designed to measure a single implementation determinant or outcome. However, EFA results indicated only the Accessibility scale was unidimensional, where all but one item loaded onto a single factor for the Accessibility scale (Table 3). This non-loading item asked consumers whether they had a problem with the wait time before beginning the intervention (RA02) and has been reworded in subsequent use to not be reverse coded. Items on the Adoptability scale grouped around two factors: one focused on whether consumers had previously discussed the intervention with others and another on the likelihood of consumers using the intervention in the future. One Adoptability item (AD06), which asked consumers about whether they have encouraged others to seek out the intervention, cross-loaded onto both factors. Items on the Acceptability scale also loaded onto two distinct factors. The first focused on the experience of the consumer during the intervention, while the second factor focused on consumer perceptions of the provider (e.g., AC13: Did you feel that you could trust your counselor?). A single item (AC15), which asked consumers whether they understood the way things were explained during the intervention, did not load onto either factor.

EFA of the Appropriateness scale also indicated items loaded onto two factors: one related to intervention fit with culture and values, and another related to consumer perceptions of intervention effectiveness. Three items did not load onto either factor (AP3, AP6, and AP8). Lastly, the Feasibility scale was the only scale to have three factors identified in EFA and it also had the most variability in structure when comparing EFA results within and across sites. The three factors within the Feasibility scale focused on 1) consumer availability to engage in intervention components; 2) consumer resources for completing the intervention (e.g., funds for transportation); and 3) consumer perceptions of the location where the intervention was delivered. A single item about the ability of community members to seek out the intervention without stigma (FS15) did not load onto any factor.

Alignment

Results of the alignment analysis indicate the Consumer mhIST were relatively invariant across the six sites with consumer data, with an R^2 ranging between 0.46 to 0.77 for each scale (Adoptability = 0.77, Acceptability = 0.65, Appropriateness = 0.69, Feasibility = 0.48, and Accessibility = 0.46). Most items were invariant across sites and only one item had non-invariant loadings in both loading and intercept across more than one site (AC12); this item asked consumers whether their provider was available when needed. Overall, several items from the Consumer mhIST were identified for further review due to nonresponse (25%), non-invariant loading (3%), or non-invariant intercept (7%); no items were found to have low covariance (Table 4).

Provider version

The total number of providers from each site is much smaller the number of consumers, ranging in sample size from 10 to 34 in five out of six studies where provider data was available. A notable exception is the trial of trauma-focused cognitive behavioral therapy in Zambia [41], where 101 providers completed the mhIST. Small provider sample sizes precluded cross-site alignment analysis. However, EFA of provider data from all sites combined yielded informative results. We identified between one to four factors for each of the Provider scales (Table 5).

Factors identified through EFA generally aligned with *a priori* subscales of the Provider mhIST (Table S2), with the exception of the Adoptability scale. Despite no pre-defined subscales, EFA indicated items in the Adoptability scale grouped around the following themes: 1) past discussions about program within the organization, 2) past discussions outside the organization, and 3) future program provision. Factors of the Acceptability scale generally aligned with the two subscales “Program/Treatment” and “Individual Professionalism”. The Appropriateness scale appeared to have two factors within the “Social/Cultural” subscale, while the remaining factors generally align with the subscales of “Self Perception of Effectiveness” and “Task Fit”. Rather than the four subscales defined by the scale developers, EFA indicated the Feasibility scale had only two factors: one relating to provider time and another to provider support and resources. The Accessibility scale, which has no predefined subscales, performed unidimensionally.

The mhIST developers included two additional scales in the Provider version not present in the Consumer, Organizational Climate (OC) and General Leadership (GL). The factor structure of the Organizational Climate scale generally aligns with the two predefined subscales: “Personal Feelings at Work” and “Perceived Work Environment”. The General Leadership scale performed unidimensionally, with all items loading on a single factor. Several items were identified for review during cross-site analysis due to non-response (19%) or low factor loading (7%); no items had low covariance (Table 6).

