Mindfulness and workplace safety: an integrative review.

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Abstract

Mindfulness has recently gained popularity in applied settings to enhance workplace safety, especially in safety-critical occupations such as healthcare and construction. In this review, we synthesize existing research across disciplines to establish a theoretical model of mindfulness and safety. Based on 32 empirical studies, we first summarize and critically analyze how mindfulness and safety are conceptualized and operationalized in the literature. We then consolidate empirical findings and conceptual arguments and draw upon the job demands-resources model to propose a theoretical model linking the basic benefits of mindfulness to safety-related job demands. Specifically, we propose that mindfulness (a) improves detection of and responses to workplace risks and hazards, (b) enhances concentration and self-monitoring of safety behaviors in cognitively demanding situations, and (c) facilitates more adaptive responses to emotional burdens. We further propose that the mindfulness-safety link can vary across boundary conditions, including personal and contextual characteristics. Our theoretical model serves as a foundation to integrate existing knowledge and guide future research. We conclude by highlighting specific opportunities for researchers and practitioners to advance research and applications of mindfulness and workplace safety.

Keywords: mindfulness, workplace safety, job demands, integrative review

Mindfulness and Workplace Safety: An Integrative Review

Mindfulness, broadly reflecting the self-regulation of one's attention and awareness of the present moment without evaluation and judgment (Bishop et al., 2004; Glomb et al., 2011; Kabat-Zinn, 2013), has recently been identified as a promising mechanism to improve safety. This emphasis on mindfulness has been spurred by findings that inadequate attention and awareness, features of low mindfulness, were major contributing factors in many adverse safety events, such as aircraft accidents and equipment misoperation in offshore environments (Sneddon et al., 2006; Stanton et al., 2001). Currently, many organizations incorporate mindfulness training to benefit both employees and operational safety and quality (Schaufenbuel, 2015). For instance, energy companies have adopted mindfulness training in their corporate safety initiatives to enhance employee attentiveness to work tasks and decrease incidents (Parker, 2018). Amazon recently incorporated guided mindfulness techniques as part of a safety program to reduce injury rates in warehouses (Hamilton, 2021). Despite these widespread applications and the promises of mindfulness in the safety domain, there has yet to be a review synthesizing knowledge in this field.

An integrative review of mindfulness and safety can summarize current knowledge, generate new insights, and advance the development of theories and practices (Cronin & George, 2023). Such a synthesis is particularly important at this point in time, given that existing research on the mindfulness-safety link is scattered across discipline-specific outlets (e.g., psychology, safety, nursing, construction). This results in a diverse, vibrant, but fragmented knowledge base with several critical conceptual and practical issues. A major limitation is that current studies have primarily adopted a practice-driven approach, with insufficient work contributing to the conceptual foundation of the mindfulness-safety link. A clear conceptualization of mindfulness is

needed to understand the nature of the construct and its implications for workplace safety. For example, existing studies have endorsed multiple conceptualizations of mindfulness, including an exclusive focus on attention and awareness (e.g., Betts & Hinsz, 2015; Kao et al., 2019) versus a multi-dimensional construct that has varying facets (e.g., Leung et al., 2016; Prudenzi et al., 2021). The ambiguous conceptualizations in the literature make it difficult to distinguish mindfulness from other similar concepts and hinder the development of valid operationalizations (Hülsheger & Alberts, 2021; Podsakoff et al., 2016). Existing studies have utilized measures of mindfulness that vary in breadth, further exaggerating concerns for construct validity (Baer et al., 2006; Brown & Ryan, 2003; Walach et al., 2006).

Furthermore, the lack of conceptual and operational clarity inhibits the theoretical understanding of the mindfulness-safety link (Podsakoff et al., 2016). Most current research has focused on demonstrating direct relationships between mindfulness and industry-specific safety metrics, such as diagnostic errors and food safety practices (Betts & Hinsz, 2015; Saban et al., 2019). These empirical findings suggest the promise of mindfulness for improving safety, but the underlying pathways and boundary conditions have been left under-examined. Greater theoretical insights are needed to supplement this practical focus to guide the development of future research questions and study designs. Finally, the need for an integrative review is especially important now due to increased attention to mindfulness in safety-critical occupations. Along with this growing interest, mindfulness-based training has been viewed as a promising approach to reducing adverse safety events in multiple sectors, such as healthcare, construction, and military settings (Liang et al., 2022; Singh et al., 2020; Zanesco et al., 2019). A timely integration of the available evidence is needed to inform practitioners and organizations of the usefulness of mindfulness for maintaining workplace safety and to help improve future

applications. Hence, this article discusses emerging conceptual and operational issues in the literature, synthesizes empirical findings across disciplines, and establishes a theoretical model to develop new knowledge and direct future investigations.

In this review, we offer three contributions to the literature on mindfulness and workplace safety. First, we present a comprehensive overview of the extant research. We integrate research in various occupational settings, critically synthesizing how scholars studied mindfulness and safety and what they have found. This review consolidates a broader knowledge base across disciplines and reveals common conceptual and operational issues in this research field. Second, we draw upon the reviewed studies to build a theoretical model of the mindfulness-safety link. We discuss how mindfulness offers personal resources that help employees handle specific safety-related job demands based on the job demands-resources (JD-R) model (Bakker & Demerouti, 2017). We also propose boundary conditions altering the benefits of mindfulness. Our theoretical model highlights the importance of explicitly considering the characteristics of safety-critical occupations to understand why, when, and how mindfulness improves safety. The particular focus on safety-critical contexts extends the existing discussion on mindfulness in general work settings and contributes to contextualization in management theory (Bamberger, 2008). Our theoretical model, along with the literature review, also provides a structure for empirical testing to develop new theoretical insights. Finally, we offer timely and concrete recommendations to guide the application of mindfulness in safety-critical work contexts. We discuss critical observations in the reviewed studies in light of the broader scholarship on mindfulness and on safety, highlight areas for theoretical and empirical development, and present exemplary studies so that future researchers and practitioners can advance this growing field.

The Potential of Mindfulness for Enhancing Workplace Safety

Mindfulness reflects how people respond to internal and external stimuli (Kabat-Zinn, 1994). Despite some debates on the specific dimensions underlying mindfulness in the literature, it is widely acknowledged that high levels of mindfulness depict individuals being attentive to and aware of the present experiences non-reactively and non-judgmentally (Bishop et al., 2004; Kabat-Zinn, 2013; Van Dam et al., 2018). Thus, in this integrative review, we consider mindfulness as *attention to and awareness of the present moment in an accepting manner*. With this definition, we aim to capture the common theme in previous scholarship which leaves room to incorporate studies from multiple disciplines (Good et al., 2016). Two types of approaches have been utilized to study the mindfulness-safety link. Specifically, some research has focused on dispositional differences in mindfulness and assessed trait mindfulness as a predictor of safety outcomes (e.g., Kao et al., 2019; Zhang & Wu, 2014). Other studies have applied training programs to teach mindfulness skills and tested the impacts on workplace safety (e.g., Singh, Lancioni, Karazsia, & Myers, 2016; Valley & Stallones, 2017). Following previous reviews on mindfulness, we incorporate both approaches to fully capture the scope of extant work (Good et al., 2016; Shahbaz & Parker, 2021).

In addition to research directly focusing on mindfulness and workplace safety, a growing body of mindfulness research in the general work context provides a foundation for our review (Eby et al., 2019; Good et al., 2016). Previous research has investigated a number of workplace benefits associated with increased mindfulness. For example, mindfulness relates to a wide range of work-related outcomes, including increased task performance in dynamic situations, reduced deviant behaviors, enhanced well-being, and reduced work stress (Bostock et al., 2019; Dane & Brummel, 2014; Hülsheger et al., 2020; Roche et al., 2014; Slutsky et al., 2019; Wolever et al., 2012). Thus, as a first step to understanding why, how, and when mindfulness improves safety,

we draw upon the greater literature to identify three basic influences of mindfulness on human functioning (e.g., Dane, 2011; Glomb et al., 2011; Good et al., 2016; Hyland et al., 2015; Kudesia, 2019; Shapiro et al., 2006). We specifically focus on how these benefits of mindfulness have the potential to promote safety.

