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Development and psychometric evaluation of a *Total Worker Health*® practice scale

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Abstract

Objective: Occupational Safety and Health (OSH) professionals increasingly need to assess and mitigate a broad scope of worker safety, health, and well-being concerns that extend beyond traditional OSH training curricula. Work-related and non-work-related psychosocial hazards, chronic physical and mental health conditions, and changing work arrangements call for an integrative, public health approach to occupational risk management; this approach has been called, "*Total Worker Health*®" by United States public health authorities (Schulte et al. 2019). OSH professionals need education to ensure that *Total Worker Health* (TWH) practice approaches are consistently and effectively applied. This study sought to develop a valid, reliable scale that could be used to assess TWH skills gaps that can be addressed with tailored, competency-based curricula.

Method: We developed a survey scale to assess professional competency for specific TWH practice approaches described in prior literature (Lee et al. 2016; Punnett et al. 2020). The scale contained 11 statements and used a 5-point scale (not skilled to highly skilled) to rate the level of competency. We pre-tested and refined the statements for face validity then administered the scale with a convenience sample of 258 professionals from mixed OSH disciplines. A total of 210 OSH professionals (31% safety, 17% industrial hygiene, 12% occupational nurses, 11% occupational physicians, 29% other) who completed 50% or more of the questions were included in the analysis. Scale reliability was assessed with a Cronbach's alpha test. Scale validity and structure were assessed with exploratory factor analysis (EFA).

Results: The 11-item scale had high internal consistency (Cronbach's $\alpha = 0.92$). The initial EFA solution suggested 2 factors that explained 65.3% of variance, with one cross-loaded question. A final 10-item, 2-factor scale was developed that accounted for 66.0% of variance with no cross-loaded items (Cronbach's alpha $\alpha = 0.91$). Factor 1 (6 items) contributed to 55.5% of the variance and captured skills related to TWH program leadership (e.g. leader commitment, integrating program systems, engaging with other program leaders and workers). Factor 2 (4 items) contributed to 10.5% of the variance and captured technical skills related to hazard identification and control (e.g. identifying hazards, designing work to reduce hazards). Internal consistency was very good for both TWH program leadership (Cronbach $\alpha = 0.89$) and TWH risk assessment and control (Cronbach $\alpha = 0.80$) subscales.

Conclusion: A novel 10-item TWH skill scale to assess specific TWH practice approaches was developed with very good reliability. Factor analysis revealed 2 latent constructs: TWH leadership skills and TWH risk assessment and control skills. This study offers an evidence-based tool to assess competency for specific TWH practices among OSH professionals. The results of this study contribute to the broader research base needed to formalize a TWH competency framework, as advocated by other scholars interested in TWH workforce education (Newman et al. 2020).

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What's Important About This Paper?

Occupational safety and health (OSH) professional practice has evolved to a more integrated, "Total Worker Health" (TWH) approach in response to the changing nature of work and workforce demographics. Professionals in multiple OSH disciplines need TWH education to ensure consistent and effective implementation. However, instruments to assess TWH learning needs and guide curriculum design are lacking. This study offers an evidence-based educational needs assessment tool and contributes knowledge relevant to the future development of a TWH competency framework.

Introduction

The practice of *Total Worker Health*® approaches to support worker well-being represents an evolution and expansion within the OSH professions in response to the changing nature of work and the workforce. The concept of *Total Worker Health* (TWH) as a holistic strategy for advancing worker safety, health, and well-being (SHW) has been gaining wide acceptance since the early 2000s among OSH scholars and practitioners (Centers for Disease Control and Prevention, 2020; Tamers et al. 2019). The "*Total Worker Health*" approach, which was coined by federal public health authorities (Schill & Chosewood, 2013), calls for OSH professionals and employers to adopt an integrated, comprehensive strategy to safeguard workforce SHW. The TWH practitioner requires new competencies that extend beyond those acquired from OSH baccalaureate and graduate programs (Peckham et al. 2017; Newman et al. 2020). Examples of practices that differentiate TWH from traditional OSH practice are that hazard assessment and intervention processes address a broader scope of environmental and personal health factors, and SHW program management (typically siloed) becomes more integrated and coordinated (Chari et al. 2018; Schulte et al. 2019; Tamers et al. 2019).

