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Safety Climate and Injuries: An Examination of Theoretical and Empirical Relationships

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Our purpose in this study was to meta-analytically address several theoretical and empirical issues regarding the relationships between safety climate and injuries. First, we distinguished between extant safety climate→injury and injury→safety climate relationships for both organizational and psychological safety climates. Second, we examined several potential moderators of these relationships. Meta-analyses revealed that injuries were more predictive of organizational safety climate than safety climate was predictive of injuries. Additionally, the injury→safety climate relationship was stronger for organizational climate than for psychological climate. Moderator analyses revealed that the degree of content contamination in safety climate measures inflated effects, whereas measurement deficiency attenuated effects. Additionally, moderator analyses showed that as the time period over which injuries were assessed lengthened, the safety climate→injury relationship was attenuated. Supplemental meta-analyses of specific safety climate dimensions also revealed that perceived management commitment to safety is the most robust predictor of occupational injuries. Contrary to expectations, the operationalization of injuries did not meaningfully moderate safety climate–injury relationships. Implications and recommendations for future research and practice are discussed.

Keywords: organizational safety climate, psychological safety climate, injury, meta-analysis

The study of safety is of obvious organizational importance. In 2007, there were over four million nonfatal work injuries and more than 5,600 work fatalities reported in the United States (Bureau of Labor Statistics, 2008). However, a recent audit of workplace injuries reported to the Occupational Safety and Health Administration (OSHA) suggested that up to two thirds of all workplace injuries and illnesses go unreported by employees due to factors such as fear of disciplinary action or the loss of valued incentives (U.S. Government Accountability Office, 2009). Consequently, actual workplace injury rates may be far greater than indicated by existing OSHA injury records. Safety climate, or employees' perceptions of organizational safety policies, procedures, and practices (Zohar, 2003), plays a critical role in workplace safety. Past meta-analytic research has demonstrated that safety climates that are supportive of safety are associated with fewer occupational injuries than safety climates that are not supportive of safety (Christian, Bradley, Wallace, & Burke, 2009; Clarke, 2006a).

However, it is noteworthy that the presumed effect of safety climate on workplace injuries has often been examined in studies that related an assessment of safety climate to injuries that occurred prior to that assessment time. In her meta-analysis, Clarke (2006a) distinguished between retrospective designs (i.e., injuries assessed prior to safety climate assessment) and prospective designs (i.e., injuries assessed after safety climate assessment) and found this distinction to moderate the safety climate–injury relationship. However, because Clarke did not disaggregate individual-level (psychological climate) and group-level (organizational climate) primary studies in her meta-analysis, important differences in the safety climate–injury relationship that result from the conceptual levels of safety climate (i.e., psychological vs. organizational; Christian et al., 2009; Ostroff, Kinicki, & Tamkins, 2003) were obscured. In addition, Clarke conceptualized retrospective and prospective designs as different means of assessing the influence of safety climate on workplace injuries (i.e., safety climate→injury) and not as the assessment of theoretically distinct relationships. We contend, in contrast, that previous retrospective studies purporting to measure the effect of safety climate on injuries have instead assessed the influence of injuries on safety climate (i.e., injury→safety climate). Thus, we argue that this is not a simple design distinction but that there are instead important theoretical differences between the safety climate→injury and injury→safety climate conceptualizations. Consequently, one objective in the present study was to use meta-analytic procedures to empirically investigate this distinction of safety climate→injury and injury→safety climate relationships while the distinction between psychological and organizational safety climate was maintained. These distinctions thus resulted in the potential for four meta-analyses of the relationships between safety climate and injuries.

An additional purpose in this study was to examine a number of moderators posited to affect the relationships between safety cli-

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mate and injuries. Injuries are defined here as workplace incidents that result in personal harm to an individual, ranging from slips, trips, and other minor occurrences (Evans, Michael, Wiedenbeck, & Ray, 2004; Oliver, Cheyne, Tomas, & Cox, 2002) to those that require first aid treatment (Hofmann & Stetzer, 1996; Michael, Evans, Jansen, & Haight, 2005) or time off work (Neal & Griffin, 2006). OSHA defined reportable injuries as those that at a minimum require more than basic first aid treatment. For analyses discussed subsequently, we incorporated this definition of workplace injuries (i.e., OSHA injuries), as well as a more expansive definition (i.e., more than OSHA injuries). The moderators examined in this study pertain to (a) how safety climate and injuries have been associated temporally and (b) how they have been operationalized. These moderators represent meaningful theoretical and conceptual variations across studies that pose important implications for both research and practice. The specific moderators examined were the length of time over which workplace injuries are assessed, measures of content contamination and deficiency of safety climate, and the operationalization of injuries. A brief discussion of each of these factors follows.

Safety Climate–Injury Relationships

Zohar (2003) conceptualized safety climate as a distal antecedent of workplace injuries. That is, the influence of perceptions of workplace safety policies, procedures, and practices on injuries is theoretically mediated via their more direct effects on behavior–outcome expectancies, which subsequently affect safety behavior and performance (Christian et al., 2009; Clarke, 2006a; Guldenmund, 2000; Neal & Griffin, 2004; Zohar, 2003). Because safety climate informs behavior–outcome expectancies, a supportive safety climate, in which safe behavior is reinforced, is expected to be associated with fewer injuries, whereas an unsupportive climate, in which safe behavior is not reinforced—or is possibly even punished—is expected to be associated with more frequent injuries (Zohar, 2003). Conversely, although safety climate is typically conceptualized as a predictor of workplace injuries (i.e., safety climate→injuries) regardless of the relative sequencing of the measurement of these two constructs (e.g., Christian et al., 2009; Clarke, 2006a; Hofmann & Stetzer, 1996; Johnson, 2007; Mearns, Whitaker, & Flin, 2003; Zohar, 2000; Zohar & Luria, 2004), injuries are also considered to be predictive of safety climate (i.e., injuries→safety climate; Zohar, 2003) because injuries provide information about the safety of the workplace. That is, when injuries occur, they are signals about the underlying safety climate in the organization (Spence, 1973) such that employees' reflection on past injury-related events and experiences will influence employees' perceptions of safety policies, procedures, and practices (Schneider & Reichers, 1983).

As previously noted, the safety climate→injury relationship has been investigated in studies using either prospective or "retrospective" designs. The methodological threats associated with retrospective designs are widely recognized (Bitektine, 2008; Denrell & Kovacs, 2008). However, in the safety climate–injuries domain, they are exacerbated because of an alternative theoretical framing that posits an injury→safety climate relationship. If this is the case, what is designated as a retrospective design under the safety climate→injury conceptualization is in fact a prospective design under the injury→safety climate conceptualization. Thus, although previous research may have labeled these as tests of prospective versus retrospective designs (e.g., Clarke, 2006a), we contend that these really represent tests of two competing theoretical frameworks: safety climate→injury versus injury→safety climate conceptualizations. Accordingly, in the present study, we considered prospective designs to represent tests of a safety climate→injury relationship and so-called retrospective designs to represent tests of an injury→safety climate relationship. Although we consider the retrospective studies included in this meta-analysis to be tests of the injury→safety climate relationship, it should be clarified that, in most cases, the authors considered injuries not to be a predictor of safety climate but rather a postdictive criterion.

Although there is a sound theoretical basis for both conceptualizations of the safety climate-injury relationship (i.e., safety climate→injury and injury→safety climate), there is little theoretical guidance as to whether one should result in a stronger relationship than the other. Clarke's (2006a) meta-analysis of safety climate and injuries revealed a weaker relationship for studies using retrospective designs (i.e., the injury→safety climate conceptualization; $\rho = -.22$) than for studies that used prospective designs (i.e., the safety climate→injury conceptualization; $\rho = -.33$). However, as previously noted, Clarke did not disaggregate the organizational and psychological climate studies in her meta-analysis, so it is unclear how much these different conceptualizations contributed to differences in her results. Hence, in the absence of a compelling theoretical or empirical basis for why one should result in a stronger relationship than the other, we pose an exploratory research question: Does the magnitude of the safety climate→injury relationship differ from that of the injury→safety climate relationship?