First, mindfulness incorporates enhanced awareness of the present moment (Dane, 2011). Mindful awareness is depicted as the "background radar of consciousness" (Brown & Ryan, 2003, p. 822), which makes individuals alert to both internal experiences and external stimuli in the environment. Accordingly, people can quickly become aware of emerging thoughts, feelings, and problems (Zheng et al., 2022). Consistent with this view, a recent meta-analysis revealed that mindfulness was related to improved performance in reacting to warning signals and switching attention across tasks (Verhaeghen, 2021). In the context of work, mindfulness is expected to help employees stay tuned to changes in internal physical and psychological states as well as external conditions (Glomb et al., 2011; Good et al., 2016; Shapiro et al., 2006), which facilitates detecting risks and generating prompt responses.

Second, sustained attention to the present circumstances is another central characteristic of mindfulness. Increased attentional capacities, as a key feature of mindfulness, allow individuals to stabilize and control their attention to the current situation (Verhaeghen, 2021). In this manner, mindfulness helps individuals regulate attention even in a distracting environment and makes them less vulnerable to external and internal interruptions (Kirk et al., 2011; Long & Christian, 2015). Despite the interrelated nature between enhanced awareness and sustained attention, they still reflect two distinct features of mindfulness (Brown & Ryan, 2003; Feldman et al., 2007; Zheng et al., 2020). Specifically, enhanced awareness depicts the function of recognizing feelings, thoughts, and problems as they occur, while sustained attention emphasizes

the process of remaining focused over time (Brown & Ryan, 2003). The benefit associated with sustained attention is frequently proposed as a primary mechanism underlying the contribution of mindfulness to human functions (Dane, 2011; Good et al., 2016). This feature may be particularly critical in occupations where employees need to concentrate on complex work tasks with safety implications over a long period of time or in a distracting environment (Huber et al., 2015).

Finally, mindfulness equips individuals with an open and accepting attitude toward experiences. In particular, mindfulness leads individuals to notice and observe experiences without attaching further meaning (Feldman et al., 2010). This non-judgmental attitude decouples individuals from potentially adverse experiences, thus reducing the threat of these unfavorable experiences to self-worth (Glomb et al., 2011; Williams, 2010). This is consistent with the benefits of mindfulness on mental detachment from experiences (Kudesia, 2019) and enhanced self-regulation (Shapiro et al., 2006). Hence, when faced with stressful, demanding experiences at work, mindfulness helps individuals better handle stress and reduces its negative impacts on safety.

In summary, there are three basic benefits of mindfulness: enhanced awareness, sustained attention, and accepting attitudes. In the next sections, we review empirical studies on mindfulness and safety to connect these benefits with job demands in safety-critical contexts and propose specific pathways to explain how mindfulness improves workplace safety.

Overview of the Current Integrative Review on Mindfulness and Safety

In this review, we aimed to integrate and critique the existing literature and understand why, how, and when mindfulness contributes to workplace safety. To achieve this, we conducted a systematic literature search to identify relevant studies. In this section, we first review trends

and research designs in the literature to provide a comprehensive picture of the field before delving into an in-depth discussion. We next analyze how studies in different disciplines conceptualize and operationalize the focal constructs. Such analysis can help enhance conceptual clarity and refine measures and manipulations in this emerging field. This is followed by a discussion of our theoretical model that proposes pathways through which mindfulness improves workplace safety. Specifically, our model incorporates common types of job demands found in safety-critical occupations based on the reviewed studies. For each job demand, we draw upon empirical findings and theoretical arguments in the reviewed studies to explain how the benefits of mindfulness can provide personal resources to help employees better manage safety-critical situations. We also propose boundary conditions to understand when the benefits of mindfulness can translate into better safety outcomes. This theoretical model provides a way to comprehensively integrate the available evidence on mindfulness and safety and offers specific directions for future research.

Literature Search and Inclusion Criteria

We conducted a systematic literature search following the reporting standards for systematic reviews and meta-analyses (PRISMA) and suggestions of prior authors (Moher et al., 2009; Schmidt & Hunter, 2015). In particular, we focused on identifying studies that empirically tested and reported a relationship between mindfulness and at least one indicator of workplace safety. To identify eligible studies, we performed a comprehensive search in multiple databases (e.g., PsycINFO, Scopus, MEDLINE, ProQuest, Academy of Management Annual Meeting Proceedings). Our search included the combination of key terms of mindfulness (i.e., *mindfulness, mind-body therapy, meditation*) and the keywords of workplace safety (i.e., *safety, accident, incident, injury, error, near-miss*). We then reviewed the reference lists of identified

articles and studies that cited identified articles, continuing this process until we could not find any new articles. We also scanned reference lists of previous meta-analyses and reviews of mindfulness and other work-related outcomes, such as job performance and burnout (e.g., Bartlett et al., 2019; Eby et al., 2019; Lomas et al., 2019; Mesmer-Magnus et al., 2017). Finally, we sent emails to authors who had studies in our database and posted on research forums to ask for unpublished articles. Altogether, 32 studies with independent samples were identified as suitable for inclusion. Table 1 presents an overview of the 32 studies.

---Insert Table 1 about here---

The Current State of the Literature on Mindfulness and Safety

To summarize trends in this literature, we plotted the number of published articles on mindfulness and safety across time and by occupation. Figure 1a displays publication trends in this growing research field. Although there was only one article before 2010, this figure shows a steady increase in the number of studies over the past decade. This indicates that mindfulness has attracted increased attention in safety research. Figure 1b presents the distribution of publications focusing on different occupations. For this figure, we coded participants' occupations according to the major occupation groups in the Standard Occupational Classification System (Bureau of Labor Statistics, 2018). Almost half of the existing research was conducted in healthcare occupations. The other half was scattered in different industries, including construction and extraction, military, food preparation, and serving-related occupational groups. The wide variety of occupations studied in this research area highlights the need for an integrative review to synthesize this growing but scattered literature.

---Insert Figure 1a and Figure 1b about here---

Research Designs in the Literature

The reviewed studies applied various research designs to investigate the mindfulness-safety link. In sum, 13 studies used survey methods, and 19 used experimental or quasi-experimental methods. In survey-based designs, participants typically responded to questions about their dispositional mindfulness and reported safety outcomes. All 13 of these studies used a cross-sectional design to test the relationship between mindfulness and safety outcomes. Moreover, 11 of these studies exclusively relied on participants' self-reports, while two studies included safety outcomes rated by experts or supervisors (Saban et al., 2019; Zhang et al., 2013). The heavy reliance on cross-sectional survey designs and the primary use of self-report measures may lead to concerns for the directionality of the relationship as well as concerns for common method variance (Podsakoff et al., 2012).

Among the 19 studies using experimental or quasi-experimental methods, the manipulation typically involved an established mindfulness training program. Four of these studies applied the randomized controlled trial (RCT) design to provide high-quality evidence for the causal impact of mindfulness on safety (Guyatt et al., 2008). Four other studies used group-level randomization to determine which unit receives the manipulation, and another four studies included a non-randomized control group. The remaining seven studies applied a single-group pre/post design to detect changes in safety outcomes following a mindfulness manipulation. The diverse methodologies further supported our choice of a qualitative, integrative review (Cronin & George, 2023; Higgins & Green, 2008).

