

Unpacking fatigue: How burnout and engagement influence commitment and overtime among South African workers



Authors:

Wessel van Jaarsveldt^{1,2}
Melissa Jacobs¹

Affiliations:

¹School of Industrial Psychology and Human Resources Management, Faculty of Economic and Management Sciences, North-West University, Potchefstroom, South Africa

²WorkWell Research Unit, Faculty of Economic and Management Sciences, North-West University, Potchefstroom, South Africa

Corresponding author:

Melissa Jacobs,
melissa.jacobs@nwu.ac.za

Dates:

Received: 30 July 2024
Accepted: 08 Oct. 2024
Published: 08 Nov. 2024

How to cite this article:

Van Jaarsveldt, W., & Jacobs, M. (2024). Unpacking fatigue: How burnout and engagement influence commitment and overtime among South African workers. *SA Journal of Industrial Psychology/SA Tydskrif vir Bedryfsielkunde*, 50(0), a2238. <https://doi.org/10.4102/sajip.v50i0.2238>

Copyright:

© 2024. The Authors.
Licensee: AOSIS. This work is licensed under the Creative Commons Attribution License.

Read online:



Scan this QR code with your smart phone or mobile device to read online.

Orientation: Workplace fatigue has harmed the working environment, with workers becoming increasingly exhausted, disgruntled and detached from their work and co-workers. Curbing workplace fatigue is important to increase job performance, commitment, satisfaction and safety in the work environment.

Research purpose: The objective of the study was to investigate the impact of fatigue on the relationship between overtime, burnout, commitment and engagement among South African blue-collar workers. The study also aims to understand the mediating role burnout and engagement play in the relationship model.

Motivation of the study: The motivation behind this study was to understand the role fatigue plays in the working life of blue-collar workers.

Research approach/design and method: A quantitative, non-experimental, cross-sectional study explored the relationship between overtime, burnout, engagement and commitment among blue-collar workers in South Africa. Data from 381 participants were gathered using purposive sampling.

Main findings: The study found negative links between burnout, work engagement, and fatigue, showing that burnout or low engagement increases fatigue. Burnout and fatigue both reduce work commitment, weakening dedication to work.

Practical/managerial implications: Reducing fatigue in blue-collar workers may lower burnout and increase commitment, engagement, and overtime willingness. Addressing burnout and promoting engagement is key to minimising fatigue's negative impact on organisational outcomes.

Contribution/value-add: The study contributed to deeper insight into the effect fatigue and burnout have on the blue-collar sample's work commitment, work engagement and willingness to work overtime.

Keywords: blue-collar workers; burnout; fatigue; overtime; work commitment; work engagement.

Introduction

In the context of South Africa, addressing employee fatigue is paramount for safety considerations (Oakman et al., 2020). Given the evolving nature of work schedules in the modern era, many employees find it challenging to achieve adequate sleep (Oakman et al., 2020). Over recent years, there has been an intensified focus on fatigue management, especially within the South African mining sector. The rise in sleep deprivation and fatigue is now viewed as an alarming trend. Such conditions can lead to reduced employee engagement, diminished organisational commitment, reluctance to work extended hours and a heightened risk of mistakes, potentially resulting in severe accidents (Oakman et al., 2020; Roets & Christiaens, 2019).

Over the past decade, vast amounts of fatigue research, especially its effect on safety behaviour, have highlighted major concerns for safety specialists in the South African working environment. Fatigue has had an adversity of human functioning (Fischer et al., 2017; Seixas et al., 2018). Physical effects of fatigue are that an individual could suffer from long-term health problems, physical restriction because of repetitive movements, digestive problems caused by inconsistent meal times and heart disease (Cenmeal times et al., 2018; D'Oliveira & Anagnostopoulos, 2021; Nolef Turns Inc, 2023). Moreover, fatigue has a detrimental domino effect on levels of burnout experienced, employee engagement, organisational commitment and willingness to work overtime (Fischer et al., 2017).

In the past, fatigue research had mainly been conducted in laboratory environments by using the simple tests to measure performance. Although there has been a renewed focus on fatigue research, measurement-based studies suggest that the relationship between fatigue and safety may not follow a linear pattern (Nielsen et al., 2019; Valirad et al., 2015). Fatigue-related risk is not by any means at its maximum when fatigue levels are highest; in some cases, it could be higher at intermediate fatigue levels when the operators pay less attention to their performance (Valirad et al., 2015). Alarming, fatigue affects not only the physical but the cognitive and behavioural safety performance and outcomes of blue-collar operators (Hersman & Whitcomb, 2018; Stepan et al., 2020). Moreover, studies have proven that there is a dominant link between shift work and long-term health disorders for blue-collar employees (Pinon, 2019). From an organisation's perspective, fatigue-related outcomes can cause decreased work engagement, increased sickness absence, employee turnover, decreased organisational commitment, decreased willingness to work overtime and poorer economic outcomes in terms of maintenance costs or insurance claims (Bidasca & Townsend, 2014).

The past 20 years have seen the impact of fatigue on safety because of preceding industrial and transportation disasters (Rodger, 2020). In South Africa, pre-1956, the annual reported fatalities in the mining environment varied by 800 employees a year. This number drastically increased on 21 January 1960, with the Coalbrook disaster, with the fatalities rising to 1400 (Simons, 1960). Esterhuysen et al. (2018) discovered that miners working at greater depths, where ventilation systems are less effective and temperatures, pressure, and humidity are elevated, experienced faster exhaustion and faced a higher risk of accidents or heat stroke-related fatalities. The negative direct and indirect consequences of blue-collar worker fatigue account for lower physical performance, decrease in productivity, poor judgement, slowed down reaction time, reduced decision-making ability, loss of awareness in critical situations, lower employee morale and attitudes, as well as poor interpersonal relationships (Ilhan, 2020). These factors consequently contribute to a negative influence on the organisation, miscommunications, lower productivity and higher accident rates of the organisation (Ilhan, 2020). Because of this type of working environment, with a high cognitive workload, employers need to be able to monitor and predict fatigue levels to ensure a safer and healthier workplace (Siravenha et al., 2019).

Fatigue can manifest physically, mentally and emotionally as described by Choshen-Hillel et al. (2021). The cumulative impact of these fatigue dimensions can result in employee burnout, decreased work engagement, reduced inclination to work extended hours and a decline in organisational commitment (Reig-Botella et al., 2021). Work engagement is characterised by an individual with a happy, productive state of mind marked by vim, devotion and concentration (Schaufeli & Bakker, 2004). Moreover, organisational commitment is

characterised by the type of bond or personal connection the individual has with their respective organisation (Bakker & Leiter, 2010). Both work engagement and organisational commitment affect an individual's willingness to work overtime to ensure work-related tasks are completed before deadlines (Bakker et al., 2008). Fatigue can therefore have a direct and indirect effect on work engagement, organisational commitment and willingness to work overtime (Bakker et al., 2008). Therefore, it is the objective of this study to understand the role fatigue levels among blue-collar workers plays and the associations with commitment, burnout, willingness to work overtime and work engagement.

This study uniquely explores fatigue among South African blue-collar workers, specifically within the mining industry: a cornerstone of the country's economy. The mining sector employs a significant portion of South Africa's blue-collar workforce and is known for its physically demanding and hazardous working environments. Fatigue management is critical in this sector because of the high risks of accidents, injuries and long-term health impacts. While previous research has highlighted the role of shift work and long hours in contributing to fatigue in mining (Oakman et al., 2020), this study goes further by explicitly linking fatigue to key organisational outcomes such as work commitment and engagement. This fills a critical gap in the literature, where the well-being of blue-collar workers, particularly in the mining industry, has often been overlooked.

The study enhances the understanding of safety and productivity risks by examining how fatigue in the mining sector leads to increased accidents and reduces work engagement and willingness to work overtime. These issues are particularly pertinent in South Africa's mining industry, which has long struggled with fatigue-related safety incidents (Roets & Christiaens, 2019). By analysing these risks in greater detail, the study offers new insights into how fatigue undermines worker performance and organisational safety, highlighting the need for targeted interventions.

Research purpose and objectives

The general aim of the study was to investigate how fatigue, overtime work, burnout, commitment and engagement are interconnected among South African blue-collar workers. The specific objectives were: (1) to assess the proposed structural model and establish the relationship between fatigue, overtime work, burnout, commitment and engagement and (2) to investigate whether burnout and engagement act as a mediator in the relationship between fatigue, commitment and overtime work.

Literature overview

In South Africa, while attention to work-related well-being primarily targets white-collar workers, the blue-collar workforce remains essential to the economy, operating across diverse industries under demanding conditions (Ilhan, 2020; Ledwaba & Nkomo, 2021). Blue-collar roles involve high-

temperature environments, long hours and workplace hazards (Ilhan, 2020; Ledwaba & Nkomo, 2021). Similarly, South African construction workers endure static work, physical strain, noise and dust, often facing changing climates and shifts (Biswas et al., 2017; Knardahl et al., 2017).

The mining industry plays a critical role in the South African economy, contributing significantly to the country's gross domestic product (GDP) and employment. However, despite the economic importance of mining, the well-being of the workforce in this sector is often underrepresented in workplace health and safety research (Ledwaba & Nkomo, 2021). This study brings much-needed attention to the experiences of miners, particularly regarding how fatigue and burnout affect their productivity, engagement and safety. By addressing these challenges, the study contributes to a deeper understanding of how to improve worker well-being and enhance organisational outcomes in South Africa's mining sector.

Moreover, blue-collar workers in the mining industry often face precarious working conditions, including long shifts, exposure to hazardous materials and physically demanding tasks, all of which increase their vulnerability to fatigue and burnout (Fischer et al., 2017). This study highlights the importance of addressing these challenges by linking fatigue and burnout to critical organisational outcomes such as work commitment and engagement. These are essential for improving safety, reducing turnover and maintaining productivity in South Africa's labour-intensive mining industry.