Organizational and Psychological Safety Climate–Injury Relationships

Ostroff et al. (2003) argued that climate can be conceptualized at the psychological and organizational levels.[1] Psychological climates constitute individuals' perceptions about a coherent set of policies, procedures, and practices and are born of both direct and indirect exposure to these (Ostroff et al., 2003). On the other hand, organizational climate is the collective's perceptions of those policies, procedures, and practices; it is an emergent group-level phenomenon that constitutes an aggregate of the climate perceptions within a group (Kozlowski & Klein, 2000). Because similar phenomena can have very different effects across organizational levels (Kozlowski & Klein, 2000), it is essential that organizational and psychological climate be distinguished from each other (Ostroff et al., 2003). Thus, psychological safety climate reflects individual perceptions of safety policies, procedures, and practices in the workplace, whereas organizational safety climate is the collective of perceptions regarding the same (Christian et al., 2009).

The safety climate→injury and injury→safety climate relationships are likely to be influenced by unique processes for organizational and psychological climate. In particular, the safety climate perceptions of individuals will be affected by their own idiosyncratic worldviews, perceptual biases, and experiences (Ostroff &

[1] In this paper, we refer to "organizational" safety climate as any group-level safety climate (e.g., work group, worksite, organization).

Bowen, 2000). These idiosyncrasies can lead to different employee interpretations of the same organizational phenomena (Guzzo & Noonan, 1994). Varying organizational interpretations can differentially affect individual behavior–outcome expectancies (Rousseau & Wade-Benzoni, 1994), subsequent safety behavior, and ultimate injury occurrences (Zohar, 2003) and will consequently attenuate relationships with injuries. Likewise, individual idiosyncrasies should also affect employee interpretations of workplace injuries and their resulting safety climate perceptions. Thus, the safety climate→injury and injury→safety climate relationships may be attenuated when considered at the psychological level as compared to the organizational level.

Conversely, organizational safety climate represents the higher level emergence of individual interpretations of and expectations regarding workplace safety. This higher level emergence correspondingly represents the amplification of a psychological phenomenon to a more pervasive group-level phenomenon (Kozlowski & Klein, 2000). Consequently, when the organizational environment leads to the group-level convergence of workplace safety perceptions, the safety-related behaviors within the group are likely to be more similar, leading to stronger associations with both past and subsequent workplace injuries within the group. That is, when considered at the group level, safety climate should have a stronger influence on future injuries and injuries should have a stronger influence on subsequent group safety climate perceptions. In line with this reasoning, Christian et al. (2009) found that organizational safety climate had a stronger association with injuries than did psychological safety climate, though they did not separate safety climate→injury and injury→safety climate relationships. We expected, consistent with Christian et al.'s (2009) results, that the safety climate→injury and injury→safety climate relationships would be stronger for organizational safety climates than for psychological safety climates.

> *Hypothesis 1:* Safety climate→injury and injury→safety climate relationships will be stronger for organizational climates than for psychological climates.

Proposed Moderators of Safety Climate–Injury Relationships

Because time has been acknowledged to be an important factor in the relationships between predictors and criteria (Ancona, Goodman, Lawrence, & Tushman, 2001; George & Jones, 2000; Mitchell & James, 2001), we sought to examine its influence on safety climate–injury relationships as a means of informing both theory and practice. We examined the length of time over which injuries are assessed as a potential moderator of the relationships between safety climate and injuries.

In addition, specification of the content domain of any two constructs necessarily affects the extent to which they will share consistent associations. For safety climate, the absence of a commonly accepted conceptualization of the construct space has resulted in tremendous variation regarding safety climate at both the theoretical and the empirical level. Further, given that injuries can range from minor to severe and, at times, have vastly different explanations for their occurrences, the specification of what constitutes an injury can greatly affect its association with safety climate. Thus, we examined safety climate content contamination and deficiency as well as the operationalization of injuries as potential moderators of safety climate–injury relationships.

Length of Time Over Which Injuries Are Assessed

The length of time over which injuries are assessed is a potential source of variance in safety climate–injury relationships. In the safety climate literature, the time frames for injury assessment have ranged from as little as three months (Hofmann & Mark, 2006) to more than two years (Garavan & O'Brien, 2001; Lyon, 2007; Varonen & Mattila, 2000) to employees' total tenure with the organization (Clarke, 2006b; Huang, Ho, Smith, & Chen, 2006; Williamson, Feyer, Cairns, & Biancotti, 1997). These vastly different time frames for injury occurrences could moderate the relationships between safety climate and injuries. However, whether longer time frames increase or decrease safety climate–injury relationships is an open question, as there are competing explanations regarding how the length of time over which injuries are assessed affects these relationships.

On one hand, Harrison and Hulin (1989) argued that the aggregation of criterion data over long time periods can constrain causal inferences because of the increased temporal distance between the measurement of the predictor and the included criterion. That is, for causation to be inferred accurately, the assumed cause must be contiguous to the presumed effect (Cook & Campbell, 1979). As the time frame expands to include injuries that are more temporally distal from the measurement of safety climate, more factors may intervene in the process and influence relationships, thereby disrupting the contiguity of the variables examined. For example, the acquisition of new technology or a change in existing work procedures could alter the relationships between safety climate and injuries, and such events are more likely to occur during longer time frames. Likewise, over a longer time period, safety climate itself could change from what it was when it was originally assessed, altering its associations with previous and subsequent organizational injuries. Thus, use of a long time frame could lead researchers to overlook the incremental and nonrecursive adjustments in the relationships between safety climate and injuries. This could occur following major organizational events, such as mergers, acquisitions, unionization, or top management team changes, but could also occur due to smaller events, such as a series of minor injuries (e.g., trips and falls, near injuries) or changes in personnel. Thus, this perspective argues that there is greater contiguity between safety climate and injuries over shorter time periods than over longer time periods, and this should hold true for both injury→safety climate and safety climate→injury relationships. Therefore, one possible effect of the length of time over which injuries are assessed on the safety climate–injury relationship could be that shorter time frames are associated with larger injury→safety climate and safety climate→injury associations due to the likelihood that fewer factors intervene between causal processes and outcomes.

Alternatively, because workplace injuries are low base-rate phenomena (Harrison & Hulin, 1989; Jacobs, 1970), when there are no injuries in a workplace it is unclear if the lack of injuries is due to an organizational propensity for few injuries to occur or to an insufficient amount of time for injuries to appear when there is a propensity for injuries to occur. Hulin and Rousseau (1980) reported that a common means of studying infrequent events is to gather criterion data over longer time intervals. That is, because injuries are low base-rate events, longer time periods for gathering injury data are often necessary for amounts of variance to be sufficient for detection of a relationship between safety climate and injuries. Consequently, it could be that longer time frames over which injuries are collected are associated with larger injury→safety climate and safety climate→injury effects. Due to the presence of competing rationales, we sought to investigate whether injury→safety climate and safety climate→injury relationships are moderated by the length of time over which injuries are assessed and, if so, to determine whether shorter or longer time frames are associated with stronger relationships.

Safety Climate Measure Content Contamination and Deficiency

There is little consensus as to which factors adequately constitute the construct of safety climate (Guldenmund, 2000). One reason for this is that safety climate is often conceptualized inductively by examining the safety literature and conducting interviews and focus groups to create industry- and situation-specific measures (Flin, Mearns, O'Connor, & Bryden, 2000). This approach has led to measures with vastly different numbers and types of factors. In the extant literature, measures of safety climate have factor structures ranging from a low of one factor (Barling, Loughlin, & Kelloway, 2002; Evans et al., 2004; Neal & Griffin, 2006) to a high of 12 factors (Krispin, 1997). Flin et al. (2000) reviewed the safety climate literature and concluded that the most common safety climate factors were management commitment to safety, safety systems, risk, work pressure, and competence. However, although these factors are the most common, there is no evidence that they constitute the best conceptualizations of the safety climate construct; in fact, there is reason to suggest that some of these dimensions may not represent safety climate at all. For example, "inherent risk" (i.e., hazards present in the job) is arguably not a theoretically appropriate aspect of the safety climate content domain; some jobs and their task elements are dangerous or risky independent of the prevailing safety climates. For example, offshore oil drilling, high-rise construction projects, firefighting, and police work are inherently risky because of the nature of the work itself and not necessarily the existing safety climates. Accordingly, it is informative to determine the degree to which safety climate measures correspond to a theoretical conceptualization of safety climate as a means of better understanding the true relationships between safety climate and injuries.