Conceptualization of Mindfulness

Existing studies have adopted different approaches to conceptualize and operationalize mindfulness. In general, the primary focus included trait mindfulness and mindfulness interventions, while state mindfulness was neglected in this field. Our review further indicated

that 28 of the 32 reviewed studies explicitly offered a definition of mindfulness. Five of these studies focused on the attention and awareness components of mindfulness. For example, Kao et al. (2019) considered mindfulness as a quality of attention, defined as attention to and awareness of present events and experiences. Gunther (2014) viewed mindfulness as sustained consciousness of ongoing experiences. Consistent with this focus, all five of these studies assessed mindfulness using the 15-item unidimensional Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), which was the most popular tool in the context of work (Hülsheger & Alberts, 2021). Despite the simplicity of a single-factor structure, this sole focus on attention and awareness omits other acknowledged components of mindfulness, such as openness, curiosity, and non-judgmental attitudes (Baer et al., 2004; Kabat-Zinn, 2013), leading to concerns for an incomplete conceptualization.

The remaining 23 studies used mindfulness definitions that incorporated the components of non-judgment and non-reactivity, in addition to attention and awareness. For instance, several studies adopted the conceptualization from Kabat-Zinn (1993, 2013), characterizing mindfulness as receptive attention to ongoing stimuli without reactivity, evaluation, and judgment (e.g., Liu et al., 2022; Saban et al., 2019). Other studies borrowed the operational definition from Bishop et al. (2004), which includes self-regulation of attention to the present moment and orientation of openness, acceptance, and curiosity toward one's current experience (e.g., Brady et al., 2012; Meland et al., 2015). However, not all of them adopted this multi-dimensional perspective in measurement. Five of these studies operationalized mindfulness using the single-dimensional MAAS (Brown & Ryan, 2003) and only assessed the attention and awareness components (e.g., O'Brien et al., 2019; Saban et al., 2019), indicating the inconsistency between the conceptualization and the actual operationalization. Among the studies using multi-dimensional

measures, three applied the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). As the name suggests, the FFMQ assesses mindfulness as a five-dimensional construct, including acting with awareness, describing, non-judging, non-reactivity, and observing. Two studies used the adapted version of the Freiburg Mindfulness Inventory (FMI; Walach et al., 2006), which measures two dimensions of mindfulness, including a presence factor and an acceptance factor (Zhang et al., 2013). Two studies used the Toronto Mindfulness Scale (TMS; Lau et al., 2006), which was designed to measure two facets (i.e., decentering and curiosity). One study combined multiple existing scales with the stated aim of capturing mindfulness in a comprehensive way and extracted nine dimensions based on the factor analysis (Leung et al., 2016). However, even among studies using multi-dimensional measures (e.g., TMS, FFMQ), only a few of them modeled different mindfulness components separately and tested their distinct effects on safety outcomes (e.g., Leung et al., 2016; Meland et al., 2015; Zhang et al., 2013).

Taken together, the theoretical and empirical neglect of non-judgmental and accepting attitudes, as critical characteristics of mindfulness, may lead to construct deficiency in this field. Omitting important components also hampers a deep and complete understanding of why and how mindfulness influences safety outcomes. Moreover, a deficient conceptualization of mindfulness makes it more challenging to distinguish it from other constructs. For instance, one construct frequently examined in the safety domain is situation awareness, which reflects an individual's ability to maintain awareness of the task environment and anticipate future developments (Sneddon et al., 2013). In this case, situation awareness shares greater similarity to the attentional component of mindfulness, so neglecting the attitudinal component of mindfulness threatens its discriminant validity. Thus, this field could benefit from adopting a more comprehensive approach to examining mindfulness.

Conceptualization of Safety Outcomes

Safety indicators examined in the reviewed studies fell into two broad categories: safety performance and safety consequences. This classification is consistent with the categorization in the safety literature (Christian et al., 2009). Safety performance represents individual behaviors on safety-oriented tasks and activities, including safety compliance and safety participation (Griffin & Neal, 2000). Safety compliance refers to following rules and performing required safety actions, while safety participation refers to voluntary behaviors to promote workplace safety (Griffin & Neal, 2000). Among the reviewed studies, 11 studies assessed employee safety behaviors in general at work or during a prior period. All 11 of these studies measured safety compliance. For example, several studies used Griffin and Neal's (2000) measures to capture common compliance behaviors (e.g., Valley & Stallones, 2017; Zhang & Wu, 2014). Other studies examined industry-specific compliance behaviors, such as following particular safety guidelines and avoiding unsafe shortcuts (Betts & Hinsz, 2015; Dierynck et al., 2017). Six of these studies also measured safety participation. Examples include voluntarily protecting coworkers from injuries and promoting the organization's safety program (Liang et al., 2022; Zhang & Wu, 2014).

Safety consequences broadly represent more distal outcomes with safety implications, such as accidents, errors in safety-critical tasks, and injuries (Christian et al., 2009; Tuncel et al., 2006; Visser et al., 2007). In our database, 24 studies assessed some type of safety consequences over a certain period ranging from one month to one year, such as medical errors (Saban et al., 2019), attentional failures (Jha et al., 2015), and injuries (Singh et al., 2009). Overall, our review indicates that most studies investigated multiple safety indicators with a greater focus on safety consequences than safety performance. Practical utility or convenience may have partly

motivated the choice of safety indicators, especially because some safety consequences were directly obtained from regular records.

A Theoretical Model of Mindfulness and Safety

The job demands-resources (JD-R) model offers a theoretical lens to organize insights from existing studies and understand how mindfulness contributes to safety. In the JD-R model, job demands refer to "physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological effort and are therefore associated with certain physiological and/or psychological costs" (Bakker & Demerouti, 2017, p. 274). Common job demands such as work pressure and emotional stress have been found to impair employee mental health and reduce job performance (Bakker et al., 2008). In high-risk occupations, certain job demands may further incur employees' physical or psychological costs, rendering it more challenging to act safely and increasing the likelihood of incidents (Nahrgang et al., 2011).

Furthermore, the JD-R model maintains that personal resources can support employees' control over the environment and buffer the unfavorable effects of job demands (Bakker & Demerouti, 2017). Based on this, we propose that mindfulness provides employees with personal resources to mitigate threats of certain job demands on safety. In the previous section, we introduced three basic influences of mindfulness on human functioning: enhanced awareness, sustained attention, and accepting attitudes. Here, we analyze the occupations in the reviewed studies to extract three common safety-related job demands—risks and hazards, cognitive demands, and emotional demands—which connect to the basic benefits of mindfulness. In addition to the intervening mechanisms, we complement our theoretical model by including personal and contextual moderators in the reviewed studies to better understand when mindfulness benefits safety outcomes. Figure 2 shows our theoretical model that explains how

the core benefits of mindfulness provide employees with resources to address safety-related job demands and presents the boundary conditions.

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Risks and Hazards in the Occupation

Some occupations are inherently more dangerous because the characteristics of the job or the nature of the working environment can pose a direct threat to safety (Burke et al., 2011; Nahrgang et al., 2011). Frequent workplace hazards include bodily reaction and exertion, exposure to harmful substances and environments, and risks of transportation accidents (Biddle, 1998). Employees in safety-critical occupations often need to spend greater efforts in handling risks and hazards.

Almost all the reviewed studies were conducted in occupations involving inherent risks and hazards. Studies in healthcare industries revealed several common risks, including interactions with sick patients and exposure to chemicals. For instance, staff in psychiatric inpatient units can face high levels of patient physical violence and verbal abuse due to intense interpersonal contact with patients in their job (Hallman et al., 2014). The working environments of nurses are often "highly arduous and dangerous due to interacting factors such as the disease process itself" (Gunther, 2014, p. 3). Another industry with dangerous working conditions is construction and extraction. Specifically, construction workers sometimes need to work at height and operate heavy equipment (Leung et al., 2016). They also have regular contact with toxic chemicals, loud noises, and poorly maintained equipment (Leung et al., 2016; Liang et al., 2022). Close exposure to physical and chemical hazards is also a safety risk in production or food preparation and service industries (Nnadede, 2018). Overall, risks and hazards in the occupational environment can increase cognitive loads, incur negative affective reactions, and

directly result in accidents and injuries (Burke & Signal, 2010; Burke et al., 2011; Dodoo & Al-Samarraie, 2019). The risky working environment requires employees to better detect and handle workplace safety hazards.

