



# Network of Mindfulness and Difficulties in Regulating Emotions in Firefighters

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## Abstract

**Objectives** Growing evidence supports the role of mindfulness in regulating emotions in the general population. However, the interactive network of mindfulness facets and difficulties in regulating emotions is not well understood, which is specifically important for individuals involved in high-risk professions, such as first responders. The aim of this study was to investigate the interactive relations between mindfulness facets (acting with awareness, non-judging, describing, observing, and non-reacting), ability to regulate emotions and alcohol use in a sample of firefighters, including military veterans.

**Method** A sample of 685 career firefighters, of whom 154 (22.5%) are military veterans, completed measures of mindfulness and difficulties in regulating emotions. The dataset was subjected to network analysis.

**Results** The mindfulness facet non-judging was negatively related to emotion-regulation challenges, such as nonaccepting attitudes and lack of clarity, and positively related to deficits in goal-directed behaviour. Acting with awareness was negatively related to goal-directed behaviour deficits and impulsivity. Alcohol use was positively linked to impulsivity and negatively linked to describing. Overall, emotion-regulation difficulties were positively linked together, and positive links were found between most mindfulness facets. Directed network analysis found non-judging and emotion-regulation strategy as primary predictors. Non-judging acted as a protective factor, supporting other mindfulness facets, while emotion-regulation strategy exacerbated emotion-regulation challenges acted as a risk factor.

**Conclusions** This network analysis demonstrated that acting with awareness and a non-judgmental attitude, facets of mindfulness, are linked to better emotion-regulation and may play protective role against impulsivity and alcohol use.

**Keywords** Network analysis · Mindfulness · Emotion-regulation · Firefighters · Military veterans

The demanding nature of firefighting involves prolonged exposure to various traumatic and chronically stressful situations. Hence, firefighters face a higher susceptibility to mental health issues, including posttraumatic stress disorder (PTSD), depression, generalized anxiety, and substance use disorders (SUD). Numerous studies consistently highlight their increased vulnerability to developing PTSD compared

to individuals in other professions (Leonard & Vujanovic, 2022; Stanley et al., 2019; Sun et al., 2020). Firefighters may also experience burnout (Makara-Studzińska et al., 2019), hazardous substance use or SUD (Miloslavich et al., 2023), and suicidal ideation (Park et al., 2019). Based on the stress sensitization theory, individuals who have previously experienced significant stress or adversity are more reactive to

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stressors and have increased vulnerability (Hammen et al., 2000; Post, 1992; Smid et al., 2012). Hence, firefighters who have prior military service and have encountered potentially traumatic events during their military tenure may exhibit heightened vulnerability to these psychological challenges (Bartlett et al., 2018). Considering the frequent exposure to potentially traumatizing experiences inherent in firefighting and the elevated prevalence of mental health issues among firefighters, it is crucial to prioritize the development of specialized programs. These programs should be tailored specifically to promote the mental well-being of firefighters and prevent the emergence of symptoms and maladaptive coping mechanisms, such as excessive alcohol consumption, within this at-risk population.

Given the challenging nature of firefighting and the heightened risk of emotion dysregulation among firefighters, understanding and implementing effective emotion-regulation strategies are crucial for maintaining mental well-being and ensuring optimal performance in high-stress situations for this population. Emotion-regulation encompasses the capacity to recognize, govern, and navigate one's emotions effectively, employing adaptive techniques to regulate and comprehend both positive and negative emotional experiences (Bjureberg et al., 2016; Bradizza et al., 2018). Firefighters often encounter traumatic situations that can trigger intense emotions; they may perceive their emotions as uncontrollable and threatening which potentially leads to difficulties in emotion-regulation. This perception can heighten their fear of trauma cues, leading to avoidance of reminders that could cause distress. Moreover, firefighters who struggle with emotion-regulation are at a higher risk of engaging in harmful coping mechanisms, including avoidance, substance abuse, and other risky behaviours (Raudales et al., 2019).

Therefore, the Difficulties in Emotion-regulation Scale (DERS) was developed to serve as a crucial instrument for assessing and comprehending deficits in emotion-regulation (Gratz & Roemer, 2004). This instrument builds upon Linehan's (1993a, 1993b) theoretical framework, emphasizing the interconnectedness of Borderline Personality Disorder (BPD), emotion dysregulation, and deliberate self-harm. While it initially had ties to BPD, the DERS has grown into a versatile instrument applicable in various situations, contributing to the examination and understanding of emotion-regulation. By examining these deficits, emotion-regulation can be conceptualized as encompassing five core facets. This includes the ability to (a) recognize and grasp emotions; (b) acknowledge and validate emotional experiences; (c) effectively handle impulsive behaviours; (d) align actions with desired goals, especially in the face of negative emotions; and (e) intelligently use suitable emotion-regulation strategies to adjust emotional responses based on personal goals and the demands of the situation. Through exploring these components, researchers can pave the way for developing

effective interventions that involve effective treatment approaches such as mindfulness.

Mindfulness has captured considerable interest among researchers as they reveal its potential advantages for general well-being and psychological aspects of human experience. Mindfulness is generally described as an awareness that emerges through consciously attending to the present moment, without passing judgment on one's internal experiences, including thoughts, emotions, impulses, and physical sensations (Kabat-Zinn, 1990; Kabat-Zinn, 1994). Desrosiers et al. (2013) assert that by adopting an observational and non-judgmental approach, individuals can disengage from negative self-monitoring and avoid rumination, thereby preventing negative self-talk and fostering a focus on the present moment without reactive responses. Numerous studies consistently demonstrated the positive influence of mindfulness on firefighters. Firefighters who incorporate mindfulness in their daily routines tend to experience lower levels of PTSD, depression, suicidal thoughts, and alcohol use issues (Smith et al., 2011; Stanley et al., 2019). Krägeloh et al. (2019) also highlighted the effectiveness of mindfulness-based interventions in reducing PTSD, depression, and alcohol use disorder in various populations. For instance, military veterans who received mindfulness-based interventions reported improvements in their mental health, including their quality of life (Smith et al., 2011). Military personnel who have undergone mindfulness-based interventions before combat training reported a decrease in stress biomarkers compared to other traditional training methods (Vujanovic et al., 2022).

To date, the Five Facet Mindfulness Questionnaire (FFMQ), developed by Baer et al. (2006), is the most widely used validated scale used in mindfulness research (Bartos et al., 2023; Lecuona et al., 2022; Okafor et al., 2023). It comprises five key facets, including acting with awareness, non-judging, describing, observing, and non-reacting. Acting with awareness involves intentionally and fully attending to present-moment activities and experiences; describing involves using language to articulate and verbally express the nature of one's experiences; observing involves being attentive and aware of both internal and external experiences without attachment or reactivity; non-reacting involves acknowledging thoughts and emotions without getting caught up in them, and non-judging involves having an accepting and non-evaluative attitude towards thoughts and emotions (Baer et al., 2006). The five facets of mindfulness were initially aligned with the module of the Dialectical Behaviour Therapy (DBT) developed by Linehan (1993a, 1993b), which incorporates the relevant mindfulness-based techniques. The Five Facet Mindfulness Questionnaire's alignment with the modules of DBT is significant as it reflects the integration of mindfulness-based techniques within DBT, emphasizing the cultivation of awareness,

non-judgment, and non-reactivity—core elements that enhance the therapeutic effectiveness of the comprehensive approach developed by Linehan (1993a, 1993b) to address emotional dysregulation and complex mental health issues.

Between the beginning of 2022 and early 2023, over 100 published studies utilized the FFMQ as a tool to measure mindfulness (Gan et al., 2023; Ketay et al., 2023; Kümmerle et al., 2023). These studies have provided insights into the distinct impacts of various mindfulness components on psychological well-being. For instance, Azizi et al. (2022) found that all mindfulness facets, except for observing, had distinct and significant relationships with psychological symptoms. Specifically, acting with awareness was the most strongly associated with negative affect, followed by non-judging and describing. Similarly, McBride et al. (2022) discovered that among college students, all aspects of trait mindfulness, except for observing, were related to lower levels of physical symptoms of stress, which was mediated by a decrease in perceived stress.