For the purposes of this study, we adopted Zohar's (2003) theoretical definition of safety climate as our exemplar.[2] Zohar's definition (employee's perceptions of the policies, procedures, and practices concerning safety) is consistent with the broader organizational climate literature (Hellreigel & Slocum, 1974; James & Jones, 1974) and aligns with Reichers and Scheider's (1990) definition of organizational climate as employees' perceptions of organizational policies, procedures, and practices as they pertain to specific organizational phenomena (e.g., safety, service; Schneider & Reichers, 1983). Additionally, Zohar's definition does not include some of the contaminants identified by other safety climate researchers (e.g., individual differences such as fatalism and safety attitudes; Neal & Griffin, 2004).

Messick (1980, 1995) argued that there are two major threats to construct validity. The first is construct-irrelevant variance (i.e., contamination). A measure is contaminated if it includes content that is not associated with the conceptual content domain (Messick, 1995). The presence of content contamination can distort the predictor–criterion relationship of interest (Messick, 1995), such that contamination in a safety climate measure can create "noise" in safety climate–injury relationships and subsequently attenuate effect sizes. For the present meta-analysis, content contamination was operationalized as the proportion of items within a given study's safety climate measure that assessed something other than safety climate, as defined by Zohar (2003).

> *Hypothesis 2:* Higher levels of safety climate content contamination will be associated with weaker safety climate–injury relationships.

Messick (1995) argued that the second major threat to construct validity is construct underrepresentation (i.e., deficiency). In this instance, it is the degree to which a measure of safety climate fails to represent the complete specified content domain. Accordingly, when a safety climate measure is deficient, empirical results using that measure should be attenuated relative to studies that use nondeficient measures. This is because the underrepresentation of a domain in a measure should result in a failure to capture the breadth of indicators of the phenomenon and overlook relevant variance components. Therefore, deficient measurement is also expected to attenuate safety climate–injury relationships. In this study, content deficiency was operationalized as the degree to which, relative to Zohar's (2003) theoretical definition, a study's safety climate measure did not tap the full safety climate domain. That is, deficiency represented the extent to which safety climate measures failed to assess employee perceptions of organizational safety policies, procedures, and practices.

> *Hypothesis 3:* Higher levels of safety climate content deficiency will be associated with weaker safety climate–injury relationships.

We conducted a series of dimension-level meta-analyses as a supplement to our scale-level analyses of safety climate content contamination and deficiency to provide a richer illustration of how common dimensions, whether relevant to the safety climate content domain or not, differentially relate to injury occurrences.[3] We note that these dimension-level analyses constitute a more fine-grained examination of safety climate dimensions than was recently reported by Christian et al. (2009). That is, we did not aggregate several distinct safety climate dimensions that Christian et al. chose to combine into single dimensions (e.g., management safety practices, safety values, and safety communication into "management commitment"). These exploratory dimension-level analyses complement our general tests of contamination and defi-

[2] For reviews of the development of the safety climate construct, see Guldenmund (2000); Neal and Griffin (2004); and Zohar (2003). For alternative definitions of safety climate, see Guldenmund (2000, Table 3).

[3] We thank an anonymous reviewer for encouraging these analyses.

ciency by revealing where common contaminants and deficiencies lie.

Injury Operationalization

Injury operationalizations often vary in terms of the degree of severity required for an injury to be reported and, subsequently, counted or measured. Minimum inclusion criteria for injury operationalizations determine the range of injuries that are included in a given study. That is, less severe minimum inclusion criteria lead to broader ranges of injury data, whereas more severe minimum criteria limit the types of injuries that can be included because injuries must be of a higher level of severity to be counted. In studies of safety climate–injury relationships, the minimum criteria for injuries have ranged from including nearly all injuries, such as slips and trips (Evans et al., 2004; Oliver et al., 2002), to only those that required at least first aid treatment (Hofmann & Stetzer, 1996; Michael et al., 2005) or time off work (Neal & Griffin, 2006).

It is common practice for organizations to use OSHA criteria for recording injuries. OSHA's specific criteria for reportable injuries include only those injuries that result in death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, loss of consciousness, or diagnosis by a physician or licensed health care professional (OSHA, 2008). Thus, OSHA criteria include only those injuries that are comparatively severe and exclude injuries that are of a less serious nature (Komaki, Barwick, & Scott, 1978). As previously noted, the nature of the reporting criteria can lead to situations in which injuries are underreported. The result is deficient data and reports of workplace injury rates (U.S. Government Accountability Office, 2009). Alternatively, employees can be asked to report all injuries regardless of their severity (Clarke, 2006b; Cree & Kelloway, 1997; Donald & Canter, 1994). The minimum severity of injury operationalizations determines the available sample of injury reports. Further, given that severe injuries are less likely to occur than more minor injuries (Crowl & Louvar, 2002; Heinrich, 1931), the use of more inclusive injury criteria should result in the majority of included injuries being less serious in nature.

Safety climate—whether organizational or psychological—should influence future injuries, regardless of their severity. Both minor and major injuries can result from safety lapses that are indicative of poor safety climates. Additionally, a pattern of minor injuries is often a precursor to more severe injuries (Crowl & Louvar, 2002). Consequently, given that minor injuries often precede more serious ones, they are more proximal to safety climate than major injuries. Thus, safety climate should be more effective in predicting injuries of a less serious nature.

On the basis of a review of the safety climate–injury literature, we dichotomized injury operationalizations as studies that used only OSHA-reportable injuries and studies that included both OSHA-reportable injuries and less severe injuries. Thus, the range of injury severity was much broader (as it was more inclusive) for this latter group of studies than for the OSHA-criteria-only studies. Therefore, we made the following hypothesis, based on this dichotomization and the theoretical arguments above.

> *Hypothesis 4a:* The safety climate→injury relationship will be moderated by injury operationalization such that the inclusion of more than OSHA-reportable injuries will be associated with stronger relationships than will the inclusion of only OSHA-reportable injuries.

With regard to the injury→safety climate relationship, it is likely that the severity of injuries affects subsequent safety climate perceptions to differing degrees. That is, minor injuries would be expected to have a lesser impact on safety climate perceptions than would more major injuries (e.g., OSHA-reportable injuries). Whereas less severe injuries can often be discounted on an individual basis, severe injuries are more memorable and would likely have a greater influence on subsequent perceptions of workplace safety. This is not to say that minor injuries are not meaningful indicators of safety climate; rather, observing or personally experiencing a minor injury should have a smaller effect on consequent safety perceptions than should observing or experiencing a severe injury. For example, witnessing a group member receive a minor cut would likely have less of an effect on safety climate perceptions than witnessing a group member break a limb. Thus, more severe injuries should have a stronger influence on safety climate than should less severe injuries.

> *Hypothesis 4b:* The injury→safety climate relationship will be moderated by injury operationalization such that OSHA-reportable injuries will have a stronger effect on safety climate than the inclusion of more than OSHA-reportable injuries.

Method

Literature Search

To locate studies, we conducted an online literature search of the PsycINFO, PubMed, and dissertation databases using the keywords *safety climate* and *injury, injuries, accident,* or *accidents.* A search of Society for Industrial and Organizational Psychology, Academy of Management, and Human Factors and Ergonomics Society conference programs from the past 7 years (2003–2009) was conducted to locate unpublished studies. Additionally, requests for published and unpublished safety climate studies were posted on three Listservs (i.e., HRDivNet, RMNet, OBlistserv). Further, researchers in the fields of safety climate and injuries were contacted directly to seek unpublished studies.