Mindfulness and Enhanced Risk Detection

As mentioned previously, a central benefit of mindfulness is increased awareness of both internal experiences and external stimuli (Brown & Ryan, 2003). This enhanced awareness can equip employees with more resources to detect risk factors and signals of danger in the workplace. One reviewed study introduced the dual process cognitive system to explain this pathway (Zhang & Wu, 2014). The authors explained that system 1 (an automatic and heuristic processing system) and system 2 (a controlled and analytic processing system) processing could jointly determine safety performance. Individuals primarily rely on system 1 in familiar situations because of its efficiency, and they tend to activate system 2 when necessary to respond to unfamiliar or novel circumstances (Evans, 2008). Mindfulness can contribute to better utilization of both processing systems. For example, mindfulness can improve system 1 processing by providing employees with greater awareness of the present work context. In addition, mindfulness can help employees notice novel, safety-critical stimuli, aiding in more effectively switching to system 2 processing.

Other researchers have also proposed that mindfulness enables employees to maintain vigilance to potential hazards, capture changes in the risk level, and form timely and proactive responses (Klockner & Thomas, 2013; Leung et al., 2016). Supporting these arguments, Ji et al. (2018) empirically revealed a positive relationship between mindfulness and risk perception. They suggested that pilots high in trait mindfulness could better discern flight risks and appraise

the risk level more accurately, leading to decreased incident involvement. Thus, mindfulness can help employees better detect risks, contributing to workplace safety.

Mindfulness and Improved Responses to Hazards

Mindfulness can also facilitate more adaptive reactions to hazards. Non-judgmental attitudes are another basic feature of mindfulness (Feldman et al., 2010). Such attitudes help individuals decouple themselves in safety-critical situations and thus treat and react to internal and external stimuli more effectively (Glomb et al., 2011). The increased openness and acceptance can promote more constructive strategies to view and cope with hazards and risks.

Several reviewed studies in healthcare occupations support this view. For example, Singh et al. (2009) maintained that patients' aggressive behaviors represented a common hazard to healthcare staff. They argued that mindfulness could help reduce staff injuries and peer injuries by changing how employees viewed patients' behaviors and altering the nature of staff-patient interactions. Specifically, healthcare employees sometimes have a pre-mature cognitive mindset to pre-empt or control patients' behaviors with physical restraints. Inaccurate estimates of the potential hazard and attempts to apply restraints when unnecessary can lead to more aggressive patient behaviors. Mindfulness enables employees to observe patients' behaviors in a more open and accepting manner so that they can mitigate pre-mature negative judgments of patients' behaviors and have a more objective estimate of the risk (Singh, Lancioni, Karazsia, & Myers, 2016). Moreover, healthcare staff displaying calmness and acceptance can facilitate better responses from patients who can gradually learn more appropriate social behaviors (Singh et al., 2009). As evidence, Singh et al. (2020) found that mindfulness training was more strongly related to increased pleasant experiences when providing care to patients and decreased use of

high-level supervision to regulate patients' behaviors compared to regular caregiver skills training.

The impact of mindfulness on forming better risk responses was also examined in other occupations. For example, due to the nature of work tasks and the construction site, several reviewed studies indicated that the safety of construction workers was threatened by various hazards, such as operating heavy equipment and being exposed to chemicals (Liang et al., 2022; Leung et al., 2016). These studies further argued that high levels of mindfulness helped employees not only stay aware of these risks but also view them from an external perspective. Specifically, with the accepting and non-judgment attitudes of mindfulness, these employees can notice changes in their own physical conditions and in the work environment without being bothered by distracting reflections, such as regrets of past misoperations or worries about future blame. In this case, they can better concentrate on developing immediate and effective responses, which helps reduce the likelihood of safety accidents.

Taken together, hazards and risks inherent in occupations represent a common safety-related job demand where mindfulness can be helpful. In particular, enhanced awareness and non-judgmental attitudes associated with mindfulness can improve the detection and appraisal of work-related risks and help employees better handle hazardous situations, leading to more favorable safety outcomes.

Cognitive Demands in the Occupation

The cognitive demands of performing required tasks are another common threat to workplace safety (Nahrgang et al., 2011). Specifically, some tasks require substantial mental efforts to maintain safety. These cognitive demands can arise from various aspects of the

occupation and work environment, including time requirements, information load, task difficulty, and work context dynamics and complexity.

In the reviewed studies, participants often worked in occupations that require high levels of cognitive demands. For instance, studies in military settings pointed out that the job of service members often requires monitoring the external environment to detect low-probability events and adapt behaviors accordingly (Jha et al., 2015, 2017). Such attentional tasks have serious safety implications, as attentional lapses during watch-standing may compromise deployment missions and lead to severe devastation (Zanesco et al., 2019). Moreover, cognitively demanding tasks can continue over long periods, making them even more exhausting (Meland et al., 2015). Similar observations were found in research with pilots and firefighters, whose jobs also required sustained attention to a wide range of stimuli in dynamic, risky environments (Denkova et al., 2020; Ji et al., 2018).

Other studies in civilian occupations also revealed high levels of cognitive demands. Healthcare occupations are described as a high-reliability industry where employees often need to stay concentrated and avoid medical errors in the presence of distractions or interruptions (Brady et al., 2012; Gunther et al., 2014). For example, nurses need to monitor medical processes and outcomes across multiple patients and administer medicine simultaneously, which is a primary source of medical errors (Wong et al., 2018). For construction and extraction industry employees, heavy workloads and long work hours have been reported as typical features of their jobs (Leung et al., 2016; Liang et al., 2022). These employees are also confronted with complex, dynamic tasks; for instance, some workers need to monitor hundreds of pieces of equipment to maintain system safety (Zhang & Wu, 2014). These high-demand tasks consume intense mental efforts and highlight the need for greater attentional resources.

Mindfulness and Improved Concentration in Safety-Critical Contexts

Mindfulness increases employees' attentional capacity to help maintain concentration in safety-critical contexts. A primary benefit of mindfulness is the enhanced ability to regulate one's attentional focus on the present experience (Verhaeghen, 2021). This can help employees reduce attentional failures and be less vulnerable to distractions and interruptions (Huber et al., 2015; Reb et al., 2015). Many studies in our review acknowledged this improved attentional regulation as a major benefit of mindfulness. For example, Jha et al. (2015) proposed that impaired cognitive control and the associated performance lapses seriously threatened safety outcomes during high-demanding tasks among military groups. They further argued that by protecting such capacities, mindfulness could enable employees to maintain present-moment attention and experience fewer mind-wandering episodes. Valley and Stallones (2017) proposed that improved attention regulation protected employees from distractions and interruptions, reducing errors in complex working environments. Consistent with this view, several studies found a negative relationship between participation in mindfulness training and military members' attentional performance lapses during high-demanding pre-deployment sessions (Jha et al., 2015, 2017; Jha, Zanesco, Denkova, Morrison, et al., 2020; Jha, Zanesco, Denkova, Rooks, et al., 2020). Prudenzi et al. (2021) found that mindfulness negatively predicted employee cognitive weariness. Wong et al. (2018) revealed decreases in energy depletion from cognitive tasks following mindfulness training, offering further empirical evidence for how greater attentional capacities can help employees manage high cognitive demands.

Mindfulness and Better Self-Monitoring of Safety Engagement

Mindfulness can also promote self-monitoring of safety engagement and decrease the likelihood of unsafe action in cognitively demanding situations. The improved attention from

mindfulness not only applies to external events but also to internal experiences, including individuals' own thoughts and behaviors (Dane, 2011). Some reviewed studies echoed this view. Leung et al. (2016) suggested that sustained attention to one's own behavioral choices and awareness of the consequences of unsafe actions helped remind employees to comply with safety rules and prevent unconscious risk-taking behaviors in demanding situations. Kao et al. (2019) also maintained that mindfulness enhanced self-awareness so that employees could be in a better position to make intentional choices of safety actions. Similarly, Liu et al. (2022) proposed that the attentional benefit of mindfulness manifested in more conscious monitoring of safety actions. Specifically, mindfulness equips employees with a tendency to observe and think more consciously, even in high-demanding situations. In this way, employees can avoid reacting based on stress alone and maintain a comprehensive and independent view of the work context. Thus, they are less likely to take shortcuts and commit safety-related violations. In support of this view, Nnadede (2018) found that mindfulness was positively related to compliance with safety regulations and was negatively related to injury frequency through employees' increased cognitive engagement at work.

