The Application of the Theory Coding Scheme to Interventions in Occupational Health Psychology

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Objective: There is a need to understand how and to what extent theory is used to inform occupational health psychology (OHP) interventions. This study examines the utility of Michie and Prestwich[1] theory coding scheme (TCS) to examine the theoretical base of OHP interventions. **Methods:** We applied the TCS to a systematically derived sample of 27 papers that reported evaluation data for work-related interventions seeking to improve employee sleep quantity or quality. **Results:** Results indicated that the original TCS was largely applicable to OHP sleep interventions. After several minor modifications to its evaluative criteria, the TCS successfully accommodates a range of OHP intervention designs. **Conclusions:** The revised TCS for OHP interventions allows for a more detailed understanding of the role and use of theory in OHP interventions and may prove to be a valuable tool for OHP researchers and practitioners.

Keywords: occupational health psychology interventions, sleep, theory, theory coding scheme

Interventions have been identified as a powerful research-to-practice translation tool in occupational health psychology (OHP), with the potential to promote measurable improvements in quality of work life for employees.[2] Within the OHP literature, interventions represent structured efforts to promote safety, health, or well-being among employees.[3] There have been calls for greater use of interventions[2] and researchers have responded with more frequent and rigorous intervention studies.[4]

Despite the uptick in its publication, intervention research is regarded as an inherently complex and difficult undertaking.[5,6] Simply implementing an intervention does not guarantee the desired results will be achieved or maintained. Instead, interventions must be designed, implemented, and evaluated with rigor in order to maximize the likelihood of sustainable impact.[5] There are several recommendations to develop more potent interventions, such as the use of a participatory design,[7] an integrated focus on health protection and promotion,[8] and process evaluation.[9] In this paper we focus

on one recommendation that is frequently offered in the literature: basing an intervention on theory.[5,10–12]

Theory in Interventions

Theory has long been regarded as a powerful tool among scientists seeking to explain phenomenon.[13–15] Although there is some debate over the exact definition of theory,[16,17] most scholars agree that theory contains a set of ideas and principles that explain phenomena and interrelationships among a set of concepts.[18] There are many benefits of using theory in science, such as ensuring that studies are well-grounded rather than haphazard.

Today, theory use is so frequently demanded in etiologic research that some scholars argue the organizational sciences have become too focused on theory.[19] In contrast, the organizational intervention literature was initially developed with much less demand for theory. Over time, however, researchers recognized deficiencies in "try it and see" intervention methodologies.[5] Consequently, calls for increased theory use in interventions began to emerge in many health-focused disciplines, including public health[12] and OHP.[20]

Benefits of Theory-Driven Interventions in Health-Focused Research

There are several reasons why basing an intervention on theory may improve the intervention's ability to promote health.[21] First, theory improves our ability to identify, define, and impact our target outcome variable(s). Social and behavioral theories are classified into two broad groups based on their primary function. Explanatory theories help researchers and practitioners understand the nature of the variable that is the target of change and establishes the nomological net of related variables that may influence the target. Change theories directly inform intervention strategies by naming drivers and processes of change in the target variable. Interventions that draw from neither explanatory nor change theories may completely miss a target variable, address a target in a weak manner, or fail to address the full range of possible targets. Of a similar note, even interventions that report a basis on theory may fail to use theory extensively and carry these same limitations.[21]

Second, theory helps researchers to consider whether the necessary design, implementation, and evaluation elements are present within an intervention.[21] Interventions with no theoretical underpinnings are often the products of ad-hoc designs, whereby a program is created to address a particular problem that is observed or thought to occur in a given context. Such interventions are, by their very natures, not intended to be generalized or adapted beyond the specific set of conditions for which they are created. Ad hoc interventions are also vulnerable to "Type III error."[21] Such errors occur when the rejection of an "ineffective" intervention is the byproduct of fundamental flaws in the program's delivery[22] rather than a true lack of association between the independent and dependent variables.

On a similar note, some interventions piece together multiple seemingly beneficial strategies, in which "everything but the kitchen sink" is delivered to participants in an intervention hoping that one or some combination of intervention elements produces a change. While multimodal or multicomponent interventions have some support,[23] there is a substantial difference between presenting

multiple components that are well-developed and theoretically based and presenting multiple atheoretical components that are pieced together in the hope of achieving a desired outcome (described as "cafeteria style research").[24] Interventions with a high number of loosely integrated components depend on complex designs and analyses to tease apart drivers of change, making it more difficult to offer parsimonious solutions to real-world problems. These interventions could also fall victim to Type III error given the challenges associated with the implementation and subsequent evaluation of complex, multicomponent intervention packages.[25] Theory-use allows researchers to develop interventions that are more explicitly targeted to the most potent drivers of change and select the strongest evaluation techniques for those strategies.