Understanding workplace hazards management is crucial for blue-collar employees' well-being. Research indicates that a supportive work culture can reduce health claims, boost productivity and enhance safety records. Rested employees foster a safe and productive environment, as excessive fatigue can disrupt health, safety and productivity dynamics (Choshen-Hillel et al., 2021; Harrison et al., 2021; Linda et al., 2018; Mossburg & Dennison Himmelfarb, 2021; Roenneberg & Merrow, 2016). Fatigue adversely impacts organisations, leading to miscommunications, reduced productivity and higher accident rates (Ilhan, 2020). Additionally, fatigue's physical and mental health effects lower commitment levels and reduce willingness to work overtime (Ilhan, 2020). Studies reveal that fatigue affects work engagement and organisational commitment, directly and indirectly influencing willingness to work overtime and overall productivity (Bakker et al., 2008).

In the blue-collar sector, heavy machine operations demand sustained mental effort and vigilance (Siravenha et al., 2019). Construction industry workers face heightened fatigue risks because of diverse occupational factors such as manual labour, environmental conditions, repetitive tasks and flexible shifts (Maynard et al., 2021). Additional factors include the distance from home, family and social obligations, and travel time (Maynard et al., 2021). Fatigue affects all workers, irrespective

of experience, influencing work engagement, organisational commitment and overtime willingness (Bakker et al., 2008; Drews et al., 2020). The National Safety Council (2020) reports that 13% of workplace injuries stem from fatigue.

Drews et al. (2020) discuss various technologies for assessing operator fatigue in mining. These technologies include fitness-for-duty assessments, or simulators, which assess the behaviour of the operator and machine during the shift. Drews et al. (2020) explore different mining technologies for evaluating operator fatigue. These include fitness-for-duty assessments or simulators, which monitor operator and machine behavior during shifts. Additionally, advanced tools like pupillometry, in-dash cameras, sensors, and glasses track eye movement speed, pupil constriction, and reflexes, providing enhanced driver safety monitoring. Siravenha et al. (2019) propose a Residual Multilayer Perceptron (MLP) network, analysing cognitive electrophysiology data from Virtual Reality (VR) training sessions to gauge fatigue levels in mining operators.

In the past decade, the definition of fatigue has evolved alongside changing work environments. In the 20th century, physical labour dominated, shaping fatigue as primarily psychological (Fletcher et al., 2015). Bills (1934) delineated three fatigue types: subjective, psychological and objective, laying groundwork for understanding fatigue despite dated perspectives.

Johnston et al. (2019) define fatigue as a subjective state, characterised by tiredness, bodily discomfort and reduced willingness to exert effort, alongside psychological impairment. Similar to mental exhaustion, fatigue induces stress, hyper-awareness, insomnia, immune suppression and digestive issues (Healthline, 2023). Tsaneva and Markov (1971, p. 11) propose a biological basis for fatigue, emphasising the role of metabolites in synaptic threshold alteration. Theofilou (2021) delineates subjective measures such as diaries, questionnaires and interviews, and objective measures focusing on physiological processes or performance, such as reaction time or error quantity. Psychological fatigue, according to Theofilou (2021), quantifies psychological change because of increased effort. Despite physiological definitions, researchers (Geraghty et al., 2019; Hidayanti & Sumaryono, 2021; Patterson et al., 2018; Shanmugham et al., 2018; Van Puyvelde et al., 2018) notice shortcomings in addressing the decrease in mental activity.

Fatigue remains complex and context-dependent (Geraghty et al., 2019; Hidayanti & Sumaryono, 2021; Patterson et al., 2018; Shanmugham et al., 2018; Van Puyvelde et al., 2018). Scholars advocate recognising occupational fatigue's multi-dimensional nature, yet research predominantly focuses on sleep, burnout and emotional exhaustion and their impacts on performance and safety (Patterson et al., 2018; Ternrud et al., 2022; Theofilou, 2021). Frone and Tidwell (2015) stress the inadequate definition of work fatigue. They propose that work fatigue encompasses pronounced exhaustion and

diminished capability, physical weariness and reduced inclination for physical exertion, mental fatigue with decreased cognitive engagement and emotional weariness with decreased emotional participation.

Frone and Tidwell (2015) assert that work fatigue encompasses significant tiredness and reduced operational ability across physical, mental and emotional energy resources. They define three types of work fatigue: physical, mental and emotional, experienced throughout the workday and at shift completion. Their categorisation details pronounced weariness and diminished engagement specific to each resource type during and at the end of the workday (Frone & Tidwell, 2015, p. 274). This definition forms the theoretical basis of this study.

Physical fatigue, characterised by weariness and bodily exhaustion, is common among workers (Ilies et al., 2015). Intense physical job demands can contribute to this fatigue (Jalilian et al., 2019; Meianto et al., 2021). Factors such as physical exertion, multitasking and job demands play roles in generating physical fatigue (Steege et al., 2015). Occupational stress and heavy job demands exacerbate physical difficulties at work (Jalilian et al., 2019). These demanding conditions can lead to both short-term and enduring fatigue (Jalilian et al., 2019; LeGal et al., 2019). Persistent fatigue resulting from rigorous job demands can have long-term health implications (LeGal et al., 2019).

Emotional fatigue, marked by a sense of emotional weariness and difficulty in engaging with tasks or interactions, is closely linked to burnout (Ilies et al., 2015; Teoh & Kee, 2019). Job demands, especially intense ones, are primary contributors to emotional fatigue (Bernuzzi et al., 2022; Ilies et al., 2015). Teoh and Kee (2019) emphasise the direct correlation between job demands, particularly challenging ones, and emotional fatigue. Hu et al. (2022) also find a significant positive association between work demands and emotional fatigue. Professions requiring emotional regulation tend to exacerbate emotional fatigue (Ilies et al., 2015). Jobs involving frequent social interactions can deplete emotional reserves, leading to emotional weariness (Ilies et al., 2015).

Mental fatigue, characterised by diminished mental clarity and agility, arises from cognitive strain (Ilies et al., 2015). Job demands draw upon cognitive reserves, exacerbating mental fatigue and reducing productivity (Ilies et al., 2015; Meianto et al., 2021). Tasks such as memory retention, concentration and technical activities deplete cognitive energy (Steege et al., 2015). Hidayanti and Sumaryono (2021) underscore the impact of intense work demands and inadequate social support on mental fatigue. Wang et al. (2021) further highlight how high job demands and limited resources detrimentally affect employees' mental well-being. Job specifics, workload and emotional demands correlate positively with increased mental fatigue and subsequent mental health issues (Lee & Eissenstat, 2018). As cognitive and emotional processing intensify, mental well-being declines, exacerbating mental fatigue (Nordhall et al., 2020).

This study investigates fatigue's adverse impacts on South African blue-collar workers. Historically, blue-collar workers engage in manual, physical and industrial labour (Reig-Botella et al., 2021). Many South African blue-collar workers are semi-literate or illiterate (Ilhan, 2020). They are predominantly employed in mining, industrial, mechanical and manufacturing sectors, exposed to challenging physical work environments (Reig-Botella et al., 2021).

According to Schaufeli and Bakker (2004), highly engaged employees maintain focus and take greater responsibility in their tasks, enhancing participation and involvement. They often exceed expectations to ensure task quality and timely completion (Bakker & Leiter, 2010). However, fatigue can significantly impact employee engagement, leading to decreased commitment, focus and productivity (Bakker & Leiter, 2010). Fatigued employees are also at risk of burnout, safety issues, reluctance to work overtime, increased sick leave and dropout rates (Kikuchi et al., 2020; Stevelink et al., 2022). The following hypotheses emerge:

H1a: A negative relationship exists between fatigue and work engagement.

H1b: A positive relationship exists between work engagement and overtime.

H2: A negative relationship exists between fatigue and commitment.

H3: A negative relationship exists between fatigue and work overtime.

The job demands-resources (JD-R) model posits that work-related outcomes are linked to the balance between job demands and available job resources (Lesener et al., 2019). Job demands encompass physical and psychological efforts exerted by employees, including mental and emotional aspects (Gonzalez-Mulé et al., 2021). Job resources refer to physical and psychological supports that reduce stress, burnout and work-related illnesses (Geisler et al., 2019). They include social support, task autonomy, feedback, career growth opportunities, among others (Geisler et al., 2019).

The model suggests that individuals facing excessive work demands with limited resources are prone to negative outcomes such as burnout, stress and work-related illnesses (Bakker & Demerouti, 2007). Burnout, characterised by physical and psychological exhaustion, cynicism and feelings of failure, is a commonly discussed consequence of this imbalance (Lesener et al., 2019). Burnout leads to disengagement and decreased commitment to organisations (Andrei et al., 2020).

Numerous blue-collar workers, including seafarers, truck drivers and bus drivers, confront escalating workloads and staffing reductions (Özsever & Tavacıoğlu, 2018). Hughes (2019) observed that truck drivers contend with heightened competition and delivery pressures, while Anund et al. (2015) identified increased competition for bus drivers from both internal and external market-related factors, all the while adhering to demands of punctuality, safety and customer

service. The advent of technological advancements has led to the partial automation of operator tasks, potentially amplifying passive task-related fatigue (Farahmand & Boroujerdian, 2018). However, despite partial automation, transport accidents are still attributed to fatigue (Zhao et al., 2020). Furthermore, even with complete automation of operator tasks, fatigue among maintenance personnel, control room staff and other stakeholders persists, posing a continuous threat to safe transport operations (Hersman & Whitcomb, 2018). Therefore, the following hypothesis emerges:

H4: A negative relationship exists between burnout and commitment.

