Original paper

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Psychometric Properties of a Safety Culture Index among Mental Health Workers in Ghana

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Abstract - Safety culture among mental health workers is essential, especially in developing countries where workplace safety seems neglected. However, few studies have provided detailed psychometric analyses of convenient safety instruments with practical relevance for the healthcare industry in the Sub-Saharan African context. We sampled 574 (54.4 % females, 45.6 % males) mental health workers from three Specialist Psychiatric Teaching Hospitals in Ghana. Initially, we collected data using adapted items from Edkins and Coakes' 25-item Airline Safety Culture Index (ASCI). Consequently, we conducted a Confirmatory Factor Analysis (CFA) using the Diagonally Weighted Least Squares estimator. We also used the item reduction analysis (Gradual Response Model) to reduce the adapted 25-item scale to 11 items (Modified Safety Culture Index, MSCI- 11). Finally, we conducted reliability analyses (alpha and omega) for the MSCI-11. We observed that the data in the CFA showed adequate fit indices [χ^2 (df = 44, N = 574) = 223.752, $p < 0.001$; CFI = 0.975; TLI = 0.968; RMSEA = 0.084 (CI 90 % 0.074- 0.096); SRMR = 0.063]. The MSCI- 11 is parsimonious and has good reliability estimates [α = 0.853 (95 % CI 0.835 – 0.870) and ω = 0.853 (95 % CI 0.837- 0.087)]. Future studies should use additional cross-validation in other high-risk jobs to generalise the new scale.

Keywords: Ghana; mental health; safety management; psychiatric status rating scales

Introduction

An organisation's safety culture is "the attitudes, beliefs, perceptions, and values employees share concerning safety" [1]. This construct is a vital element of the overall organisational culture, and it is a major concern for industries like construction, nuclear science, aviation, oil and gas, mining, and healthcare [2-4]. Following Westrum's popular classification of organisational safety culture into pathological (power-oriented), bureaucratic (rule-oriented), and generative (performance-oriented), there have been several recent developments in the area [5]. Today, organisations are moving away from mere safety culture measurements to measuring and maintaining a resilient safety culture [6]. Resilient safety culture is characterised by a continuous commitment to assess, manage, and improve organisational safety culture to produce an ultra-safe work environment [6,7].

There is an increasing need for a brief, reliable, and valid scale for measuring safety culture across various organisations [8,9]. As the world

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seeks to promote a resilient safety culture at the worksite, researchers find it challenging to agree on standard dimensions to measure safety culture [9,10]. Aside from the inconsistencies in the definition of universal safety culture dimensions among both occupational health and safety practitioners and researchers, the safety culture construct is often confused with safety climate [11]. Thus, it is noted that some researchers aim to assess the safety culture construct but end up measuring safety climate instead, which is a dimension of organisational safety culture [8]. Essentially, safety climate measures the safety perceptions of managers and employees in an organisation, while safety culture measures the universal safety within an organisational culture [1,8-11]. Also, another weakness observed among some of the existing self-reported safety culture measures is the disproportionate use of diagnostic rather than predictive assessment practices [11]. Specifically, diagnostic assessment helps experts understand why safety incidents occur, while predictive assessment forecast what is likely to happen in the future. This diagnostic approach has led to a decline in constructive methods for developing safety culture interventions [11].

Additionally, most existing self-reported instruments have several limitations. Some of these safety culture scales were developed from developed settings or western cultures [10,12]. For instance, the 25-item Airline Safety Culture Index (ASCI) was developed to measure the perceived safety culture among employees of the Australian regional airline industry [12]. The ASCI is an easy-to-use and comprehensive safety culture instrument with items covering eight dimensions of the construct (beliefs about accident causation, emergency procedures, employee commitment, level of perceived risk, management action, management commitment, provision of safety training, and safety communication) [12].