To meet the need for new competencies, universities and OSH professional associations have responded by offering TWH professional education curricula (Centers for Disease Control and Prevention, 2021; Schulte et al. 2019; Tamers et al. 2019). Although TWH practice approaches have been identified (Lee et al. 2016; Punnett et al. 2020) and broad competencies have been proposed (Newman et al. 2020), there is a need for a practical instrument to identify the gaps in TWH skill sets that can be addressed with tailored curricula. Understanding strengths and gaps in OSH professionals' TWH skill sets in relation to these new practice approaches can help prioritize education and training objectives when designing TWH curricula for different professional groups.

TWH practice approaches

The term *TWH* is defined as "policies, programs, and practices that integrate protection from work-related safety and health hazards with promotion of injury and illness-prevention efforts to advance worker well-being" (Centers for Disease Control and Prevention, 2020). Evidence-based guidelines for TWH practice approaches have been published based on knowledge generated by experts in government (Lee et al. 2016) and academia (McLellan et al. 2017; Punnett et al. 2020). These guidelines are intended for use when implementing and evaluating TWH programs. Based on this prior work, 6 defining elements (i.e. criteria, or indicators) of TWH practice have been described (Fig. 1). Each practice element is described below.

TWH practice 1: risk assessment methods identify work and non-work hazards.

A TWH approach to workforce risk assessment holistically identifies both work and non-work hazards that contribute to employee safety, health, and well-being. This criterion does not appear in government publications of TWH essential program elements (Lee et al. 2016) but has been emphasized by other TWH scholars as foundational for facilitating the identification of the full range of work-related contributors to poor safety and health outcomes of workers (Schulte et al. 2012, 2019; Chari et al. 2018; Punnett et al. 2020). The rationale is that worker SHW are influenced by multiple physical, social, and psychological factors at work, home, and community, as well as personal health conditions and behaviors (Punnett et al. 2020). OSH professionals' training focuses on collecting, analyzing, and interpreting data on work-related hazards, injuries, and illnesses. OSH training does not typically address assessment of personal health conditions, mental well-being, and health behaviors that may be influenced by working conditions. Integrated assessment, therefore, represents an expanded skill set that OSH professionals would need to develop as TWH practitioner.

TWH practice 2: interventions use integrated approaches.

TWH interventions prioritize the reduction or elimination of workplace safety and health hazards while promoting the health and well-being of workers. This emphasis on integrated (i.e., multi-faceted, multi-level,

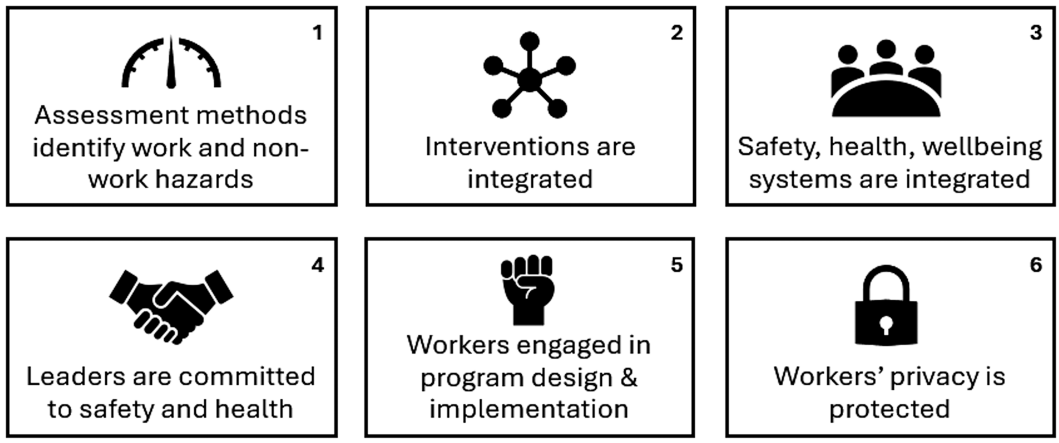

Fig. 1. Defining elements of TWH practice approaches.

comprehensive) solutions to address poor safety and health outcomes is the signature concept of TWH approaches (Lee et al. 2016; Centers for Disease Control and Prevention, 2020; Punnett et al. 2020). By addressing employee health concerns holistically and attending to root causes in work and non-work domains, there is a higher likelihood of achieving better workforce safety and health outcomes (Schulte et al. 2012, 2019). The design of integrated interventions, specifically that focus on non-work domains or health promotion behaviors, is not part of traditional OSH discipline training. OSH professionals need expanded knowledge and skills to perform this aspect of TWH practice. The ability to apply an integrated approach to designing interventions depends on the holistic assessment of SHW, as described in the criterion above.