Finally, basing an intervention on theory not only contributes to the ongoing refinement of interventions but also contributes to the continuous refinement the theory itself,[21] although the practice of using intervention results to refine theory is rare.[26] As a cumulative science, both theories and interventions are dynamic and continue to evolve based on iterative research. Basing an intervention on theory guides researchers by specifying what to measure in a process evaluation. This makes researchers more adept at matching approaches and audiences, distinguishing between necessary/unnecessary program elements, implementing necessary modifications to improve the likelihood of an intervention's success, and understanding when and why interventions succeed or fail.[11,21] Collection of intervention data within the parameters of a theoretical framework promotes the accumulation of evidence across context, populations, and behaviors,[1] allowing a discipline to develop a more nuanced understanding of when an intervention may be effective.

It is important to note that despite the many hypothesized benefits of theory use in intervention design, implementation, and evaluation, current support for the idea that basing an intervention on theory leads to more effective interventions is mixed. While some reviews have found support for increased effectiveness,[27–29] others have found no evidence or minimal evidence for the superiority of theory-based interventions.[26,30,31] Among the potential explanations for inconsistent findings within this literature is the possibility that crude comparisons that group very different uses of theory together into a single category, that potential confounding effects of the increased methodological rigor of studies that tend to report the use of theory, and that trends in theory selection or combining multiple theories each make meaningful comparisons more difficult.[32] Difficulties in capturing the extent of theory use could explain inconsistencies in the literature.[32] In existing reviews, studies that incorporated superficial use of theory (ie, naming a theory in the methods section) tend to be grouped together with studies that incorporated an extensive use of theory (ie, carefully linking theory-based constructs to intervention strategies, using theory to select recipients or tailor the intervention to recipients, and explicitly incorporating theory-based measures and mediation analyses into the intervention evaluation). Similarly, poor reporting makes it difficult to tell how and to what extent theory was used. Although basing an intervention on theory continues to be described as a useful practice, the literature will be unable to effectively address inconsistent findings regarding the increased effectiveness of theory-based interventions without more careful attention to the extent of theory use in interventions.[32]

Existing Investigations of Theory Use in OHP Interventions

Given the numerous benefits, occupational safety and health researchers have often recommended that interventions be based in theory. Some of the earliest instances came in the form of guidelines for program evaluation in applied research.[33] Over time, views of theory-use in intervention research are becoming so positive that a theoretical basis has now been included in some definitions of

interventions.[20] Over the past several decades, there have been several attempts to gauge the level of adherence to these recommendations. Early work concluded that very few interventions were theory based,[5] while more recent investigations find that about half of OHP interventions published in the previous 25 years were based (to some greater or lesser extent) in theory.[10]

While this notable increase in theory use suggests progress in the use of theory in OHP intervention research, it is important to note that the extent of implications of existing reviews may be limited by broad operationalizations of theory use. For example, an early review operationalized theory use as using theory to explain the proposed causal relationships between intervention strategies and desired outcome or using theory to inform evaluation.[5] In a more recent systematic review of workplace ergonomics interventions, authors delineated implicit theory use (addressing sequential change processes) from explicit theory use (substantially grounding an intervention in change theory).[34] A review of Total Worker Health® interventions defined theory use as mentioning a theory as the basis of an intervention or performing a mediational analysis of theoretical mechanisms of change.[35] Finally, a recent review whether theory use was absent, implicit, or explicit. They designated a study as non-theoretical if no theory was mentioned, sub-theoretical if a theory was mentioned in the introduction or discussion, and theoretical if a theory was mentioned in the intervention rationale.[10]

Although existing operationalizations have allowed OHP researchers to answer important questions regarding the prevalence of theory use, there is an opportunity to take a more nuanced approach. Existing categorizations simply allow us to assess whether theory was used, with limited insight into how and to what extent a theory was used. There are benefits of a more precise understanding of the specific ways in which theory was used. For example, not knowing how to translate an abstract theory into concrete intervention features can be a barrier to theory use,[11] and a rich description of the specific ways in which theory can be used could serve as a prescriptive tool for intervention researchers. Second, a refined understanding of specific uses of theory in design, implementation, and evaluation of interventions helps move our field away from using theory as a loose framework to using theory as a core component of intervention research.[1] Expanding existing operationalizations of theory use would allow researchers to test whether certain specific uses of theory in an intervention are more prevalent or effective than others and better identify gaps in theory use.