Discussion

Our study is the first to evaluate the psychometric performance of a set of implementation measures, the Mental Health Implementation Sciences Tools (mhIST), across several countries. After aggregating responses from 814 consumers and 223 providers of mental health interventions across six countries, we examined item performance and measure structure for each scale within the Consumer and

Provider versions of the mhIST. Our findings provide evidence of the internal validity and reliability of the instrument in diverse settings at these two levels and highlights areas for further scale refinement through item-level review and subscale revisions.

We found evidence for good to excellent internal reliability of the Consumer mhIST, with a Cronbach's α greater than 0.8 for all scales. However, factor analysis indicated four of five scales are multidimensional, in which case Cronbach's α may not be the best indicator of reliability, despite a high α [46]. We also provide evidence the Consumer scales measure the same constructs across populations and settings; alignment analysis indicated acceptable levels of invariance for all five measures, though there was considerable range in the invariance index [45, 47]. Lastly, we highlighted items across all scales that merit further review and potential revision due to participant nonresponse, low factor loadings, or non-invariance; no item meet the criterion for low covariance. Our results can inform future iterations of the mhIST for an enhanced valid and reliable cross-cultural set of measures.

We found scales within the Provider mhIST to have similar internal reliability to those within the Consumer version, with an α of at least 0.8 for all Provider scales except Adoptability. In contrast to the Consumer version, several of the Provider scales were defined to have subscales during scale development. Results indicated five of eight scales were multidimensional during factor analysis, with dimensionality generally aligning with predefined subscales. Unfortunately, the small number of providers from each study did not allow for adequately powered alignment analysis. Measurement invariance of the Provider scales is therefore relatively unknown. Only six items were identified for review and potential revision due to low or cross item loading.

These findings build on the research of Haroz et al. [18] to provide additional evidence of reliability and validity for a set of implementation measures developed specifically for mental health interventions in LMIC. Estimates of internal consistency for the mhIST were good to excellent for nearly all scales, comparable to estimates reported by Haroz et al. [18], and greater than internal consistency estimates from most measures identified in a review of implementation science measures by Clinton-McHarg et al. [13]. Internal consistency estimates for the Acceptability, Appropriateness, and Feasibility Provider scales were slightly lower than those reported for the alternative Acceptability, Appropriateness, and Feasibility measures developed by Weiner et al. [48], though both sets of measures have demonstrated excellent psychometric properties and have distinct advantages and disadvantages. The scales developed by Weiner and colleagues are short, unidimensional, and efficient measures of their respective implementation outcomes, though their simplicity also means they carry limited explanatory power. In addition, translation of the subtle English synonyms used in each scale may be challenging or impossible in diverse global contexts. The mhIST scales are longer, multi-dimensional, and less efficient and the scales developed by Weiner and colleagues, though their complexity derives from their explanatory power. In fact, individual mhIST items can be helpful to guide programmatic needs and adaptations, independent of scale summary scores.

While our work identified items for revision or removal based on psychometric properties, there may be other reasons to retain items. Items with low or cross factor loadings may have still have individual utility despite not aligning within the scale or subscale for which it was developed. For example, an item asking whether consumers understood the way in which things were explained may still provide useful program information despite not sufficiently loading onto a factor in the Acceptability scale. It may be preferable to retain and separate items with low or cross loadings, rather than removing them completely, since each scale is intended to be averaged to provide a summary score for the given implementation outcome or determinant. Other measures in the literature may not capture the breath of potential items related to an implementation domain [12]. While this has benefits for psychometrics, ultimately it may not be that informative for implementation studies. The ability of the mhIST to both be scored as scales representative of an underlying construct, and to track item-level indicators of implementation, enables flexibility for research and practice use.

Limitations

Our primary limitation was the inability to evaluate measurement invariance of the Provider mhIST due to the small sample sizes of intervention providers within each contributing study, except for the trial of trauma-informed cognitive behavioral therapy in Zambia [41]. Small sample sizes preclude both within-site EFA and cross-site alignment analysis, which would provide information on how measure structure and item performance may differ across the six settings. The large sample of providers from Zambia relative to other settings also disproportionately weights results to responses from Zambian providers in the EFA of pooled Provider mhIST data, i.e., these results are more representative of Zambian providers than those from other settings. Small sample sizes also precluded cross-validation methods to prevent overfitting of the alignment analysis. Nonresponse was an issue for some items. However, since the aim of the study is a pragmatic evaluation of measure performance, nonresponse is in fact informative and useful when considering how the instrument may be improved. We also mitigate the impact of missing data in our analysis by use of pairwise rather than listwise comparison in EFA and alignment analysis, allowing for the inclusions of observations with some data missing. Finally, while all data came from consumers or providers of mental health services in LMIC, the data may have differed on other important factors that may

contribute to cross-site comparison (e.g., type of mental health intervention, demographics of the samples). Due to sample sizes we were unable to control for these potential confounders.