Moreover, this study specifically focuses on work-related fatigue, which has primarily been characterised by physical, mental and emotional exhaustion. Therefore, work-related fatigue has a positive relationship with the burnout component of the job demands-resources model (Andrei et al., 2020; Van De Voorde & Beijer, 2015). Based on the research, the following hypothesis is proposed:

H5: A positive relationship exists between fatigue and burnout.

The mediating role of burnout and work engagement

Employees in South Africa face reduced control over their working hours because of organisational flexibility and market unpredictability (Hittle et al., 2020; Pen cavel, 2015; Vila-Vázquez et al., 2018). Gracia et al. (2019) added that expected employment roles are constantly changing, using the alteration, volumes, and methods of work. As a result, employers need to adapt to shifting demands in production and service delivery (Han et al., 2014). Employers prioritise profitability over workforce welfare, leading to increased pressure on employees (Vila-Vázquez et al., 2018). The Basic Conditions of Employment Act limits weekly overtime to 10 h (Fourie & Keyser, 2018). Commitment to work involves enthusiasm for assigned responsibilities and alignment with the organisation's aims, mission, and vision (Linda et al., 2018). Burnout and decreased work engagement negatively impact organisational outcomes (İlhan, 2020).

Organisations can mitigate high health management costs resulting from employee fatigue by testing and managing sleep disorders (Myers et al., 2018). Epstein (2019) emphasises the importance of addressing employee fatigue to maintain competitive advantage and prevent potential disasters. A United States study found that 90% of employers reported negative impacts from fatigued employees, with 50% noticing instances of employees falling asleep at work (National Safety Council, 2020). Additionally, 43% of employees admitted to being unable to operate safely because of exhaustion (National Safety Council, 2020). According to 2018 Occupational Safety and Health Administration statistics, work-related fatigue costs U.S. employers \$136.4 billion annually, underscoring the significance of managing fatigue-related risks (National Safety Council, 2020). This information from the American National Safety Council holds relevance for South Africa's approach to fatigue-related accidents.

Hakanen et al. (2008) proposed that work engagement mediates the connection between job resources and organisational commitment. Work engagement serves as a mediator between job resources and positive outcomes such as low turnover intention, organisational commitment, individual initiative and task innovation (Hakanen et al., 2006, 2008; Llorens et al., 2006). Job demands indirectly affect motivation through burnout, which decreases work engagement. Thanacoody et al. (2014) demonstrated that work disengagement among healthcare professionals fully mediates relationships between emotional exhaustion and affective commitment and turnover intentions. Commitment assumes a mediating role in the correlation between various dimensions of job burnout and organisational commitment as a structure. This study hypothesises that fatigue leads to decreased work or organisational commitment if employees already experience burnout or reduced overtime work if employees are disengaged from their work because of fatigue. These relationships are indirectly mediated by burnout and work engagement:

H6a: Burnout mediates the relationship between fatigue and commitment.

H6b: Burnout mediates the relationship between fatigue and overtime.

H7a: Work engagement mediates the relationship between fatigue and overtime.

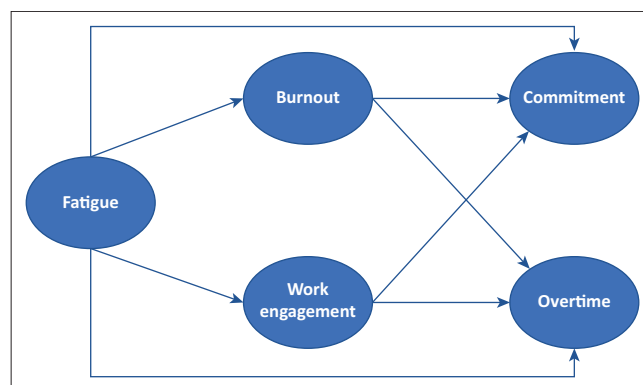
H7b: Work engagement mediates the relationship between fatigue and commitment.

The model depicted in Figure 1 illustrates the proposed links between the constructs.

Research design

Research approach and participants

A quantitative, non-experimental, cross-sectional design with a purposive sample of blue-collar employees ($N = 381$) was selected from the blue-collar corporate environment in South Africa. Participation was voluntary and all participants completed the questionnaires in paper and pencil format. The participants were ensured of the confidentiality and anonymity by giving consent to the participation. The sample consisted mostly of male participants ($n = 330$; 86.6). In terms of racial distribution, the majority were black African



Source: Van Jaarsveldt, W. (2024). Investigating employee fatigue management among blue-collar employees within the South African organisational context: Measurement and intervention [Unpublished doctoral thesis]. North-West University

FIGURE 1: Conceptual model.

participants ($n = 312$; 81.89). The age distribution showed that nearly half of the sample fell in the 30–39 age range ($n = 153$; 40.16%), while ($n = 127$; 33.33%) were in the 20–29 age group.

Measures

The biographical section was included to determine the biographical characteristics of the participants working in a blue-collar environment in South Africa. Information of the following nature: Gender, ethnic group and age group was obtained with the use of the questionnaire.

The *Checklist Individual Strength (CIS-20R)* was used to measure fatigue (Eyskens et al., 2019). The CIS-20R consists of 20 statements in which the respondent must respond on a 7-point Likert scale to what extent the statement applies to the participant. Fatigue was self-assessed by the participants using the CIS-20R questionnaire. The number of items per dimension varies. The dimension 'subjective fatigue' has eight items, for example, 'I feel tired', a reduction in motivation, four items, for example 'I feel no desire to do anything', reduction in activity three items, for example 'I don't do much during the day', and reduction in concentration five items, for example 'My thoughts easily wander'. Internal consistencies for the CIS-20R total scale and subscales are adequate at 0.90 for the total scale and a range of 0.83–0.92 for the subscales (Eyskens et al., 2019; Van de Werken et al., 2012). By adding the four dimensions, a CIS-20R total score can be calculated.

The *Three-Dimensional Work Fatigue Inventory (3D-WFI)*, created by Frone and Tidwell (2015), was used as the 18-item fatigue measurement, based on a 5-point Likert-type scale, of which six items measure each type of work fatigue, for example 'I feel physically exhausted at the end of the workday', and within each type, three items assessing the extreme tiredness aspect, for example 'I feel physically drained at the end of the work day' and three items assessing the reduced functional capacity aspect of work fatigue, for example 'I want to avoid anything that takes too much physical energy at the end of the work day'. Internal consistency reliability (coefficient alpha) was estimated for each of the three dimensions of work fatigue. The coefficient alphas of this WFI were determined to be 0.94 for physical work fatigue, 0.95 for mental work fatigue and 0.96 for emotional work fatigue (Frone & Tidwell, 2015).

The *Psychological Fitness Index (PFI)*, standardised and validated for the South African context by Afriforte (2020), was used as the 23-item questionnaire to measure the two subscales of psychological fitness, namely distress that consists of subscales: exhaustion (five items, e.g. 'After a day at work I feel tired and used up'); mental distance (five items, e.g. 'When I get to work, I tend to postpone certain tasks because I just don't feel like doing them'); cognitive weariness (five items, e.g. 'I find it difficult to focus while at work'). Eustress is measured with two subscales, including vitality (four items, e.g. 'When I am working, I feel a lot of energy') and work devotion (four items, e.g. 'My work gives me a

sense of meaning and purpose'). All items are measured on a seven-point frequency rating scale ranging from zero ('never') to six ('always'). The coefficient alpha for all the scales is 0.70 and higher in all official languages in South Africa (Brand-Labuschagne et al., 2012).

Statistical analysis

This study applied correlations and structural equation modelling (SEM) methods, with Mplus 7.4 (Muthén & Muthén, 2017) and IBM SPSS (Version 26, 2019) for descriptive statistics (Pallant, 2020). Descriptive statistics were employed to offer an overview of the data collected from participants (Tanious & Onghena, 2021), including measures such as the mean, standard deviation, skewness, kurtosis and the alpha coefficient, which evaluated internal consistency. In addition, confirmatory factor analysis (CFA) was performed to verify the construct validity of the instruments, with alpha coefficients used for assessing internal consistency (Marsh et al., 2020). Model fit was evaluated using metrics such as the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA). To examine possible indirect effects, a mediation model was applied to test the hypothesised relationships. Bootstrapping with 5000 samples was conducted to generate 95% confidence intervals (CI) for the indirect effects (Hayes, 2009). Product–moment correlations were used to determine the relationships between the scales (Steyn & Swanepoel, 2008), with 0.30 (medium effect) and 0.50 (large effect) as cut-off points for practical were assessed, interviewed and given intervention models to assist them with significance (Cohen, 1989). The CI for determining statistical significance was set at 95% ($p \leq 0.05$).

Ethical considerations

The proposed study obtained approval from the North-West University Economic and Management Sciences Research Ethics Committee (EMS-REC). (Ref. No. NWU-01907-19-A4). Prior authorisations from the senior management were obtained from the selected organisations to conduct the study. The purpose of the research was clearly explained to the participants, providing an explanation of the research design and objective, and consent was obtained. Participation in the study was voluntary, and participant confidentiality was ensured by using their clock numbers as unique identifiers.

Results

Convergent validity

Convergent validity refers to the degree to which the constructs show positive correlations with one another.

Table 1 presents significant findings regarding the relationship between exhaustion and various factors. The level of exhaustion displayed a medium-effect positive correlation with physical fatigue ($p < 0.01$, $r = 0.45$). In addition, exhaustion showed a large-effect negative association with commitment ($p < 0.01$, $r = -0.50$). Moreover, exhaustion had a small practically significant negative relationship with overtime hours worked ($p < 0.01$, $r = 0.02$).