Notwithstanding these merits, a 10-item short version of the ASCI was developed over a decade ago with few cross-cultural studies to validate it, especially across the African context [12]. However, a cursory review of the literature shows that mental healthcare stands out as one of the high-risk jobs [13,14]. Thus, our present study is needed to provide a comprehensive psychometric analysis of the adapted full-scale in Ghanaian healthcare settings. Our study also uses Confirmatory Factor Analysis to reduce the scale to a shorter version. Although some safety studies with moderate to high validity do exist within developed country contexts, we believe this study is one of the first to sample participants from mental healthcare workers in Ghana, Africa. Moreover, healthcare settings, especially psychiatric facilities in Ghana and globally, are considered high-risk work environments. According to Jack and associates professionals working in mental healthcare facilities in Ghana face several safety hazards, including aggression [14-16]. To address the weaknesses of past research, we saw the necessity to conduct this study to assist the healthcare industry in promoting a resilient safety culture.

Materials and Methods

Research design

We conducted a cross-sectional study between 2016 and 2020 following an ethical clearance from the Institutional Review Board of the University of Cape Coast, Cape Coast (Reference number: UCCIRB/CES/2019/16). Before data collection, we obtained additional approvals from the three specialist psychiatric hospitals (Ankaful, Accra, and Pantang Psychiatric Hospitals).

Sampling and sample size

The estimated population size of mental health workers in Ghana in the three hospitals was 1,306 staff. Based on sample size adequacy for factor analytic studies, we recruited 574 (54.4 % females and 45.6 % males) participants. According to Kyriazos, this sample meets the required minimum sample size for our number of variables and factors [17]. After data collection, this selected number of participants represented 44 % of the total population of mental health workers in Ghana. According to Roscoe's rule-of-thumb, sample sizes between 30 and 500 are acceptable for behavioural science studies [18]. Similar sample sizes have been used across safety culture studies [19,20].

The participants included 32.3 % (n = 186) from Accra Psychiatric Hospital, 32.5 % (n = 187) from Ankaful Psychiatric Hospital and 35.2 % (n = 203) from Pantang Hospital. This sample also included 45.5% (n = 262) male and 54.5% (n = 314) female mental health workers. Age of the participants ranged from 20 to 59 years (M = 30, SD = 4.6). Among the participants, 48.8 % (n = 281) were married, 40.8 % (n = 235) were never married, 5.2 % (n = 30) living with a partner/co-habiting, 3.50 % (n = 20) were separated and 1.7 % (n = 10) divorcees. Besides, they included 7.6 % (n = 44) of mental health workers who had certificates in their professional training, 63.4 % (n = 365) had diploma level education, 26.4 % (n = 152) had bachelor's degree, 2.1 % (n = 12) had master's degree and 0.5 % (n = 3), Doctor of Medicine (MBChB)/ specialisation in psychiatry. The working experiences of mental health workers ranged from one year to about 30 years (M = 5, SD = 3.1). The mental health workers also worked at different shifts per the previous year. The shift systems run in these hospitals indicated that 15.1 % (n = 87) work only morning, 4.7 % (n = 27) work only afternoons, 5.0 % (n = 29) work only night, 27.4 % (n = 158) work only morning and afternoon shifts and 47.7 % (n = 275) work on morning, afternoon, and night shifts. Furthermore, annual absence from duty due to sickness reported by these mental health workers ranged from less than one day to a maximum of 30 days (M = 2, SD = 4.4). From the analysis, 42.9 % (n = 246) of the mental health workers were absent due to sickness, while 57.1 % (n = 329) did not report being sick to work in the past year.

