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Identifying Occupational Stress and Coping Strategies

Edited by Kavitha Palaniappan

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Contributors
Krupal J Joshi, Bhautik Modi, Sanjay Singhal, Sanjay Gupta, Rajani G. Tumane, Shubhangi K. Pingle, Avinash S. Gaikwad, Ravichandran Beerappa, Nassir-Maru Yesuf, Ayoola Awosika, Mayowa J. Adeniyi, Richard M. Millis, Serah F. Ige, Erebouni Arakelian, Kavitha Palaniappan

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Meet the editor

Assistant Professor Dr. Kavitha Palaniappan is the project lead for Health Services Regulation at the Centre of Regulatory Excellence at Duke-NUS Medical School, Singapore. She is currently working on identifying regulatory gaps based on the new trends in the health services sector. Dr. Palaniappan is also actively involved in multi-disciplinary research, including the prevalence of psychosocial illnesses and their impacts on society, economy, and country. She also researches alternative therapies to enhance sleep, yoga and its health benefits, the toxicity of nanomaterials, exposure measurements and hygiene requirements for nanomaterials, associations between seasonal patterns, climate variables, and dengue risks in Singapore. She is also a conjoint associate professor at the University of Newcastle, Australia.

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Preface

People believe that when one is happy and content while performing a particular task, then that task should be their occupation. However, almost all tasks come with their own stress factors, and depending on the timeframe and accuracy the task requires to be completed, the stress levels vary. Hence, occupational stress is inherent to any task, whether the person does it with utmost interest and happiness or without any willingness to do it. It is important to understand that every work or occupation comes with a certain level of stress and the solution is not quitting the work but rather seeing how one can cope with that stress and complete the work successfully.

This book identifies the factors associated with occupational stress and the effectiveness of certain coping strategies, specifically with regard to the mining industry and hospital settings. Chapter 1 introduces the concepts of occupational stress and the ways in which it manifests itself in different individuals. It rationalizes the various theories behind the occurrence of occupational stress and lists the causes of occupational stress. The chapter concludes by providing some of the coping strategies that could be explored in different occupational settings to overcome stress.

Chapter 2 describes the various biomarkers that can be used to identify occupational stress, specifically in industrial workers, taking the mining industry as an example. This systematic review showcases the pathophysiological changes that take place in humans as a response to occupational stress. The chapter concludes by highlighting the importance of interventions to reduce such occupational stress in industrial workers.

Chapters 3–5 are dedicated to healthcare professionals and deal with the various factors that contribute to occupational stress in physicians, front-line healthcare workers, technicians, nurses, perioperative nurses, and anesthesiologists. The chapters discuss prevalence rates, factors associated with burnout, and a potential framework for the well-being of healthcare workers.

Finally, Chapter 6 focuses on coping strategies to overcome occupational stress. It compares the efficiency of certain approaches such as teamwork and conflict resolution and discusses the types of power and stress management strategies between public and private entities. The chapter finds team spirit and emotion-focused coping strategies to be useful.

This book provides a comprehensive overview of the prevalence of occupational stress in various healthcare settings and certain industrial sectors across the globe

and highlights the importance of both government and private entities to come up with various interventional coping strategies to take care of their employees.

Kavitha Palaniappan
Assistant Professor,
Centre of Regulatory Excellence,
Duke-NUS Medical School,
Singapore

Chapter 1

Introductory Chapter: Occupational Stress and General Coping Strategies

Kavitha Palaniappan

1. Introduction

The American Psychological Association's Dictionary of Psychology defines Occupational Stress as "a physiological and psychological response to events or conditions in the workplace that is detrimental to health and well-being" [1]. Such responses do vary from individual to individual, and it depends on several factors such as the level of autonomy, responsibility and independence that the individual has in his or her workplace, the amount, pace and type of work that needs to be performed, the level of safety and security associated to the work and finally the relationships that the individual maintains with his or her colleagues and supervisors.

Occupational stress may manifest itself in one or more of the following three different ways: (i) physical strain—affecting the various parts of the body and this is the most common way by which occupational stress manifests itself. It can range from having mild headaches or body pain to severe migraines; (ii) psychological strain—affecting the rationale thinking abilities of an individual and can lead to loss in memory and concentration or depression and anxiety; (iii) behavioral strain—causing a change in the usual or normal habits of an individual, like, for example, binge eating or starving, excessive or loss of sleep, ignoring to perform regular tasks or duties and avoiding responsibilities and absenteeism.