Mindfulness is instrumental in addressing emotion-regulation difficulties, as outlined in the DERS. Mindfulness is particularly beneficial for firefighters in fostering acceptance of emotional responses. This approach, as advocated by Lutz et al. (2014) and Iani et al. (2018), allows for acknowledging and understanding emotions without unnecessary self-criticism, building mental and emotional strength in the face of adversity. By encouraging the cultivation of a detached and non-judgmental attitude towards thoughts and emotions, as emphasized by Garland et al. (2015) and Lindsay and Creswell (2017), mindfulness enables firefighters to gain a refreshed perspective. This approach is essential for breaking free from negative self-monitoring and preventing rumination. Rather than berating themselves for certain emotions, firefighters learn to acknowledge and accept them, which, over time, strengthens their psychological fortitude. Mindfulness becomes a valuable tool, offering firefighters a more balanced and compassionate relationship with their emotions in the demanding context of their profession.

In demanding and dynamic situations, mindfulness facilitates a focused and purposeful approach to goal-directed tasks which unveils its potential as a transformative tool for improved decision-making and performance. Vago and Silbersweig (2012) note that mindfulness enables firefighters to navigate their emotional responses effectively, resulting in a more focused and efficient engagement in goal-directed behaviours. By cultivating this mindfulness practice, firefighters gain not only mental clarity and resilience but also a refined ability to interpret and manage their emotions, ensuring a more efficient and effective engagement in their tasks with specific objectives. Essentially, mindfulness acts as a transformative tool, elevating their overall cognitive and emotional capabilities for optimal performance in the challenging landscape of their profession.

Additionally, mindfulness practices play a pivotal role in promoting enhanced emotion-regulation, specifically in gaining better control over impulsive reactions, as described by Roemer et al. (2015). Firefighters are usually required to stay calm and make thoughtful decisions in intense situations, therefore having a heightened awareness and control through mindfulness is crucial. Mindfulness equips them with a pause button for their minds, to take a quick breath, assess the situation, choose the best way to respond, and ultimately contribute to overall mental resilience. This ability is particularly relevant for firefighters, helping them navigate intense situations with increased awareness and control.

Moreover, firefighters benefit significantly from mindfulness as it provides them with access to a broader array of emotion-regulation strategies. In the demanding environments they operate within, firefighters find particular value in mindfulness, which allows them to reappraise cognitive processes (Wimmer et al., 2019). Through mindfulness practices, firefighters develop the ability to reassess challenging situations differently, thereby changing the emotional impact of those situations. This cognitive reappraisal, coupled with the other emotion-regulation strategies gained through mindfulness, equips firefighters with the tools needed for emotional resilience and adaptive responses in the face of challenging circumstances.

Mindfulness proves exceptionally beneficial for firefighters by addressing challenges related to emotional clarity. According to insights from Guendelman et al. (2017), mindfulness empowers firefighters to not only observe but also describe their internal emotional states. This process contributes significantly to enhancing emotional clarity, granting firefighters a better understanding of the transient nature of emotions. In practical terms, it means that by practicing mindfulness, firefighters gain a clearer awareness of how they feel inside during intense situations. This heightened emotional clarity serves as a valuable tool, allowing them to recognize that emotions come and go, fostering a more composed and effective response in the face of the complex and emotionally charged scenarios.

The Monitor and Acceptance Theory (MAT), as proposed by Lindsay and Creswell (2017), provides a valuable framework for improving emotion-regulation through two fundamental mindfulness skills: attention monitoring and acceptance. MAT suggests that by mindfully observing emotions and accepting them without judgment, individuals can cultivate a compassionate and adaptable approach to their emotional experiences. Drawing upon the MAT framework, Schuman-Olivier et al. (2020) put forth the idea that the awareness and acceptance components of mindfulness, when applied, enable firefighters to recognize and embrace their emotions without judgment. This contributes to firefighters establishing a more positive relationship with their intense emotional experiences, thereby promoting enhanced

psychological well-being. However, criticisms have been raised by Simione and Saldarini (2023). They argue that MAT lacks consistent measurement tools for monitoring and acceptance mindfulness skills, and there is limited evidence supporting a direct impact of monitoring on psychological symptoms and well-being. Despite these critiques, the present study acknowledges MAT as a relevant framework and aims to explore the interplay between mindfulness and emotion-regulation, considering MAT as a theoretical basis for investigation.

Building upon the comprehensive benefits of mindfulness discussed earlier, its role in addressing emotional challenges extends to offering a constructive alternative to coping mechanisms, such as alcohol abuse, prevalent among firefighters (Haddock et al., 2022; Lebeaut et al., 2020; Zegel et al., 2019). The regular exposure to potentially traumatic events often leads some firefighters to turn to alcohol to navigate psychological distress, but this practice comes with substantial risks in terms of regulating emotions and controlling behaviour (Stappenbeck & Fromme, 2014). In contrast, the established effectiveness of mindfulness-based interventions in addressing substance use disorders, combined with findings demonstrating dispositional mindfulness as a protective factor against alcohol use in healthcare workers (Barré et al., 2022), highlights the potential of mindfulness as a valuable tool for cultivating healthier coping strategies within the firefighting community.

The recent research indicates complex relationships between emotion-regulation and different facets of mindfulness, especially when considering the influence of alcohol (Wisener & Khoury, 2019; Wisener & Khoury, 2020). However, the exact nature of these interactive relations is not well understood due to methodological limitations in previous studies, such as moderation, mediation, and correlation analyses. Such analyses can be useful to investigate hypothesized relationships between variables of interest, but they are inherently limited due to arbitrary assigning predictor, outcome, and mediator or moderator roles to variables of interest. Earlier studies have only examined a subset of the relevant variables, limiting the understanding of their interrelations, particularly for individuals engaged in risky professions (Fisher et al., 2022; Huang, 2022; Strohmaier et al., 2020).

The application of network analysis to study psychopathology represents a relatively recent but powerful methodology for examining complex systems characterized by asymmetrical relationships. In line with this approach, Borsboom (2017) introduced the Network Theory of Psychopathology. According to this theory, psychopathology is conceptualized as a complex network of interconnected symptoms rather than a single underlying cause or factor. The network model emphasizes the importance of symptom

interactions and their influence on each other. Rather than assuming a hierarchical structure with one central cause, the theory suggests that symptoms can directly influence and activate each other. This novel perspective highlights the interconnections and interplay among symptoms, challenging the traditional approach of isolating them in treatment.

Network relationships can be divided into two types: directional and nondirectional, both of which are used to study complex systems' structure and dynamics. Nondirectional network analysis assumes that node relationships are symmetrical and have no direction. Directional network analysis has been widely validated in both theoretical and applied contexts. For example, it has already been applied to investigate interactive relations between mindfulness facets, distress variables (Barcaccia et al., 2020; Medvedev et al., 2021), and Big Five personality traits (Roemer et al., 2024). Unlike traditional methods that require the designation of dependent or independent variables, nondirectional network analysis allows for the examination of multiple relations among these factors within a single network and reduces the likelihood of encountering false positives resulting from repetitive testing (Åkerblom et al., 2021).

Alternatively, directional network analysis offers a more detailed comprehension of complex systems' structure and dynamics, particularly when directionality is relevant, causality needs to be modelled, and more informative measures are necessary to understand the interrelation between variables such as mindfulness and emotion-regulation in firefighters. Borsboom et al. (2021) discussed the robustness of network measures, emphasizing their applicability in psychological science. Numerous empirical studies have successfully employed directed network analysis to implement its potential for insight into structural relations among core psychological processes to inform the health psychology science and practice (Christensen et al., 2020; Heeren et al., 2021; Hevey, 2018; Ventura-León et al., 2023).

While directional network analysis stands on its own merit, it is also essential to consider its strengths relative to other network modelling methodologies. Directional network analysis, Structural Equation Modeling (SEM), and Group Iterative Multiple Model Estimation (GIMME) are all approaches used to analyse variable relationships in data, but they have distinct principles, assumptions, and applications. In terms of the analysis of relationships, directed network analysis focuses on capturing directional relationships within a network, while SEM examines relationships between observed and latent variables (Sarstedt & Ringle, 2020), and GIMME is specialized for estimating directed functional connectivity over time (Yin et al., 2023). Furthermore, directed network analysis is the optimal choice for the current study due to its versatility and applicability to assume asymmetrical relationships in various fields, SEM

is commonly used in the social sciences for hypothesis testing and assumes latent variable structures, and GIMME is specialized for dynamic changes in relationships over time in neuroimaging data. Overall, directed network analysis emerges as the best choice for studying mindfulness and emotion-regulation aspects in firefighters.