Findings from our study should be interpreted alongside a few considerations. The first is the need to balance theory- and data-driven approaches within psychometric research. The mhIST took over five years to develop and was based on leading theoretical frameworks and existing measures, expert consultation, and pilot tests. Data from the seven studies included in this analysis indicate how the instrument performed across diverse settings. Nonetheless, results should not be considered prescriptive. For instance, removing an item may lead to modest improvements in internal reliability or measurement invariance, though this evidence should be weighed alongside *a priori* theory and reasoning. Second, the scope of the present study does not include all relevant types of validity and reliability, such as test-retest reliability, criterion validity or predictive validity. Further research in these areas will become feasible as the mhIST are more widely adopted within global mental health research. The development of a centralized repository would help to standardize and facilitate future psychometric research of implementation instruments. Lastly and relatedly, our findings are limited by the lack of gold standard validation approaches within implementation research. While some studies have used vignette-based approaches [18, 48], in general measurement in implementation research is impeded by the complexity of defining and operationalizing major domains of implementation science. There is a need to establish best practices for validation techniques for implementation research in mental health, particularly within LMIC.

Conclusion

We found the Consumer mhIST performed similarly across diverse populations and contexts within LMIC and provide psychometric evidence of item performance and measure structure for the Consumer and Provider versions. Our findings will ultimately inform a future iteration of the mhIST that is based on retaining items robust across settings and serves as a valid and reliable tool for implementation research in mental health within LMIC.

Abbreviations

AC: Acceptability; AD: Adoptability; AUD: alcohol use disorder; AP: Appropriateness; BA: behavioral activation; CBT: cognitive behavioral therapy; CETA: Common Elements Treatment Approach; EFA: Exploratory factor analysis; FS: Feasibility; GL: General Leadership; IDP: internally displaced persons; IPV: interpersonal violence; OC: Organizational Climate; LMIC: Low- and middle-income countries; mhIST: Mental Health Implementation Science Tools; PST: problem solving therapy; RA: Accessibility; SD standard deviation; TF-CBT trauma-focused cognitive behavioral therapy

Declarations

Ethics approval and consent to participate

This study relies on secondary data analysis and was approved by the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health (FWA #00000287).

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from corresponding authors of each contributing study but restrictions apply to the availability of these data, which were used under agreement for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission from corresponding authors of contributing studies.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was funded by a grant from the National Institute of Mental Health (#R01MH115495-02S1; PIs: Laura Murray, Izukanji Sikazwe). LA was supported by a T32 training grant in Mental Health Services and Systems from the National Institute of Mental Health (#T32MH109436; PIs: Emma Elizabeth McGinty, Elizabeth A. Stuart). JK was supported by a grant from the National Institute on Alcohol Abuse and Alcoholism (#K01AA026523). AJN was supported by the iTHRIV Scholars Program; the iTHRIV Scholars Program is supported in part by the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Numbers UL1TR003015 and KL2TR003016 as well as by the University of Virginia. LM and JU were supported by a grant from the National Institute of Mental Health (#U19MH109988; PI: Lisa Marsch). EH was supported by a Mentored Career Development Award from the National Institute of Mental Health (#K01MH116335).

Authors' contributions

All listed authors qualify for authorship based on making one or more substantial contributions to the manuscript according to the Contributor Roles Taxonomy. LA, EH, JB, PB, and LKM contributed to the conceptualization of this study. LA, AN, EH contributed to formal analysis. LA wrote the original draft of the manuscript; AN, CK, KD, EH, JB, and LKM contributed to reviewing and editing subsequent drafts of the manuscript. LKM, EH, JB, AN, PB were involved in original scale development. JK, JB, SH, JU, AN, LAM, LKM, and PB contributed to data acquisition, data curation, and investigation. All authors read and approved the final manuscript.