TWH practice 3: safety, health, and well-being program systems are coordinated.

TWH is a coordinated program strategy that links programmatic systems relevant to workforce SHW across an organization. As an example, coordinated goals and activities between OSH promotion may be achieved by a common reporting structure and the systematic analysis of data across program domains to assess how health and safety risk factors interact with each other (Punnett et al. 2020). Another approach is to bring together leaders and teams with overlapping or complementary responsibilities for planning and priority setting (e.g., holding joint meetings of safety, occupational health, human resources, and wellness committees) (Lee et al. 2016). Integrating and coordinating across traditionally siloed program functions has implications for OSH professional competencies and for organizational structures and resources needed to support planning, evaluation, knowledge management, and communication among different actors within a multi-disciplinary system.

TWH practice 4: leaders are committed to safety, health, and well-being.

Adoption of TWH practices in the workplace requires that leaders at all levels of the organization demonstrate commitment to worker SHW. This criterion appears in several guidelines documents as an essential TWH program element (Lee et al. 2016; McLellan et al. 2017). Some scholars have described specific roles of organizational leaders in achieving TWH adoption and outcomes, as well as effective leader training approaches (Schwatka et al. 2021a, 2021b). However, other scholars have argued that leadership commitment is not a unique criterion for TWH programs but is fundamental for any effective OSH program (Punnett et al. 2020). Although leadership support is widely recognized as essential for any successful organizational endeavor, the cross-functional coordination needed to introduce a unified TWH organization strategy requires specific forms of upper management resources and supports. These supports may include authorizing cross-unit planning and evaluation as well as establishing integrated information systems and reporting structures. The role and competency of OSH professionals, as TWH subject experts, are critical for facilitating leadership support.

TWH practice 5: workers are engaged in program design and implementation.

TWH promotes worker engagement throughout all stages of SHW intervention design and implementation. While the traditional safety and health promotion program is compliance-driven and top-down, a TWH approach posits that involving employees from all levels (including and especially front-line workers)

can improve organizational SHW outcomes. Through worker engagement, there is a better likelihood of identifying intervention targets that are meaningful to workers and that will be well-accepted and impactful (Lee et al. 2016; Punnett et al. 2020). Additionally, worker participation contributes to greater job control, which by itself is health-promoting and stress-reducing (Henning et al. 2009; Punnett et al. 2009).

TWH practice 6: ensure workers' privacy.

OSH professionals' skills in maintaining confidentiality and privacy when handling workers' personal health data are foundational for protecting the welfare and rights of workers. This TWH indicator has been emphasized by NIOSH in recognition of the risk to workers when considering personal health status and well-being concerns as part of an overall organizational TWH strategy (Lee et al. 2016). Ethical concerns about data privacy and discrimination need to be taken seriously as organizations attempt to adopt a TWH strategy (Rogers and Schill 2021). This TWH indicator is especially relevant in the context of TWH practice of integrated assessment activities. However, some TWH scholars argue that issues of worker privacy and confidentiality are not unique to TWH, but rather are an important consideration of quality and ethics for all health and safety activities sponsored by employers (Punnett et al. 2020).

Assessing OSH professionals' TWH practice gaps

Interest in, and adoption of TWH approaches are growing among OSH and related professions, which has stimulated greater availability of TWH training and education programs (Tamers et al. 2019). Education is needed to ensure that TWH concepts are understood and applied consistently in practice settings. The ability to design and deliver education that addresses TWH knowledge and practice gaps depend on educators being able to assess those gaps. Survey tools can be useful for measuring gaps and tailoring curricula accordingly. The use of a validated survey instrument for self-assessment is important for ensuring the validity and reliability of results. Currently, no validated survey tools are available to support the assessment of TWH skill sets among OSH professionals. Therefore, the objective of this paper is to develop a short, practical scale to assess skill for TWH practice approaches and to conduct psychometric evaluation of the scale.