Directional network analysis can be conducted in a novel way using the Bayesian Gaussian Graphical Models (BGGM) by utilizing the statistical R package (Williams & Mulder, 2020). The BGGM allows researchers to integrate prior knowledge or assumptions about the relations, structuring the analysis based on Directed Acyclic Graphs (DAGs). In network analysis, specifically in the context of Bayesian network modelling, a DAG represents a graphical structure where nodes (variables) are connected by directed edges, indicating causal relationships or dependencies between them, for example between mindfulness facets and difficulties in emotion-regulation, which can improve parameter estimation and inference accuracy, particularly when sample sizes are limited or when relevant information is available from previous research (Williams & Mulder, 2020). Moreover, BGGM offers posterior distributions for all parameters, giving a more thorough understanding of the uncertainty in parameter estimates.

The objective of this research was to examine how different aspects of mindfulness relate to the ability to regulate emotions among firefighters and military veterans using both nondirectional and directional network analyses because it can provide a superior understanding of the complex system under investigation. Based on available evidence, the general hypothesis was that specific mindfulness facets, including acting with awareness, observing, non-reacting, and non-judging, would be negatively associated with difficulties to regulate emotions, particularly in terms of emotion nonacceptance. Additionally, it was hypothesized that the non-judging and describing facets of mindfulness would be negatively associated with difficulties in emotional clarity. Furthermore, it was expected that the acting with awareness would be positively related to goal-oriented behaviours. The study also considered the influence of alcohol as a controlling factor, hypothesizing that it is positively related to impulsivity and negatively related to emotional clarity. In this study, we also controlled for firefighters' age as this may be related to emotional regulation and ensured that the sample included experienced firefighters.

## Method

### Participants

This study is a follow-up analysis of data gathered from a larger project that examined the impact of stress and

health-related behaviours among firefighters (Bartlett et al., 2018). The full sample included 910 firefighters, 209 of whom were military veterans, as reported in the earlier study focused on unrelated research questions and methodology (Bartlett et al., 2018). The current study included 685 firefighters, of which 154 (22.5%) were military veterans, who completed measures on mindfulness, difficulties in regulating emotion, and alcohol use. Table 1 demonstrates the demographic characteristics of the full sample and the sample extracted for the current study, including statistical comparisons of these samples to ensure that the current sample is representative of the full study sample. It is shown that there were no statistical differences between these samples. In the current sample, 8.8% displayed clinical PTSD scores according to criteria proposed by Ibrahim et al. (2018). The research was carried out at a fire department located in a large metropolitan area in the southern part of the United States.

### Procedure

Data collection occurred from 2016 to 2018 at a large urban fire department in the southern part of the United States. Interested participants completed a consent form and were informed about the possible pros and cons of their involvement. To qualify, individuals needed to be currently employed firefighters, at least 18 years old, and have provided the consent form. Those who met the criteria and had submitted the necessary form proceeded to complete a survey comprising a concise demographic questionnaire and multiple evaluations of mental well-being. Upon finishing the study, participants could elect to be entered into a raffle to win various rewards (e.g. gift cards).

### Measures

**Demographic Questionnaire** Participants were requested to provide information about their demographics, including their social and economic background, as well as their personal history serving as firefighters or in the military.

**Five Facet Mindfulness Questionnaire (FFMQ)** The FFMQ (Baer et al., 2006) is a well-known self-reported assessment tool consisting of 39 items that evaluate five aspects of mindfulness. A 5-point Likert scale was used, ranging from *Never or very rarely true* to *Very often or always true*. The five facets of mindfulness assessed including acting with awareness (act aware), describing (describe), observing (observe), non-reacting to inner experience (nonreact), and non-judging of experience (nonjudge). It is important to note that 19 of the items are worded negatively and need to be reverse coded before analysing the data. Researchers in New Zealand used the Rasch methodology to validate this

**Table 1** Descriptive statistics for participant demographics

	Full sample ( <i>n</i> = 910)	Current sample ( <i>n</i> = 685)	<i>p</i> -value
Age <i>M</i> (SD)	38.40 (8.64)	38.65 (8.57)	0.449
Gender <i>n</i> (%)			
Male	862 (94.7%)	641 (93.6%)	0.129
Female	43 (4.7%)	39 (5.7%)	0.358
Transgender	5 (0.5%)	5 (0.7%)	0.750
Race/ethnicity <i>n</i> (%)			
White	675 (74.2%)	532 (77.7%)	0.085
Hispanic/Latino	250 (27.5%)	178 (26.0%)	0.420
Black/African American	117 (12.9%)	76 (11.1%)	0.370
Other	84 (9.2%)	53 (7.7%)	0.256
Asian	17 (1.9%)	11 (1.6%)	0.658
Native Hawaiian/Pacific Islander	1 (0.1%)	1 (0.1%)	--
American Indian/Alaskan Native	16 (1.8%)	12 (1.8%)	0.802
Education <i>n</i> (%)			
GED (or equivalent)	11 (1.2%)	5 (0.7%)	0.486
High school	75 (8.2%)	56 (8.2%)	0.962
Some college	427 (46.9%)	323 (47.2%)	0.834
Bachelor's degree	397 (43.6%)	301 (43.9%)	0.867
Marital status <i>n</i> (%)			
Married	623 (68.5%)	464 (67.7%)	0.896
Divorced	55 (6.0%)	53 (7.7%)	0.208
Living with partner	45 (4.9%)	37 (5.4%)	0.568
Single	185 (20.3%)	129 (18.8%)	0.465
Widowed	2 (0.2%)	2 (0.3%)	0.890
Employment status <i>n</i> (%)			
Part-time paid	14 (1.5%)	6 (0.9%)	0.111
Part-time volunteer	3 (0.3%)	2 (1.2%)	0.155
Full-time paid	888 (97.7%)	674 (99.6%)	0.118
Full-time volunteer	4 (0.4%)	3 (0.4%)	0.823
Years of service <i>M</i> (SD)	13.17 (9.12)	13.30 (8.78)	0.583

measure, and they developed conversion tables to transform ordinal scores into interval-level data, which were applied in the present study (Medvedev et al., 2017). The reliability of each mindfulness facet tested with the current data was as follows: observing ( $\omega=0.87$ ); describing ( $\omega=0.77$ ); acting with awareness ( $\omega=0.92$ ); non-judging ( $\omega=0.90$ ); and non-reacting ( $\omega=0.88$ ).

**Difficulties in Emotion-Regulation Scale-16 Item Version (DERS-16)** The DERS-16 (Gratz & Roemer, 2004) is a tool used to assess emotional regulation, with five subscales: nonacceptance (difficulties in accepting emotions), goals (difficulties in maintaining goal-directed behaviour when distressed), impulse (difficulties in impulse control), strategies (limited access to emotion-regulation strategies), and clarity (a lack of emotional clarity). The same 5-point Likert scale as the DERS-36 (ranging from almost *never* to *almost*

*always*) is used to score the items, with a total score range of 16–80. The DERS-16 has been validated in three samples, showing good construct validity, both in terms of convergent and discriminant validity (Bjureberg et al., 2016). Additionally, the tool has demonstrated great internal consistency with the current dataset ( $\omega=0.94$ ).

**Alcohol Use Disorders Identification Test (AUDIT)** The AUDIT (Saunders et al., 1993) is a 10-item screening tool that assesses problematic drinking behaviours using a 5-point Likert scale. Developed by the World Health Organization, it includes subfactors for hazardous drinking, alcohol dependence, and harmful drinking, with a cut-off score of 8 indicating potential AUD. The AUDIT has high sensitivity and specificity for identifying hazardous or harmful drinking, as well as probable alcohol dependence (sensitivity: 87–96%, specificity: 81–98%; Saunders

et al., 1993). Test-retest reliability is good ( $r=0.84$ ; Selin, 2003), and internal consistency was high with the current dataset ( $\alpha=0.85$ ;  $\omega=0.86$ ). The AUDIT has been extensively validated, demonstrating good convergent and discriminant validity. The scoring ranges from 0 to 40, with higher scores indicating more severe problematic drinking behaviours. The AUDIT is a reliable and valid tool for identifying individuals presenting with alcohol problems, with potential applications in various clinical and research settings.