Acknowledgements

We are grateful to the multitude of people who were involved the studies from which we analyzed data, namely the researchers who oversaw measure administration and the intervention providers and recipients who completed the measures.

References

1. Patel V, Saxena S, Lund C, et al. The Lancet Commission on global mental health and sustainable development. *Lancet* 2018; 392: 1553–1598.
2. Singla DR, Kohrt BA, Murray LK, et al. Psychological Treatments for the World: Lessons from Low- and Middle-Income Countries. *Annu Rev Clin Psychol* 2017; 13: 149–181.
3. van Ginneken N, Tharyan P, Lewin S, et al. Non-specialist health worker interventions for mental health care in low- and middle-income countries. *Cochrane Database Syst Rev*, 11. Epub ahead of print 2011. DOI: 10.1002/14651858.cd009149.
4. Cubillos L, Bartels SM, Torrey WC, et al. The effectiveness and cost-effectiveness of integrating mental health services in primary care in low- and middle-income countries: systematic review. *BJPsych Bull* 2020; 45: 1–13.
5. Keynejad RC, Spagnolo J, Thornicroft G. WHO mental health gap action programme (mhGAP) intervention guide: Updated systematic review on evidence and impact. *Evid Based Ment Health* 2021; 1–7.
6. Wainberg ML, Scorza P, Shultz JM, et al. Challenges and Opportunities in Global Mental Health: a Research-to-Practice Perspective. *Curr Psychiatry Rep*, 19. Epub ahead of print 2017. DOI: 10.1007/s11920-017-0780-z.
7. De Silva MJ, Ryan G. Global mental health in 2015: 95% implementation. *The Lancet Psychiatry* 2016; 3: 15–17.
8. Thornicroft G. Evidence-based mental health care and implementation science in low-and middle-income countries. *Epidemiology and Psychiatric Sciences*. Epub ahead of print 2012. DOI: 10.1017/S2045796012000261.
9. Proctor EK, Silmere H, Raghavan R, et al. Outcomes for implementation research: Conceptual distinctions, measurement challenges, and research agenda. *Adm Policy Ment Heal Ment Heal Serv Res* 2011; 38: 65–76.
10. Proctor EK, Landsverk J, Aarons GA, et al. Implementation research in mental health services: An emerging science with conceptual, methodological, and training challenges. *Adm Policy Ment Heal Ment Heal Serv Res* 2009; 36: 24–34.
11. Glasgow RE, Riley WT. Pragmatic measures: What they are and why we need them. *Am J Prev Med* 2013; 45: 237–243.
12. Lewis CC, Fischer S, Weiner BJ, et al. Outcomes for implementation science: An enhanced systematic review of instruments using evidence-based rating criteria. *Implement Sci* 2015; 10: 1–17.
13. Clinton-McHarg T, Yoong SL, Tzelepis F, et al. Psychometric properties of implementation measures for public health and community settings and mapping of constructs against the Consolidated Framework for Implementation Research: A systematic review. *Implement Sci*, 11. Epub ahead of print 2016. DOI: 10.1186/s13012-016-0512-5.
14. Mills A. Health Care Systems in Low- and Middle-Income Countries. *N Engl J Med* 2014; 370: 552–557.