Methods

We followed best practice in scale development including (i) developing a sufficient number of items to represent the full scope of relevant practice behaviors (content validity); (ii) evaluating that questions are interpreted consistently by researchers and study participants (face validity); (iii) ensuring the reliability of the instrument items (i.e. repeated measurement produces similar results); and (iv) evaluating the structure of the scale to assess the concepts actually being measured (construct validity) (DeVellis 2012; Fowler 2014).

Survey development

Item generation. The initial development of the scale content was facilitated through a comprehensive review of the literature to cover the breadth of TWH practice approaches, as described above. For example, the scale included practices of demonstrating leadership for supporting safety, health, and well-being (Lee et al. 2016; Newman et al. 2020); using assessment methods that span risks in work and non-work domains of employees' experience (Schulte et al. 2019; Punnett et al. 2020); developing interventions that prioritize attention to removing work hazards before addressing individual preventive behavior (e.g. applying the Hierarch of Controls framework) (Lee et al. 2016; Schulte et al. 2019; Punnett et al. 2020); coordinating and collaborating across units within an organization to achieve integration of safety, health, and well-being systems (Lee et al. 2016; Schulte et al. 2019; Newman et al. 2020; Punnett et al. 2020); and ensuring worker privacy and confidentiality when handling personal safety and health information (Schill and Chosewood 2013; Lee et al. 2016). TWH skill statements were drafted to reflect key specific behavioral indicators that would exemplify and operationalize each TWH practice approach. The statements incorporated language that would be easily understood by a range of OSH practitioners and related professions. For example, when using the phrase "non-work risks," examples were given for clarity (e.g. home exposures, health conditions, health behaviors). For brevity, 2 skill items were developed to assess 5 of the 6 TWH practice approaches. The sixth TWH practice approach of "ensuring worker privacy" was assessed with a single item.

Content and face validation. Initial versions of the TWH skill scale questions were pre-tested for face validity with a convenience sample of 5 OSH professionals using cognitive interviews. Participants included an industrial hygienist, an occupational health nurse, a safety professional, and 2 occupational epidemiologists. Participants were asked to read each statement and describe their interpretation of the meaning. The researcher took hand-written notes on any difficulties such as ambiguous terms, technical language, complex sentence structure, and redundant concepts or words that needed to be addressed.

Refinement of scale items. TWH skill scale statements were refined based on pretest feedback, optimizing the wording for clarity and brevity. For instance, the plain language phrase, "worker characteristics" replaced the term "demographics." Examples of programs (e.g. safety, occupational health, human resources, wellness) were added to clarify the meaning of "integrate relevant program systems." The final scale included items with identical and/or refined versions of the TWH practice definitions contained in the NIOSH Fundamentals of *Total Worker Health*® Approaches checklist (Lee et al. 2016), plus new statements to capture the breadth of the core concepts represented in the literature. The final version of the TWH skill scale items is listed in Table 1, along with examples of revisions made during the pretest phase. See Supplementary Table S1 for scale questions and response options.

Psychometric evaluation

Recruitment.

Convenience sampling was used to recruit professionals from 4 core OSH disciplines, including industrial hygienists, safety professionals (safety program directors and managers, injury prevention specialists, etc.), occupational health nurses, and occupational physicians (McAdams et al. 2011). Professionals from other disciplines relevant to TWH practice (e.g. health promotion, human resources) were also invited to participate. Regional associations for professionals in occupational safety, industrial hygiene, occupational health nursing, and occupational medicine, as well as 5 university-based TWH Centers for Excellence (CDC, 2023) sent an email to their networks containing a standard study announcement and a link to access the online survey in Qualtrics (Qualtrics 2020). Survey eligibility criteria included a minimum age of 18 years and current employment (minimum 20 h/week) as an OSH professional. A gift card drawing was offered as an incentive for survey participation. The study protocol was approved by the university's review board (IRB#: 22-103).