Taken together, our review indicates that the enhanced attentional function of mindfulness leads employees to pay sustained attention to a wide range of internal and external information in a complex environment. In this way, employees can have reduced attentional lapses and increased engagement in safety behaviors during cognitively demanding tasks.

Emotional Demands in the Occupation

In addition to the presence of risks and high cognitive demands, emotional burden, another common job demand, also plays an important role in impacting safety outcomes. Emotional job demands broadly represent tasks requiring emotional investment and mood

regulation. Employees in safety-critical occupations may be particularly prone to such emotional burdens due to the high-demanding nature of their work and the resulting limited psychological resources (Huber et al., 2015).

Several reviewed studies explicitly identified types of emotional stressors faced by employees. For instance, beyond the job demands of technical tasks, frequent interpersonal contact with patients poses an extra emotional burden to healthcare employees (Hallman et al., 2014). Brady et al. (2012) also mentioned that healthcare employees often face the emotional demand of "managing other person's suffering" (p. 129). Similarly, firefighters' jobs frequently expose them to traumatic and emotionally challenging circumstances involving the loss or death of other people (Denkova et al., 2020).

Although research on emotional demands is often conducted in the human service industry (Le Blanc et al., 2001; Van de Ven et al., 2013), employees in other occupations are also frequently affected by the emotional demands of their work. For example, because of the nature of their job, military members need to cope with the stress of possible combat situations or "friendly fire" incidents (i.e., harm to innocents). Another emotional stressor for military personnel is habituating themselves to long-term separation from their family and facing all the uncertainty and danger alone (Jha et al., 2015). In construction and extraction occupations, employees frequently experience emotional burdens caused by the characteristics of the industry. One major source of work stress for construction workers stems from unstable, temporary employment and a lack of management support (Leung et al., 2016; Liu et al., 2022). Moreover, construction workers have to cope with frequent interpersonal conflict due to the pressing environment and high mobility workforce (Liu et al., 2022). These emotional stressors make

high-risk occupations even more taxing, so employees can benefit by mastering skills to cope with emotional demands and alleviate their potential impacts on safety.

Mindfulness and More Adaptive Stress Responses

Mindfulness can elicit more adaptive responses to stress, helping employees handle the emotional demands of their job and mitigate threats to safety. As noted earlier, a basic feature of mindfulness is an orientation of openness, curiosity, and acceptance toward one's current experience (Bishop et al., 2004). Mindfulness makes individuals more likely to accept unpleasant events and interpret unfavorable or even threatening experiences more constructively (Keng et al., 2018; Keng & Tong, 2016). This translates into a more adaptive approach to coping with the emotional burdens in safety-critical occupations. Specifically, Brady et al. (2012) argued that mindfulness enhanced the endorsement of an open and non-judgmental attitude in healthcare occupations. Hence, mindfulness lets employees separate themselves from emotionally demanding interactions with patients and continue focusing on their work responsibilities, which helps ensure the safety of their work. Other researchers also proposed that mindfulness reduced negative appraisals of distressful work experiences so that employees could have more available psychological resources to engage in safety behaviors (Dierynck et al., 2017; O'Brien et al., 2019).

The benefits of mindfulness in coping with emotional demands were widely tested in the reviewed studies but were primarily treated as separate outcomes from safety indicators. For instance, Meland et al. (2015) measured cortisol levels to assess stress responses and found the stress-buffering effect of mindfulness training as indicated by steeper cortisol slopes. Denkova et al. (2020) revealed a positive relationship between participation in mindfulness training and firefighters' resilience and positive affect. Several studies further reported reduced psychological

distress and burnout following mindfulness training (Daigle et al., 2018; Prudenzi et al., 2021; Singh et al., 2015).

In sum, our synthesis pinpointed that employees in high-risk occupations often have to handle emotional burdens in addition to their dangerous and mentally demanding job tasks. Findings from the reviewed studies jointly supported the role of mindfulness in eliciting more effective coping processes to stressful situations, reducing the interference of emotional demands with workplace safety.

Boundary Conditions of the Mindfulness-Safety Link

The benefits of mindfulness for safety outcomes may also vary across boundary conditions. The broader impact of mindfulness on work-related outcomes is often more complicated than its benefits for well-being and depends on both personal and contextual characteristics (Dane, 2011). Echoing this view, several reviewed studies discussed boundary conditions altering the mindfulness-safety link. For example, Zhang et al. (2013) proposed that the enhanced attentional breadth of mindfulness often comes with the costs of more information load, which sometimes might be distracting or even harmful. The gains from mindfulness may outweigh such costs in certain conditions, such as when the working environment requires greater attentional resources and when individuals can effectively process and utilize the increased information input. Therefore, as shown in Figure 2, we proposed that the mindfulness-safety link was contingent on contextual factors, including workload and task complexity, and personal factors, including work experience and intelligence.

The reviewed studies offered empirical evidence for this proposition. Specifically, Zhang et al. (2013) found that mindfulness improved safety performance only in high-complexity tasks, where increased attention to internal and external stimuli was particularly necessary. Kao et al.

(2019) revealed a stronger association between mindfulness and safety behavior when the priority of safety considerations was perceived as high by the workforce. Saban et al. (2019) found that mindfulness was more strongly related to reduced medical errors when the workload was high. As for personal characteristics, Zhang and Wu (2014) found that mindfulness more strongly predicted safety performance for people with more work experience and those with higher intelligence. Therefore, instead of viewing mindfulness as a one-sizes-fits-all cure for workplace safety, it is important to consider the characteristics of the work environment and working population for a comprehensive understanding of the mindfulness-safety link.

Moving Forward: Opportunities for Future Research and Practices

As mindfulness receives increasing attention from researchers and organizations for its potential to build a safer workplace, this article offered a timely synthesis of research on mindfulness and safety outcomes. Specifically, we discussed conceptual and operational issues about the focal constructs in the existing literature and established a theoretical model to understand how, why, and when mindfulness contributes to safety (see Figure 2). Our model proposed that mindfulness (a) leads to increased detection of and better responses to risks, (b) equips employees with greater attentional resources to sustain concentration and maintain self-monitoring in cognitively demanding situations, (c) facilitates more adaptive responses to stressful experiences to help employees better cope with emotional job demands. We also brought up boundary conditions altering the strength of the mindfulness-safety link. Our critical summary of the literature and the theoretical model can serve as a foundation to inspire future research and applications.

To help advance this growing literature, in this section, we discuss key opportunities for future investigations. Table 2 summarizes these directions to researchers and practitioners. For

each point, we start with observations based on the reviewed studies and combine them with insights from the broader mindfulness and safety literature to offer specific guidance.

---Insert Table 2 about here---

Clarifying the Nature of Mindfulness

Our review showed that prior studies have endorsed different perspectives to conceptualize and operationalize mindfulness. Specifically, we found that some existing studies equated mindfulness with improved attention and awareness of the present moment while neglecting other important components, including non-judgment, openness, and non-reactivity (e.g., Betts & Hinsz, 2015; Gunther, 2014). This deficient conceptualization does not represent the complete construct domain and makes it difficult to distinguish mindfulness from other constructs focusing on attention and awareness at work (e.g., situation awareness; Sneddon et al., 2013), threatening the construct validity of mindfulness measures. Furthermore, among studies considering non-judgmental and accepting attitudes as characteristics of mindfulness, we found a discrepancy in the number and the specific content of mindfulness dimensions (e.g., Leung et al., 2016; Meland et al., 2015; Prudenzi et al., 2021). Future researchers should incorporate both attentional and attitudinal components in conceptualizing mindfulness. A consistent and comprehensive definition helps compare empirical findings across studies and facilitates knowledge accumulation and theory development in this emerging field. For example, our theoretical model suggests that the components of non-judgment and acceptance are particularly important to forming constructive responses to risks and emotional demands. A narrow focus fails to capture these intervening mechanisms, which may alter the observed magnitude of the mindfulness-safety link.