Inclusion Criteria

Studies were initially eligible for inclusion if they reported the relationship between a measure of safety climate and a measure of workplace injuries and included either an appropriate effect size or sufficient information to permit the computation of one. Further, given that the terms *safety culture* and *safety climate* are often used interchangeably despite their theoretical differences (Denison, 1996), we examined studies that purported to measure safety culture to determine if the substance of what was being measured was in fact safety climate. We also examined studies that assessed related constructs such as "safety attitudes." Additionally, studies had to provide sufficient information for us to determine if the reported injuries occurred before or after the assessment of safety climate. We excluded studies in which this information was not provided and those in which injuries and the assessment of safety climate could have occurred concurrently.

In cases where an overall safety climate–injury effect size was not reported and factor-specific effect sizes were present, a composite effect size was computed (Nunnally & Bernstein, 1994). Multiple effect sizes within a given study were each eligible for inclusion as long as they were associated with independent samples or offered unique contributions to the meta-analyses. For example, safety climate→injury and injury→safety climate conceptualizations associated with the same sample (e.g., Neal & Griffin, 2006) were eligible for inclusion, given that these relationships were meta-analyzed separately.

Information pertinent to moderator analyses (e.g., length of time over which injuries were assessed or safety climate measure used) was required for inclusion in the relevant analyses. For example, a study lacking information on the operationalization of injuries would not be eligible for inclusion in the analysis of injury operationalization as a moderator. These inclusion criteria resulted in an overall sample of 32 injury→psychological safety climate effect sizes ($N = 16{,}011$), 10 injury→ organizational safety climate effect sizes ($N = 251$), and 11 organizational safety climate→injury effect sizes ($N = 458$). Because we located only one study that examined the psychological safety climate→injury relationship (i.e., Hofmann & Morgeson, 1999), we could not conduct a meta-analysis of this relationship. As a result, there were three rather than four highest level relationships for the present study. Studies that were included in the meta-analyses are marked by asterisks in the reference list.

Data Coding

Each study was coded for pertinent sample information, aspects of the study design, and information on the predictor and criterion measures. It should be noted that some effect sizes were transposed to ensure that, for all effect sizes, a negative sign indicated that more favorable safety climates are related to fewer injuries and vice versa. Jeremy M. Beus and Stephanie C. Payne coded each study independently. This exercise resulted in 91% agreement across all coded elements between the two coders. Discrepancies were resolved by discussion and by revisiting the articles in question. For our supplemental analyses, safety climate dimensions were grouped primarily on the basis of their author-assigned labels, although for labels that were ambiguous or unclear, items were examined where possible to facilitate more precise categorizations.

Meta-Analytic Procedures

This meta-analysis was conducted with Hunter and Schmidt's (2004) meta-analytic approach. Corrections were made for sampling error and unreliability in the safety climate measures using an artifact distribution; separate distributions were computed for each subgroup analysis. Effect sizes were not corrected for unreliability in the measurement of injuries because reliabilities are typically not reported for injury measures, in large part because injury measures are often counts rather than psychological scales.

Analysis of Moderators

Because organizational and psychological safety climate→injury and injury→safety climate relationships are theoretically distinct, there are four separate theoretical associations. We were able to examine three of them meta-analytically: (a) organizational safety climate→injury; (b) injury→organizational safety climate; and (c) injury→ psychological safety climate. To evaluate research questions and hypotheses relating to these highest level conditions, we compared the absolute values of the population estimates obtained and interpreted them as absolute differences that reflect true population differences (Hunter & Schmidt, 2004).

To determine whether moderators were likely to be operating, we calculated the percentage of variance explained by statistical artifacts and constructed 95% credibility intervals. If after correction for statistical artifacts much of the variance in effect sizes is unaccounted for, it is likely that moderators are present. Likewise, credibility intervals provide an estimate of the amount of variability across studies and suggest moderation when the interval includes zero (Hunter & Schmidt, 2004). However, considerable variance may still be indicated by a large standard deviation value and thus still suggest moderation even when the credibility interval does not include zero. Thus, moderation was determined to exist if credibility intervals included zero and if the standard deviations of the different moderator conditions were not smaller relative to the overall population estimate's standard deviation (i.e., variance did not decrease after accounting for the proposed moderators).

All proposed moderators were examined hierarchically within organizational and psychological safety climate→injury and injury→safety climate relationships. Categorical moderators were assessed with Hunter and Schmidt's (2004) subgroup analysis. That is, separate meta-analyses were performed for each proposed moderator condition (i.e., OSHA injuries vs. more than OSHA injuries) to allow for comparisons between conditions. As an a priori decision rule, proposed moderator conditions were determined to be meaningfully different by comparing confidence intervals around the sample-weighted mean observed effect size for each condition; overlapping confidence intervals suggest that moderator conditions are not meaningfully different.

For continuous moderators, weighted least squares multiple regression (WLS) was used to test for moderation. Monte Carlo simulations demonstrate that this method provides the most accurate estimates and is least affected by multicollinearity, even with small sample sizes (Steel & Kammeyer-Mueller, 2002). The weighting factor used was the inverse square root of the sampling error (Steel & Kammeyer-Mueller, 2002).

Contamination and deficiency in safety climate measures. Twenty-nine of a possible 35 measures, which accounted for 47 of the 53 total effect sizes in this meta-analysis, were evaluated for content contamination and deficiency. Items were gathered by reviewing published sources or by contacting the authors; we were unable to obtain the six remaining measures. Of the 29 measures obtained, 15 were used in psychological climate studies only, 10 were used in organizational climate studies only, and four measures were used at least once for each safety climate conceptualization. The number of items in these measures ranged from three to 69.

Before the measures were evaluated, all identifying information (e.g., names of the authors for the studies utilizing the measure; year of publication; source of publication) was removed, leaving only the set of items. Four subject matter experts (SMEs; two industrial–organizational psychology professors and two industrial–organizational psychology doctoral students) evaluated contamination and deficiency on the basis of divergence from or convergence with Zohar's (2003) definition of safety climate and his delineation of policies, procedures, and practices (see Appendix for rating cover sheet). Contamination was operationalized as the proportion of contaminated items in a measure. Deficiency was rated on a 7-point Likert scale ranging from 1 (*not at all deficient*) to 7 (*completely deficient*). The SMEs rated each of the 29 measures individually and then met to resolve discrepancies and reach consensus. Preconsensus levels of interrater agreement for contamination (r_{wg} = .89) and deficiency ratings (r_{wg} = .81) were satisfactory.

Results

Safety Climate→Injury Versus Injury→Safety Climate Relationships

Results for the categorical analyses are provided in Table 1. With regard to our first research question, the injury→organizational safety climate relationship (ρ = −.29, *k* = 10, *N* = 251) was stronger than the organizational safety climate→injury relationship (ρ = −.24, *k* = 11, *N* = 448). This suggests that for organizational climate, injuries are more predictive of safety climate than safety climate is of injuries. With regard to Hypothesis 1, the injury→organizational safety climate relationship (ρ = −.29) was stronger than the injury→psychological safety climate relationship (ρ = −.16, *k* = 32, *N* = 16,011). Comparisons of organizational and psychological safety climate→injury relationships could not be made due to the unavailability of psychological safety climate→injury studies. Thus, for the available data, Hypothesis 1 was supported.

With regard to the likelihood of moderation, the credibility intervals for injury→psychological safety climate (CV = −.39 to .07), injury→organizational safety climate (CV = −.66 to .08), and organizational safety climate→injury (CV = −.65 to .18) all included zero, suggesting that moderators may be operating. These are addressed next.

Length of Time Over Which Injuries Were Assessed

Results for the analyses of continuous moderators are provided in Table 2. The effects of the length of time over which injuries are assessed were tested with WLS multiple regression. Results showed that the length of the time interval over which injuries were assessed moderated only the organizational safety climate→injury relationship, accounting for 39% of the variance in those effect sizes with a positive standardized regression coefficient (β = .62, $p < .05$). Because the corrected correlation between safety climate and injuries was negative, a positive beta indicates that effect sizes tended to approach zero (i.e., become smaller) as the length of time over which injuries were assessed increased. Thus, this suggests that the ability of a given assessment of safety climate to predict future injuries is lessened as the time period over which injuries are assessed increases.