Data collection.

The 11-item TWH skills scale (Table 1) was administered as part of a broader TWH educational needs assessment survey. Participants were asked to indicate their current skill level for each statement, using a 5-point response scale ranging from 1 (not skilled) to 5 (highly skilled). Survey data were collected over a 5-month period from July to November 2022. A total of 258 OSH professionals responded to the survey; of these, respondents who completed 50% or more of the survey were included in the final analysis, giving a total of 210 participants.

Data analysis.

Participants' discipline, level of OSH experience, career stage, service setting (internal vs. consultant), and employer size and region were summarized by computing frequencies. Employer state was recoded using the U.S. Census Bureau's (2021) region categories. Data were analyzed using SPSS version 28.0 (IBM Corporation 2021).

A Cronbach's alpha test for internal consistency was performed to assess the scale reliability. Factor analysis was performed to assess the construct validity. Exploratory factor analysis (EFA) was performed on the 11-item TWH competency scale to assess the factor structure and to identify candidate items for removal. Maximum likelihood with an oblique rotation (Oblimin with Kaiser Normalization) was selected based on the expected positive correlation between TWH practices (Costello and Osborne 2005). Kaiser–Meyer–Olkin measure of sampling adequacy (KMO = 0.912) and Bartlett's test of sphericity (approximate X^2 (*55*, N = 198) = 1,180.8, $P < 0.001$) confirmed that the dataset met criteria for factor analysis. Factor analysis was performed on 198 cases of scale data after rows with missing data were excluded listwise.

Results

Participants

Survey participants included 210 OSH professionals representing safety (31%), industrial hygiene (17%), occupational health nursing (12%), occupational physicians (11%), wellness/health promotion (7%), academic researchers/educators (7%) and other mixed OSH-related disciplines (16%) (Table 2). About 3 quarters (78%) of survey participants described themselves as mid- or advanced-career OSH professionals. Slightly less than half provided "in-house" OSH services (vs consulting), and slightly more than half were employed by large organizations. Survey participants were employed from Northeast (31%), Western (31%), Midwest (16%), and Southern (19%) states in the United States.

Scale Reliability

The internal consistency (Cronbach's α) was performed on the 11-item TWH skill scale. The 11-item scale had excellent reliability (Cronbach's α = 0.92). Only slight changes in Cronbach's α (0.91–0.92) were estimated if any single item was to be removed. Item correlations ranged from 0.26 to 0.78 ($P < 0.001$). Lower correlation coefficients were observed for pairs involving TWH Practice 3 (ensure confidentiality, r = 0.26–0.47) compared with other items in the matrix (r = 0.36–0.78) (see Supplementary Table S2).

Table 1. TWH skills scale items, pretest modifications, and sources.