Instrument

We adapted the 25-item ASCI to construct our Modified Safety Culture Index (MSCI-11) for data collection [12]. The level of agreement with statements in ASCI was measured on a 5-point ASCI was measured on a 5-point Likert scale, ranging between 'strongly disagree' to 'strongly agree.' We modified words like 'company' and 'airline' to 'institution' to make the scale content relevant and valuable to most organisations aside from airline contexts. Since most of the existing tools in the healthcare settings measure patient safety, the adaption was necessary to measure the organisational safety culture of personnel, which is often neglected [21,22]. Furthermore, the safety culture issues in the airline industry share some similarities with that of healthcare, especially mental health [23,24]. The original ASCI recorded a Cronbach's alpha reliability coefficient of 0.94 [25]. Factorability of the ASCI's correlation matrix indicated a Kaiser-Meyer-Olkin measure of sampling adequacy of 0.92. Again, factor loadings of the original 25-item scale were above 0.30 ($0.38 < \lambda < 0.70$), making it valid and reliable safety culture tool [12]. In addition to the safety culture items, we collected participants' biodata such as gender, age, education, position at work, speciality, number of years in employment, current district/region, nature of shift at work, and number of days absent due to sickness.

Data Analysis

We conducted a Confirmatory Factor Analysis using the Diagonally Weighted Least Squares estimator for the two-factor and one-factor solution with the lavaan package, considering items to be ordered [26]. The model fit is assessed using fit indices: Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardised Root Mean Square Residual (SRMR), and χ^2 (**C**hi-squared).

Furthermore, we estimated discrimination parameters and difficulty parameters using the Gradual Response Model (GRM) of Item Response Theory (IRT) with mirt package, version 1.30 [27,28]. We used IRT to identify the parameters of the items and reduce the scale. After deleting the items using IRT to estimate if the scale was invariant among the workers from the three types of psychiatric health facilities, we conducted confirmatory multi-group analysis with the lavaan package [26]. Three invariance levels were tested: configural, metric, and scalar invariance. We used the MBESS package to access reliability estimates (alpha and omega) of the scale (MSCI-11) with confidence intervals [29]. We conducted all the analyses using the R software [30].

Results

First, we tested the two-factor model for the original 25-item ASCI following Edkins and Coakes approach [12]. However, the covariance matrix of latent variables was not a positive definite, which might be a symptom of model misspecification. Thus, testing if the instrument has one or two dimensions directly based on fit indices was not feasible. Secondly, we tested a single-factor model with an adapted ASCI confirmatory factor analysis. The data's goodness of fit from the confirmatory factor analysis had the following statistics: χ^2 (274, N = 574) = 1,848.51, $p < 0.001$; Comparative Fit Index (CFI) = 0.934; Tucker-Lewis Index (TLI) = 0.934; Root Mean Square Error of Approximation (RMSEA) = 0.100 (CI 90 % 0.096 - 0.104); Standardised Root Mean Square Residual (SRMR) = 0.087. Standardised factor loadings can be seen in Table 1.

After confirming the goodness of fit statistics of the unidimensional structure, we sought to reduce the scale using Item Response Theory with GRM for the 25 items of the scale [26]. Parameters a (discrimination/slope) and parameters b (difficulty/threshold) of the items are shown in Table 1.

We decided to retain the smallest number of items with moderate to perfect discrimination (based on Baker [31]) that covered a large and different portion of the construct . Thus, we had two criteria for item selection: item discrimination and coverage of the construct. Based on Table 1, we excluded items 8 and 25 because they showed low discrimination (i.e., a < 0.65) [31]. In addition, using Figure 1 (which represents the item information trace's line plots), we retained eleven items (1, 2, 3, 6, 9, 11, 14, 15, 20, 21, 22) because of their contribution to the instrument based on information and coverage of θ. For instance, items 5, 7, 8, 12, 19, 23, and 25 are clear examples of items with low information (the blue line is almost flat on the vertical axis). The 11 items will be used in subsequent analysis. Figure 2 represents the test information curve of the MSCI - 11.

The continuous line represents the test information curve. The dotted line represents the standard error of the measurement.

We ran a new confirmatory factor analysis for the 11-item version. The data's goodness of fit from the confirmatory factor analysis had the following statistics: χ^2 (44, N = 574) = 223.752, p < 0.001; Comparative Fit Index (CFI) = 0.975; Tucker-Lewis Index (TLI) = 0.968; Root Mean Square Error of Approximation (RMSEA) = 0.084 (CI 90 % 0.074 - 0.096); Standardised Root Mean Square Residual (SRMR) = 0.063.