15. Joshi R, Alim M, Kengne AP, et al. Task shifting for non-communicable disease management in low and middle income countries - A systematic review. *PLoS One*; 9. Epub ahead of print 2014. DOI: 10.1371/journal.pone.0103754.
16. Patel V, Chisholm D, Parikh R, et al. Addressing the burden of mental, neurological, and substance use disorders: Key messages from Disease Control Priorities, 3rd edition. *Lancet* 2016; 387: 1672–1685.
17. World Health Organization. *Mental Health Gap Action Programme - Scaling up care for mental, neurological, and substance use disorders*. 2016. Epub ahead of print 2016. DOI: ISBN: 9789241596.
18. Haroz EE, Bolton P, Nguyen AJ, et al. Measuring implementation in global mental health: Validation of a pragmatic implementation science measure in eastern Ukraine using an experimental vignette design. *BMC Health Serv Res* 2019; 19: 1–11.
19. Aarons GA, Ehrhart M. The implementation leadership scale (ILS): development of a brief measure of unit level implementation leadership. *Implement Sci* 2014; 9: 45.
20. Luke DA, Calhoun A, Robichaux CB, et al. The program sustainability assessment tool: A new instrument for public health programs. *Prev Chronic Dis* 2014; 11: 1–11.
21. Lee C, Myo K, Nguyen AJ, et al. *Assessing implementation and scale-up of an evidence-based psychotherapy (CETA) in Myanmar: consumer-level and provider-level perspectives on adult CETA*. 2018.
22. Lee C, Nguyen AJ, Russell T, et al. *Assessing implementation and scale-up of an evidence-based psychotherapy (CETA) in Myanmar: consumer-, caregiver-, provider-, and organization-level perspectives on child CETA*. 2018.
23. Dorsey S, Gray CL, Wasonga AI, et al. Advancing successful implementation of task-shifted mental health care in low-resource settings (BASIC): Protocol for a stepped wedge cluster randomized trial. *BMC Psychiatry* 2020; 20: 1–14.
24. Hamdani SU, Zill-E-Huma, Warraitch A, et al. Technology-assisted teachers' training to promote socioemotional well-being of children in public schools in rural Pakistan. *Psychiatr Serv* 2021; 72: 69–76.
25. Magidson JF, Joska JA, Myers B, et al. Project Khanya: a randomized, hybrid effectiveness-implementation trial of a peer-delivered behavioral intervention for ART adherence and substance use in Cape Town, South Africa. *Implement Sci Commun* 2020; 1: 1–12.
26. Desrosiers A, Schafer C, Esliker R, et al. mHealth-supported delivery of an evidence-Based family home-visiting intervention in Sierra Leone: Protocol for a pilot randomized controlled trial. *JMIR Res Protoc*; 10. Epub ahead of print 2021. DOI: 10.2196/25443.
27. Moore SK, Saunders EC, McLeman B, et al. Implementation of a New Hampshire community-initiated response to the opioid crisis: A mixed-methods process evaluation of Safe Station. *Int J Drug Policy* 2021; 95: 103259.
28. Damschroder LJ, Aron DC, Keith RE, et al. Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science. *Implement Sci* 2009; 4: 1–15.
29. Aarons GA, Hurlburt M, Horwitz SMC. Advancing a conceptual model of evidence-based practice implementation in public service sectors. *Adm Policy Ment Heal Ment Heal Serv Res* 2011; 38: 4–23.
30. Kane JC, Murray LK, Bass JK, et al. Validation of a substance and alcohol use assessment instrument among orphans and vulnerable children in Zambia using Audio Computer Assisted Self-Interviewing (ACASI). *Drug Alcohol Depend* 2016; 166: 85–92.
31. Murray LK, Kane JC, Glass N, et al. Effectiveness of the Common Elements Treatment Approach (CETA) in reducing intimate partner violence and hazardous alcohol use in Zambia (VATU): A randomized controlled trial. *PLoS Med* 2020; 17: 1–22.
32. Bolton P, Lee C, Haroz EE, et al. A Transdiagnostic Community-Based Mental Health Treatment for Comorbid Disorders: Development and Outcomes of a Randomized Controlled Trial among Burmese Refugees in Thailand. *PLoS Med*; 11. Epub ahead of print 2014. DOI: 10.1371/journal.pmed.1001757.
33. Murray LK, Dorsey S, Haroz E, et al. A common elements treatment approach for adult mental health problems in low- and middle-income countries. *Cogn Behav Pract* 2014; 21: 111–123.
34. Lee C, Nguyen AJ, Russell T, et al. Mental health and psychosocial problems among conflict-affected children in Kachin State, Myanmar: A qualitative study. *Confl Health* 2018; 12: 1–11.
35. Murray LK, Haroz EE, Doty SB, et al. Testing the effectiveness and implementation of a brief version of the Common Elements Treatment Approach (CETA) in Ukraine: A study protocol for a randomized controlled trial. *Trials* 2018; 19: 1–16.
36. Marsch LA, Gómez-Restrepo C, Bartels SM, et al. Scaling Up Science-Based Care for Depression and Unhealthy Alcohol Use in Colombia: An Implementation Science Project. *Psychiatr Serv* 2021; appi.ps.2020000.
37. Hamdani SU, Akhtar P, Zill-e-Huma, et al. WHO Parents Skills Training (PST) programme for children with developmental disorders and delays delivered by Family Volunteers in rural Pakistan: study protocol for effectiveness implementation hybrid cluster randomized controlled trial. *Glob Ment Heal*; 4. Epub ahead of print 2017. DOI: 10.1017/gmh.2017.7.