TWH practice approach	Pre-tested items and sources	Modifications (if any) based on feedback	Final scale items
1a. Leadership commitment	Demonstrate leadership commitment to worker safety, health, and well-being at all levels of the organization. (Lee *et al.* 2016)	Wording unchanged	Demonstrate leadership commitment to worker safety, health, well-being at all levels of the organization.
1b. Leadership commitment	Facilitate leadership commitment to worker safety, health, and well-being across all levels of the organization. (Lee *et al.* 2016)	Modified to reflect the role of OSH professionals; removed "all levels" to improve specificity.	Facilitate leadership commitment to worker safety, health, and well-being.
2a. Integrated assessment	Use an integrated approach to assessment of work and non-work risks. (Punnett *et al.* 2020)	Modified to clarify examples of non-work risks to include in TWH risk assessment methods	Use an integrated approach to the assessment of work and non-work (e.g. home exposures, health conditions, health behaviors) risks.
2b. Integrated assessment	Identify demographic characteristics or working conditions in your organizations that are associated with one or more health conditions. (NIOSH webinar evaluation survey)	Replaced "demographic" with a less technical term, "worker."	Identify worker characteristics or working conditions in your organization that are associated with one or more health conditions.
3. Maintain confidentiality	Ensure confidentiality and privacy of workers. (Lee *et al.* 2016)	Modified to clarify the focus of the practice behavior (e.g. "when handling data")	Ensure confidentiality and privacy for workers when handling safety and health data.
4a. Integrated interventions	Design work to eliminate or reduce safety and health hazards and promote worker well-being. (Lee *et al.* 2016)	Added an example (e.g. applying the Hierarchy of Controls) that would be easily recognizable to OSH professionals.	Design work to eliminate or reduce safety and health hazards and promote worker well-being. (e.g. Use the Hierarchy of Controls adapted for TWH to prioritize workplace over individual-level changes).
4b. Integrated interventions	Develop workplace programs that integrate elements of safety/health protection with health promotion to promote worker well-being. (Schulte *et al.* 2019; Punnett *et al.* 2020)	Replaced "promote" with "advance" to avoid redundant wording.	Develop workplace programs that integrate elements of safety/health protection with health promotion to advance worker well-being.
5a. Worker engagement	Promote and support worker engagement throughout program design and implementation. (Lee *et al.* 2016)	Wording unchanged	Promote and support worker engagement throughout program design and implementation.
5b. Worker engagement	Identify safety and health issues most important to front-line employees. (Lee *et al.* 2016)	Wording unchanged	Identify safety and health issues most important to front-line employees.
6a. Systems integration	Integrate relevant program systems to advance worker well-being (Lee *et al.* 2016)	Modified to clarify the meaning of program systems	Integrate relevant program systems (e.g. safety, occ health, HR, wellness) to advance worker well-being.
6b. Systems integration	Bring together leaders and teams with overlapping or complementary responsibilities for planning and priority setting. (Lee *et al.* (2016)	Added an example to clarify who is meant by leaders and teams	Bring together leaders and teams with overlapping or complementary responsibilities for planning and priority setting (e.g. safety, occ health, HR, wellness).

Table 2. Participant characteristics (n = 210).

Variable	*N*	(%)
Job role		
Safety, Environmental Health and Safety or Ergonomics	66	31%
Industrial Hygiene	35	17%
Occupational Health Nurse	25	12%
Occupational Health Physician	23	11%
Wellness	14	7%
Researcher/educator	14	7%
Other (nurse, operations, risk management, etc.)	21	15%
Career stage		
Advance career	95	46%
Midcareer	66	32%
Early career	47	22%
Occupational Safety and Health practice setting		
Internal employer setting	101	49%
External consulting setting	50	24%
Provides OSH services in internal and external settings	41	20%
Other (does not provide OSH direct services)	15	7%
Employer size		
More than 1,000 employees	109	55%
251–1,000 employees	33	17%
51–250 employees	17	8%
1–50 employees	39	20%
US region[a]		
West	58	31%
Midwest	30	16%
South	34	19%
Northeast	58	31%
International	5	3 %

[a]U.S. Census Bureau's (2021) classifications used.

Construct validity

The initial EFA solution suggested 2 factors with Eigenvalues greater than 1, together explaining 65.3% of the variance. One scale item ("facilitate leadership commitment") initially cross-loaded on both factors (coefficients of 0.43 and 0.39, respectively). To resolve cross-loading, the EFA was repeated twice more, each time testing the model with either the "demonstrate leadership commitment" item or the "facilitate leadership commitment" item. After the removal of the "demonstrate leadership commitment" item, the "facilitate leadership commitment" item showed no cross-loading anymore, and no change in the total variance was observed. A final 10-item, 2-factor scale was developed that accounted for 66.0% of variance with no cross-loaded items (Table 3). Factor 1 contributed to 55.5% of the variance and captured skills related to TWH program leadership (e.g. leader commitment, integrating program systems, engaging with other program leaders and workers). Factor 2 contributed to 10.5% of the variance and captured technical skills related to hazard identification and control (e.g. identifying hazards, designing work to reduce hazards). Internal consistency (Cronbach α) for the final

Table 3. Factor analysis results for the TWH skills scale.