## Data Analyses

Our study employed BGGM (Williams & Mulder, 2020) using RStudio (RStudio Team, 2020). We chose BGGM for its ability to incorporate prior knowledge into the analysis, enhancing the stability and accuracy of parameter estimates, particularly under limited sample sizes or when prior information is valuable. Utilizing the BGGM package, we estimated posterior parameters for means, standard deviations, and credible intervals, focusing on the connections between mindfulness, emotion-regulation, and alcohol use in firefighters and military veterans (Table 2).

We used the BGGM package in R for the partial correlation network analysis, visualized through the qgraph package, to represent unique associations between variables. The unique associations were represented as edges or lines, the blue edges represented positive correlations, while red edges represented negative correlations. The thickness and colour intensity of the edges represented the strength of the association between the nodes. To ensure robustness, we conducted bootstrapping with 5000 iterations, providing confidence intervals for network edges and thus quantifying uncertainty.

Specifically, the “explore” function of BGGM package was used to estimate partial correlations between nodes while accounting for all other relations in the full set of

nodes. The estimated associations were based on a semi-parametric copula model that used ranked likelihood. The resulting partial correlation matrix retained only the relationships whose 95% credible intervals did not include zero. A 95% credible interval provides a range of values where a population parameter is expected to fall with 95% certainty. The retained partial correlations in the matrix were statistically significant and could be used to infer the relationships between the variables in the model.

This BGGM approach requires the specification of priors; it inherently incorporates a regularization technique through its Bayesian framework, specifically using prior distributions on the partial correlation coefficients. Unlike traditional regularization algorithms such as LASSO or Ridge, BGGM utilizes a Bayesian approach, where regularization is achieved by setting priors on the parameters (partial correlations). We specified normal priors for the partial correlation coefficients with a standard deviation of 0.25. This choice reflects our assumption that many relationships in our model are likely to be weak or non-existent, typical in psychological data where strong correlations are rare.

By setting the prior *SD* to 0.25, we essentially apply a form of regularization, reducing the estimated partial correlations towards zero. This helps produce a more stable and interpretable model, especially when dealing with complex data and potential multicollinearity issues. This Bayesian approach to regularization is advantageous in handling multicollinearity, as it shrinks the estimates of weak partial correlations towards zero, reducing its potential impact. We ensured that all details of our Bayesian model specification, including the prior settings, were transparently reported, facilitating full reproducibility of our analysis and enabling other researchers to understand the influence of our methodological choices on the results. Using this approach for partial correlation network analysis, we controlled for linear relations between variables while addressing multicollinearity issues, providing a robust approach to estimate unique associations in complex psychological data.

In the context of our BGGM analysis, predictability emerges as a more pertinent and informative measure compared to traditional centrality metrics. This is primarily because BGGM focuses on understanding the unique, direct relations between variables, reflected in partial correlations that consider the influence of all other variables in the network. Predictability in BGGM provides insights into how much of a node’s variability is explained by its direct connections within the network without estimating a potential direction of such links. This is important for our study as it directly aligns with our goal to examine the direct and unique influences among variables such as facets of mindfulness, emotion-regulation, and alcohol use. It allows us to understand the extent to which one variable can

**Table 2** Posterior estimates for means, standard deviations and credible lower and upper bounds

Node	Post. means	Post. <i>SD</i>	Cred. lb	Cred. ub
Observe	0.61	0.03	0.55	0.66
Describe	0.46	0.03	0.41	0.51
Actaware	0.54	0.03	0.49	0.60
Nonjudge	0.59	0.03	0.54	0.65
Nonreact	0.61	0.03	0.55	0.67
Clarity	0.45	0.03	0.40	0.50
Goals	0.62	0.03	0.57	0.67
Impulse	0.52	0.03	0.47	0.58
Strategies	0.72	0.03	0.67	0.77
Nonaccept	0.57	0.03	0.52	0.63
Alcohol	0.16	0.02	0.12	0.20
Age	0.04	0.01	0.02	0.07

be predicted based on its relationships with others, offering practical insights for interventions and policy-making (Chalmers et al., 2022).

Centrality measures, on the other hand, often emphasize the importance of a node based on its overall connectivity within the network. While this can be useful in many contexts, in BGGM, where the focus is on the strength and significance of direct relationships, centrality may provide less relevant information. In our case, understanding the predictability of each node offers more specific insights for our research objectives than assessing their centrality. Thus, while centrality can complement our understanding of the network, predictability is a more aligned and sufficient indicator of node importance in the context of our analysis.

We have also used a robust approach to directional network analysis, which is important in understanding the directed relationships between variables. This analysis was performed using the *deal* package in R, which allows for learning the structure of a Bayesian network, represented by a Directed Acyclic Graph (DAG), from data. In this process, we conducted 10,000 iterations to learn the structure of the Bayesian network. This high number of iterations ensures a more reliable estimation of the network structure, accounting for the variability and complexity inherent in our dataset. The script involved the following key steps. Using the *deal* package, we learned the directional relationships between variables. This step is important as it moves beyond mere associations to understanding potential causal pathways, offering deeper insights into how changes in one variable might influence others. We visualized the directed graph structure using *Rgraphviz*, providing a clear and interpretable representation of the directional relationships. We also explored the strength of the connections in the network, adding another layer of robustness to our analysis. This allowed us to understand not just the presence of directional relationships but also their relative influence within the network.

## Results

There was no collinearity between variables included in the network as evidenced by Variance Inflation Factor (VIF) ranging from 1.18 to 3.57. VIF was calculated with IBM SPSS Statistics (Version 27). This involved a systematic process beginning with running separate linear regression analyses for each independent variable in the model, with the remaining variables serving as predictors. From the regression output,  $R$ -squared values were obtained for each model, and subsequently, VIF values were manually calculated using the formula  $VIF = \frac{1}{(1-R^2)}$  for each independent variable. This procedure was repeated iteratively for all independent variables in the model. The interpretation of VIF values

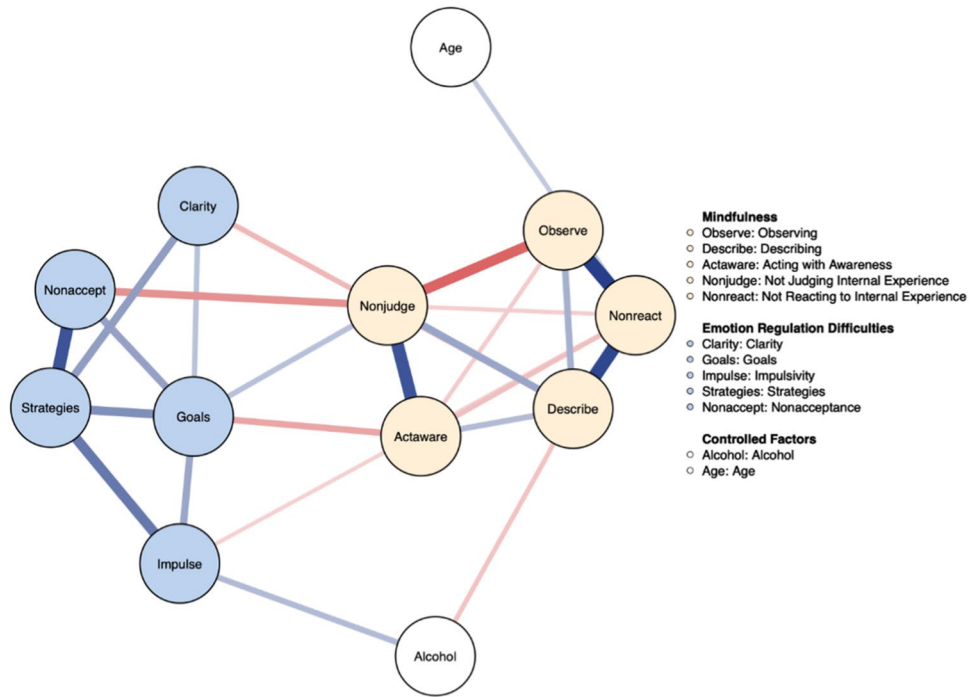
followed established guidelines, where values below 5 typically indicate minimal multicollinearity, while values exceeding 10 suggest significant multicollinearity requiring attention. Documentation of these findings was meticulous, ensuring transparency and thoroughness in the assessment of multicollinearity within the regression model. Overall, the VIF values ranging from 1.18 to 3.57 indicated that multicollinearity was not a major concern among the variables in the model, thereby supporting the validity of the regression analysis results.