The Michie and Prestwich Theory Coding Scheme

Intervention researchers within the public health community have developed a tool that assesses the degree to which an intervention uses theory to guide intervention design, implementation, and evaluation. This tool was developed by Michie and Prestwich[1] and is appropriately named the theory coding scheme (TCS). The purpose of the TCS is to unify the scientific community's understanding of what constitutes a theory-based intervention in response to the increased recognition of the importance of theory as a blueprint for all forms of psychology and health research. Michie and Prestwich framed the TCS using four important elements of theory-based interventions: "named modifying factors, explanations as to how these factors will bring about change, methods to demonstrate changes in the modifying factors, and demonstration of how those changes contributed to behavior change."[1,36]

Michie and Prestwich[1] operationalized the framework as three overarching TCS categories: the relationship between the theoretical constructs and the chosen intervention techniques, the methods used to measure the constructs, and tests for mediated effects. These categories were expanded into an initial set of 10 specific coding criteria, which ranged from noting whether a theory was mentioned in the introduction of a journal article to whether the

findings of the study were discussed in a theoretical context. Michie and Prestwich[1] enlisted the input of multiple raters and followed a systematic and iterative 13-step process to refine the TCS into its final 19-item version. The 19 items are classified into six non-exclusive categories: referencing underlying theory (three items), targeting relevant theoretical constructs (seven items), using theory to select participants or tailor the intervention (two items), measuring relevant constructs (two items), testing intervention effects (seven items), and using results to refine theory (one item). Each item is categorically evaluated (Yes/No/Don't know), and the assigned codes are justified by supporting evidence (eg, page numbers corresponding to relevant passages from the intervention article under review).

The TCS addresses a broad range of criteria related to theory use in behavioral intervention research, including how and to what extent theory is used. Because the TCS provides a thorough and systematic examination of theory use, it serves as a valuable framework for examining the recursive relationship between intervention research and theory. It provides a mechanism for assessing past interventions' theory use and relevance for the broader scientific community. It functions as a comprehensive framework that can be used to improve the use of theory as a blueprint for the design and reporting of future intervention studies. It also generates insights into the degree to which the existing body of intervention literature can reasonably inform the development and refinement of explanatory or change theories.

While first applied to community health promotion interventions, Michie and Prestwich[1] noted that the utility of the TCS for other disciplines "will be determined by its application" (p. 7). Thus, assuming sound application, it is reasonable to expect that the TCS may also serve as a useful tool for evaluating the use of theory in interventions from other disciplines and fields, including OHP. In fact, the likelihood of its applicability to OHP is enhanced by the inherent similarities between public health interventions and workplace safety and health interventions.[3]

Despite such parallels in intervention design, implementation, and evaluation strategies, the applicability and utility of the TCS has not yet been established for other health-promoting disciplines, including OHP. In a review of recommendations to strengthen workplace resource-based interventions, Briner and Walshe[37] reference the TCS as one possible way to increase theory-based interventions. Aside from this recommendation, there has been no overt discussion of the TCS within the OHP community.

Furthermore, given that OHP possesses roots in public health and other health-promoting disciplines,[3] it may be possible that some aspects of the TCS require modification to maximize relevance to each discipline's typical intervention approaches. For example, the TCS was originally developed in a public health context and tested on a sample of community-based health promotion interventions. Yet in OHP, interventions may vary widely in their focus, targets of change, and strategies of change[7] due to the breadth of disciplinary influences in OHP. Minor modifications may be needed in order to best account for intervention variety. In response, this paper examines the application of the TCS to a sample of OHP interventions, noting instances where the TCS requires adaptation to more fully assess theory use in organizational intervention research.

Although the utility of theory is not restricted to one type of intervention, we opted to focus this initial OHP-based application of the TCS on contemporary work-related interventions for sleep health. In recent years, sleep health has risen to the top as a critical health topic and has been identified as a strategic priority for national research and practice.[38,39] Despite the known importance of sleep and its links to worker health and safety, evaluations of the efficacy of work-related sleep interventions are notably lacking. To our knowledge, only one systematic review has been published examining the sleep and work-related outcomes associated with employer-initiated sleep interventions.[40] This qualitative review did not evaluate theory use as an intervention quality metric, indicating no duplication of effort by our TCS application work.

In sum, we aim to apply the TCS to a sample of workplace sleep health interventions as an initial examination of the applicability of the TCS to OHP interventions. We will identify whether or not any TCS criteria might warrant modifications to increase the applicability of the TCS to a workplace context and OHP intervention methodology.

Research Question: What modifications, if any, should be made to the theory coding scheme to facilitate its use as an intervention research quality evaluation tool for the OHP community?

METHOD

Literature Search Strategy

From September 21 to October 15, 2018, two authors of the current study (K.H., J.S.) conducted comprehensive searches for peer-reviewed literature that described work-related interventions to improve sleep quantity or quality. The databases and search terms included in our strategy are presented in Table 1. Our list of key terms associated with the health outcome of sleep or sleepiness were modeled after the key terms used in a review of work-related interventions.[41] Because the current study sought first and foremost to assess the utility of the TCS rather than critique the quality of the interventions to which the TCS was applied, only studies published between January 1, 2007 and the literature search performance dates were considered. This search returned a total of 5138 records. Unpublished materials and reference lists from the returned articles were not searched to identify additional peer-reviewed articles.

Screening for Inclusion

The flow chart presented in Fig. 1 provides an overview of the screening process used to select the final set of articles that we evaluated against the TCS.