The analysis indicates that burnout significantly correlates with several factors. Burnout was negatively associated with work commitment ($p < 0.01, r = -0.28$), suggesting a small-effect relationship, and with engagement ($p < 0.01, r = -0.31$), indicating a medium-effect relationship. Conversely, burnout demonstrated significant positive relationships with various forms of fatigue: physical fatigue ($p < 0.01, r = 0.49$, medium-effect), mental fatigue ($p < 0.01, r = 0.53$, large-effect), emotional fatigue ($p < 0.01, r = 0.48$, medium-effect) and overall fatigue ($p < 0.01, r = 0.55$, large-effect), supporting H5. In addition, burnout negatively correlated with work commitment ($p < 0.01, r = -0.54$, large-effect), supporting Hypothesis 4. However, burnout showed a small practically insignificant negative relationship with the number of overtime hours worked ($p < 0.01, r = -0.02$).

The level of work devotion showed significant associations with various factors. It had a medium-effect negative relationship with physical fatigue ($p < 0.01, r = -0.46$) and a large-effect negative relationship with mental fatigue ($p < 0.01, r = -0.51$). Furthermore, work devotion displayed a medium-effect negative relationship with emotional fatigue ($p < 0.01, r = -0.45$) and a large-effect negative relationship with overall fatigue ($p < 0.01, r = -0.52$). Conversely, work devotion exhibited a large-effect positive relationship with work commitment ($p < 0.01, r = 0.64$). However, its relationship with the number of overtime hours worked was small and practically insignificant ($p < 0.01, r = 0.01$).

The level of engagement exhibited significant associations across several dimensions. It had a large-effect negative relationship with physical fatigue ($p < 0.01, r = -0.51$) and a similarly large-effect negative relationship with mental fatigue ($p < 0.01, r = -0.55$). Moreover, engagement showed a medium-effect negative relationship with emotional fatigue ($p < 0.01, r = -0.49$) and a large-effect negative relationship with overall fatigue ($p < 0.01, r = -0.57$), consistent with Hypothesis 1a. Conversely, engagement displayed a large-effect positive relationship with work commitment ($p < 0.01, r = 0.70$). However, its relationship with the number of overtime hours worked was small and practically insignificant ($p < 0.01, r = 0.01$), leading to the rejection of H1b.

TABLE 1: Correlation matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Exhaustion	1.00	-	-	-	-	-	-	-	-	-	-	-	-
2. Mental distance	0.83**	1.00	-	-	-	-	-	-	-	-	-	-	-
3. Cognitive weariness	0.91**	0.88**	1.00	-	-	-	-	-	-	-	-	-	-
4. Burnout	0.93**	0.90**	0.98**	1.00	-	-	-	-	-	-	-	-	-
5. Vitality	-0.27**	-0.26**	-0.29**	-0.29**	1.00	-	-	-	-	-	-	-	-
6. Work devotion	-0.26**	-0.26**	-0.28**	-0.28**	0.87**	1.00	-	-	-	-	-	-	-
7. Engagement	-0.29**	-0.28**	-0.30**	-0.31**	0.95**	0.92**	1.00	-	-	-	-	-	-
8. Physical fatigue	0.45**	0.44**	0.48**	0.49**	-0.48**	-0.46**	-0.51**	1.00	-	-	-	-	-
9. Mental fatigue	0.50**	0.48**	0.52**	0.53**	-0.52**	-0.51**	-0.55**	0.87**	1.00	-	-	-	-
10. Emotional fatigue	0.44**	0.43**	0.47**	0.48**	-0.46**	-0.45**	-0.49**	0.77**	0.84**	1.00	-	-	-
11. Fatigue	0.51**	0.49**	0.54**	0.55**	-0.54**	-0.52**	-0.57**	0.89**	0.97**	0.87**	1.00	-	-
12. Commitment	-0.50**	-0.49**	-0.53**	-0.54**	0.66**	0.64**	0.70**	-0.31**	-0.34**	-0.30**	-0.35**	1.00	-
13. Overtime	-0.02**	-0.02**	-0.02**	-0.02**	0.01**	0.01**	0.01**	-0.12**	-0.14**	-0.12**	-0.14**	0.03**	1.00

** Statistically significant correlation $p < 0.01$.

The analysis revealed several significant relationships regarding fatigue levels and work-related factors. Physical fatigue showed a medium-effect negative relationship with work commitment ($p < 0.01, r = -0.31$) and a small-effect negative relationship with the number of overtime hours worked ($p < 0.01, r = -0.12$). Similarly, mental fatigue demonstrated a medium-effect negative relationship with work commitment ($p < 0.01, r = -0.34$) and a small-effect negative relationship with the number of overtime hours worked ($p < 0.01, r = -0.14$). Emotional fatigue also displayed a medium-effect negative relationship with work commitment ($p < 0.01, r = -0.30$) and a small-effect negative relationship with the number of overtime hours worked ($p < 0.01, r = -0.12$). Overall fatigue had a medium-effect negative relationship with work commitment ($p < 0.01, r = -0.35$), supporting Hypothesis 2, and a small-effect negative relationship with the number of overtime hours worked ($p < 0.01, r = -0.14$), supporting H3. Furthermore, work commitment exhibited a small practically insignificant positive relationship with the number of overtime hours worked ($p < 0.01, r = 0.03$).

Model fit statistics

Table 2 displays the fit statistics for the measurement model. The structural equation modelling process yielded the following fit indices: CFI (0.91), TLI (0.91), RMSEA (0.04) and SRMR (0.06). These values exceed the established cut-off criteria and are deemed acceptable.

From Table 3, in terms of the reliability analyses, all the constructs had acceptable composite reliability coefficients: exhaustion ($p = 0.65$), mental distance ($p = 0.73$), cognitive weariness ($p = 0.74$), vitality ($p = 0.71$), work devotion ($p = 0.78$), physical fatigue ($p = 0.85$), mental fatigue ($p = 0.92$), emotional fatigue ($p = 0.93$), commitment ($p = 0.88$), burnout ($p = 0.95$), engagement ($p = 0.93$) and fatigue ($p = 0.94$).

TABLE 2: Fit statistics of the measurement model.

Description	χ^2	df	CFI	TLI	RMSEA	SRMR
Model	2214.682*	1019	0.911	0.906	0.055	0.071

χ^2 , Chi-square; df, degrees of freedom; CFI, comparative fit index; TLI, Tucker–Lewis Index; RMSEA root mean square error of approximation; SRMR, standardised root mean residual.

*, Statistically significance level = $p < 0.001$.

Fatigue showed statistically significant regressions to commitment, burnout, overtime and engagement. The strongest relationships for fatigue were with engagement ($\beta = 0.57$; S.E. = 0.05; $p < 0.001$) and burnout ($\beta = 0.55$; S.E. = 0.06; $p < 0.001$). The regression from fatigue to commitment was also found to be significant ($\beta = -0.35$; S.E. = 0.12; $p < 0.011$). The relationships of fatigue to burnout ($\beta = -0.55$; S.E. = 0.06; $p < 0.011$) and fatigue to engagement were significant ($\beta = -0.57$; S.E. = 0.05; $p < 0.011$). Fatigue showed a statistically significant regression to overtime ($\beta = -0.26$; S.E. = 0.11; $p < 0.015$). However, burnout also showed non-significant regression to overtime ($p < 0.277$) and engagement showed a non-significant regression to overtime ($p < 0.163$). This is visually represented in Table 4.

Mediating effects

Table 5 reveals very interesting findings. The results of the bootstrapping showed that there was only one meaningful indirect effect for burnout as a mediator, and that is in the relationship between fatigue and commitment (0.28; 95% CI [0.18, 0.40] supporting H6a). The results indicated that there was an indirect effect from fatigue to commitment through work engagement (0.42; 95% CI [0.33, 0.53] supporting H6b). The remaining two indirect effects both crossed zero and therefore had p -values above 0.05 (rejecting H6b and H7a). However, the significant indirect effect is small and should be interpreted as such.

Discussion

This research study aimed to investigate the relationship between fatigue, overtime work, burnout, commitment to work and work engagement in the context of South African blue-collar workers. The study further explored the mediating role of burnout and engagement in the proposed model. This study is the first to integrate all the aforementioned constructs within a single investigation in the South African context.

Hypothesis 1a proposed that fatigue (physical, mental and emotional) has a significant negative relationship with work engagement. This means that when fatigue increases, work engagement decreases. This study found that fatigue had a large-effect relationship with work engagement, supporting H1a. This is further confirmed by the collective definition of fatigue, which suggests that the basis of fatigue is twofold: (1) extreme tiredness, along with (2) a decrease in functional capacity (Geraghty et al., 2019; Hidayanti & Sumaryono, 2021; Johnston et al., 2019; Patterson et al., 2018; Shanmugham et al., 2018; Theofilou, 2021; Van Puyvelde et al., 2018). Thus, the decreased functional capacity of an employee could lead to a lack of motivation and lower levels of engagement towards certain inherent activities in the workplace (Frone & Tidwell, 2015).

Hypothesis 1b proposed that there exists a substantial positive correlation between work engagement and overtime,

suggesting that an increase in work engagement corresponds to an elevated inclination to work overtime. However, the study results indicated a small positive relationship between engagement and overtime that did not reach practical statistical significance. Although the data showed a positive link between work engagement and overtime hours worked, the effect size was small, offering limited support for H1b. This implies that when work engagement levels are low, employees may display decreased motivation for work-related activities and may be less inclined to invest additional hours post-work to fulfil their responsibilities, and conversely. This finding aligns with Schaufeli and Bakker (2004) and Bakker and Leiter (2010), who observed that heightened engagement is associated with increased productivity and focus, and conversely, a decline in engagement corresponds to a reduced willingness to work overtime to meet deadlines.