The measurement invariance (MI) was analysed among the workers from the three types of psychiatric health facilities using multi-group confirmatory factor analysis. Table 2 represents the comparison among configural, metric, and scalar models. Following the recommendations of Chen, invariance is established when the CFI (ΔCFI) drop between the

Table 1. Items Discrimination and difficulty Parameters of 25-Item ASCI

	Factor Loading	a	b_1	b_2	b_3	b_4
1.	0.68	1.58	-1.05	-0.23	0.18	1.66
2.	0.63	1.40	-1.81	-0.28	0.38	1.71
3.	0.60	1.29	-2.03	-0.63	-0.02	1.99
4.	0.61	1.30	-1.75	-0.30	0.35	2.23
5.	0.42	0.78	-2.49	-0.84	-0.08	2.20
6.	0.60	1.29	-1.79	-0.24	0.61	2.60
7.	0.52	1.04	-2.52	-1.08	-0.41	1.81
8.	0.33	0.59	-3.55	-1.51	-0.33	2.13
9.	0.63	1.37	-1.23	0.15	0.84	2.29
10.	0.61	1.31	-1.32	-0.02	0.73	2.21
11.	0.69	1.62	-1.63	-0.21	0.35	1.92
12.	0.48	0.93	-2.10	-0.32	0.38	2.86
13.	0.57	1.17	-1.03	0.28	1.33	2.90
14.	0.66	1.48	-1.15	0.19	0.92	2.50
15.	0.61	1.29	-1.32	0.18	0.90	2.67
16.	0.56	1.15	-1.80	-0.24	0.85	2.33
17.	0.60	1.26	-0.93	0.47	1.02	2.54
18.	0.58	1.22	-1.77	-0.34	0.29	2.50
19.	0.47	0.90	-1.86	-0.18	1.46	3.51
20.	0.66	1.51	-1.28	0.17	0.78	2.40
21.	0.64	1.41	-1.31	0.16	1.02	2.98
22.	0.62	1.34	-1.72	-0.30	0.38	1.88
23.	0.53	1.06	-1.21	0.40	1.50	3.49
24.	0.56	1.16	-1.34	0.29	1.12	2.99
25.	0.30	0.54	-4.03	-1.52	-0.33	3.07

a = discrimination parameter. b = threshold (difficulty) parameter.
Parameters of discrimination and difficulty estimated by Graded Response Model.