We first used a set of five inclusion criteria to screen the titles and abstracts of the records identified by the electronic searches. These criteria are detailed in rows denoted with an I in Table 2. In summary, we marked an article for further consideration if it: (1) was published in English; (2) was published in a peer-reviewed

TABLE 1. Literature Search Strategy

|	Description
Electronic Databases Searched	Academic Search Complete, CINAHL, ERIC, Nursing and Allied Health, PsycInfo, PubMed, SAGE, Science Direct, Scopus, and TRID.
Search Terms	(sleep* OR insomnia OR drows* OR fatigu* OR shiftwork OR shift AND work) AND (employ* OR work* OR staff* OR perso*el OR supervis* OR team* OR manage* OR organi?ation OR office* OR industr* OR compan* OR institut*) AND (treat* OR interven* OR therap* OR trial* OR promot* OR educat* OR seminar* OR workshop* OR program* OR course* OR efficac* OR effect* OR eval*).
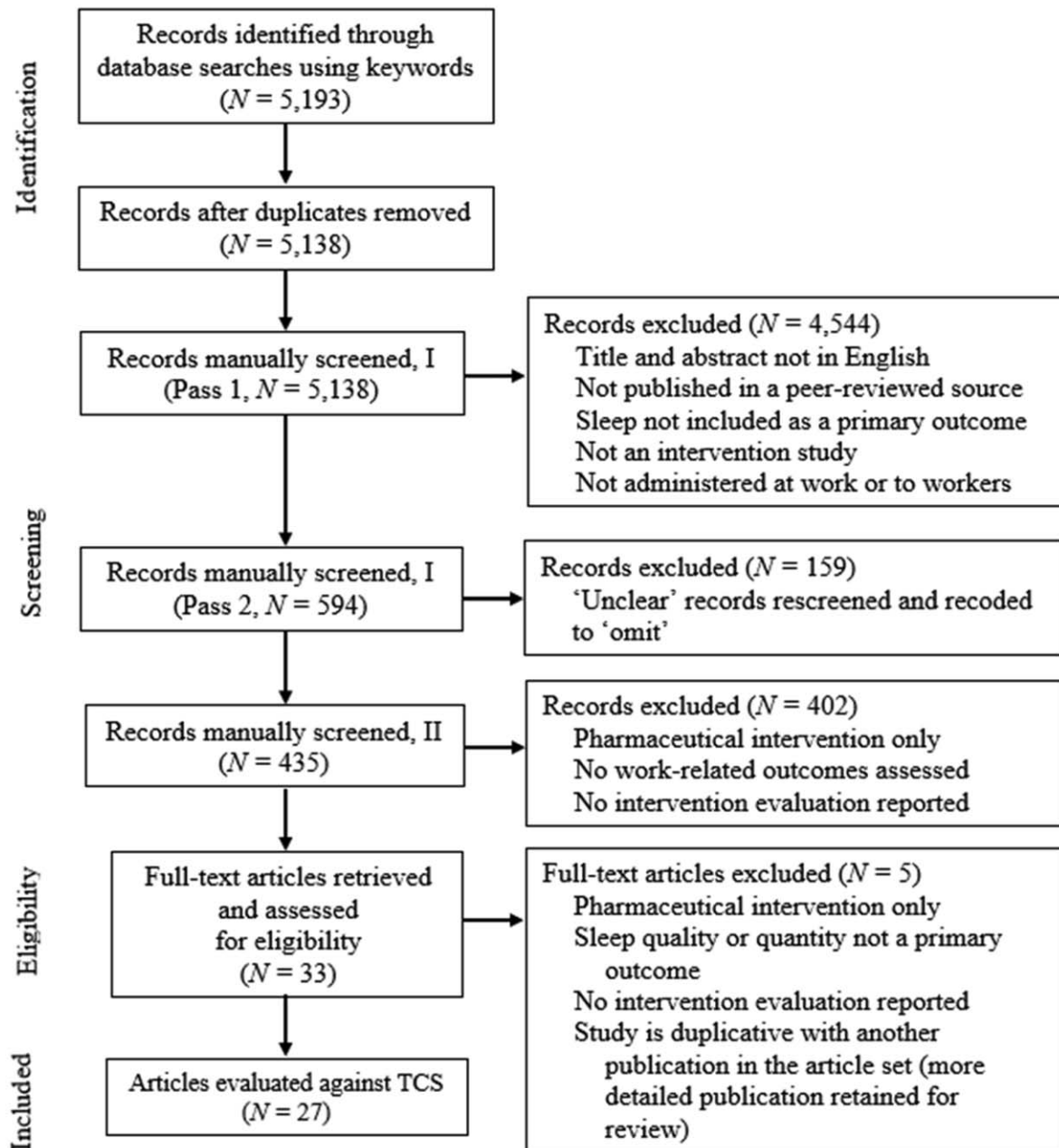
FIGURE 1. Flow chart for inclusion of peer-reviewed work-related interventions to improve sleep.

journal; (3) included sleep quality or quantity as a primary study outcome; (4) described an intervention (ie, an effort to systematically change someone or something to produce a positive outcome); and (5) was designed to affect either the workplace or workers. We then randomly assigned two authors of the current study to complete independent screens of the title and abstract for each of the 5138 records.