Therefore, it is important for future studies to adopt a complete view and clarify the nature of mindfulness. Specifically, researchers can continue contributing to the conceptual work by testing the dimensionality of mindfulness in different occupations and cultures. Several reviewed studies have taken the first step in this direction. Zhang et al. (2013) found two dimensions of mindfulness, the presence dimension and the acceptance dimension, based on factor analyses. Leung et al. (2016) compiled mindfulness dimensions from multiple measures and showed nine distinct dimensions of mindfulness. These inconsistent findings suggest that more empirical efforts are required to enhance the conceptual clarity of mindfulness. One promising approach is to examine mindfulness in work settings (Hülsheger & Alberts, 2021; Zheng et al., 2022). Current literature on mindfulness primarily relies on the conceptual work originating from clinical research (Lau et al., 2006). However, there are different manifestations and emphases between mindfulness in clinical settings and mindfulness in work contexts. Thus, examining workplace mindfulness can more accurately capture the construct of interest and adjust it to be more applicable to working populations. Several conceptualizations and measures have been recently developed for use in work contexts (Hülsheger & Alberts, 2021; Zheng et al., 2022), which can serve as a basis for future research to study mindfulness in the safety domain.

Finally, our review revealed that an important topic, state mindfulness, was under-examined in this field. Researchers use the term mindfulness to depict a trait, state, or practice. Among them, state mindfulness, a state of consciousness, represents the focus of early research (Conze, 1956; Lau et al., 2016). However, recent research in the safety domain primarily considered trait mindfulness and mindfulness practices, with none of them examining how state mindfulness relates to safety outcomes. Studying state mindfulness could not only lead to a more complete construct domain but also identify a proximal factor in the mindfulness-safety link.

Specifically, trait mindfulness reflects individual differences in the tendency to experience mindful states (Allen & Kiburz, 2012; Glomb et al., 2011). Thus, the display of mindful states, especially when performing safety-critical tasks, may be the key process through which trait mindfulness improves safety behaviors and reduces adverse events at daily work. Also, one important goal of mindfulness-based intervention programs is to teach mindfulness skills and help individuals cultivate mindful states in daily life (Bartlett et al., 2019; Eby et al., 2019). Thus, state mindfulness serves as a critical intermediate stage underlying the proposed benefits of both trait mindfulness and mindfulness interventions. Studying these state or momentary mindful experiences is necessary to connect the current scholarship on trait mindfulness with mindfulness intervention to produce a more comprehensive conceptual understanding. To do so, researchers can apply experience sampling methods to assess employee experiences of state mindfulness, such as during safety-critical periods or before and after mindfulness practices, and investigate how these experiences relate to safety outcomes (Sawyer et al., 2022; Shoham et al., 2017).

Testing and Extending the Theoretical Model

We borrowed theoretical insights from the JD-R model and drew upon the reviewed studies to establish a theoretical model of the mindfulness-safety link. We also showed some initial empirical evidence for the theoretical model. Moving forward, our model can serve as a basis for greater theoretical discussions and empirical investigations.

Future research can begin by testing the propositions outlined in our theoretical model. Only a few studies have empirically investigated mediating mechanisms between mindfulness and safety, including risk perception (Ji et al., 2018), coping (Liang et al., 2022), and emotional and cognitive engagement (Nnadede, 2018). Apart from these studies, the primary focus of the

existing literature has been the direct impacts of mindfulness on safety. Many pathways proposed in our theoretical model stemmed from conceptual discussions and have not been empirically tested. Hence, our model's proposed pathways can provide a structure for future studies. For example, although the benefits of mindfulness on attentional capacities have been widely acknowledged (Verhaeghen et al., 2021), the mediating effects of attention on safety performance and safety consequences still need empirical support. Future research can achieve this goal by measuring attentional functions in cognitive tasks (e.g., Jha et al., 2015). Other pathways requiring more empirical support include behavioral responses to risks and hazards, self-monitoring of safety actions, and emotion regulation.

Furthermore, researchers can extend our theoretical model by including additional theoretical considerations. Future studies can examine other mechanisms through which mindfulness relates to safety. For example, Reina et al. (2022) proposed a mindful relating framework and argued that mindfulness increased empathy and improved interactions at work. This function may be particularly helpful to employees confronted with demands for safety-critical interpersonal interactions such as in contact with patients and cooperation with coworkers (Hallman et al., 2014; Liang et al., 2022). There may also be other potential boundary conditions. Based on the JD-R model, one possible moderator is job resources, referring to physical, social, psychological, or organizational aspects that can help achieve work goals and stimulate personal growth (Bakker & Demerouti, 2007, 2017). Some job resources may motivate employees to employ the benefits of mindfulness to perform safety behaviors, such as job autonomy, organizational support, as well as leaders' and coworkers' endorsement of safety importance. The safety outcome type may also moderate the mindfulness-safety link. Griffin and Hu (2013) pointed out that safety participation was more closely influenced by motivational factors, such as

external support and management inspiration. In contrast, safety compliance was more strongly impacted by available attentional resources, which can be bolstered through mindfulness (Griffin & Hu, 2013). In addition to other mediators and moderators, the JD-R model suggests the moderating effect of personal resources (Bakker & Demerouti, 2017), pointing to another possibility of studying how mindfulness alters the relationship between job demands and safety outcomes. Existing studies primarily focused on the linear effect of mindfulness as reflected in the theoretical model. In this review, we summarized common job demands in safety-critical occupations, including inherent risks, cognitive demands, and emotional demands. Therefore, future researchers can examine the extent to which mindfulness buffers the negative impact of particular job demands on workplace safety.

Finally, future research can refine the theoretical model by examining the distinction and connection between research on trait mindfulness and research on mindfulness intervention. As mentioned previously, we integrated the two approaches to build a comprehensive theoretical model (Good et al., 2016; Shahbaz & Parker, 2021). Our review further supported this choice as we found similar arguments and evidence derived from both approaches for each pathway. This suggests that we offered a unifying theoretical model applicable to the existing literature. However, it is possible that some nuanced differences remain underexamined in the reviewed studies and, thus, have not been reflected in our model. One potential example is the potential distinct mechanisms underlying mindfulness training. Mindfulness-based intervention programs offered by the organization may provide additional job resources beyond teaching mindfulness skills (Hansez & Chmiel, 2011). Based on the JD-R model, these training programs convey the organization's concern for employee welfare and dedication to creating a safe workplace, which may motivate employees to engage in safety behaviors (Griffin & Neal, 2000; Vinodkumar &

Bhasi, 2010). Moreover, researchers can tie the research on trait mindfulness and the research on mindfulness interventions more closely by examining the interactive effect. People with high trait mindfulness tend to stay more engaged in mindfulness training (Shapiro et al., 2011), strengthening its positive impacts on safety outcomes. Thus, more in-depth examinations of each component in the theoretical model are needed for a nuanced understanding of the mindfulness-safety link.

Expanding the Research Scope

Future studies can advance this emerging field by maintaining a broader focus in terms of the focal constructs and the occupational settings. First, future research can study the influence of mindfulness beyond the individual level. A related but different concept is mindful organizing, defined as "a team's capacity to develop a rich awareness of discriminatory details about internal and external process and to regulate team behaviors accordingly" (Dierynck et al., 2017, p. 83). Mindful organizing shares similar features as individual-level mindfulness, such as attention and awareness. However, it is a unique construct given that it primarily focuses on social processes among multiple team members (Badham & King, 2021; Vogus & Sutcliffe, 2012). Hence, mindfulness at higher levels may affect the pattern of interpersonal dynamics and the shared mental model, thus impacting safety outcomes beyond individual mindfulness (Dierynck et al., 2017). As interdependence is characteristic of many safety-critical occupations, it is important for future research to test the multi-level contributions of mindfulness (Saban et al., 2019).