Hypothesis 2 proposed that fatigue (physical, mental and emotional) has a significant negative relationship with commitment, which means that when fatigue increases, commitment to the work decreases. The results of this study found that fatigue had a statistically significant negative relationship with commitment, which indicates that the relationship between fatigue and commitment had a medium-effect relationship (supporting H2). Hypothesis 3 proposed that fatigue (physical, mental and emotional) has a significant negative relationship with work overtime. Fatigue was found to have a statistically significant negative relationship with overtime hours worked, which indicates that the relationship between fatigue and overtime hours worked had a small-effect relationship (supporting H3).

Both H2 and H3 are supported by the notion that detrimental physical and mental health effects of fatigue can further negatively influence organisational outcomes such as the employees' ability and desire to work overtime or their level of commitment towards their organisations (İlhan, 2020). This is supported by other sources that found workers who are fatigued to be in poorer mental and physical health, further contributing to lack of commitment to work and even less so their willingness to work overtime (Andrei et al., 2020; Bakker & Demerouti, 2007; Geisler et al., 2019).

Hypothesis 4 proposed that burnout has a significant negative relationship with commitment. This means that when the risk of burnout increases, the individual becomes burnt-out. Burnout was found as having a statistically significant negative relationship with commitment, as the relationship between burnout and commitment had a medium-effect relationship (supporting H4). Their commitment decreases. This is supported by research that suggests that job-related burnout has been described in terms of extreme physical and psychological exhaustion, cynicism and feelings of failure (Lesener et al., 2019), which can further negatively influence employees' level of commitment towards their organisations (İlhan, 2020). The job demands-resources model effectively proves this statement as those workers who are not provided

TABLE 3: Standardised loading for the latent factors.

Factor	Item	Loading	SE	<i>p</i>	<i>R</i> -square	Composite reliability
Exhaustion	-	BY	-	-	-	0.65
	SAP_EX1	0.61	0.05	0.001	0.37	-
	SAP_EX2	0.47	0.06	0.001	0.22	-
	SAP_EX3	0.68	0.05	0.001	0.47	-
	SAP_EX5	0.47	0.07	0.001	0.22	-
Mental distance	-	BY	-	-	-	0.73
	SAP_MD1	0.72	0.04	0.001	0.51	-
	SAP_MD2	0.72	0.05	0.001	0.51	-
	SAP_MD4	0.46	0.06	0.001	0.21	-
	SAP_MD5	0.65	0.06	0.001	0.42	-
Cognitive weariness	-	BY	-	-	-	0.74
	SAP_CW1	0.64	0.05	0.001	0.41	-
	SAP_CW2	0.58	0.05	0.001	0.34	-
	SAP_CW3	0.67	0.05	0.001	0.45	-
	SAP_CW4	0.68	0.05	0.001	0.46	-
Vitality	-	BY	-	-	-	0.71
	SAP_VI1	0.65	0.04	0.001	0.42	-
	SAP_VI2	0.66	0.05	0.001	0.44	-
	SAP_VI3	0.67	0.06	0.001	0.45	-
	SAP_VI5	0.47	0.09	0.001	0.22	-
Work devotion	-	BY	-	-	-	0.78
	SAP_WD1	0.67	0.05	0.001	0.45	-
	SAP_WD2	0.76	0.05	0.001	0.58	-
	SAP_WD3	0.58	0.07	0.001	0.34	-
	SAP_WD4	0.70	0.05	0.001	0.50	-
Physical fatigue	-	BY	-	-	-	0.85
	PHYS1	0.59	0.05	0.001	0.35	-
	PHYS2	0.77	0.04	0.001	0.60	-
	PHYS3	0.69	0.04	0.001	0.48	-
	PHYS4	0.81	0.03	0.001	0.65	-
	PHYS5	0.71	0.04	0.001	0.50	-
	PHYS6	0.63	0.05	0.001	0.39	-
Mental fatigue	-	BY	-	-	-	0.92
	MEN1	0.75	0.03	0.001	0.56	-
	MEN2	0.80	0.03	0.001	0.64	-
	MEN3	0.82	0.03	0.001	0.68	-
	MEN4	0.90	0.02	0.001	0.81	-
	MEN5	0.84	0.02	0.001	0.71	-
	MEN6	0.71	0.04	0.001	0.50	-
Emotional fatigue	-	BY	-	-	-	0.93
	EMO1	0.84	0.03	0.001	0.70	-
	EMO2	0.78	0.04	0.001	0.61	-
	EMO3	0.85	0.02	0.001	0.72	-
	EMO4	0.88	0.02	0.001	0.78	-
	EMO5	0.84	0.03	0.001	0.71	-
	EMO6	0.76	0.03	0.001	0.58	-
Commitment	-	BY	-	-	-	0.88
	SAP_AO1	0.73	0.04	0.001	0.54	-
	SAP_AO2	0.45	0.06	0.001	0.20	-
	SAP_AO4	0.66	0.04	0.001	0.44	-
	SAP_AO5	0.79	0.04	0.001	0.62	-
	SAP_AO6	0.52	0.06	0.001	0.27	-
	SAP_AO7	0.75	0.04	0.001	0.57	-
	SAP_AO8	0.80	0.04	0.001	0.63	-
	SAP_AO9	0.85	0.03	0.001	0.72	-
Burnout	-	BY	-	-	-	0.95
Exhaustion	-	0.93	0.05	0.001	0.86	-
Mental distance	-	0.90	0.04	0.001	0.81	-
Cognitive weariness	-	0.98	0.04	0.001	0.96	-
Engagement	-	BY	-	-	-	0.93

Table 3 continues on the next page →

TABLE 3 (Continues ...): Standardised loading for the latent factors.

Factor	Item	Loading	SE	<i>p</i>	<i>R</i> -square	Composite reliability
Vitality	-	0.95	0.04	0.001	0.89	-
Work devotion	-	0.92	0.04	0.001	0.84	-
Fatigue	-	BY	-	-	-	0.94
Physical fatigue	-	0.89	0.03	0.001	0.80	-
Mental fatigue	-	0.97	0.02	0.001	0.95	-
Emotional fatigue	-	0.87	0.03	0.001	0.75	-

Note: All *p*-values < 0.001.

SE, Standard error.

TABLE 4: Indirect paths for the structural model.

Indirect path	β	L 95% CI	U 95% CI
The sum of indirect effects from fatigue to overtime	0.12	-0.03	0.30
Fatigue → Burnout → Overtime	0.05	-0.04	0.13
Fatigue → Engagement → Overtime	0.07	-0.02	0.19
The sum of indirect effects from fatigue to commitment	0.69	0.52	0.92
Fatigue → Burnout → Commitment	0.28	0.16	0.42
Fatigue → Engagement → Commitment	0.42	0.31	0.56

L 95% CI, lower 95% confidence interval; U 95% CI, upper 95% confidence interval.

adequate resources to do their jobs, become stressed and disengaged with their tasks (Gonzalez-Mulé et al., 2021; Lesener et al., 2019), and as a result become burnt out (Bakker & Demerouti, 2007; Geisler et al., 2019).

Hypothesis 5 proposed that fatigue (physical, mental and emotional) has a significant positive relationship with burnout. This indicates that when an individual becomes increasingly fatigued, so does the risk of burnout. According to the results, burnout did have a statistically significant positive relationship with fatigue, which indicates that the relationship between burnout and fatigue had a medium-effect relationship (supporting H5). Supporting the notion that work-related fatigue, which has primarily been characterised by physical, mental and emotional exhaustion, can be closely linked back to the burnout component of the job demands-resources model. Furthermore, emotional fatigue specifically is seen as the most vital aspect of burnout (Patterson et al., 2018; Theofilou, 2021; Teoh & Kee, 2019; Ternrud et al., 2022). According to Ilies et al. (2015) and Bernuzzi et al. (2022) researchers have found a link between high job demands, distress and emotional fatigue. As individuals become more burnt out within organisations, they experience decreased levels of employee engagement, which in turn decreases the individual's commitment towards their respective organisations and decreases their levels of willingness to work overtime (Fischer et al., 2017). In the working environment of blue-collar workers there are several reasons to believe that fatigue remains a hazard, for not only the individual but also the organisation.

Hypothesis 6a proposed that burnout mediates the relationship between fatigue (physical, mental and emotional) and commitment. This means that burnout has a direct impact on the relationship between fatigue and commitment. As confirmed by the results, there was only one significant indirect effect for burnout as a mediator, and that is in the relationship between commitment and fatigue (supporting H6a). This implies that burnout is

TABLE 5: Structural path results.

Structural path	β	SE	<i>p</i>	Result
Fatigue → Commitment	-0.35	0.12	0.003	Significant
Burnout → Commitment	-0.51	0.09	0.001	Significant
Engagement → Commitment	0.73	0.06	0.001	Significant
Fatigue → Burnout	0.55	0.06	0.001	Significant
Fatigue → Engagement	-0.57	0.05	0.001	Significant
Fatigue → Overtime	-0.26	0.11	0.015	Significant
Burnout → Overtime	-0.09	0.08	0.277	Not Significant
Engagement → Overtime	0.13	0.09	0.163	Not Significant

β , standardised beta coefficient; SE, standard error.

p, two-tailed statistical significance.

not necessarily required in the relationship between commitment and fatigue. Hence, it can be assumed that blue-collar workers do not need to experience burnout to become fatigued. Although there are studies that investigate the mediating effects of burnout in the relationships between multiple organisational outcome factors and exhaustion, there are no studies that specifically investigate fatigue in the place of exhaustion. This is interesting as other studies show that burnout has a significant relationship with work engagement (Hakanen et al., 2006; Kar & Suar, 2014; Llorens et al., 2006). This means that although fatigue and engagement, and burnout and engagement have significant relationships, burnout is a more severe form of fatigue; therefore, does not impact the relationship between fatigue and engagement.