Scale items[a]	Factor loading	
	1 $\alpha = 0.89$	2 $\alpha = 0.80$
Factor 1 items: TWH Program Leadership Skills		
4b. Develop workplace programs that integrate elements of safety/health protection with health promotion to advance worker well-being.	**0.884**	–0.081
6a. Integrate relevant program systems to advance worker well-being	**0.870**	–0.072
6b. Bring together leaders and teams with overlapping or complementary responsibilities for planning and priority setting (e.g. safety, occ health, HR, wellness).	**0.766**	0.046
5a. Promote worker engagement throughout program design and implementation.	**0.743**	0.018
2a. Use an integrated approach to assessment of work and non-work (e.g. home exposures, health conditions, health behaviors) risks.	**0.556**	0.232
1b. Facilitate leadership commitment to worker SHW	**0.551**	0.224
Factor 2 items: TWH Risk Assessment and Control Skills		
2b. Identify worker characteristics or working conditions in your organization that are associated with one or more health conditions.	–0.029	**0.758**
5b. Identify safety and health issues most important to front-line employees.	0.165	**0.706**
3. Ensure confidentiality and privacy for workers when handling safety and health data.	–0.040	**0.611**
4a. Design work to eliminate or reduce safety and health hazards and promote worker well-being. (e.g. use the Hierarchy of Controls adapted for TWH to prioritize workplace over individual level changes).	0.291	**0.493**

N = 197. The extraction method was maximum likelihood with oblique (oblimin with Kaiser Normalization) rotation. Factor loadings greater than 0.30 are in bold.
[a]5-point response scale: 1 = not at all skilled, 5 = highly skilled.

10-item TWH skill scale was 0.91. Internal consistency was very good for both TWH program leadership (Cronbach α = 0.89) and TWH risk assessment and control (Cronbach α = 0.80) subscales.

Discussion

A novel 10-item TWH skill scale was developed to assess the level of skill for 6 broad TWH practice approaches that have been described in the literature. This study offers an evidence-based tool to assess professionals' competency for specific TWH practices. Although the study used a convenience sample, the participants represented a broad range of OSH-related disciplines that reflect the population of professionals who might seek TWH education in the future. Prior studies reported that OSH professionals have a high interest in and readiness for TWH education. In 2 recent studies of 253 occupational nurses and 2,064 mixed OSH professionals, respectively, 75% of respondents agreed they were interested in continuing education to learn about TWH (Scott et al. 2019; Olszewski et al. 2021). However, these studies did not assess specific learning needs in relation to TWH practice approaches. Having a validated scale with strong reliability can assist with assessing how OSH professionals see their strengths and areas for development, which can guide prioritization of educational goals when developing curricula.

Exploratory factor analysis of the scale revealed 2 latent constructs underlying TWH practice approaches: TWH program leadership skills and TWH risk assessment and control skills. The TWH program leadership construct included skills for facilitating leadership commitment to worker safety and well-being, engaging workers in safety and health improvements, and integrating program systems to support worker SHW. TWH technical skill areas included skills related to data privacy, risk assessment, and hazard control. These results are consistent with other published studies on OSH professional competencies that differentiate technical (hazard assessment, hazard controls, analyzing data) and non-technical skills (e.g. professionalism, communication, business practices, leadership). For example, published competencies of safety professionals feature 5–7 categories specific to hazard recognition, hazard assessment and control, safety training and management, applying regulations, and applying business principles (ASSP n.d.; Olson et al., 2013; Chang et al. 2012) whereas industrial hygienists or international OSH professionals describe competency categories of hazard evaluation, hazard controls, and functional/behavioral competencies (e.g. collaboration, communication, leadership relationships) (AIHA 2018; IOSH 2019). Although the categorization approach is similar, the content of the TWH scale items differs from OSH professional competencies based on their specificity for *integration* of health protection and health promotion concepts and their emphasis on worker engagement.