However, the concept of multicollinearity is important in traditional statistical analyses like regression, and network analyses such as BGGM and DAG naturally incorporate mechanisms to handle the interdependencies among variables, which in other contexts would be labelled as multicollinearity. This inherent capability of network analyses to adjust for shared variances among variables offers a more nuanced and accurate understanding of the relationships and dependencies within the data.

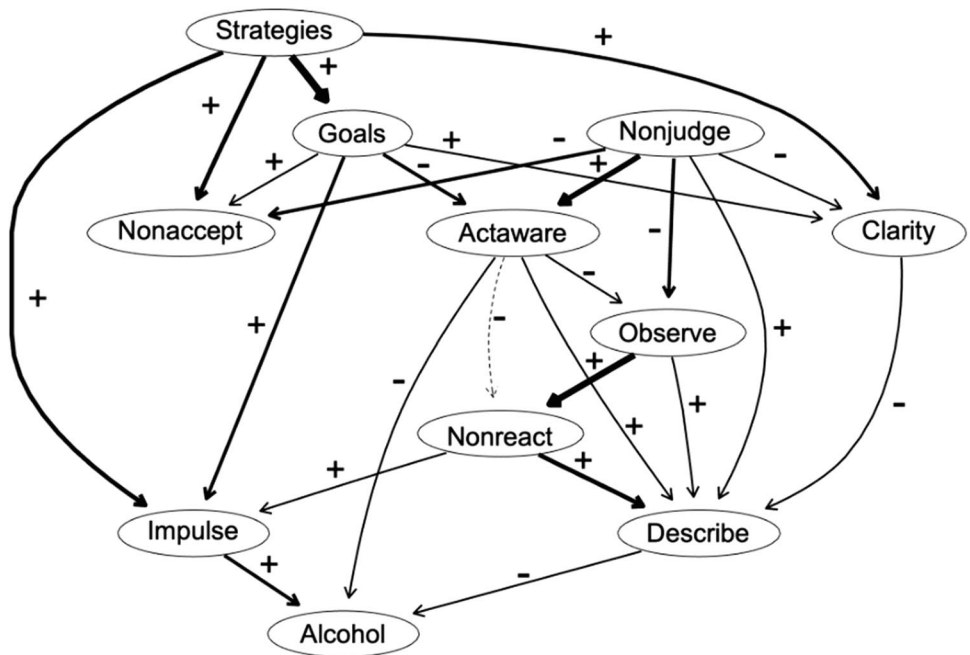
Figure 1 illustrates the nondirectional network analysis among mindfulness facets, difficulties in regulating emotion, alcohol, and age. In nondirectional network analysis, all variables including demographic covariates such as age can be included as nodes in the network, which permits to evaluate their potential relations with primary variables of interest. The resulting partial correlation matrix is included in Supplementary Table S1 and retained only the relationships whose 95% credible intervals did not include zero. According to Fig. 1, the facet of mindfulness non-judging (nonjudge) was negatively associated with emotion-regulation problems such as nonaccepting attitude and lack of clarity, but positively linked to the inability to maintain goal-directed behaviour. The facet of mindfulness acting with awareness (act aware) was negatively linked to difficulties in regulating emotion, such as maintaining goal-directed behaviour and impulsivity. Alcohol was positively linked to impulsivity and had a negative association with the describing (describe) facet of mindfulness. Overall, difficulties in regulating emotion were positively linked together, and most mindfulness facets showed positive relationships. The directed network analysis revealed nonjudge and emotion-regulation strategy as the parental predictors in the entire network. Nonjudge exhibited a protective role, supporting most mindfulness facets and contributed to better emotion-regulation, while emotion-regulation strategy exacerbated challenges in emotion-regulation, serving as a risk factor.

Figure 2 depicts the estimated directional links among mindfulness facets, difficulties in regulating emotion, alcohol, and age. All directional links presented in Fig. 2 were statistically significant and their exact estimates are included in Supplementary Table S2. Specifically, both non-judge and lack of emotion-regulation strategies were each found to exert a strong and direct influence on emotional

**Fig. 1** Network analysis of five mindfulness facets, five aspects of difficulties in regulating emotion, alcohol, and other factors



**Fig. 2** Directional graph of relationships between five mindfulness facets, five aspects of difficulties in regulating emotion, alcohol, and other factors



nonacceptance and lack of emotional clarity. A non-judgmental attitude could plausibly compensate for challenges in accepting emotions and achieving emotional clarity. Additionally, nonjudgment may also directly facilitate the ability to describe individual experiences. As can be seen in Fig. 2, with the support of a non-judgmental attitude, act aware potentially prevents alcohol abuse directly. On the other hand, a non-judgmental attitude potentially could hinder the

ability to attentively observe (observe), which in turn led to decreased non-reactivity (nonreact), subsequently negatively impacting the ability to describe.

In terms of emotion regulating, the lack of strategies emerged as the parental node, exerting a strong and direct influence on all other facets of difficulties in regulating emotion. Specifically, limited access to emotion-regulation strategies significantly contributed to the inability to achieve

goals, subsequently affecting both impulsivity and act aware, ultimately leading to alcohol use. Similarly, lack of supporting strategies may also facilitate alcohol abuse by directly impacting impulsivity. Moreover, the absence of supporting strategies also directly impacted emotional clarity, resulting in a diminished ability to describe individual experiences. Additionally, the lack of emotional regulation strategies and the inability to achieve goals positively contributed to emotional nonacceptance. The ability to describe experiences appeared to be an outcome of many variables in the network; specifically, it was supported by non-reactivity, acting with awareness, and mindful observing and non-judgmental attitude while impaired by lack of emotional clarity. Finally, describe appeared as directly important in preventing alcohol use. Overall, in the network, nonjudge was identified as the parent node exerting directional influence on protective factors, while the lack of emotional regulation strategies was identified as the parent node associated with risk factors, with alcohol being the ultimate consequence or outcome variable.

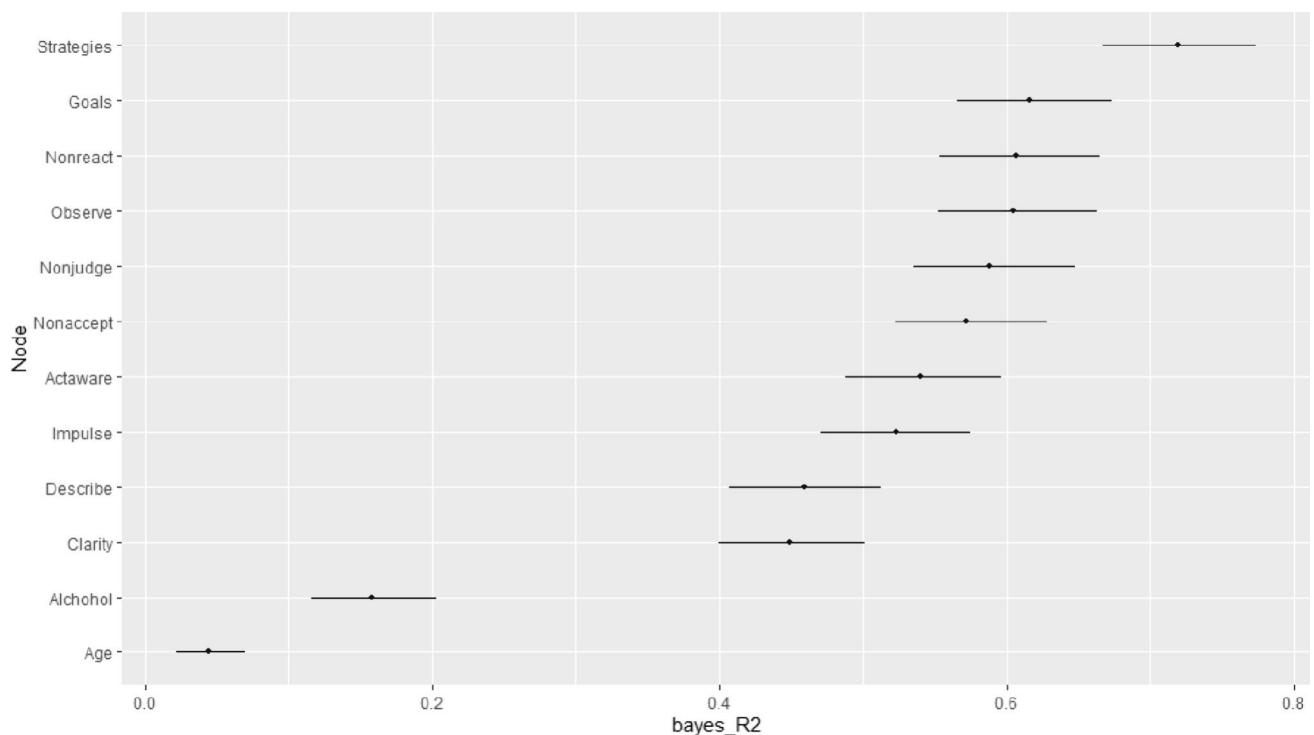
In evaluating the robustness and fit of our DAG analysis, several key aspects stand out. Firstly, the Bayesian network structure was effectively learned using score-based methods, specifically through a Hill-Climbing learning algorithm and Bayesian Information Criterion (BIC) for scoring. The resultant model, a partially directed graph, comprises 11 nodes and 25 arcs, indicating a moderately complex network structure. This complexity is further highlighted by the average Markov blanket size of 6.55, suggesting that, on average, each node is directly influenced by over six other nodes. The robustness of the model was further assessed using a bootstrap replicate approach with 10,000 samples. This approach, crucial for evaluating the stability and reliability of the network, yielded significant insights as evidenced in the *bootnet* results. The strengths and directions of the connections, as shown in the *bootnet* head, revealed varying degrees of relationships among the nodes. For instance, a strong connection between observe and nonjudge (strength: 1.00, direction: 0.45) suggests a high degree of dependency or influence. Moreover, the use of the optimal cutoff point according to Scutari and Nagarajan (2013) and the subsequent calculation of the average network (*avgnet1*) and its BIC score (−18711.35) provided a quantitative measure for the goodness-of-fit of the model. This BIC score, compared against the original (−22358.21), indicates an improved fit in the averaged network. The optimal significance threshold found (0.46) was instrumental in determining the strength and relevance of the edges in the network, as seen in the arc strength computation. The robustness of the findings is further underscored by the inclusion of penalization coefficient (3.27) and the number of tests (995) used in the learning procedure, ensuring that the model is not overfitted and is generalizable. Finally, the visualization of the DAG, with