Hypothesis 6b proposed that burnout mediates the relationship between fatigue (physical, mental and emotional) and overtime. This means that burnout has a direct impact on the relationship between fatigue and overtime. However, the results showed that burnout is not a strong mediator between the organisational outcome factor of commitment and fatigue (rejecting H6b). Existing research does indicate that fatigue and burnout, fatigue and overtime and burnout and overtime have strong relationships with each other, respectively (Andrei et al., 2020), but there is no support that burnout mediates or has any impact on the relationship between fatigue and commitment. This indicates that burnout may only refer to the severity of fatigue experienced in relation to willingness to work overtime.

H7a and H7b in question stated that work engagement mediates the relationship between fatigue and organisational outcomes such as commitment and overtime. This means that work engagement is expected to have a direct impact on the relationships between commitment and overtime,

respectively. As displayed by the results, there was only one significant indirect effect for work engagement as a mediator, which is in the relationship between commitment and fatigue (rejecting H7a and supporting H7b). However, the results showed that engagement is not a strong mediator between the organisational outcome factor of commitment and fatigue. This implies that engagement is not necessarily required in the relationship between commitment and fatigue. Therefore, it can be assumed that blue-collar workers' levels of fatigue are not independently reduced by higher levels of work engagement. Other studies have however found that fatigue, engagement, commitment and willingness to work overtime have connecting relationships with one another (Bidasca & Townsend, 2014; Fischer et al., 2017), meaning that the closer an individual is to burnout, the lower will be their engagement, commitment and willingness to work overtime (Bakker et al., 2008). This differs from the results of this study and warrants future studies to explore this further.

Practical implications

The findings of this study reveal that significant relationships exist between the fatigued blue-collar workers' experience and their work commitment, engagement, willingness to work overtime, experiences of exhaustion and ultimately burnout. These findings indicate that blue-collar workers are vulnerable to fatigue and the resulting consequences thereof; therefore, more care needs to be given by their management to ensure that their workers are not overworked to the point where they make mistakes or cause fatal accidents because of exhaustion. From this study, organisations can learn to create programmes to train workers to be more skilled, create tasks that result in visible success, provide support services to workers who may have emotional or psychological needs, and perhaps even create a fair roster indicating who works overtime (or who is willing to do more overtime work), to overcome physical exhaustion. Managers could use this study to further understand that blue-collar workers take pride in their work and will lose commitment and become disengaged when fatigued – opening the avenue of identifying those who are fatigued and creating intervention models to combat this.

Limitations and recommendations

Several limitations were identified throughout this research study. The first limitation identified was that all scales used for the questionnaires were only standardised in English, whereas most of the sample spoke English only as a second language. Moreover, as mentioned previously, blue-collar workers have generally been characterised as the majority semi-literate and illiterate individuals. This could have led to possible inaccuracies in the responses from the participants as they may have misunderstood some of the questions or statements. Firstly, the limitation identified was that all the questionnaire scales were standardised in English, while most participants spoke it as a second language. Additionally,

as noted earlier, blue-collar workers are often characterised by lower literacy levels, which could have led to inaccurate responses due to potential misunderstandings of certain questions or statements. Secondly, a limitation identified was the absence of South African statistical norms for the scales used. Regarding the South African working environment, there is no valid measure of fatigue or national benchmark against which to efficiently compare the workforce. The third limitation identified was the over-representation of certain South African provinces. Most of the sample used consisted of blue-collar workers in Mpumalanga. Thus, the sample does not completely represent the South African population as it excluded a few of the other South African provinces. The final and most crucial limitation identified throughout this study was the sample size. Because of the relatively small sample size used for this study, the statistical conclusions cannot be generalised to the greater extent of the South African blue-collar population.

Based on the above-mentioned limitations, it is recommended that future research studies of a similar nature should include a more inclusive and wider sample to allow the conclusions of the studies to be generalised to the greater South African blue-collar workforce. Moreover, studying a more inclusive and wider population will allow future researchers to create more specific and accurate norms for the South African blue-collar workforce. Furthermore, to ensure more accurate raw data from blue-collar individuals in the future, interpreters should be present while assessing these individuals to ensure that all participants give accurate and true information regarding their experiences within the blue-collar working environment.

Furthermore, this topic relates very closely to some problems managers experience in terms of the blue-collar workforce who contribute towards work incidents and injuries because of fatigue. It would be greatly beneficial for organisations if this study made some contribution as to why the blue-collar workforce is fatigued within the workplace and how fatigue influences the overall performance of an organisation. If the level of fatigue of individuals plays a significant role in the percentage of workplace incidents and injuries, as suggested by this study, managers will be able to successfully implement interventions to address and prevent these incidents and injuries within the work environment. These interventions will not only assist organisations in becoming more profitable and efficient but will also help organisations decrease the number of incidents and injuries within the working environment while improving the mindsets and well-being of their working individuals.

Moreover, as suggested by the literature discussed throughout this study, it is evident that fatigue occurs before an individual experiences' complete burnout. However, the statistics displayed small to medium affect relationships for all the hypotheses, which suggests that fatigue might not be the last step before burnout occurs. Hence, future research studies should focus on what comes after fatigue and before burnout.

Conclusion

This conceptual exploration demonstrated that blue-collar workers become easily fatigued because of the physically demanding nature of their jobs. This concept of fatigue encompasses physical, mental and emotional fatigue, which occasionally have severe consequences on employee well-being, work productivity, job satisfaction, commitment, burnout and on the safety of those in the work environment. The existing literature on blue-collar fatigue is outdated and many of the more recent sources explore fatigue in the transport and nursing fields.

The findings of the study revealed significant relationships between burnout, work engagement and fatigue. Fatigue was found to have a significant relationship with the risk of burnout, which in turn results in significantly lower commitment. Fatigue was found to have a significant relationship with work engagement, which in turn had a significant relationship with commitment. This indicates that individuals who experience fatigue, have low work engagement, are more prone to being burnt out and as a result lower commitment towards the organisation they work in. The results also indicated that fatigue could diminish work commitment in individuals.

Acknowledgements

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

W.v.J. conceptualised the study and conducted the formal analysis, wrote the original draft and gathered the required resources. M.J. assisted with writing, reviewing and supervision of the research study.

Funding information

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data availability

The data that support the findings of this study are available, upon reasonable request, from the corresponding author, M.J.

Disclaimer

The views and opinions expressed in this article are those of the authors and are the product of professional research. It does not necessarily reflect the official policy or position of any affiliated institution, funder, agency or that of the publisher. The authors are responsible for this article's results, findings and content.

References

- Afriforte. (2020). *The Psychological Fitness Index: A new standard in safety and accident prevention*. Retrieved from <https://www.afriforte.com/home/psychological-fitness-index/>
- Andrei, D.M., Griffin, M.A., Grech, M., & Neal, A. (2020). How demands and resources impact chronic fatigue in the maritime industry: The mediating effect of acute fatigue, sleep quality, and recovery. *Safety Science, 121*, 362–372. <https://doi.org/10.1016/j.ssci.2019.09.019>
- Anund, A., Fors, C., Kecklund, G., Van Leeuwen, W., & Akerstedt, T. (2015). Countermeasures for fatigue in transportation: A review of existing models for drivers on road, rail, sea, and in aviation. *Accident Analysis & Prevention, 85*, 148–156. <https://doi.org/10.1016/j.aap.2015.09.022>
- Bakker, A.B., & Demerouti, E. (2007). The Job Demands-Resources model: *State of the art*. *Journal of Managerial Psychology, 22*(3), 309–328. <https://doi.org/10.1108/02683940710733115>
- Bakker, A.B., & Leiter, M.P. (2010). Where to go from here: Integration and future research on work engagement. In A.B. Bakker & M.P. Leiter (Eds.), *Work engagement: A handbook of essential theory and research* (pp. 181–196). Psychology Press.
- Bakker, A.B., Schaufeli, W.B., Leiter, M.P., & Taris, T.W. (2008). Work engagement: An emerging concept in occupational health psychology. *Work & Stress, 22*(3), 187–200. <https://doi.org/10.1080/02678370802393649>
- Bernuzzi, C., Setti, I., Maffoni, M., & Sommovigo, V. (2022). From moral distress to burnout through work-family conflict: The protective role of resilience and positive refocusing. *Ethics & Behavior, 32*(7), 578–600. <https://doi.org/10.1080/10508422.2021.1955682>
- Bidasca, L., & Townsend, E. (2014). *The business case for managing road risk at work*. PRAISE Work-related road safety. Brussels.
- Bills, A.G. (1934). *General experimental psychology*. Longmans, Green and Co.
- Biswas, G., Bhattacharya, A., & Bhattacharya, R. (2017). Occupational health status of construction workers: A review. *International Journal of Medical Science and Public Health, 6*(4), 1. <https://doi.org/10.5455/ijmsph.2017.0745302112016>
- Brand-Labuschagne, L., Mostert, K., Jnr, S.R., & Rothmann, J.C. (2012). Burnout and work engagement of South African blue-collar workers: The development of a new scale. *Southern African Business Review, 16*(1), 58–93.
- Choshen-Hillel, S., Ishqer, A., Mahameed, F., Reiter, J., Gozal, D., Gileles-Hillel, A., & Berger, I. (2021). Acute and chronic sleep deprivation in residents: *Cognition and stress biomarkers*. *Medical Education, 55*(2), 174–184. <https://doi.org/10.1111/medu.14296>
- Cohen, A. (1989). Comparison of correlated correlations. *Statistics in Medicine, 8*(12), 1485–1495. <https://doi.org/10.1002/sim.4780081208>
- D'Oliveira, T.C., & Anagnostopoulos, A. (2021). The association between shift work and affective disorders: A systematic review. *Chronobiology International, 38*(2), 182–200. <https://doi.org/10.1080/07420528.2020.1838533>
- Drews, F.A., Rogers, W.P., Talebi, E., & Lee, S. (2020). The experience and management of fatigue: A study of mine Haulage operators. *Mining, Metallurgy & Exploration, 37*(6), 1837–1846. <https://doi.org/10.1007/s42461-020-00259-w>
- Epstein, L. (2019, July). STOP THE GRIND: How employers can curb workplace fatigue and drive productivity. *Benefits Magazine*, pp. 36–43.
- Esterhuysen, A., Knight, J., & Keartland, T. (2018). Mine waste. *Progress in Physical Geography. Earth and Environment, 42*(5), 650–666. <https://doi.org/10.1177/0309133318793581>
- Eyskens, J.b, Illegems, J., De Nil, L., Nijs, J., Kampen, J.K., & Moorkens, G. (2019). Assessing chronic fatigue syndrome: Self-reported physical functioning and correlations with physical testing. *Journal of Bodywork and Movement Therapies, 23*(3), 598–603. <https://doi.org/10.1016/j.jbmt.2019.03.006>
- Farahmand, B., & Boroujerdian, A.M. (2018). Effect of road geometry on driver fatigue in monotonous environments: A simulator study. *Transportation Research Part F: Traffic Psychology and Behaviour, 58*, 640–651. <https://doi.org/10.1016/j.trf.2018.06.021>
- Fischer, D., Lombardi, D.A., Folkard, S., Willetts, J., & Christiani, D.C. (2017). Updating the 'Risk Index': A systematic review and meta-analysis of occupational injuries and work schedule characteristics. *Chronobiology International, 34*(10), 1423–1438. <https://doi.org/10.1080/07420528.2017.1367305>
- Fletcher, A., Hooper, B., Dunican, I., & Kogi, K. (2015). Fatigue management in safety-critical operations. *Reviews of Human Factors and Ergonomics, 10*(1), 6–28. <https://doi.org/10.1177/1557234X15573947>
- Fourie, R., & Keyser, E. (2018). The relationship between Blue Collar employee fatigue, level of substance use, absenteeism based on the demographical information of employees. *International Journal of Social Sciences and Humanity Studies, 10*(1), 205–221.
- Frone, M.R., & Tidwell, M.-C.O. (2015). The meaning and measurement of work fatigue: Development and evaluation of the Three-Dimensional Work Fatigue Inventory (3D-WFI). *Journal of Occupational Health Psychology, 20*(3), 273–288. <https://doi.org/10.1037/a0038700>
- Geisler, M., Berthelsen, H., & Muhonen, T. (2019). Retaining social workers: The role of quality of work and psychosocial safety climate for work engagement, job satisfaction, and organizational commitment. *Human Service Organizations: Management, Leadership & Governance, 43*(1), 1–15. <https://doi.org/10.1080/23303131.2019.1569574>
- Geraghty, K., Jason, L., Sunnquist, M., Tuller, D., Blease, C., & Adeniji, C. (2019). The 'cognitive behavioural model' of chronic fatigue syndrome: Critique of a flawed model. *Health Psychology Open, 6*(1), 205510291983890. <https://doi.org/10.1177/2055102919838907>