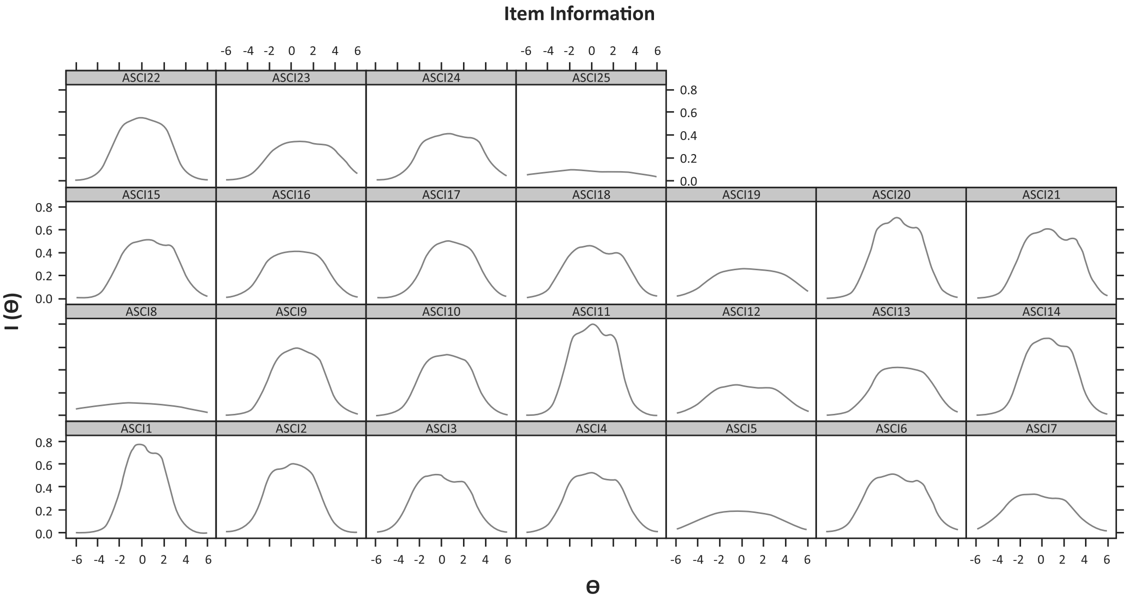

Figure 1. Item information Traceline Plots of the 25-item version.
θ = construct ; $I(\theta)$ = information.

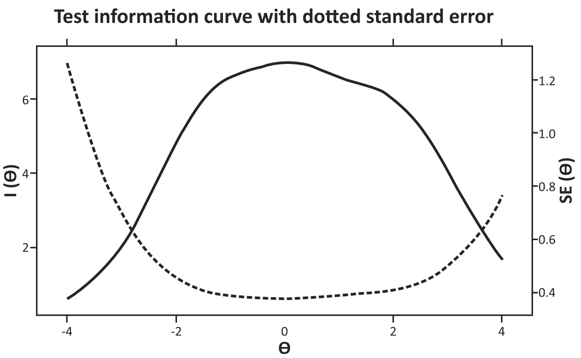

Figure 2. Test information curve of the MSCI-11.

less and more restrictive model is not larger than 0.01 [32]. Similarly, ΔRMSEA should not be higher than 0.015. Although observed, the configural, metric, and scalar invariance between health facilities using the RMSEA criteria is not enough firm evidence without the CFI (for the Metric Invariance: ΔCFI = 0.011). According to Chen, scalar invariance cannot be established without metric invariance [32]. However, the final version of the scale presented good reliability estimates, being $\alpha = 0.853$ (95 % CI 0.835 – 0.870) and $\omega = 0.853$ (95 % CI 0.837 – 0.087).

Table 2. Measurement Invariance (MI) testing between three health facilities

	χ^2	$\Delta\chi^2$	Df	ΔDf	$\Delta\chi^2$ Statistical Significance	RMSEA	ΔRMSEA	CFI	ΔCFI
Configural	353.47		105			0.112		0.928	
Metric	432.63	79.16	145	40	$p < 0.001$	0.102	0.010	0.917	0.011
Scalar	479.12	46.49	163	18	$p < 0.001$	0.101	0.001	0.909	0.008

χ^2= Chi Square; RMSEA= Root Mean Square Error of Approximation; CFI= Comparative Fit Index

Table 3. Correlation between ASCI and MSCI-11

		ASCI	MSCI-11
ASCI	Pearson Correlation	1	0.938**
	Sig. (2-tailed)		0.000
	Sum of Squares and Cross-products	168633.750	80484.875
	Covariance	293.276	139.974
	N	576	576
	Mean	70.9375	30.7188
	Std. Deviation	17.12531	8.71006

**. Correlation is significant at the 0.01 level (2-tailed).

Additionally, we correlated ASCI with MSCI-11 since there were no other relevant variables in the dataset. In Table 3, we observed a high correlation index of 0.9, indicating that the 11-item index captures the essence of the 25-item index well.