38. World Health Organization. Training parents to transform children's lives, http://www.who.int/mental_health/maternal-child/PST/en/ (2019, accessed 17 December 2020).
39. Kane JC, Skavenski Van Wyk S, Murray SM, et al. Testing the effectiveness of a transdiagnostic treatment approach in reducing violence and alcohol abuse among families in Zambia: study protocol of the Violence and Alcohol Treatment (VATU) trial. *Glob Ment Heal* 2017; 4: E18.
40. Kane JC, Glass N, Bolton PA, et al. Two-year treatment effects of the common elements treatment approach (CETA) for reducing intimate partner violence and unhealthy alcohol use in Zambia. *Glob Ment Heal* 2021; 8: 119–122.
41. Murray LK, Skavenski S, Kane JC, et al. Effectiveness of trauma-focused cognitive behavioral therapy among trauma-affected children in Lusaka, Zambia: A randomized clinical trial. *JAMA Pediatr* 2015; 169: 761–769.
42. Muthén LK, Muthén BO. *Mplus User's Guide. Eighth Edition*. Los Angeles, CA, 2017.
43. Guadagnoli E, Velicer WF. Relation of Sample Size to the Stability of Component Patterns. *Psychol Bull* 1988; 103: 265–275.
44. Fabrigar LR, Wegener DT, MacCallum RC, et al. Evaluating the use of exploratory factor analysis in psychological research. *Psychol Methods* 1999; 4: 272–299.
45. Asparouhov T, Muthén B. Multiple-Group Factor Analysis Alignment. *Struct Equ Model* 2014; 21: 495–508.
46. Raykov T. Scale construction and development using structural equation modeling. In: *Handbook of structural equation modeling*. New York, NY, US: The Guilford Press, 2012, pp. 472–492.
47. Fischer R, Karl JA. A primer to (cross-cultural) multi-group invariance testing possibilities in R. *Front Psychol* 2019; 10: 1–18.
48. Weiner BJ, Lewis CC, Stanick C, et al. Psychometric assessment of three newly developed implementation outcome measures. *Implement Sci* 2017; 12: 1–12.

Tables

Table 1: Mental Health Implementation Science Tools (mhIST) versions and scales

Scale domain	Stakeholder version		
	Consumers*	Providers*	Organization
Acceptability	•	•	•
Adoption	•	•	•
Appropriateness	•	•	•
Feasibility	•	•	•
Accessibility / Reach	•	•	•
Organizational Climate	n/a	•	•
General Leadership	n/a	•	•

*included in current study

Table 2. Context of studies included in the mhIST psychometric analysis

Study	Setting	Intervention	Clients			Providers				
			Target population	n	Female (%)	Age (Mean, SD)	Provider background	n	Female (%)	Age (Mean, SD)
Marsch et al. [36]	Colombia	BA, PST, CBT	Adults with depression, AUD	117	76.9	54.7 (15.9)	Primary care providers	30	63.3	37.4 (7.8)
Lee et al., [21]	Karen State & Yangon, Myanmar; Mae Sot, Thailand	CETA	Adults affected by conflict or political persecution	198	78.3	36.0 (1.2)	Lay health workers	34	47.1	42.1 (2.2)
Lee et al. [22]	Kachin State, Myanmar	CETA	IDP youths	n/a	n/a	n/a	Lay health workers	18	77.8	27.6 (8.4)
Hamdani et al. [37]	Pakistan	Parents Skills Training	Caregivers of children with developmental delays	166	100	35.0 (7.6)	Caregivers of children with developmental delays	10	100	34.9 (4.4)
Murray et al. [35]	Ukraine	CETA	IDP and veterans	77	63.6	38.9 (9.9)	Psychologists, social workers, and lay health workers	30	86.7	41.0 (9.6)
Kane et al. [39]	Zambia	CETA	Families with IPV and unhealthy alcohol use	256	51.9	29.9 (11.2)	Lay health workers	n/a	n/a	n/a
Murray et al. [41]	Zambia	TF-CBT	Adolescents with HIV risk behaviors	n/a	n/a	n/a	Lay health workers	101	76.2	44.3 (11.2)