- Gonzalez-Mulé, E., Kim, M. (Mia), & Ryu, J.W. (2021). A meta-analytic test of multiplicative and additive models of job demands, resources, and stress. *Journal of Applied Psychology, 106*(9), 1391–1411. <https://doi.org/10.1037/apl0000840>
- Hakanen, J.J., Bakker, A.B., & Schaufeli, W.B. (2006). Burnout and work engagement among teachers. *Journal of School Psychology, 43*(6), 495–513. <https://doi.org/10.1016/j.jsp.2005.11.001>
- Hakanen, J.J., Perhoniemi, R., & Toppinen-Tanner, S. (2008). Positive gain spirals at work: From job resources to work engagement, personal initiative and work-unit innovativeness. *Journal of Vocational Behavior, 73*(1), 78–91. <https://doi.org/10.1016/j.jvb.2008.01.003>
- Han, K., Trinkliff, A.M., & Geiger-Brown, J. (2014). Factors associated with work-related fatigue and recovery in hospital nurses working 12-Hour shifts. *Workplace Health & Safety, 62*(10), 409–414. <https://doi.org/10.3928/21650799-20140826-01>
- Harrison, E.M., Schmied, E.A., Yablonsky, A.M., & Glickman, G.L. (2021). Implementation of interventions designed to promote healthy sleep and circadian rhythms in shiftworkers. *Chronobiology International, 38*(4), 467–479. <https://doi.org/10.1080/07420528.2020.1845190>
- Healthline. (2023). How to treat and prevent mental exhaustion. *Healthline*. Retrieved from <https://www.healthline.com/health/mental-exhaustion#vs-stress>
- Hersman, D.A.P., & Whitcomb, E.A. (2018). Fatigue risk management in high-risk environments: A call to action. *Prehospital Emergency Care, 22*(suppl 1), 1–2. <https://doi.org/10.1080/10903127.2017.1380097>
- Hidayanti, R.C., & Sumaryono, S. (2021). The role of sleep quality as mediator of relationship between workload and work fatigue in mining workers. *Jurnal Psikologi, 48*(1), 62. <https://doi.org/10.22146/jpsi.61154>
- Hittle, B.M., Caruso, C.C., Jones, H.J., Bhattacharya, A., Lambert, J., & Gillespie, G.L. (2020). Nurse health: The influence of chronotype and shift timing. *Western Journal of Nursing Research, 42*(12), 1031–1041. <https://doi.org/10.1177/0193945920916802>
- Hughes, R.C. (2019). Breaking the law under competitive pressure. *Law and Philosophy, 38*(2), 169–193. <https://doi.org/10.1007/s10982-019-09345-7>
- Ilios, R., Huth, M., Ryan, A.M., & Dimotakis, N. (2015). Explaining the links between workload, distress, and work–family conflict among school employees: Physical, cognitive, and emotional fatigue. *Journal of Educational Psychology, 107*(4), 1136–1149. <https://doi.org/10.1037/edu0000029>
- Jalilian, H., Shouraki, F., Azmoon, H., Rostamabadi, A., & Choobineh, A. (2019). Relationship between job stress and fatigue based on job demand-control-support model in hospital nurses. *International Journal of Preventive Medicine, 10*(1), 56. https://doi.org/10.4103/ijpvm.IJPVM_178_17
- Johnston, D.W., Allan, J.L., Powell, D.J.H., Jones, M.C., Farquharson, B., Bell, C., & Johnston, M. (2019). Why does work cause fatigue? A real-time investigation of fatigue, and determinants of fatigue in nurses working 12-hour shifts. *Annals of Behavioral Medicine, 53*(5), 551–562. <https://doi.org/10.1093/abm/kay065>
- Kar, S., & Suar, D. (2014). Role of burnout in the relationship between job demands and job outcomes among Indian nurses. *Vikalpa, 39*(4), 23–38. <https://doi.org/10.1177/0256090920140403>
- Kikuchi, H., Odagiri, Y., Ohya, Y., Nakanishi, Y., Shimomitsu, T., Theorell, T., & Inoue, S. (2020). Association of overtime work hours with various stress responses in 59,021 Japanese workers: Retrospective cross-sectional study. *PLoS One, 15*(3), e0229506. <https://doi.org/10.1371/journal.pone.0229506>
- Knardahl, S., Johannessen, H.A., Sterud, T., Härämä, M., Rugulies, R., Seitsamo, J., & Borg, V. (2017). The contribution from psychological, social, and organizational work factors to risk of disability retirement: A systematic review with meta-analyses. *BMC Public Health, 17*, 176. <https://doi.org/10.1186/s12889-017-4059-4>
- Ledwaba, S., & Nkomo, T.S. (2021). An exploration of motivations for women mine workers to work underground. *SAGE Open, 11*(3), 1–11. <https://doi.org/10.1177/21582440211032157>
- LeGal, P., Rhéaume, A., & Mullen, J. (2019). The long-term effects of psychological demands on chronic fatigue. *Journal of Nursing Management, 27*(8), 1673–1681. <https://doi.org/10.1111/jonm.12857>
- Lesener, T., Gusy, B., & Wolter, C. (2019). The job demands-resources model: A meta-analytic review of longitudinal studies. *Work & Stress, 33*(1), 76–103. <https://doi.org/10.1080/02678373.2018.1529065>
- Linda, D., Nsikan, N., Afolabi, I., Folusho, A., Nayagawa, M.J., Chima, E., & Ahmed, S. (2018). *Fatigue risk management: Effective solution to workplace stress in the petroleum industry*. Paper presented at the SPE Nigeria Annual International Conference and Exhibition, Lagos, Nigeria.
- Llorens, S., Bakker, A.B., Schaufeli, W., & Salanova, M. (2006). Testing the robustness of the job demands-resources model. *International Journal of Stress Management, 13*(3), 378–391. <https://doi.org/10.1037/1072-5245.13.3.378>
- Marsh, H.W., Guo, J., Dicke, T., Parker, P.D., & Craven, R.G. (2020). Confirmatory Factor Analysis (CFA), Exploratory Structural Equation Modeling (ESEM), and Set-ESEM: Optimal balance between Goodness of Fit and Parsimony. *Multivariate Behavioral Research, 55*(1), 102–119. <https://doi.org/10.1080/00273171.2019.1602503>
- Maynard, S., Jones, W., Filtness, A., Gibb, A., & Haslam, R. (2021). Going underground: Fatigue and sleepiness in tunnelling operations. *Applied Ergonomics, 90*, 103237. <https://doi.org/10.1016/j.apergo.2020.103237>
- Meianto, S., Bahiramsyah, A., & Endri, E. (2021). Work effectiveness in relation with communication, workload, and work discipline. *Linguistics and Culture Review, 6*(S1), 134–145. <https://doi.org/10.21744/lingculture.v6ns1.1998>
- Mossburg, S.E., & Dennison Himmelfarb, C. (2021). The association between professional burnout and engagement with patient safety culture and outcomes: A systematic review. *Journal of Patient Safety, 17*(8), 1307–1319. <https://doi.org/10.1097/PTS.0000000000000519>
- Muthén, B., & Muthén, L. (2017). Mplus. In W.J. Van der Linden (Ed.), *Handbook of item response theory* (pp. 507–518). Chapman and Hall/CRC.
- Myers, J.B., Wages, R.K., Rowe, D., Nollette, C., Touchstone, M., Sinclair, J., Mund, E.L., Eberly, J.M., Montes, J.D., Sherlock, R.J., Barger, L.K., Drummond, S.P.A., & Gurubhagavatula, I. (2018). What an evidence-based guideline for fatigue risk management means for us: Statements from stakeholders. *Prehospital Emergency Care, 22*(1), 113–118. <https://doi.org/10.1080/10903127.2017.1380100>
- National Safety Council. (2020). *NSC Survey: 90% of employers negatively impacted by tired employees*. NSC. Retrieved from <https://www.nsc.org/in-the-newsroom/nsc-survey-90-of-employers-negatively-impacted-by-tired-employees>
- Nielsen, H.B., Hansen, Å.M., Conway, S.H., Dyreborg, J., Hansen, J., Kolstad, H.A., Larsen, A.D., Nabe-Nielsen, K., Pompeii, L.A., & Garde, A.H. (2019). Short time between shifts and risk of injury among Danish hospital workers: A register-based cohort study. *Scandinavian Journal of Work, Environment & Health, 45*(2), 166–173. <https://doi.org/10.5271/sjweh.3770>
- Nolef Turns Inc. (2023). *Risks that come with working a blue-collar job*. Nolef Turns. Retrieved from <https://www.nolefturns.org/risks-that-come-with-working-a-blue-collar-job/>
- Oakman, J., Kinsman, N., Stuckey, R., Graham, M., & Weale, V. (2020). A rapid review of mental and physical health effects of working at home: How do we optimise health? *BMC Public Health, 20*(1), 1825. <https://doi.org/10.1186/s12889-020-09875-z>
- Özsever, B., & Tavacıoğlu, L. (2018). Analysing the effects of working period on psychophysiological states of seafarers. *International Maritime Health, 69*(2), 84–93. <https://doi.org/10.5603/IMH.2018.0013>
- Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using SPSS for Windows* (7th Ed.). Open University Press.
- Patterson, P.D., Weaver, M.D., Fabio, A., Teasley, E.M., Renn, M.L., Curtis, B.R., Matthews, M.E., Kroemer, A.J., Xun, X., Bizhanova, Z., Weiss, P.M., Sequeira, D.J., Coppler, P.J., Lang, E.S., & Higgins, J.S. (2018). Reliability and validity of survey instruments to measure work-related fatigue in the emergency medical services setting: A systematic review. *Prehospital Emergency Care, 22*(suppl 1), 17–27. <https://doi.org/10.1080/10903127.2017.1376134>
- Pinon, A. (2019). Why most psychologists should assess and report personality. *Frontiers in Psychology, 10*, 1982. <https://doi.org/10.3389/fpsyg.2019.01982>
- Reig-Botella, A., Dettaille, S., Clemente, M., López-Golpe, J., & De Lange, A. (2021). Time perspective and the risk of developing burnout: An empirical study among different blue-collar workers in Spain. *Sustainability, 13*(6), 3271. <https://doi.org/10.3390/su13063271>
- Rodger, J.A. (2020). An expert system gap analysis and empirical triangulation of individual differences, interventions, and information technology applications in alertness of railroad workers. *Expert Systems with Applications, 144*, 113081. <https://doi.org/10.1016/j.eswa.2019.113081>
- Roenneberg, T., & Merrow, M. (2016). The circadian clock and human health. *Current Biology, 26*(10), R432–R443. <https://doi.org/10.1016/j.cub.2016.04.011>
- Roets, B., & Christiaens, J. (2019). Shift work, fatigue, and human error: An empirical analysis of railway traffic control. *Journal of Transportation Safety & Security, 11*(2), 207–224. <https://doi.org/10.1080/19439962.2017.1376022>
- Schaufeli, W.B., & Bakker, A.B. (2004). Job demands, job resources, and their relationship with burnout and engagement: A multi-sample study. *Journal of Organizational Behavior, 25*(3), 293–315. <https://doi.org/10.1002/job.248>
- Shanmugham, M., Strawderman, L., Babski-Reeves, K., & Bian, L. (2018). Alarm-related workload in default and modified alarm settings and the relationship between alarm workload, alarm response rate, and care provider experience: Quantification and comparison study. *JMIR Human Factors, 5*(4), e11704. <https://doi.org/10.2196/11704>
- Siravenha, A.C.Q., Reis, M.N.F., Cordeiro, I., Tourinho, R.A., Gomes, B.D., & Carvalho, S.R. (2019). Residual MLP network for mental fatigue classification in mining workers from brain data. In *2019 8th Brazilian Conference on Intelligent Systems (BRACIS)* (pp. 407–412). Salvador, Brazil.
- Steege, L.M., Drake, D.A., Olivas, M., & Maza, G. (2015). Evaluation of physically and mentally fatiguing tasks and sources of fatigue as reported by registered nurses. *Journal of Nursing Management, 23*(2), 179–189. <https://doi.org/10.1111/jonm.12112>
- Stepan, M.E., Altmann, E.M., & Fenn, K.M. (2020). Effects of total sleep deprivation on procedural placekeeping: More than just lapses of attention. *Journal of Experimental Psychology: General, 149*(4), 800–806. <https://doi.org/10.1037/xge0000717>
- Stevellink, S.A.M., Mark, K.M., Fear, N.T., Hotopf, M., & Chalder, T. (2022). Chronic fatigue syndrome and occupational status: A retrospective longitudinal study. *Occupational Medicine, 72*(3), 177–183. <https://doi.org/10.1093/ocmed/kqab170>
- Steyn, H.S., & Swanepoel, C.J. (2008). *Praktiese statistiek* (2nd Ed.). North-West University.
- Tanius, R., & Onghena, P. (2021). A systematic review of applied single-case research published between 2016 and 2018: Study designs, randomization, data aspects, and data analysis. *Behavior Research Methods, 53*(4), 1371–1384. <https://doi.org/10.3758/s13428-020-01502-4>
- Teoh, K.B., & Kee, D.M.H. (2019). Psychological safety climate and burnout: The mediating role of challenge and hindrance demands. *Journal of Management and Marketing Review, 4*(1), 92–99.
- Ternrud, L., Hlebowicz, J., Sandberg, C., Johansson, B., & Sparv, D. (2022). Prevalence of fatigue in adults with congenital heart disease. *Cardiology in the Young, 32*(9), 1432–1439. <https://doi.org/10.1017/S1047951121004297>