Discussion

Our study among mental healthcare professionals yielded a shorter version of the safety culture index, MSCI - 11, from the existing adapted scale, ASCI [12]. Specifically, the MSCI - 11 focuses on the common constituents of safety culture measured by researchers. These factors include management and employees' commitment to safety, management action, perceived risk levels, accident causation perceptions, emergency response procedures, communication, and delivery of safety training [33,34]. Following recommendations by Samejima we reduced the 25-item ASCI to an 11-item MSCI - 11 scale [28]. We retained eleven items in MSCI - 11 and presented the test information curve of the modified scale. The MSCI - 11 is a brief scale measuring resilient safety culture and has a stable unidimensional structure and adequate goodness of fit statistics [35]. Although 11 items out of 25 were selected, items in the MSCI - 11 scale still covered all seven safety culture dimensions since the other 14 items were additional items in these dimensions. Also, the relatively high correlation index of $r = 0.9$ indicates that the MSCI - 11 captures the core safety dimensions of the 25-item ASCI.

Given Chen's recommendations, the configural, metric, and scalar invariance among the three health facilities using the RMSEA criteria were insufficient as MSCI - 11 could not report acceptable CFI values to claim measurement invariance [32]. Besides, Chen's recommendation is for comparing two groups that follow a normal distribution (i.e., it should be used when comparing groups at an interval level). Similarly, we did not find a simulation study to give the best guidelines of fit statistics for ordinal variables for comparing three groups. Thus, our measurement invariance results should be carefully interpreted as we await new simulation studies to light up this gap. Notwithstanding this weakness, we noted that the reliability estimates of MSCI - 11 are better than the reliability of ASCI among our Ghanaian health professional sample. Furthermore, the reliability of MSCI - 11 is significantly higher than 0.80 ($\alpha = 0.85$ and $\Omega = 0.85$) [35]. Therefore, our new MSCI - 11 may offer a more parsimonious means of measuring the safety culture construct among health workers without impairing the theoretical and statistical foundations in the literature

The scope of safety culture operating in healthcare affects the quality of patient care and the safety assessment tools in Ghana [and other developing locations [36,37]. Also, a systematic review by Mento et al. observed similar trends among developed countries [39]. A brief tool to assess safety culture in organisational settings like health care is beneficial to advance the health and safety of personnel and patients. As a short and reliable scale, MSCI - 11 psychometric properties across three different health facilities in Ghana make it ideal and valuable as the world fights for a continuous commitment to assess, achieve, and advance resilient organisational safety culture [6-9].

The findings from our study are currently among the few datasets from West Africa using mental healthcare workers. Also, it provides an economical and effective unidimensional tool to assess occupational safety culture. Nevertheless, the following issues border on the generalizability of our results. First, although noted as a high-risk occupational health and safety environment, the sample pools from the three mental health facilities do not represent all industries in Ghana. Second, the present study included participants from only Ghana with no representations from other countries.

Further studies with larger sample sizes from different industries like aviation, mining, construction, and other countries will be needed to address these issues in the future. A longitudinal study may also offer an added understanding regarding the practical usefulness of MSCI - 11 over time. Additionally, future research should evaluate the criterion validity of MSCI - 11 with other external, non-test criteria, as suggested by Cohen and Swerdlik [and Piedmont [40,41]. Also, it would be important to investigate other reliability tests like test-retest reliability to provide more robust evidence about its utility.

We conducted this study to investigate the structural validity and reliability items in the 25-item ASCI. Additionally, our findings showed the reliability parameters of a new safety culture instrument using Ghanaian mental health workers. The MSCI - 11, adapted from the existing ASCI has good psychometric properties [12]. As an instrument, the MSCI - 11 exists irrespective of the 574 participants used to evaluate its psychometric properties. Observation of our results and its eleven items show the scale's alignment with present literature on the scope of safety culture [9-12,33]. We propose that future studies of the scale should be directed to assessing the utility of MSCI - 11 in other health settings and different international locations. The broader item selection and general theoretical safety culture scope may allow our scale to be functional in other high-risk industries. Future validation studies must provide adequate empirical evidence to establish MSCI - 11 as a brief unidimensional measure of workplace safety culture.

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Conflict of Interest

None to declare.

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