The injury→safety climate relationships for organizational and psychological climate were not moderated by the length of time for assessing injuries. For both, no variance (R^2 = .00) was accounted for by the time frame over which injuries were assessed. These results consequently suggest that the influence of injuries on safety climate perceptions is largely unaffected by the injury time frame.

Safety Climate Content Contamination and Deficiency

The effects of safety climate measure content contamination and deficiency on safety climate–injury relationships were tested with WLS multiple regression. Both proposed moderators were entered simultaneously into regression equations to account for shared

Table 1
Results for Categorical Moderators of Safety Climate–Injury Relationships

Variable	*k*	*N*	$\bar{r}$	% var. sampling error	95% CI *LL*	95% CI *UL*	ρ	*SD*ρ	% var. accounted for	95% CV *LL*	95% CV *UL*
Injury→psychological safety climate	32	1,6011	−.15	14.29	−.19	−.11	−.16	.12	14.82	−.39	.07
OSHA injury criteria	3	961	−.23	4.20	−.52	−.08	−.25	.28	4.30	−.79	.30
OSHA and more	29	1,5050	−.14	19.42	−.18	−.11	−.15	.10	20.16	−.34	.03
Injury→organizational safety climate	10	251	−.26	55.37	−.41	−.10	−.29	.19	55.76	−.66	.08
OSHA injury criteria	6	122	−.35	38.08	−.61	−.09	−.39	.28	38.62	−.94	.16
OSHA and more	4	129	−.17	100	−.28	−.06	−.19	0[a]	100	—	—
Psychological safety climate→injury											
Psychological safety climate[b]	—	—	—	—	—	—	—	—	—	—	—
Organizational safety climate→injury	11	448	−.22	36.75	−.37	−.07	−.24	.21	36.84	−.65	.18
OSHA injury criteria	2	50	−.08	100	−.35	.19	−.08	0[a]	100	—	—
OSHA and more	9	398	−.24	33.05	−.40	−.07	−.26	.22	33.11	−.70	.18

Note. Dashes indicate analyses that could not be conducted. *k* = number of safety climate–injury effect sizes; *N* = total number of participants across studies; $\bar{r}$ = sample weighted mean observed *r*; % var. sampling error = percentage of variance attributed to sampling error; 95% CI = confidence interval, lower (*LL*) and upper (*UL*) bounds; ρ = corrected mean *r*; *SD*ρ = standard deviation of corrected effect size; % var. accounted for = percentage of variance attributed to corrected statistical artifacts; 95% CV = credibility interval, lower (*LL*) and upper (*UL*) bounds; OSHA = Occupational Safety and Health Administration.
[a] For cells with a *SD*ρ of 0, the variance of ρ was less than the average sampling error that was subtracted from it. This leads to a negative *SD*ρ, which Hunter and Schmidt (2004) argued should be interpreted as zero variance. [b] Only one study was found that investigated the safety climate→injury relationship at the psychological level (i.e., Hofmann & Morgeson, 1999).

Table 2
Results for Continuous Moderators of Safety Climate–Injury Relationships

Variable	*k*	*M*	*SD*	β	R^2
Injury→psychological safety climate	32				
Time frame for gathering injury data[b]	25	11.24[a]	6.65	−.05	.00
Safety climate content analyses					
Overall model	28				.13
Contamination	28	0.21	0.21	−.16*	
Deficiency	28	2.32	1.02	.38*	
Injury→organizational safety climate	10				
Time frame for gathering injury data	10	16.20[a]	8.97	−.03	.00
Safety climate content analyses					
Overall model	9				.79
Contamination	9	0.28	0.18	−.71*	
Deficiency	9	3.11	1.69	.77*	
Organizational safety climate→injury	11				
Time frame for gathering injury data	11	9.45[a]	3.62	.62*	.39
Safety climate content analyses					
Overall model	10				.05
Contamination	10	0.04	0.07	−.19	
Deficiency	10	2.80	0.92	−.09	

Note. Moderation was examined with weighted least squares multiple regression. k = number of effect sizes; M = mean; SD = standard deviation; β = beta weight; R^2 = proportion of variance attributed to moderators.
[a] Number of months. [b] Seven injury→psychological safety climate studies were excluded from this analysis because injuries were gathered over employees' organizational tenure and not fixed time frames.
* $p < .05$.

variance.[4] The combined effects of safety climate content contamination and deficiency accounted for 13%, 79%, and 5% of the variance in safety climate–injury effect sizes for injury→psychological safety climate, injury→organizational safety climate, and organizational safety climate→injury relationships, respectively.

Safety climate content contamination. The results for Hypothesis 2, which posited that safety climate content contamination would result in weaker safety climate–injury relationships, were mixed. Contamination had a meaningful effect on injury→safety climate relationships for psychological climate (β = −.16, $p <$ .05) and organizational climate (β = −.71, $p < .05$) but not for the organizational safety climate→injury relationship (β = −.07, $p >$ .05). However, contrary to expectation, greater contamination was associated with stronger injury→safety climate relationships for organizational and psychological climate. Although contamination was found to be a meaningful moderator in two out of three analyses, because effects were contrary to expectation, Hypothesis 2 was not supported.

Safety climate content deficiency. Hypothesis 3 posited that deficiency in safety climate measures would moderate the safety climate–injury relationship such that deficiency would bias effect sizes downward (i.e., make effect sizes smaller). The results revealed that deficiency in safety climate measures was a moderator for injury→safety climate relationships both for psychological climate (β = .38, $p < .05$) and for organizational climate (β = .77, $p < .05$) but not for the organizational safety climate→injury relationship (β = −.09, $p > .05$). As hypothesized, greater deficiency was associated with weaker safety climate-injury relationships. However, because deficiency was a moderator only for injury→safety climate relationships, there is only partial support for Hypothesis 3, with two of three possible meta-analyses consistent with our expectations.

Safety climate dimensions. We conducted dimension-level meta-analyses of safety climate and injury relationships to further examine how common safety climate dimensions and contaminants variously relate to injuries and consequently contribute to observed effects. Table 3 lists the meta-analytic results of all the reported dimension-level effect sizes that could be gleaned from the included studies. We reported the meta-analytic results for any dimensions for which there were two or more reported effect sizes. This resulted in meta-analyses of 10, nine, and seven separate dimensions for injury→psychological safety climate, organizational safety climate→injury, and injury→organizational safety climate relationships, respectively.

Of the noncontaminated safety climate dimensions meta-analyzed, perceived management commitment to safety was the most common. The prevalence of management safety commitment in safety climate measures is not surprising, given that it is one of the most widely agreed-upon dimensions in the safety climate literature (Flin et al., 2000) and a salient indicator for employees regarding organizational safety policies and practices (Zohar, 2003). Consequently, it is noteworthy that perceived management commitment to safety had stronger effects in its prediction of future injuries (ρ = −.30, k = 10, N = 431) than injuries did in predicting management safety commitment both for organizational safety climate (ρ = −.22, k = 6, N = 120) and for psychological safety climate (ρ = −.12, k = 10, N = 5,903). Furthermore, perceived management commitment to safety demonstrated a stronger association with subsequent injuries than any other safety climate dimension (with the exception of safety reporting, which had the same effect), and it is also the only assessed dimension in which validity generalized (i.e., the credibility interval did not include zero). Consequently, for organizational safety climate, management commitment to safety is the dimension that constitutes the most robust predictor of injuries. Table 3 provides a listing of the other safety climate dimensions assessed and their respective effects.

Contaminated dimensions were job safety/risk, personal safety attitudes, and supervisor competence. Note that these were not the only contaminated dimensions identified in the included studies but rather were the most commonly reported dimension-level content contaminants. Other content contaminants that could not be meta-analyzed included fatalism, optimism, job security, job commitment, and employee appreciation.

[4] Contamination and deficiency were correlated .17, −.18, and .01 for psychological injury→safety climate, organizational injury→safety climate, and organizational safety climate→injury relationships, respectively.