strengths and thresholds appropriately marked, provided not only a clear depiction of the network but also an intuitive understanding of the relationships between different facets of the data. Overall, these results demonstrate a robust and well-fitted Bayesian network analysis, substantiating the relationships within the data with statistical rigor and visual clarity.

Figure 3 shows the predictability plot for each variable in the network analysis. Overall, limited access to relevant emotional regulation strategies explained more variance in the overall network compared to other variables, which was reflected by  $R^2$  around 0.72. The next important variables were difficulties in maintaining goal-directed behaviour, nonreact, observe, nonjudge, emotion nonacceptance, act aware, difficulties in impulsivity control, describe, and emotional clarity, all of which explained relatively high amount of variance in predicting scores of other variables in the network with  $R^2$  range from 0.40 to 0.60. Alcohol had lower predictability compared to the most variables in the network, and lastly, age was explaining merely a negligible amount of variance.

## Discussion

The aim of the current study was to investigate how facets of mindfulness and ability to regulate emotions are inter-related in firefighters and military veterans. A remarkable finding that emerged from the present investigation is the pivotal role of the non-judging mindfulness facet and limited access to emotion-regulation strategies in influencing other variables in the network. The non-judgmental attitude, one of the key facets of mindfulness, was notably associated with acting with awareness and ability to describe, positively contributing to these mindfulness aspects while exhibiting an inverse relationship with the ability to observe and challenges in emotion-regulation, such as a nonaccepting attitude and lack of clarity. This suggests that fostering a non-judgmental attitude may be conducive in firefighters and military veterans as a potential to achieving better emotional clarity and acceptance while also potentially impeding the ability to attentively observe. In regard to emotion-regulation, the absence of emotion-regulation strategies was positively related to the remaining aspects of DERS. This highlights the critical importance of providing firefighters with relevant emotion-regulation strategies. Equipping them with these strategies is essential for supporting and addressing challenges across various aspects of emotion-regulation. Notably, this study provides evidence supporting the idea that difficulties in regulating emotion are closely intertwined, illuminating the complex, interconnected nature of emotional regulation. Additionally, the discovery of positive links between most facets of mindfulness further emphasizes



**Fig. 3** Predictability plot for each variable in the network analysis

the integrated nature of mindfulness as a multifaceted construct, and its beneficial role in emotion-regulation. Perhaps most strikingly, the results also revealed that alcohol use was positively linked to impulsivity and negatively linked to the describe facet of mindfulness. This suggests that higher alcohol consumption may exacerbate impulsive behaviours while concurrently undermining the ability to mindfully articulate one's internal experiences.

The current study found a strong negative association between non-judging and emotion nonacceptance, partially supporting our hypothesis. However, this finding does not fully align with the results of previous studies (Desrosiers et al., 2013; Garland et al., 2015; Lindsay & Creswell, 2017), which have reported that non-judging, acting with awareness, observing, and non-reacting mindfulness facets were linked to emotion acceptance. These earlier studies posited that the non-judgmental nature of mindfulness involves observing one's mental states without identification and cultivating acceptance, leading to improved self-awareness and curiosity. One of the interpretations for this result could be that while mindfulness facets like acting with awareness, observing, and non-reacting involve elements of present-moment attention and non-reactivity, they may not necessarily capture the full spectrum of emotion acceptance. Emotion acceptance extends beyond mere observation and non-reactivity, encompassing an embracing and allowing stance towards the emotional experience.

Furthermore, in interpreting our study's findings, especially the positive association between non-judging and emotion acceptance among firefighters, it is important to consider the distinct characteristics of this group. Firefighters are routinely exposed to high-stress situations and potentially traumatic events, shaping their emotional responses and coping mechanisms. Our study diverges from those involving the general population or groups not regularly facing intense stressors, suggesting that firefighters may respond differently to emotional challenges. It is essential to understand that not judging oneself harshly for having strong negative emotions is a key step towards accepting these emotions. In a profession where encountering intense emotional situations is the norm, the link between mindfulness aspects like non-judging and accepting difficult emotions may be distinct from those less familiar with such experiences. Thus, our results shed light on the complex ways mindfulness interacts with the emotional dynamics in high-risk professions like firefighting. They suggest that the practice of non-judging mindfulness in such contexts may be particularly effective in fostering emotion acceptance, a crucial skill for coping with the demands of this challenging profession.

While research has indicated that mindfulness as a whole has been linked to improved emotion-regulation (Roemer et al., 2015; Vago & Silbersweig, 2012), the specific aspects or components of mindfulness that contribute to enhancing

emotional clarity are not yet fully understood. Specifically, the current findings provided partial support for the expected relationship between nonjudgment and inability of emotional clarity, showing a negative correlation. The current findings align with the results of a study conducted by Guendelman et al. (2017), which found that non-judgmental aspect of mindfulness was associated with a decrease in the lack of emotional clarity. This non-judgmental mindset involves individuals adopting an attitude of openness, curiosity, and acceptance towards individuals' emotional experiences. This creates an environment that fosters emotional clarity, where emotions are seen as transient and unique combinations of physiological sensations and cognitive processes (Guendelman et al., 2017).

In fact, when examining the expected direct correlation between the facet of describing and emotional clarity, the findings have been less conclusive and have not emerged in available research (Iani et al., 2018). Interestingly, the directional graph, in the present study, estimated a direct and negative impairment of the ability to describe one's experience due to a lack of emotional clarity. When firefighters lack emotional clarity, they may struggle to accurately recognize and label their emotions. As a result, they may find it challenging to effectively describe their emotional experiences to themselves or others (Torre & Lieberman, 2018). More research is needed to explore the intricate dynamics between different facets of mindfulness and their specific impact on emotional clarity, providing a comprehensive understanding of how mindfulness practices influence emotion-regulation.