Screener pairs were in full agreement with their independent decisions to retain or omit 88% ($N = 4544$) of the records. We resolved the remaining 594 instances of disagreement using a two-step process. In step one, instances of disagreement due to a decision mismatch because one screener was "unclear" on one or more of the inclusion criteria ($N = 533$) were rescreened by the "unclear" screener only. If, after rereading the title and abstract, the "unclear"

screener was in consensus with the other screener decision to "omit" or "retain" the article, the record was rectified accordingly. This resolved 483 records. In step two, we randomly assigned a third author to serve as the tie-breaking screener for each remaining instance of disagreement.

We then used the criteria denoted with II in Table 2 to complete a second round of screening for all records previously marked as either "retain" ($N = 234$) or "unclear" ($N = 201$). In summary, we marked an article for full text review if it: (1) contained at least one non-pharmaceutical element; (2) measured sleep and one or more work-related outcomes at the individual or organizational level (to ensure that selected sleep interventions were grounded within an OHP context, rather than broader public health interventions delivered in a sample of working people); and (3)

TABLE 2. Codebook for Systematic Review of Titles, Abstracts, and Full text for Articles Describing Work-Related Interventions to Improve Sleep

Screening Phase	Criteria	Definition	Code 1 (Yes)	Code 0 (No)	Code 88 (Unclear)
I	English	The article is written in the English language. Note: the abstract may be presented in more than one language.	Article is published in English	Article is available in non-English only	Article availability in English is unclear
I	Peer-Reviewed	The manuscript is published in a scientific, peer-reviewed journal.	Journal is peer-reviewed	Journal is not peer-reviewed or has no clear description of a peer-review process	Peer-review status is unclear
I	Sleep	One focus of the study is the quantity or quality of sleep or conditions/states associated with sleep (insomnia, drowsiness, fatigue). Inclusion of outcomes in addition to sleep is acceptable, if a sleep-related outcome is part of the study.	Sleep is one primary outcome for the study	Sleep is not a primary outcome for the study	Inclusion of sleep as primary outcome is unclear
I	Intervention	The Method section (or its equivalent) mentions or describes a systematic effort to change something or someone to produce a positive outcome or avoid a negative outcome. The effort can include any type of change (eg, behavioral, pharmacological, environmental, etc). The intervention can be administered at the individual or organizational level. Pre-post or control group designs are acceptable.	Study activities meet definition of Intervention	Study activities fail to meet 1+ elements of definition of Intervention	Study's adherence to Intervention definition is unclear
I	Work	The target of the intervention must be the workplace or employees in the workplace. The intervention should be delivered in the workplace or among employees. Employee participation in the intervention can be during work or non-work hours. Employees can come from one specific employer or multiple employers/organizations.	Employees or workplace are priority for intervention	Non-work-related population is priority	Priority population is unclear
II	nonRX	Intervention includes more than just pharmaceuticals	Intervention contains at least one non-pharmaceutical element, regardless of whether pharmaceuticals are also used	Intervention consists of pharmaceuticals only	Intervention elements are unclear
II	SleepWork	Intervention measures sleep and at least one work-relevant outcome, at either the individual or organizational level	Sleep and one or more work-specific outcomes are measured. Other nonwork outcomes may or may not be measured	Sleep is the only outcome measured. Sleep and one or more nonwork (ie, general health) outcomes are measured, but no work-specific outcomes are measured.	List of study outcomes is unclear
II	Evaluation	Study is an intervention evaluation (ie, completed intervention) study	Article describes intervention design, implementation, and evaluation Article discusses implementation and evaluation and cites prior pub(s) as source(s) for information on intervention design Article discusses evaluation and cites prior pub(s) as source(s) for info on intervention design and implementation	Article reports no direct assessment of intervention effects, regardless of whether design or implementation are discussed	Article's inclusion of intervention evaluation data is unclear

reported the results of an intervention evaluation. We assigned two authors to screen all records they had not previously reviewed so that each record was ultimately screened by all four authors. Using the additional criteria, the round two screener pairs were in full agreement to "retain" or "omit" 89% ($N = 386$) of the viable records. We assigned a third author to serve as a tie-breaking screener on each of the remaining 49 records and render a final "retain" or "omit" decision.

At the end of the process, 33 records were considered eligible for full-text assessment. We excluded five of these after retrieving the full texts because one or more of the following applied: (1) they were not intervention studies, (2) they did not include sleep as a primary outcome, (3) they were limited to pharmaceutical elements only, or (4) they duplicated another intervention study already in the sample. This left a total of 27 work-related sleep health intervention articles to assess using the TCS.