Table 3
Dimension-Level Meta-Analyses of Safety Climate–Injury Relationships

Variable	*k*	*N*	$\bar{r}$	% var. sampling error	95% CI *LL*	95% CI *UL*	ρ	*SD*ρ	% var. accounted for	95% CV *LL*	95% CV *UL*
Injury→psychological safety climate	32	1,6011	−.15	14.29	−.19	−.11	−.16	.12	14.82	−.39	.07
Management commitment to safety	10	5,903	−.11	34.16	−.15	−.06	−.12	.06	35.11	−.24	.00
Management safety attitudes	4	992	−.19	11.40	−.37	−.01	−.20	.18	11.52	−.55	.15
Management safety practices	6	2,732	−.15	3.86	−.34	.04	−.16	.24	4.14	−.64	.32
Specific safety policies	4	3,614	−.08	2.19	−.30	.14	−.09	.24	2.24	−.56	.39
Coworker safety	7	2,760	−.20	5.63	−.35	−.05	−.22	.21	5.73	−.63	.20
Safety communication	2	1,096	−.15	100	−.17	−.14	−.18	0[a]	100	—	—
Safety training	3	2,407	−.17	71.06	−.21	−.12	−.19	.02	76.04	−.24	−.15
Housekeeping	2	450	−.15	100	−.17	−.12	−.24	0[a]	100	—	—
Personal safety attitudes	5	2,943	−.08	38.94	−.14	−.03	−.09	.06	39.45	−.20	.02
Job safety/risk	7	3,979	−.21	5.11	−.34	−.08	−.23	.19	5.47	−.59	.14
Injury→organizational safety climate	10	251	−.26	55.37	−.41	−.10	−.29	.19	55.76	−.66	.08
Management commitment to safety	6	120	−.21	66.15	−.42	.01	−.22	.17	66.36	−.56	.11
General safety policy	2	21	−.53	100	−.82	−.23	−.62	0[a]	100	—	—
Safety procedures	2	20	−.39	100	−.56	−.22	−.43	0[a]	100	—	—
Safety communication	2	26	−.19	56.56	−.70	.32	−.21	.27	56.56	−.73	.32
Safety reporting	3	72	−.11	61.22	−.40	.19	−.12	.18	61.23	−.47	.24
Safety behavior	4	41	−.26	38.17	−.75	.22	−.30	.44	38.19	−1.0	.57
Personal safety attitudes	4	42	−.24	100	−.53	.05	−.29	0[a]	100	—	—
Job safety/risk	3	28	−.40	74.91	−.78	−.03	−.47	.19	76.41	−.85	−.10
Supervisor competence	2	26	.17	100	.11	.23	.19	0[a]	100	—	—
Psychological safety climate→injury	—	—	—	—		—	—	—	—		—
Organizational safety climate→injury	11	448	−.22	36.75	−.37	−.07	−.24	.21	36.84	−.65	.18
Management commitment to safety	10	431	−.27	87.44	−.37	−.18	−.30	.06	87.87	−.41	−.18
Management safety practices	6	195	−.08	27.65	−.35	.19	−.09	.31	27.65	−.69	.52
Safety procedures	4	96	.17	56.15	−.09	.44	.19	.19	56.15	−.19	.56
Safety communication	4	96	.18	52.52	−.09	.45	.19	.21	52.52	−.21	.60
Safety reporting	3	139	−.27	100	−.33	−.20	−.30	0[a]	100	—	—
Safety behavior	2	30	−.06	82.87	−.47	.34	−.07	.13	82.89	−.32	.18

Note. Italicized dimension labels signify contaminated dimensions; dashes indicate analyses that could not be conducted. k = number of safety climate-injury effect sizes; N = total number of participants across studies; $\bar{r}$ = sample weighted mean observed *r*; % var. sampling error = percentage of variance attributed to sampling error; 95% CI = confidence interval, lower (*LL*) and upper (*UL*) bounds; ρ = corrected mean *r*; *SD*ρ = standard deviation of corrected effect size; % var. accounted for = percentage of variance attributed to corrected statistical artifacts; 95% CV = credibility interval, lower (*LL*) and upper (*UL*) bounds.
[a] For cells with a *SD*ρ of 0, the variance of ρ was less than the average sampling error that was subtracted from it. This leads to a negative *SD*ρ, which Hunter and Schmidt (2004) argued should be interpreted as zero variance.

As previously stated, because the risk level for a given job can often be attributed to the nature of the work itself and not necessarily to the prevailing safety climate, job safety/risk represents a contaminated assessment of safety climate. Job safety/risk is perhaps the most pervasive contaminant of safety climate measures. That is, in addition to constituting the most prevalent dimension-level contaminant, individual job safety/risk items were found to be present in 50% of all the safety climate measures that were rated by SMEs to contain any degree of contamination. The injury→job safety/risk effects at the psychological level ($\rho = -.23$, $k = 7$, $N =$ 3,979) and organizational level ($\rho = -.47$, $k = 3$, $N = 28$) were greater than the overall meta-analytic injury→safety climate relationships obtained for both respective climates ($\rho = -.16$, $\rho = -.29$). Thus, consistent with the general effects of content contamination, the assessment of job safety/risk in safety climate measures would have spuriously inflated safety climate and injury relationships.

Personal safety attitudes represent another contaminant given that they are not descriptive of an organization's safety policies, procedures, or practices, to which safety climate refers even when considered at the psychological level. At the psychological level, the injury→personal safety attitudes effect ($\rho = -.09$, $k = 5$, $N =$ 2,943) was weaker than the overall injury→psychological safety climate effect ($\rho = -.16$). For organizational climate, the injury→personal safety attitude effect ($\rho = -.29$, $k = 4$, $N = 42$) did not differ from the overall injury→organizational safety climate effect ($\rho = -.29$).

Finally, because the perceived competence of supervisors does not necessarily bear a direct relationship to their safety behaviors, supervisor competence is also a safety climate contaminant. For organizational climate, the injury→supervisor competence association ($\rho = .19$, $k = 2$, $N = 26$) was positive in direction and weaker in magnitude relative to the overall injury→organizational safety climate relationship ($\rho = -.29$).

Injury Operationalization

Hypothesis 4a posited that the use of more than OSHA-reportable injuries (i.e., including more minor injuries) would be more associated with stronger safety climate→injury relationships than would the use of only OSHA-reportable injuries (i.e., inclusion restricted to severe injuries). Consistent with expectation, the use of more than OSHA injuries ($\bar{r} = -.24$) resulted in a stronger sample-weighted observed effect size for the organizational safety climate→injury relationship than did the use of only OSHA injuries ($\bar{r} = -.08$). However, overlapping confidence intervals suggest that the magnitude of the safety climate→injury relationship does not differ substantially on the basis of the severity of injury operationalizations. Thus, Hypothesis 4a was not supported.

Hypothesis 4b posited that the inclusion of only OSHA-reportable injuries would result in a stronger injury→safety climate relationship than would the inclusion of more than OSHA-reportable injuries. Results revealed, consistent with the direction of our hypothesis, that the use of OSHA-reportable injuries demonstrated stronger sample-weighted mean effect sizes than did the inclusion of more than OSHA-reportable injuries for psychological climate ($\bar{r} = -.23$ vs. $\bar{r} = -.14$) and organizational climate ($\bar{r} = -.35$ vs. $\bar{r} = -.17$). However, overlapping confidence intervals for both comparisons suggest that this is not a meaningful source of moderation. Consequently, Hypothesis 4b was not supported.