Also, a wider range of safety outcomes is needed. Self-reports represent the major approach to assessing safety. Beyond this, future research can incorporate more diverse safety behaviors and safety consequences from multiple sources, such as ratings from supervisors and peers or objective safety records. When it is not feasible to assess safety outcomes in actual work

settings, researchers can consider using measures in simulated safety-critical scenarios (Jha, Zanesco, Denkova, Rooks, et al., 2020). In addition, more process-based safety outcomes can be added in future research to supplement the current focus on personal safety outcomes. As demonstrated by the disastrous blowout on the Deepwater Horizon drilling rig in 2010, process safety events can result in large fires, explosions, and loss of containment, causing multiple fatalities and enormous environmental damage (Roberts et al., 2015). Consequently, these process safety events deserve more research attention when investigating mindfulness and workplace risk management.

Finally, future research should include employees from a broader range of occupations. Employees from healthcare, military, and construction and extraction occupations were the three main populations in existing studies, but the mindfulness-safety link needs to be tested and expanded in more occupations. For example, other high-risk occupations, such as the manufacturing and transportation industries, can also benefit from mindfulness. Including more occupations increases the generalizability of findings. It further offers opportunities for theory development, such as exploring whether the major mechanisms underlying the mindfulness-safety link vary across different occupational settings.

Improving Mindfulness Training Programs

Given the promises of mindfulness for improving safety, many organizations are interested in applying mindfulness training to benefit the welfare and safety of the workforce. Therefore, we present additional recommendations for designing and implementing mindfulness-based training programs in the workplace.

Our review revealed several mindfulness-based intervention programs frequently used in the field, which can serve as examples for future applications. Among the reviewed studies, six

used or adapted the Mindfulness-Based Stress Reduction program (MBSR; Kabat-Zinn, 2003). MBSR is a classic and widely accepted mindfulness-based training focusing primarily on reducing stress, anxiety, and pain (Kabat-Zinn, 1993). Typical components of MBSR consist of focused attention (i.e., intentional attention to the present moment) and open monitoring (i.e., controlled observation of current state) meditation techniques. Three studies applied the Mindfulness-Based Mind Fitness Training (MMFT; Stanley, 2014). The MMFT is designed to improve attentional control and tolerance of challenging experiences to improve resilience, which was frequently used among military personnel (Jha et al., 2015). Three studies applied the Mindfulness-Based Attention Training (MBAT; Zanesco et al., 2019). Similar to the MMFT, the MBAT is designed to boost cognitive resilience and help individuals cope more effectively with high cognitive-demand situations. Three other studies used the Mindfulness-Based Positive Behavior Support training (MBPBS; Singh et al., 2014). The MBPBS combines mindfulness with training on positive behavior support and emphasizes equanimity and supportive compassion (Singh et al., 2015, 2020; Singh, Lancioni, Karazsia, & Myers, 2016). Among these different types of mindfulness interventions, common components included basic knowledge of mindfulness, guided mindfulness practices, and instructions on coping skills.

In addition to these common components, future researchers can also design or modify these intervention programs to better fit specific occupational settings or research goals. For instance, one previous study showed that a training program tailoring mindfulness practices to the operational environment of military personnel was more effective than a general mindfulness training program (Jha et al., 2015). Relatedly, mindfulness training delivered by instructors familiar with the occupational setting has been found to have greater benefits (Jha, Zanesco, Denkova, Morrison, et al., 2020). Future research can consider adding occupation-relevant

exercises and scheduling mindfulness practices based on the timing of safety-critical events and test the extent to which specific modifications are beneficial.

Researchers should also give more rigorous considerations to the research design to strengthen the validity of causal inferences. Studies using randomized controlled trial (RCT) designs have been recognized as providing high-quality evidence for establishing causal impact (Guyatt et al., 2008), so despite the practical constraints of creating a randomized control group, researchers could strive to overcome these barriers through different means. As an exemplary study, Valley and Stallones (2017) randomly assigned participants into an experimental group and a wait-list control group. By including a randomized control group, this approach increases research rigor and provides support for causality in the mindfulness-safety link. It also guarantees that all participants can receive the intervention eventually, which satisfies the needs of the participating organizations and employees. Future studies can also use RCT designs to compare the effectiveness of different modifications across treatment groups, which would provide more practical recommendations.

The durability of the intervention effect is another important consideration in research design and the implementation of mindfulness training programs. For instance, researchers can include multiple measurement time points (e.g., Singh et al., 2009), assess employees' adherence to mindfulness practices during and after the training, and monitor safety outcomes over a long time. Expanding the time frame of studies in these ways would better show the trajectory underlying the effect of mindfulness training, which may not always be linear. For example, two reviewed studies detected a trend of increased error reporting following mindfulness training (Gunther, 2014; Mumber, 2014), suggesting that mindfulness practices may lead employees to notice and report more errors at first, which then transfers to reduced errors later. Therefore,

researchers and practitioners need to consider the effect of mindfulness training in both the short- and long-term with intensive longitudinal data collection.

Finally, it should be noted that although our review outlined a number of potential benefits related to increased mindfulness, mindfulness training should primarily be used to supplement, but not replace, existing safety training. Instead of replacing necessary components of safety training, such as enhancing safety knowledge and improving safety culture (Grabowski & Jankowski, 2015; Leder et al., 2019), organizations can consider adding mindfulness applications to improve safety outcomes and gain additional benefits on employee well-being (Singh, Lancioni, Karazsia, Chan, et al., 2016; Singh, Lancioni, Karazsia, & Myers, 2016).

Conclusion

This integrative review critically summarized and analyzed the literature on mindfulness and workplace safety. Based on this review, we proposed a theoretical model and highlighted promising future research directions. The newly developed theoretical model sheds light on how, why, and when mindfulness contributes to safety. We hope researchers and practitioners benefit from these suggestions to continue expanding theoretical insights about the mindfulness-safety link and improve mindfulness applications in safety-critical occupations.

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Table 1

Summary of Reviewed Studies on Mindfulness and Workplace Safety

Study	Sample description (Occupation)	Research design	Mindfulness operationalization	Safety operationalization
Betts & Hinsz (2015)	Food service workers (Food preparation and serving related occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Safety compliance
Brady et al. (2012)	Behavioral health staff (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (One-group pre/post)	Measure (TMS); Manipulation (MBSR)	Patient safety events
Daigle et al. (2018)	Nurses (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (RCT)	Manipulation (MBSR)	Medical errors
Denkova et al. (2020)	Firefighters (Protective service occupations)	Experimental or quasi-experimental method (Pre/post with a non-randomized control group)	Manipulation (MBAT)	Attentional performance
Dierynck et al. (2017)	Nurses (Healthcare practitioners and technical occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Safety compliance, occupational injuries
Gunther (2014)	Nurses (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (Pre/post with a non-randomized control group)	Measure (MAAS); Manipulation (Mindfulness educational training)	Medical errors
Hallman et al. (2014)	High-acuity psychiatric inpatient unit staff (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (One-group pre/post)	Measure (TMS); Manipulation (MBSR)	Patient safety events
Jha et al. (2015)	Active-duty U.S. Army members (Military specific occupations)	Experimental or quasi-experimental method (Group randomized control group)	Manipulation (MMFT)	Attentional performance
Jha et al. (2017)	U.S. Marine Corps reservists (Military specific occupations)	Experimental or quasi-experimental method (Pre/post with a non-randomized control group)	Manipulation (MMFT)	Attentional performance
Jha, Zanesco, Denkova,	Active-duty U.S. Army members (Military specific occupations)	Experimental or quasi-experimental method (Group randomized control group)	Manipulation (MBAT)	Attentional performance