Refining the TCS for OHP

Preparing the TCS for OHP Interventions

We used Michie and Prestwich[1] TCS, described previously, along with a set of coding instructions that they had developed for wider use, as the starting point for the current effort.

We made several modifications to the TCS instructions before using it with our sample of work-related sleep intervention studies. First, we summarized definitions for fundamental concepts from the Michie and Prestwich[1] instructions such as "theory," "construct," "predictor," and "intervention technique" to make these definitions easier to identify for coders who may not be as familiar with the application of theory to interventions. Second, we expanded the concept of "predictor" to include factors that can influence behavior or the work environment because OHP interventions can be designed to promote change through individual-level or the organizational-level strategies.[6,23,42] For example, an intervention that redesigns a work task or setting to promote better health is aiming to influence employee outcomes through modification of the work environment without direct modification of employee behavior. Applied to our specific sample of articles, a sleep hygiene intervention would alter sleep through behavioral predictors, whereas an office lighting intervention would alter sleep through an environmental predictor without necessitating a change in employee behavior. Finally, because we expanded the TCS to code for behavioral and environmental predictors, we added examples to demonstrate how intervention techniques might be linked to outcomes in a behavioral intervention and an environmental intervention.

Applying the TCS to OHP Interventions

We employed a multistep process to ensure consistent coding procedure. First, each coder independently applied the TCS to the same randomly selected article from the study database.[43] Then, we all met via phone to compare codes, discuss questions or challenges associated with using the TCS, reach coding consensus for the selected article, and agree on modifications needed to increase the TCS's utility for OHP.

We then repeated this process to assess the utility of our modified TCS. First, all four coders independently applied the revised TCS to two additional articles. We randomly selected one of these[44] from our sample of work-related sleep intervention articles. Next, we randomly selected the other article[45] from our list of excluded articles to ensure the modified TCS successfully discriminated between intervention and non-intervention studies. After completing our independent codes, we met via phone to compare codes, discuss challenges, reach coding consensus for the selected articles, and implement additional TCS modifications. During the first two rounds of coding, we made minor additions to

the wording of some items, adding further clarification on concepts for coders who may not be as familiar with the process of linking constructs and predictors to strategies. For example, we added descriptions of contamination and deficiency to help coders more easily answer items 7 through 11. Additions to the item stems were made whenever additional clarification was needed in order for raters to achieve consensus on an item.

After the two rounds of TCS training and modification, we assigned each author to independently review and code 12 of the remaining 24 articles using the modified TCS. This approach yielded two independent reviews per article. To achieve 100% inter-rater agreement, each possible pair of coders (K.H./J.B., K.H./M.P., K.H./J.S., J.B./M.P., J.B./J.S., M.P./J.S.) met in-person or via phone to compare and discuss their independent codes, reach coding consensus for their assigned articles, and create a list of additional TCS modifications for the full group to consider. We sequenced these meetings over the course of 5 weeks, such that two coder pairs met approximately every 17 days (August 2, 2019, August 23, 2019, and September 6, 2019). This sequence afforded us an opportunity to iteratively refine the modified TCS throughout the project. Between rounds of coder pair meetings, our full group met via phone to provide progress updates, discuss questions or concerns about the TCS, and render consensus decisions on additional modifications needed to improve the TCS's utility for the OHP community.

RESULTS

Modifications to the TCS are described below. The revised instrument, the Theory Coding Scheme for Workplace Interventions (TCS-WI) is provided in an online supplement titled Appendix A, http://links.lww.com/JOM/A849.

Modification to Coding Options

The original TCS scheme specified three response codes that raters could assign to each item: Yes (Y), No (N), or Don't know (DK). We encountered articles that varied widely with respect to the level of detail they supplied about the development of the intervention being evaluated. One key feature of this diversity was the degree to which study authors referred to previously published protocols, registered trials, or manuscripts. Our coding team agreed there may be instances where an intervention's theoretical underpinnings are addressed in these cited sources rather than the evaluation article we were reviewing. For example, one study[46] provided limited details about their workplace mindfulness training methods but cited another paper that fully documented the development of the intervention and its theoretical basis.

Although the authors of the original TCS intended for coders to review all publicly available cited material, we recognized this approach may not always be feasible (or may sometimes have limited utility) for OHP. For example, a public health intervention evaluation study may cite the protocol for a registered trial that provides very concrete details on intervention development. An OHP intervention evaluation study, on the other hand, may cite previous intervention studies that vary in the degrees to which they provide necessary information, potentially citing other studies in their own rights as well. Within the cumulative body of OHP literature, the process of reviewing all available information could prove to be lengthy and cumbersome.