AUD alcohol use disorder; BA behavioral activation; CBT cognitive behavioral therapy; CETA Common Elements Therapeutic Approach; IDP internally displaced persons; IPV interpersonal violence; mhIST Mental Health Implementation Science Tools; n/a not applicable (not included in study); PST problem solving therapy; SD standard deviation; TF-CBT trauma-focused cognitive behavioral therapy

Table 3. Structure of the Consumer mhIST scales

	Number of factors and subscale item loadings				
	α	1	2	3	χ^2 ^a
Adoptability (AD)	0.84	3, 4, 6	5-10		6
Acceptability (AC)	0.93	1-6	7-14		15
Appropriateness (AP)	0.90	1, 2, 5, 7	4, 9-14		3, 6, 8
Feasibility (FS)	0.86	1-5, 11, 12	6-10	13, 14	15
Accessibility (RA)	0.82	1, 3-8			2

^aitems not loading onto any factor at ≤ 0.4 or loading onto < 1 factor; mhIST Mental Health Implementation Science Tools

Table 4. Items identified for further review from the Consumer mhIST

Item	EFA			Alignment	
Label	Nonresponse ≥ 20%	Low covariance	Low or x- loading	Invariant loading	Invariant intercept
Adoptability					
Have encouraged			X		
Acceptability					
Provider interest	X				
Provider available				X	X
Provider qualified	X				
Understood program			X		
Appropriateness					
Fit schedule			X		
Fit males	X				
Fit females	X				
Organization good	X		X		
Good locale	X				
Address problems			X		
Feasibility					
Transport money	X				
Other money	X				
Maintain income	X				
Childcare available	X				
Seek without stigma			X		
Accessibility / Reach					
Wait time			X		
Most people seek	X				
Women seek	X				
Men seek	X				
Caregivers seek	X				
Children seek	X				

mhIST Mental Health Implementation Science Tools, EFA exploratory factor analysis, x-loading cross-loading

Table 5. Structure of Provider mhIST scales

	Factors and item loadings					χ^a
	α	1	2	3	4	
Adoptability (AD)	0.72	1, 5	2-6	6, 8, 9		6, 7
Acceptability (AC)	0.81	1-6, 8, 10, 12	7, 11, 13			9
Appropriateness (AP)	0.84	1-3	4, 5	1, 2, 7-10	11-16	
Feasibility (FS)	0.83	1-5, 13	7-12, 14, 15			
Accessibility (RA)	0.79	3-7				9
Organizational Climate (OC)	0.90	1, 3-10, 12	7, 11, 13-18			2, 7
General Leadership (GL)	0.87	1-9				

^aitems not loading onto any factor at ≤ 0.4 or cross-loading onto < 1 factor; Mental Health Implementation Science Tools

Table 6. Items identified for further review from the Provider mhIST

Item		EFA		
Code	Label	Nonresponse $\geq$ 20%	Low covariance	Low or x-loading
Adoptability				
AD03	Discussed impact	X		
AD04	Discussed experience	X		
AD06	Have encouraged			X
AD07	Refer others			X
Acceptability				
AC9	Provider abilities			X
Appropriateness				
AP6	Military culture	X		
Feasibility				
FS11	Program budget	X		
FS12	Enough providers	X		
Accessibility				
RA01	Community aware	X		
RA02	Wait time	X		
RA07	Caregivers seek	X		
RA09	Military seek	X		X
Organizational Climate				
OC02	Workload OK			X
OC07	Org prof. growth			X
OC17	Program fit in org	X		
OC18	Program useful to org	X		
General Leadership				
GL09	Leaders strategies	X		

mhIST Mental Health Implementation Science Tools, EFA exploratory factor analysis, x-loading cross-loading

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