While Schuman-Olivier et al. (2020) suggested a positive association between high situational and emotional self-awareness and goal-directed behaviours, our study revealed a reversal of the anticipated relationship among firefighters. Essentially, we discovered that firefighters who experience difficulty engaging in goal-directed cognition and behaviour when distressed tend to exhibit lower levels of acting with awareness. Previous studies have highlighted that individuals with reduced goal pursuit and attainment tend to demonstrate higher level of stress, depression, and anxiety (Boudreaux & Ozer, 2013; Christoe-Frazier & Johnson, 2021). Our findings suggested the capacity to stay present and attentive to one's thoughts, feelings, and surroundings may diminish when firefighters and military veterans find it challenging to focus on and pursue their objectives during their tasks. This emphasizes the importance of addressing goal-directed challenges in high-stress professions, as it directly influences the firefighters' ability to maintain mindfulness and awareness in demanding situations. Understanding this relationship sheds light on the interconnectedness of goal-directed behaviours and mindfulness among individuals in high-stress professions.

In addition, the results partially supported the initial expectations of the positive correlation between alcohol use

and impulsivity. The finding aligns with what Stappenback and Fromme (2014) reported that alcohol use could inversely impact emotion-regulation and increase impulsivity. The research conducted by Herman and Duka (2019) supports the idea that alcohol consumption can have an impact on impulsivity and reckless behaviour, particularly among Northern Irish military veterans, as found in the study by McGlinchey et al. (2022). This suggests that impulsivity can both contribute to and result from alcohol use in this population. Specifically, the directional graph demonstrated that alcohol use was caused by impulsivity. There is evidence indicating that impulsiveness is regarded as a significant risk factor that predisposes individuals to initiate, continue, and engage in excessive alcohol use (Adan et al., 2017; Bartlett et al., 2019; Dick et al., 2010; Jakubczyk et al., 2018; Stamates & Lau-Barraco, 2020). The findings from the directional graph also indicated that acting with awareness serves a protective role in dealing with alcohol use. The obtained results align with the findings of Barré et al. (2022), providing consistency in the literature. The study by Barré et al. (2022) reported that mindfulness can serve as an effective coping mechanism for addressing alcohol use.

Contrary to what was hypothesized, the study did not reveal a direct association between alcohol use and emotional clarity. However, the directed network analysis discovered these two variables were linked through the describing facet of mindfulness. The results suggest emotional clarity can enhance the ability to accurately describe inner experiences, potentially leading to a reduction in alcohol use. One possible explanation for this relationship is that emotional clarity can offer firefighters insight into the underlying causes and triggers of their emotions. By accurately describing their inner experiences, firefighters develop greater awareness of the emotional states influencing their alcohol use. This heightened self-awareness enables more informed decision-making and intentional choices regarding alcohol consumption. Therefore, further research is necessary to explore the potential relationship or mechanism between alcohol use and emotional clarity, aiming to effectively address alcohol-related issues.

Additionally, the ability to describe inner experiences acts as a form of emotional regulation. Instead of relying on alcohol to cope with or suppress challenging emotions, individuals with improved emotional clarity can identify and communicate their emotional needs effectively. When firefighters actively and effectively manage their emotions, they are less likely to depend on alcohol as a means of coping or suppressing challenging emotions. Roos et al. (2015) conducted a study exploring the association between mindfulness facets and alcohol use, revealing a negative correlation between three aspects of mindfulness—describing, acting with awareness, and non-judging—and alcohol outcomes. The study revealed that the describing facet may play a vital

role in reducing problematic drinking as it was significantly associated with alcohol problems through the mediation of risky drinking motives. The ability to recognize and label internal experiences may mitigate the negative influence of implicit alcohol motivations on drinking behaviour.

In the network of variables examined in the study, the ability to describe experiences was found to be influenced by several factors, with non-judging playing a significant role. Non-judging entails the ability to observe and embrace internal experiences without resorting to harsh criticism or judgmental attitudes. Our analysis revealed that all facets of mindfulness, including non-reacting, acting with awareness, mindful observing, and maintaining a non-judgmental attitude, are pivotal in facilitating effective description of experiences. Through fostering non-reactivity, individuals are better equipped to observe and convey experiences accurately, without overwhelming emotions or immediate reactions. Acting with awareness, characterized by full presence and attentiveness, fosters heightened mindfulness and perceptual clarity, enhancing articulation. Mindful observing, marked by a non-judgmental and non-evaluative approach to thoughts, emotions, and experiences, significantly contributes to the ability to describe personal experiences with precision. Developing these facets of mindfulness can enhance the ability to describe experiences effectively, ultimately leading to a deeper understanding and awareness of one's internal world. This finding highlights the importance of conducting further research to explore and expand our understanding of the complex relationship between these variables for individuals' internal growth.

Besides the expected outcomes discussed earlier, there are several novel findings regarding emotion-regulation from the study that are worth noting. The first unexpected finding from this study is that non-judging has emerged as a key parental factor in our network analysis, revealing itself as a significant influence on various aspects of mindfulness. Its pivotal role suggests that a non-judgmental attitude serves as a protective factor for emotion-regulation and holds substantial value in supporting other facets of mindfulness. Notably, non-judging exhibits a positive association with both acting with awareness and the ability to describe. This implies that firefighters who adopt a non-judgmental stance are more likely to demonstrate heightened awareness in their actions and possess a superior capacity to articulate and express their internal experiences. Furthermore, the analysis suggested that a non-judgmental approach fosters a sense of comfort and openness in acknowledging and describing one's thoughts and feelings. This lack of judgment creates an atmosphere of acceptance and awareness, enabling firefighters to explore and articulate their internal experiences without the fear of criticism. However, our findings also unveil a potential challenge associated with a non-judgmental attitude, indicating its negative impact on the ability to observe.

This implies that firefighters with a strong non-judgmental attitude might face difficulties in maintaining a detached and objective observation of their thoughts and feelings.

Interestingly, our graph further reveals a different dynamic—being more observant is linked to greater non-reactivity. This mechanism of mindfulness fosters a sense of detachment and perspective-taking, enhancing the ability to observe experiences without an immediate reactive response. Building on this, Lecuona et al. (2021) conducted a comprehensive assessment of the Five Facet Mindfulness Questionnaire (FFMQ) using network analysis. They discovered a notable connection between the 'observing' and 'non-reacting' facets, essentially measuring a similar contemplative mindset. This mindset is characterized by maintaining a calm and non-reactive attitude towards various experiences, including sensations, thoughts, emotions, and sounds. The suggested interpretation is that the items in these aspects relate to a contemplative mindset, acknowledging the impermanent nature of experiences. This diminishes attachment and improves non-reactivity, contributing to an increased sense of equanimity and composure when confronted with difficult or distressing circumstances (Uusberg et al., 2016). Therefore, while a non-judgmental attitude may present challenges in objective observation, the interconnectedness between observing and non-reactivity reveals a nuanced interplay within the broader context of mindfulness.

Expanding on the concept of non-judging, a non-judgmental attitude plays a crucial role in supporting the ability to act with awareness. This attitude creates an atmosphere of acceptance, a vital foundation that empowers individuals to approach their internal experiences with compassion and understanding. As highlighted by Lutz et al. (2014), acting with awareness, according to this perspective, entails being fully present and attentive without the burden of judgment or criticism. The essence of acceptance in this context aligns with Kabat-Zinn's concept of mindfulness as initially proposed by Kabat-Zinn in 1990 and 1994. This concept emphasizes intentional and mindful engagement with present-moment activities, encouraging individuals to be fully present without the interference of judgment or criticism. This principle is at the core of mindfulness-based interventions (MBIs), where numerous studies consistently reveal that practicing awareness and acceptance predicts sustained improvements in mindfulness and overall mental well-being over time.

For example, in therapeutic approaches like DBT developed by Linehan (1993a, 1993b) mindfulness plays a fundamental role as a central element of personal transformation, highlighting the fostering of mindfulness and openness (Eeles & Walker, 2022). The objective of DBT techniques is to support individuals in elevating their consciousness of their internal states and nurturing more adept reactions to difficult emotions and circumstances. Within the DBT

framework, the mindfulness component seeks to enable individuals to observe their thoughts and emotions without passing judgment. Initially, the emphasis is on learning to articulate these experiences, ultimately leading to the cultivation of heightened awareness and acceptance (Linehan, 2014). Overall, DBT focuses on the development and enhancement of mindfulness skills as a means of promoting emotional regulation and reducing psychological distress and the FFMQ was tailored to measure such outcomes.