As an intermediate step, and to highlight the substantial difference in true lack of reporting compared with citing additional sources, we added the response option of Don't Know—Cited (DKC) to the TCS. This allows researchers who use the TCS to preserve the intended size and scope of their reviews, while retaining the option to return and read the cited material in more detail. We recommend using this option whenever a previous paper, protocol paper, registered trail, or manual (when authors cited an

established treatment manual, such as an established protocol for cognitive-behavioral therapy [CBT] for insomnia, the study was coded as "Yes" under "Mentions Theory." This decision was made after consulting a clinical psychologist specializing in behavioral health medicine who stated that established treatment protocols for CBT are regarded among their discipline as having a strong foundation in theory, particularly Beck Cognitive Theory.[47]) is cited in the methods section of an intervention paper, but it is unclear whether theory is discussed in the cited material. It should be noted that this code is best used as an intermediate step, with coders reviewing publicly available cited material whenever possible to decide on a more definitive Yes or No code. This option may also provide value in the case where a study cites a propriety intervention manual that is not publicly available (To examine whether the use of the DKC code would exclude available, relevant literature that would substantially change conclusions regarding the theory use of an intervention, two authors [K.H. and J.D.] randomly selected 10% of articles using the DKC code and searched for all cited literature. This process revealed that some cited literature was not publicly available and when cited literature was available, reading the full text did not systematically result in changing DKC to a more concrete Y or N code. A more detailed description of this review is available from the first author upon request).

Application of the new DKC code varied across TCS items, ranging from 0% ($N = 0$) to approximately 26% of studies ($N = 7$). DKC was least applicable to intervention implementation and evaluation components, as the code was not used for any items referring to the selection of recipients, tailoring of the intervention, quality of theory-relevant measures, randomization, changes in theory-relevant constructs, or mediation analysis. DKC was most applicable to intervention design elements, where this code was used most often for items referring to the development of intervention techniques (26% of studies, $N = 7$) and basing an intervention on a single theory (22% of studies; $N = 6$).

Expansion Beyond Behavioral Focus

Given that the original TCS was developed in a public health context, the tool's behavioral focus is understandable and expected. Michie and Prestwich[1] coding scheme was designed according to the following logic: interventions modify a predictor to change participation in a health behavior to ultimately improve health. However, targeted constructs and mechanisms of change may be broader in an OHP context, meaning that interventions could intend to modify something other than employee behavior. The need for adding environmental constructs and predictors was anticipated early in our process and confirmed throughout the coding and agreement procedures. While a number of interventions included in our sample did actively target behavioral change (eg, an Internet Cognitive Behavioral Therapy intervention to improve employee insomnia),[48] other intervention studies modified the environment and expected changes in outcome variables to occur without specifically targeting individual behaviors known to be directly linked to sleep quantity or quality (eg, an initiative to promote worktime flexibility that improved sleep and other well-being factors without directly targeting any individual-level health behaviors[49]). (Although sleep can be described as a lifestyle behavior,[50] it is important to note that sleep is a multi-faceted construct that can be operationalized in a number of ways.[51] Some intervention outcome measures included operationalizations of sleep that are more closely linked to behavior [ie, sleep hygiene], while others included operationalizations of sleep that do necessarily reference behavior [ie, sleep quality]. Thus, a decision was made that "health outcome" would represent a more flexible and inclusive term).

Expansion to accommodate environmental intervention strategies was accomplished by referencing environmental intervention strategies in both the TCS instructions and items, by including examples of both behavioral and environmental interventions in the instructions, and by modifying the measurement items (13e. to 13 h.) to refer to a "health outcome" rather than a behavioral outcome. This proved to be a valuable modification, as roughly 33% ($N = 9$) of the intervention studies we reviewed contained some sort of environmental component.

Methodological and Evaluative Criteria

Several components of Michie and Prestwich[1] TCS focus on using theory to strengthen the methodological rigor of an intervention evaluation. Specifically, item 14 references the use of random assignment, as based on theory a researcher would expect the intervention to promote a significant difference among previously equivalent groups. While there are many benefits to the use of a randomized controlled trials (RCTs), researchers in OHP have also recognized the value of using other designs to evaluate interventions. Specifically, strict adherence to the notion that RCT is the only appropriate evaluative framework may ignore other research designs that can better account for context and the realities and complexities of applied program evaluation.[52] In keeping with this advancement in the OHP literature, we added a Not Applicable (NA) code to the randomization items in the TCS (items 14a. to 14d.). This code applied to approximately 11% ($N = 3$) of designs, providing an appropriate coding option for studies without a control group[49,53] and a study that used innovative rotating design to protect against threats to internal validity using a single group design.[54]