Discussion

Our purpose in this study was to distinguish safety climate→injury and injury→safety climate relationships for organizational and psychological safety climates and to investigate the effects of several potential moderators of these relationships. Results revealed that the predictive effects of injuries on organizational safety climate ($\rho = -.29$) are slightly stronger than those of organizational safety climate on injuries ($\rho = -.24$). Further, the injury→safety climate relationship was stronger for organizational climate ($\rho = -.29$) than for psychological climate ($\rho = -.16$). Credibility intervals that included zero and large proportions of unexplained variance after correcting for statistical artifacts supported a priori expectations concerning the presence of moderators for each safety climate–injury relationship. Accordingly, the length of time over which injuries were assessed was found to be a significant moderator of the organizational safety climate→injury relationship, with longer time frames yielding weaker associations. Concerning the operationalization of safety climate, safety climate content contamination and deficiency moderated the injury→safety climate relationships for organizational and psychological climate but not the organizational safety climate→injury relationship. However, the direction of contamination's effect was contrary to expectations, such that greater contamination led to stronger safety climate–injury effects. In addition, supplemental analyses revealed that perceived management commitment to safety is the safety climate dimension with the most robust association with future injuries. Finally, injury operationalization was not found to be a moderator for any of the safety climate–injury relationships. We elaborate on these findings and discuss their implications below.

Conceptual Framing of the Safety Climate–Injury Relationship for Psychological and Organizational Climates

Our findings suggest that injuries have a greater predictive effect on safety climate than safety climate has on injuries, but the magnitude of this difference is very small. Safety climate's effect on workplace injuries does not appear to be substantively different from the effect of injuries on safety climate. Thus, consistent with theory, not only is safety climate associated with future injuries but the converse is also true, such that individuals appear to recalibrate their perceptions of organizational safety following injuries, resulting in changes to both psychological and organizational climate (Zohar, 2003). The contention that safety climates shift following workplace injuries supports the notion that climates are dynamic, as opposed to static, organizational phenomena (Schneider & Reichers, 1983). Consequently, although safety climate is most frequently hypothesized to affect injuries, these results suggest that injuries have a very similar—and even a slightly stronger—effect on organizational safety climate. The slightly greater magnitude for the effect of injuries on safety climate might be due to injuries' more proximal influence on safety climate relative to safety climate's influence on injuries, as injuries directly inform safety climate perceptions but safety climate affects injuries via workplace behaviors. Consistent with this, our safety climate→injury effect sizes were smaller than the safety climate→safety behavior effect sizes reported by Christian et al. (2009).

The evidence of a stronger injury→safety climate relationship for organizational climate than for psychological climate suggests that injuries that occur within a group have a greater impact on the group's safety climate than individual injuries have on the injured person's psychological safety climate. For safety climate researchers, this further underscores the need to differentiate between organizational and psychological safety climates, as the use of one conceptualization over another affects empirical relationships and subsequent research conclusions due to unique processes that occur within levels.

An alternative explanation for stronger effects at the group level is that injuries within a group may predict organizational safety climate better than individual injuries predict psychological safety climate, due to the fact that workplace injuries are generally rare events (Jacobs, 1970). There normally is a greater probability of injuries being incurred within a group of people than by any specific individual. Greater variance in injury data in turn allows for greater statistical power to detect effects at the group level. Although we cannot rule out this alternative explanation, we posit that emergent group-level processes, not the mere probability of injury occurrences, are primarily responsible for the stronger injury→safety climate effects demonstrated for organizational safety climate.

Moderators of the Safety Climate–Injury Relationship

Our finding that safety climate assessments appear to lose their ability to predict injuries over time indicates that time is important when examining safety climate's influence on injuries. However, we also found that the influence of injuries on psychological and organizational safety climate remains stable regardless of the time period over which injuries are assessed. This is perhaps not surprising, given that workplace injuries are rare events that are likely stored in employees' long-term memories (Jacobs, 1970). These results point to a number of research questions that need to be addressed about the role of time in safety climate–injury relationships. For example, at what point in time (e.g., after 6 months? 1 year?) does a given snapshot of safety climate no longer affect injury occurrences? Further, to what degree does safety climate change when workplace injuries occur? Answers to these questions concerning the relationship between safety climate and injuries over time would aid safety researchers and practitioners in future safety climate research and the development of safety interventions.

Although our analyses revealed that content contamination and deficiency are meaningful moderators of injury→safety climate relationships, it is noteworthy that they did not moderate the organizational safety climate→injury relationship. There is no conceptual reason to expect the effects of content contamination and deficiency to differ for the various safety climate–injury relationships, so it was unexpected to find that this particular relationship was unaffected by contamination and deficiency when the other relationships were. A closer examination of organizational safety climate→injury studies reveals that, on average, the safety climate measures used had very small proportions of contamination ($M = 0.04$). This suggests that the safety climate measures used in these studies aligned more closely with Zohar's definition. It is probable that, if there had been contamination present in these measures, the effect of contamination on the organizational safety climate→injury relationship would have been similar to that found in the other safety climate–injury analyses. With regard to the null effects of content deficiency on the organizational safety climate→injury relationship, although the average deficiency rating for these studies ($M = 2.80$) was not noticeably different from those for the other study subgroups, the variability was considerably lower ($SD = 0.92$). This reduced the ability to detect the effect of this potential moderator. Again, if the variability had been more similar to that for injury→safety climate relationships, it is likely that deficiency would have had a similar effect on this relationship.

Safety Climate Dimensions

Our examination of safety climate dimensions sheds light on why content contamination resulted in larger safety climate–injury relationships. A number of the dimensions (e.g., job safety/risk; individual safety attitudes) contaminating safety climate measures are important aspects of the context surrounding safety in organizations, even if they are not indicators of safety climate themselves. Inherent job risk is a useful variable to consider, especially given its meaningful association with both past and subsequent workplace injuries as conveyed here. Although job risk, as it is commonly assessed in safety climate measures, refers to the level of risk inherent in the job being performed, it is important to note that perceptions of job risk can also be influenced by coworker or supervisor actions. For example, the actions of an employee who deliberately disregards safety practices and endangers his or her fellow coworkers would certainly be expected to affect fellow employees' perceptions regarding workplace risk. Whereas we contend that inherent job risk is not an aspect of safety climate, the safety-related behaviors of coworkers and supervisors arguably are a part of safety climate.[5] In extant safety climate measures, the safety-related behaviors of coworkers are often assessed within a different dimension (e.g., coworker safety practices or safety behavior). Given the influence that coworker safety behaviors should have on perceptions of job risk, future research should determine the extent to which this safety climate dimension affects subsequent risk perceptions. However, because inherent job risk is not an aspect of safety climate, we reiterate that it should be treated separately.

Despite our finding that contaminants tended to strengthen the relationships between safety climate and workplace injuries, it is important to note that without clean (i.e., noncontaminated) measures of focal constructs, it is difficult to draw conclusions about the factors that influence organizational events and therefore difficult for organizational stakeholders to make decisions about interventions to improve organizational safety. Conversely, although the content of safety climate measures can readily be identified as contaminated or not on the basis of Zohar's (2003) theoretical definition, it is difficult to provide a succinct recommendation regarding the complete, nondeficient safety climate content domain. As has been evidenced in the extant safety climate literature, there are numerous safety-related policies, procedures, and practices that likely contribute to employees' safety climate perceptions. Thus, a value of Zohar's (2003) definition of safety climate, in addition to its correspondence with the extant organizational climate literature, is its applicability across organizational settings.

Our findings regarding content deficiency are informative for future safety climate research. For example, of the safety climate measures that were rated by SMEs as neither deficient nor contaminated, the reported dimensions fell under the categories of management commitment to safety; the priority of safety; general safety policies, procedures, and practices; safety training; safety communication; safety reporting; and employee safety involvement. Although we do not posit that the above-listed dimensions necessarily represent the complete safety climate content domain, we would argue that they do represent substantial breadth within the domain. Unfortunately, we were unable to conduct dimension-level meta-analyses for all of these dimensions, and many that could be meta-analyzed were based on a limited number of studies. Consequently, we encourage future safety climate researchers to consider these dimensions in their assessments of safety climate to ensure more complete representation of the construct space.

Limitations and Future Directions

A limitation of this meta-analysis was the unavailability of data to test all of the proposed safety climate and injury relationships. Only one psychological safety climate→injury study was found, so the meta-analytic comparison of psychological safety climate→injury and injury→psychological safety climate relationships was not possible. This study (Hofmann & Morgeson, 1999) reported a −.28 relationship between psychological safety climate and injuries for a sample of 49 workers. Clearly, additional research on this relationship is warranted. Further, the present meta-analyses were based on a relatively small number of studies. In spite of this, our study represents a more extensive quantitative examination of the safety climate and injuries literature than past safety climate meta-analyses and addresses important theoretical and conceptual issues not previously considered (e.g., safety climate→injury vs. injury→safety climate relationships).