However, our directional network analysis demonstrated that describing is the predictor of mindfulness, but it rather appears as an outcome from interactions of other mindfulness facets. Our findings extend the directional network analysis of the FFMQ by Heeren et al. (2021). In their study, the arrangement of each facet within DAG is viewed as resulting from the conditional distribution of each facet, given its parent facets in the model. This approach is key to understanding how different aspects of mindfulness interrelate in our study. Heeren et al. (2021) identified acting with awareness as a primary or parental node, indicating that other facets, like describing, may depend on it. In other words, those who score high in acting with awareness tend to also score high in describing. While this specific finding does not completely align with our results, our study also identifies a directional relationship between acting with awareness and describing. However, in our network analysis, non-judging emerged as a parent node. Our findings, particularly relevant to the firefighting population, suggest that a non-judgmental attitude is instrumental in fostering acting with awareness. Being present and attentive seems to be a fundamental aspect of mindfulness that supports the development of other facets, like describing. This indicates that within the unique context of firefighting, non-judging may play a crucial role in enhancing overall mindfulness, perhaps more so than in general populations. The findings hold noteworthy implications across various fields, as their relevance and potential contributions extend far and wide.

Moreover, the directional graph revealed the association between emotion-regulation difficulties and demonstrated that firefighters' inability to achieve their goals and strategies for attaining them, leading to a nonaccepting attitude. Encountering challenges and setbacks in both accessing effective emotion-regulation strategies and striving towards goals often evokes feelings of frustration, disappointment, and a sense of failure (Höpfner & Keith, 2021). These negative experiences or perceived failures in managing emotions and achieving desired outcomes can contribute to a nonaccepting attitude, where high-stress professions find it challenging to acknowledge and embrace their current circumstances or the outcomes they have attained. Thus, these results highlighted the importance of addressing both aspects in interventions aimed at promoting adaptive coping strategies and enhancing resilience in the face of adversity.

Another significant finding discovered is that the inability to achieve goals and the lack of supporting strategies have a direct impact on emotional clarity. When firefighters struggle to accomplish their goals or face obstacles without effective strategies, it can create confusion and uncertainty, leading to a diminished understanding of their own emotions. This impaired emotional clarity, in turn, directly affects their ability to observe and describe their inner experiences (alexithymia) accurately (Halpern et al., 2012). When individuals lack clarity about their emotions, it becomes challenging for them to objectively describe their thoughts, feelings, and sensations. This lack of clarity creates a barrier to effectively engage with and understand their own inner world. Therefore, the inability to achieve goals and the absence of supporting strategies have a direct negative impact on emotional clarity, subsequently hindering the ability to describe individual experiences. This interconnected relationship highlights the importance of developing goal-oriented strategies and cultivating emotional clarity for enhanced self-awareness and understanding.

Furthermore, it is found that the absence of effective emotion-regulation strategies had a significant impact on goal-directed behaviours. Consequently, this contributes to increased impulsivity, further associated with alcohol use (McGlinchey et al., 2022). Weiss et al. (2015) found that individuals lacking supportive emotion-regulation strategies may experience emotional challenges, leading to difficulties in maintaining focus, resisting distractions, and persisting in the pursuit of their goals. The frustration and disappointment associated with goal non-attainment that arises from the limited access of strategies for managing emotion can further result in impulsive behaviours (Miller & Racine, 2020). This finding holds significant implications for high-risk professions, including firefighters and military veterans who often encounter life-threatening emergencies and high-stress situations. Interventions aimed at addressing the underlying factors that hinder goal-directed behaviours could play a crucial role in mitigating risks and improving overall psychological outcomes in firefighting operations.

Lastly, an additional novel finding arising from the study is that limited access to relevant emotional regulation strategies exhibits a more substantial influence on the overall network. This finding is supported not only by the estimated directional graph discussed earlier but also by the predictability plot, which demonstrates its capacity to explain a greater amount of variance compared to other factors considered. Supported by goals, which is the next important variable, the availability and effectiveness of emotional regulation strategies play a crucial role in influencing the dynamics of the overall network. When individuals have limited access to these strategies, it has a more significant effect on their emotion-regulation and outcomes compared to other factors

that were investigated. The predictability plot serves as supporting evidence, visually representing the magnitude of this influence compared to other variables.

Overall, in examining our results, it is found that the theories may not directly address the specific findings; however, it could potentially be relevant in understanding and interpreting the results. Including the stress sensitization theory proposed by Post (1992) is partially supported by the results, showing that firefighters who lack goal-maintained behaviours and relevant emotion-regulation strategies are more likely to experience higher impulsivity as demonstrated in the directional graph. Furthermore, the observed patterns in our results are consistent with the principles outlined in the Monitor and Acceptance Theory (Lindsay & Creswell, 2017), such as the crucial role of non-judgmental observation, acceptance of emotions, and acting with awareness for effective emotion-regulation. Lastly, utilizing network analysis in this study allowed for the examination of variables and revealed their interactive network, offering a novel perspective on psychopathology. The Network Theory of Psychopathology, proposed by Borsboom (2017), highlights the intricate connections between symptoms, offering insights into how they interact and contribute to psychopathology. These theories deepen our understanding of psychological functioning and offer avenues for further exploration and intervention development.

### Limitations and Directions for Future Research

While the current study offers insightful findings into the interplay between facets of mindfulness and emotion-regulation, several limitations warrant discussion and provide direction for future research. The nature of the cross-sectional data used in this study, common to many investigations, restricts the ability to observe changes over time or establish causality. The application of both BGGM and directional networks to such data can elucidate potential relationships and correlations but makes it challenging to infer the temporal order of variables or causal directionality. Future studies employing longitudinal designs would provide a more robust basis for examining the progression and causal relationships between these variables. There were no standardized measures that assessment resilience, PTSD, generalized anxiety, depression, and suicidality which has been used in previous first responder network studies (Ponder et al., 2023).

It is important to consider the limitations and challenges associated with analysing data and interpreting results. Without a comprehensive timeline and complete information, drawing accurate conclusions can be akin to solving a mystery with insufficient clues. The presence of correlations does not necessarily imply meaningful

relationships and can be influenced by hidden variables. Complex methodologies like BGGM and directional networks further complicate the task of unravelling the true connections between variables, resembling the challenge of cracking a safe without the correct combination. Additionally, these techniques require a substantial sample size to generate reliable and valid outcomes. Drawing an analogy, examining only a limited subset of the data is comparable to appreciating merely a fraction of a masterpiece, risking the omission of crucial details. In our study, our scope was restricted to firefighters and military veterans, necessitating the inclusion of a more extensive and diverse participant cohort to ensure the reliability and robustness of the findings. Future research should strive to encompass a broader range of participants, fostering increased generalizability and yielding a more comprehensive comprehension of the phenomenon being investigated.

Another potential hiccup is multicollinearity. If the variables in our dataset are as entangled as vines, it could skew our BGGM and directional network analyses, throwing off their accuracy. It is akin to trying to discern individual voices in a bustling crowd—if they are too similar, it is a tough job to distinguish them. In addition, like any observational study, we could not establish the rigorous control that we could have in a lab experiment. This could make our findings vulnerable to confounding factors and bias. Therefore, future research should use longitudinal data to advance our understanding of the complexities of the network. By doing so, future research should be better equipped to untie the complex knot of relationships between mindfulness facets and emotion-regulation, which could lead us to more effective interventions.

In conclusion, the study's findings underscore the integral role of mindfulness, specifically the facets of acting with awareness and non-judgmental attitude, in promoting better emotion-regulation. These results point towards a novel perspective in understanding and addressing the emotional challenges faced by firefighters and military veterans, where the cultivation of these specific mindfulness facets could potentially serve as protective factors against emotional dysregulation and detrimental behaviours such as alcohol use.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s12671-024-02348-z>.

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**Author Contribution** Hui Ning Chiang: conceptualization, methodology, data analyses, writing—original draft preparation, reviewing and editing. Oleg N. Medvedev: supervision, conceptualization, data analyses, reviewing and editing. Warren Ponder: conceptualization, writing—reviewing and editing. Jose Carbajal: conceptualization,

writing—reviewing and editing. Anka Vujanovic: data curation, conceptualization, writing—reviewing and editing.

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**Data Availability** The data is not publicly available due to the ethical restrictions for collecting data from the vulnerable population.

## Declarations

**Ethics Approval** The study was approved by IRB from the University of Houston (IRB ID: CR00000529).

**Informed Consent** All participants provided their informed consent before participating in the study.

**Use of Artificial Intelligence** AI tool ChatGPT was used to check grammar and improve English language (OpenAI, 2023).

**Conflict of Interest** The authors declare no competing interests.

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