Morrison, et al. (2020)				
Jha, Zanesco, Denkova, Rooks, et al. (2020)	Active-duty U.S. Army members (Military specific occupations)	Experimental or quasi-experimental method (Group randomized control group)	Manipulation (MMFT)	Attentional performance
Ji et al. (2018)	Pilots (Transportation and material moving occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Safety incidents
Kao et al. (2019)	Petroleum distribution workers (Production occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Safety compliance, safety participation, occupational injuries
Klockner & Thomas (2013)	Tradespeople, managers, professionals, clerks, etc. (Multiple occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Safety compliance
Leung et al. (2016)	Construction workers (Construction and extraction occupations)	Survey method (Cross-sectional)	Measure (multiple scales)	Safety compliance
Liang et al. (2022)	Construction workers (Construction and extraction occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Safety compliance, safety participation
Liu et al. (2022)	Doctors (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (RCT)	Measure (MAAS); Manipulation (Mindfulness training)	Safety incidents
Meland et al. (2015)	Military helicopter unit personnel (Military specific occupations)	Experimental or quasi-experimental method (Pre/post with a non-randomized control group)	Measure (FFMQ); Manipulation (MBSR)	Attentional performance
Mumber (2014)	Radiation oncology staff (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (One-group pre/post)	Measure (MAAS); Manipulation (Mindfulness leadership training)	Safety incidents
Nnadede (2018)	Construction, manufacturing, and metal fabrication employees (Multiple occupations)	Survey method (Cross-sectional)	Measure (FFMQ)	Safety compliance, safety participation, occupational injuries
O'Brien et al. (2019)	Nurse aides (Healthcare practitioners and technical occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Occupational injuries

Prudenzi et al. (2021)	Healthcare professionals (Healthcare practitioners and technical occupations)	Survey method (Cross-sectional)	Measure (FFMQ)	Safety compliance
Saban et al. (2019)	Nurses (Healthcare practitioners and technical occupations)	Survey method (Cross-sectional)	Measure (MAAS)	Medical errors
Singh et al. (2009)	Professionals providing direct care to people with developmental disabilities (Healthcare practitioners and technical occupations	Experimental or quasi-experimental method (One-group pre/post)	Manipulation (Mindfulness training)	Occupational injuries
Singh et al. (2015)	Professionals providing direct care to people with developmental disabilities (Healthcare practitioners and technical occupations	Experimental or quasi-experimental method (One-group pre/post)	Manipulation (MBPBS)	Occupational injuries
Singh et al. (2020)	Professionals providing direct care to people with developmental disabilities (Healthcare practitioners and technical occupations	Experimental or quasi-experimental method (RCT)	Manipulation (MBPBS)	Occupational injuries
Singh, Lancioni, Karazsia, & Myers (2016)	Professionals providing direct care to people with developmental disabilities (Healthcare practitioners and technical occupations	Experimental or quasi-experimental method (One-group pre/post)	Manipulation (MBPBS)	Occupational injuries
Valley & Stallones (2017)	Direct patient care workers (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (RCT)	Manipulation (MBSR)	Safety compliance, safety participation
Wong et al. (2018)	Nurses (Healthcare practitioners and technical occupations)	Experimental or quasi-experimental method (One-group pre/post)	Manipulation (MBSR)	Attentional performance
Zanesco et al. (2019)	Active-duty U.S. Army members (Military specific occupations)	Experimental or quasi-experimental method (Group randomized control group)	Manipulation (MBAT)	Attentional performance
Zhang & Wu (2014)	Control room operators (Construction and extraction occupations)	Survey method (Cross-sectional)	Measure (FMI)	Safety compliance, safety participation

Zhang et al. (2013)	Control room operators and field operators (Construction and extraction occupations)	Survey method (Cross-sectional)	Measure (FMI)	Safety compliance, safety participation

Note. RCT = Randomized Controlled Trial, MAAS = Mindful Attention Awareness Scale, TMS = Toronto mindfulness Scale, FFMQ = Five Facet Mindfulness Questionnaire, FMI = Freiburg Mindfulness Inventory, MBSR= Mindfulness-Based Stress Reduction, MBAT=Mindfulness Based Attention Training, MBPBS= Mindfulness-Based Positive Behavior Support, MMFT= Mindfulness-Based Mind Fitness Training.

Table 2

Recommendations for Future Research on Mindfulness and Safety

Research Directions	Exemplary Research
Clarifying the Nature of Mindfulness	
Adopt a comprehensive conceptualization of mindfulness	Zhang et al. (2013): identified a two-factor structure of mindfulness with differential effects on safety outcomes
Investigate how state mindfulness relates to safety outcomes	Sawyer et al. (2022): applied experience sampling method to assess state mindfulness and its impact on helping behavior
Testing and Extending the Theoretical Model	
Test underlying pathways outlined in the theoretical model	Ji et al. (2018): tested the mediation of risk perception on safety incidents
Include additional theoretical considerations	Reina et al. (2022): proposed improved interaction quality as a function of mindfulness
Examine the connection and distinction between trait mindfulness and mindfulness intervention	Shapiro et al. (2011): tested the moderation of trait mindfulness on the effectiveness of mindfulness training
Expanding the Research Scope	
Investigate mindfulness at both individual-level and organization-level	Dierynck et al. (2017): tested the prediction of mindful organizing on safety performance
Incorporate a wider range of safety outcomes	Saban et al. (2019): included expert ratings of medical errors
Include diverse occupations in addition to healthcare, military, and construction and extraction occupations	Betts & Hinsz (2015): recruited employees from food preparation and serving-related occupations
Improving Mindfulness Training Programs	
Design and test the effectiveness of modifications to mindfulness training	Jha et al. (2015): revealed increased training effectiveness with instructors more familiar with the occupation
Implement more rigorous experimental studies	Valley & Stallones (2017): used a randomized controlled design with a wait-list control group
Examine the durability of the intervention effect	Singh et al. (2009): monitored safety outcomes at multiple time points before and after the intervention

Figure 1a

Time trends for the published articles

Figure 1b

Occupation distribution in the published articles

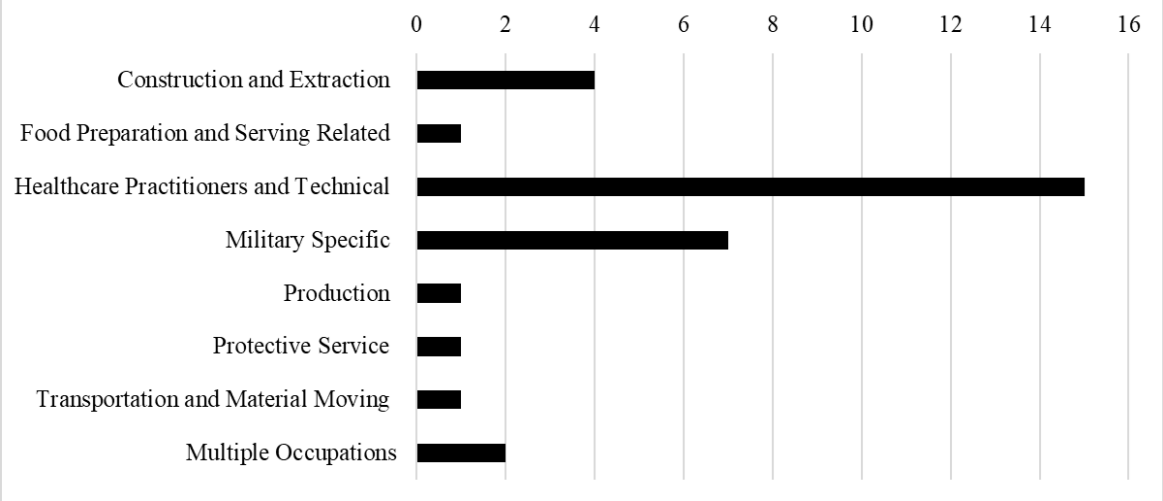

Figure 2

Theoretical Model of the Mindfulness-Safety Link