It was noteworthy that some TWH skill pairs in the same TWH practice approach (e.g. TWH assessment skills 2a and 2b; intervention skills 4a and 4b; systems integration skills 5a and 5b in Table 1) ended up loading in different factors. This may indicate that the current scale statements may need further clarification and that retesting the scale (or an expanded version of the scale) with a larger sample would be useful to verify the 2-level structure. The elimination of item 1 (demonstrate leadership commitment) from the scale resulted from the cross-loading of this item during the EFA and may reflect ambiguity about *who* is demonstrating leadership commitment—the professional, or other leaders in the organization. Newman et al. (2020) proposed 6 core competency domains for TWH practice, along with broad knowledge requirements within each domain. The 6 competency domains include subject matter expertise (i.e., the technical knowledge and skills of OSH and other disciplines), advocacy and engagement; program planning, implementation, and evaluation; communication and dissemination; leadership and management; and partnership building and coordination (which addresses interdisciplinary and integration concepts). The latter 5 competency domains are conceptually aligned with the 6 items represented in the Program Leadership subscale identified in this study. Newman et al.'s (2020) 6 competency domains may offer a useful resource for future studies to develop and evaluate an expanded version of the TWH skills scale that captures a fuller range of TWH practice behaviors. Such a study could reevaluate the scale constructs, which would strengthen the value of the tool for assessing learning needs for curriculum development.

One item in the TWH skill scale, which maintains confidentiality and privacy for workers when handling safety and health data, was weakly correlated with all other scale items. This raised questions about the appropriateness of including this practice in the TWH skill scale. On the one hand, ensuring confidentiality and privacy is an OSH ethical standard for any professional working with health data, and, therefore, this practice is not unique to TWH. However, using an integrated approach to risk assessment expands the breadth of data that OSH professionals may have been trained to work with. In addition, the cross-program collaboration advocated by TWH could introduce new data-sharing practices across organizational units. The ethical principles of autonomy, nonmaleficence, beneficence, and justice for workers have been discussed in the context of decision-making by OSH professionals when implementing TWH practices (Rogers and Schill 2021). These principles are important as OSH and other

professionals increasingly enter "uncharted territory" to share data for purposes that benefit both worker and employer interests (Rogers and Schill 2021, p. 2). Thus, holistic SHW risk assessment has implications for advanced data handling competencies that may justify retaining this item in the TWH skill scale.

It is important to recognize methodological limitations that may have influenced the study results and their generalizability. Firstly, the sample size, although sufficient for our analyses, was relatively small. Convenience sampling likely generated a sample of professionals who were already interested and had a basic understanding of the TWH concept. Additionally, partnering with OSH professional societies for recruitment very likely attracted professionals with higher education and OSH training than the general population of OSH professionals, which includes practitioners from diverse and varied training histories. Our results may have been different had we used random sampling, or other sampling strategies to systematically recruit for different levels of prior training (e.g. "shop floor" OSH team leaders, technicians, and non-certified OSH professionals). Future research would be useful to test the face validity of the survey items with a broader, more diverse set of OSH professionals, including those who have no prior understanding of TWH concepts. It is also important to recognize that TWH is an evolving practice. Over time and with more experience, our knowledge will continue to expand regarding TWH practice behaviors, necessitating that the survey items expand accordingly. The emerging nature of TWH practice prevented the evaluation of criterion-related validity because no other TWH practice assessment instruments were available to compare to our scale.

To our knowledge, the factor analysis results provide the first empirical evidence available to support a hierarchical organizing structure for a TWH competency framework. These results contribute to the broader research base needed to formalize a TWH competency framework, as advocated by other scholars interested in TWH workforce education (Newman et al. 2020). Future research can build on the current study to expand and refine the scale statements to reflect specific practice performance measures (i.e., competencies) that can be used in conjunction with TWH educational programs. In addition, future studies could explore the utility of adapting the scale to assess organizational TWH performance, given that TWH practice approaches, by definition, involve multiple organizational actors and units.

Conclusions

A novel 10-item TWH skill scale to assess skill for 6 specific TWH practice approaches was developed with very good reliability. Factor analysis revealed 2 latent constructs: TWH leadership skills and TWH risk assessment and control skills. The development of the scale contributes to the broader research base needed to formalize a TWH competency framework, as advocated by other scholars interested in TWH workforce education (Newman et al. 2020). The scale is useful to OSH professionals for assessing their level of competency on specific TWH practices, which can guide prioritization of course goals when developing TWH educational curricula for different groups. Future research is needed to further evaluate the reliability and validity of the scale with a larger sample size and to use the scale in practice to assess TWH educational needs and guide TWH curriculum design.

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Conflict of interest

None declared.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

Supplementary material

Supplementary material is available at *Annals of Work Exposures and Health* online.

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