- Thanacoody, P.R., Newman, A., & Fuchs, S. (2014). Affective commitment and turnover intentions among healthcare professionals: The role of emotional exhaustion and disengagement. *The International Journal of Human Resource Management*, 25(13), 1841–1857. <https://doi.org/10.1080/09585192.2013.860389>
- Theofilou, P. (2021). Investigation of organizational commitment and Job Satisfaction among employees in the pharmaceutical industry: The effect of fatigue. *Journal of Human Resources Management and Labor Studies*, 9(1). <https://doi.org/10.15640/jhrmls.v8n2a1>
- Tsaneva, N., & Markov, S. (1971). A model of fatigue. *Ergonomics*, 14(1), 11–16. <https://doi.org/10.1080/00140137108931217>
- Valirad, F., Ghaffari, M., Abdi, A., Attarchi, M., Mircheraghi, S.F., & Mohammadi, S. (2015). Interaction of physical exposures and occupational factors on sickness absence in automotive industry workers. *Global Journal of Health Science*, 7(6), 276–284. <https://doi.org/10.5539/gjhs.v7n6p276>
- Van De Voorde, K., & Beijer, S. (2015). The role of employee HR attributions in the relationship between high-performance work systems and employee outcomes. *Human Resource Management Journal*, 25(1), 62–78. <https://doi.org/10.1111/1748-8583.12062>
- Van de Werken, H.J.G., De Vree, P.J.P., Splinter, E., Holwerda, S.J.B., Klous, P., De Wit, E., & De Laat, W. (2012). 4C technology: Protocols and data analysis. *Methods in Enzymology*, 513, 89–112. <https://doi.org/10.1016/B978-0-12-391938-0.00004-5>
- Van Jaarsveldt, W. (2024). Investigating employee fatigue management among blue-collar employees within the South African organisational context: Measurement and intervention [Unpublished doctoral thesis]. North-West University.
- Van Puyvelde, M., Neyt, X., McGlone, F., & Pattyn, N. (2018). Voice stress analysis: A new framework for voice and effort in human performance. *Frontiers in Psychology*, 9, 1994. <https://doi.org/10.3389/fpsyg.2018.01994>
- Vila-Vázquez, G., Castro-Casal, C., Álvarez-Pérez, D., & del Río-Araújo, L. (2018). Promoting the Sustainability of organizations: Contribution of transformational leadership to job engagement. *Sustainability*, 10(11), 4109. <https://doi.org/10.3390/su10114109>
- Wang, I.-A., Tsai, H.-Y., Lee, M.-H., & Ko, R.-C. (2021). The effect of work–family conflict on emotional exhaustion and job performance among service workers: The cross-level moderating effects of organizational reward and caring. *The International Journal of Human Resource Management*, 32(14), 3112–3133. <https://doi.org/10.1080/09585192.2019.1651373>