In another methodologically focused item (No. 16), the TCS evaluates the use of mediation to test that intervention-related behavioral changes are explained by theory-relevant constructs. Similar to other disciplines, OHP researchers recognize the value of performing a mediation analyses to explain the mechanisms of change in an intervention.[35] However, the original TCS described one four-part method of testing mediation effects. Specifically, the mediator must predict the dependent variable, the mediator must predict the dependent variable after controlling for the independent variable, the intervention must not predict the dependent variable when controlling for the mediation, and the mediated effect must be statistically significant.[1] Because the OHP literature contains examples of analysis plans that assess mediated intervention effects without using this specific approach,[55] we added a note to item 16 explaining that mediation could be supported by other criteria (a review performed by the second author of the original TCS revealed that the original intention of the mediation item was to allow for other analytical approaches and that taking this opportunity to make that intention more explicit would be beneficial. The original TCS included steps a. through d. in item 16 describing the criteria for supported mediation. Our study team believed that testing mediation and supporting mediation can both bring value to theory-driven intervention development. For example, a study that tests a non-supported theory-based mediation hypothesis could be coded as "No" in any of these steps. Yet, testing the mediator and finding that it is unsupported would be important in the future refinement of theory. For this reason, we reorganized the steps in item 16 to reference testing mediation and supporting mediation separately. Such a revision is consistent with other items in the TCS that represent increasingly higher levels of study quality, such as the items assessing measure quality). This change applied to 11% of studies ($N = 3$) that relied on methods that tested indirect effects using bootstrapping,[49,56,57] which can be accomplished in regression-based frameworks or structural equation modeling.

DISCUSSION

This study sought to apply Michie and Prestwich[1] TCS to interventions in OHP, examining potential modifications to increase the tool's applicability to interventions conducted in a workplace setting. Modifications for an OHP context were relatively minor,

including the addition of a coding option that notes when an intervention references cited literature, expansion to nonbehavioral targets in the instructions and items, adaptation of randomization items to better account for designs other than RCT, and descriptions of alternative means of evaluating mediation among theory-relevant constructs.

Implications for Research and Practice

The present study expands the applicability and usefulness of the TCS to OHP by creating the TCS-WI. Importantly, all of the benefits, strengths, and applications of the original TCS still apply. Specifically, the TCS-WI serves as a tool for systematic examinations of the use of theory within interventions by highlighting not only prevalence of theory use, but also how theory is being used. In this way, researchers may begin to have more concrete, detailed conversations about the role of theory in OHP interventions. It will permit OHP to move away from loose applications of theory and towards an explicit and nuanced use of theory in interventions. Similar to the implications described for the original TCS, the TCS-WI also stands to make a particular contribution to the summary of OHP literature in reviews and meta-analyses. Michie and Prestwich[1] suggest that their scheme could be used to assess theory use as a metric of study quality in health promotion reviews and meta-analyses, and the same logic would apply in OHP literature. Practically speaking, the TCS-WI can also serve as a framework when it comes to the design and implementation of theory-based OHP interventions.

Strengths, Limitations, and Future Directions

This study is strengthened by several features. First, it leverages a tool that has been widely used since its publication. At the time of the current study, Michie and Prestwich[1] TCS had been cited more than 500 times, and 22 systematic reviews and meta-analyses had used the tool to provide a concrete assessment of theory use by studies from their respective fields.[58,59] The tool has also been referenced in recommendations for a standardized reporting checklist for behavior change interventions.[60] These trends serve as evidence of the acceptability and utility of the TCS. This study is also strengthened by the rigorous procedures used for articles selection and screening, in addition to the high levels of interrater agreement, ensuring confidence that our final sample of articles adequately represented sleep interventions in the workplace.

However, it could be argued that a focus on a single type of intervention, such as sleep interventions, is a limitation of the study. Limiting the scope of articles in this initial study allowed our team to focus on the utility and modification of the TCS to an OHP context and fully understand how applications of theory could vary within a single type of OHP intervention. This methodology is similar to that used for the original development of the TCS,[1] which was applied to interventions to improve healthy eating rather than all types of health behavior interventions. Although the diversity of types of interventions and outcome variables assessed in the sample does lend support to the use of this tool for other types of interventions, it is important that future research replicate the use of this tool for other types of OHP interventions. This would ensure the applicability of the TCS-WI for the broad range of targets that exist in OHP interventions beyond sleep, such as stress or other health behaviors. Future research could also incorporate additional signs of utility, such as inter-rater agreement in final codes.

CONCLUSION

Given the many benefits of using theory in OHP interventions and the frequent calls for increased theory use, the OHP community would benefit from a more nuanced conceptualization of theory use in interventions. Having access to a tool that helps researchers, reviewers, editors, and consumers of OHP literature assess the degree to which an intervention is based in theory would ensure consistent, standardized assessments of the prevalence, and quality of theory use for the field. The Michie and Prestwich[1] TCS has served this function for the public health community. Using a sample of workplace sleep interventions, we found that the TCS was largely applicable to workplace interventions. Minimal modifications were required to improve the tool's relevance for OHP. The TCS-WI acknowledges the tendency to cite previous literature or protocol papers to describe intervention development, expands instructions and items to non-behavioral intervention targets, and better accommodates a full range of research designs and analyses present in OHP interventions. The TCS-WI is a tool that can be used within the OHP literature to guide our field closer to stronger interventions that are more explicitly based in theory.

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