Our dichotomization of workplace injuries was also a limitation, given that the more inclusive injury category included severe

[5] We thank an anonymous reviewer for bringing this to our attention.

injuries in addition to the more minor injuries. Thus, although the majority of the injuries included in the "more than OSHA" category would likely have been minor, severe injuries would have been included as well. Unfortunately, the effect of injury severity could not be teased apart meta-analytically. Hence, there is need for research that separates injury occurrences by levels of severity to better delineate the influence of safety climate on the severity of workplace injuries and vice versa.

A third potential limitation of this study was the reliance on SME ratings to assess safety climate content contamination and deficiency. Because these proposed moderators could be assessed only by using rater judgments, attempts were made to minimize the possible influence of rater effects by using a common theoretical framework, preserving scale anonymity, and holding consensus meetings to discuss ratings. Additionally, it was not always possible to verify dimension labels, based on corresponding item content, for our dimension-level analyses; thus, some of the safety climate dimensions could only be coded according to the labels provided in the primary studies.

There are additional theoretical moderators that warrant further investigation. For example, groups vary in terms of climate strength, or how much group members agree about safety climate (Schneider, Salvaggio, & Subirats, 2002). Stronger climates are more indicative of group behavior than are weaker climates, so strong safety climates should have larger associations with safety-related outcomes than do weak safety climates. However, such analyses could not be performed here, as a consistent measure of the variability of group safety climate perceptions across studies is required; for group-level safety climate studies, this necessitates information regarding the variability of safety climate perceptions within each examined group. A related moderator is that groups also vary in terms of the interdependence of their work. Safety climates in highly interdependent groups would be expected to relate more strongly to subsequent safety outcomes than would safety climates in groups with low interdependence. A favorable safety climate would be critical for groups in which individual safety is dependent on the actions and perceptions of others. Thus, future research is needed to examine group interdependence and climate strength as moderators of safety climate–injury relationships.

Practical Implications

There are a number of notable implications for managers and safety practitioners that can be gleaned from this study's findings. The role of perceived management commitment to safety in reducing future occupational injuries is of particular importance. Employee perceptions of the extent to which managers and supervisors are committed to workplace safety likely influence employee safety behavior and, subsequently, injuries. This has specific implications for manager and supervisor safety training. Managerial safety training that emphasizes the manager's or supervisor's role as a safety referent could increase awareness of the extent to which employees scrutinize managerial actions regarding safety. Commitment to safety can be communicated through words or actions. Employees' perceptions of management's commitment to safety, regardless of how it is conveyed, clearly play an important role in safety climate perceptions.

Our finding that the length of time over which injuries were assessed did not moderate the effect of injuries on subsequent safety climate perceptions is also meaningful. This suggests that past injuries—arguably those of greater severity—tend to influence employee interpretations of organizational safety even well after actual injury occurrences. For managers and safety practitioners, this suggests the need to investigate and address the factors that have contributed to past injuries and then to clearly communicate to employees what has been done to decrease the likelihood of their recurrence. This approach could potentially alleviate the negative influence of past safety incidents on subsequent safety climate perceptions. However, given that managers can only address the problems of which they are aware, it is critical to encourage timely and open reporting of workplace injuries and accidents by employees. The meaningful negative relationship that safety reporting demonstrated with consequent injuries in this meta-analysis underscores this need.

Furthermore, the stronger negative relationship that injuries demonstrated with subsequent organizational safety climates relative to psychological safety climates suggests that injuries have a stronger effect on safety perceptions at the group level. Consequently, organizational efforts to increase the extent to which employees share safety climate perceptions may be particularly effective in decreasing future injuries. For example, organizational socialization tactics (e.g., new employee orientations, formal mentoring, ongoing training) focused specifically on communicating safety expectations and norms may be an effective means for organizations and work groups to create greater homogeneity in safety climate perceptions and, thus, to improve occupational safety.

Many of the moderators investigated in this study are associated with methodological decisions for those studying safety climate–injury relationships; therefore, we offer a number of recommendations for future primary studies and safety climate assessments in the field. First, in cases where researchers and practitioners are interested in how safety climate affects the occurrence of injuries, prospective safety climate→injury relationships should be examined along with theoretical mediators (e.g., safety behavior), as this allows more accurate causal inferences regarding the influence of safety climate on injuries. Further, given that injuries were demonstrated to affect safety climate, a given safety climate cannot be presumed to have been the same phenomenon prior to the injuries that preceded its assessment. Second, future research on safety climate–injury relationships should specify theoretical reasons for studying organizational or psychological safety climates and offer conclusions that are consistent with the specified theoretical level (Ostroff et al., 2003; Zohar, 2003). Third, there is a need for developmental studies (e.g., Beck & Wilson, 2001) to better determine how both safety climate and workplace injuries change, how their relationships change over time, and what influences those changes. Developmental designs would also enable researchers to examine both safety climate→injury and injury→safety climate relationships, as well as to better understand what is happening within time frames in which injuries are typically assessed. Fourth, safety researchers and practitioners may want to consider the moderators we tested when examining other outcomes besides injuries. Examples include safety behavior, both compliance and participation, and errors. Finally, we encourage critical examination by safety researchers of safety climate assessment tools for deficiency (e.g., a lack of management commitment to safety) and potential contaminants (e.g., inherent risk).

Conclusion

Our purpose in the present study was to meta-analytically examine a number of factors posited to influence the relationships between safety climate and injuries. This study contributes to the extant safety climate literature in several ways. First, this is the only known attempt to differentiate meta-analytically between organizational and psychological safety climates and to distinguish between safety climate→injury and injury→safety climate relationships. Our study contributes to the safety climate literature by elucidating the relationships that exist between safety climate and injuries at the theoretically appropriate levels of analysis. It revealed that injuries are more predictive of safety climate than safety climate is of injuries and that the injury→safety climate relationship is stronger for organizational climates than for psychological climates. Second, this study represents the most extensive examination to date of potential moderators of these relationships. Of note, we found that organizational safety climate's influence on subsequent injuries is weakened as the time frames over which injuries are assessed increase. Further, this study represents the first attempt to quantitatively assess the effect of safety climate content contamination and deficiency on safety climate–injury relationships. Whereas contamination tended to inflate the relationships between safety climate and injuries, deficiency tended to attenuate them. Given the number of safety climate measures in existence and the extensive content variability among them, these findings suggest that greater attention should be paid to the operationalization of safety climate. That is, we recommend that safety climate researchers and practitioners select or create measures that are consistent with the extant theoretical conceptualization of safety climate. We hope the findings of this study will facilitate greater convergence in future safety climate assessments as well as inspire additional research that will enrich our understanding of the relationships between safety climate and injuries, so that organizations can ultimately become safer places for all workers.

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Appendix

Safety Climate Scale Rating Questionnaire

The purpose of this questionnaire is to rate a set of safety climate measures according to the degree to which they represent a commonly held definition of safety climate. Specifically, safety climate measures will be rated according to their level of deficiency and contamination in relation to the specified safety climate construct. Deficiency is the degree to which a given scale fails to represent the specified content domain (Messick, 1980) and will be rated on a seven-point Likert scale. Contamination is the degree to which a scale measures construct irrelevant content (Messick, 1980) and will be operationalized as the proportion of contaminated items within a measure. The definition of safety climate for the purpose of gauging deficiency and contamination appears below.

Definition of Safety Climate

Zohar (2003) defined safety climate as the perception of the policies, practices, and procedures pertaining to safety. According to Zohar and Luria (2005), *safety policies* define strategic safety goals and the means for their achievement while *safety procedures* provide planned courses of action relating to those goals. Safety policies and procedures both exist at the organizational level and are maintained by upper management (Zohar & Luria, 2005). *Safety practices* refers to the implementation of policies and procedures at the work group level (Zohar & Luria, 2005).

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