The necessity to study occupational stress stems from the fact that it can have significant effects on both the physical and mental wellbeing of an individual and also an impact on the productivity of the workplace, which can have a negative impact on the global economy in turn. The Safety and Health at Work team of the International Labour Organization (ILO) found that the direct and indirect costs of occupational stress are in the range of billions of dollars annually all over the world [2].

The "State of the Global Workplace 2022 Report" by Gallup reports the results of the worldwide survey on the workplace wellbeing and shows that around 44% of the employees experience occupational stress around the world. Looking at some of the important factors that could have contributed to the occupational stress from the study, the United States and Canada have the highest regional percentage of engaged employees (33%), whereas Europe has the lowest regional percentage of the engaged employees (14%). Engaged employees refer to the employees who enthusiastically participate in all the activities of their work and are happy as their basic needs are met and are able to contribute positively to the organization. We could consider the second important factor as the percentage of employees living comfortably on their

present household income which was found to be highest (55%) in Australia and New Zealand and lowest (10%) in Sub-Saharan Africa. The third factor is the social factor, which refers to the way by which employees were treated in their organizations—South Asia, which includes India, Sri Lanka, Bangladesh, Nepal, Pakistan and Afghanistan, had the highest regional percentage of respondents (19%) who felt that there were not treated with respect at their workplaces [3].

2. Theories for the occurrence of occupational stress

There are a few theories in the field of psychology to explain the occurrence of occupational stress (**Figure 1**). The first and most accepted theory is the demand-control model wherein stress can happen when the workload is high; however, the decision-making authority is low. Alternatively, when the workload is high and there is a significant lack of resources or support to perform that job, that can also lead to stress and in that case, the demand-resource model would be applicable. Stress can occur when the skills, abilities and attitude of the employee do not match the requirements of the job, and this is called the person–environment fit model. When the efforts put in for a particular job are not rewarded appropriately in the form of pay or fair treatment or even a mere appreciation, it can lead to stress, and in this case, it is referred to as the effort–reward imbalance model. Finally, as indicated at the start of this chapter, it is also important to understand that the ability to cope to various stressful conditions differs from individual to individual, and when the stressors go beyond an individual's ability to cope with stress, then, it is referred to as the diathesis–stress model.

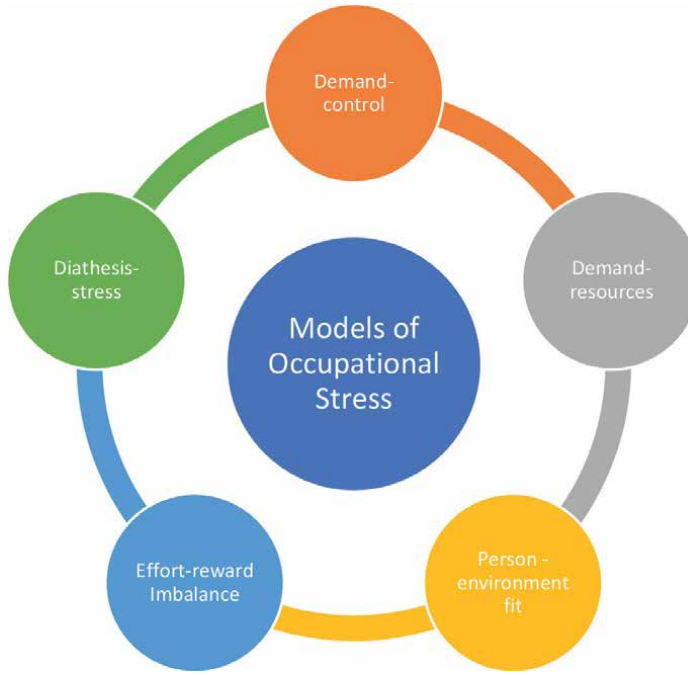

Figure 1.
Models to explain the occurrence of occupational stress.

3. Cause of occupational stress

One may argue that the causes of occupational stress may not be solely due to the workplace conditions and that there are possibilities of personal factors stemming from an individual's family or social life that could have an impact on their physical and mental wellbeing. However, scientific evidences do show that several workplace conditions contribute to occupational stress in a significant manner. The various causes of occupational stress are depicted in **Figure 2**.

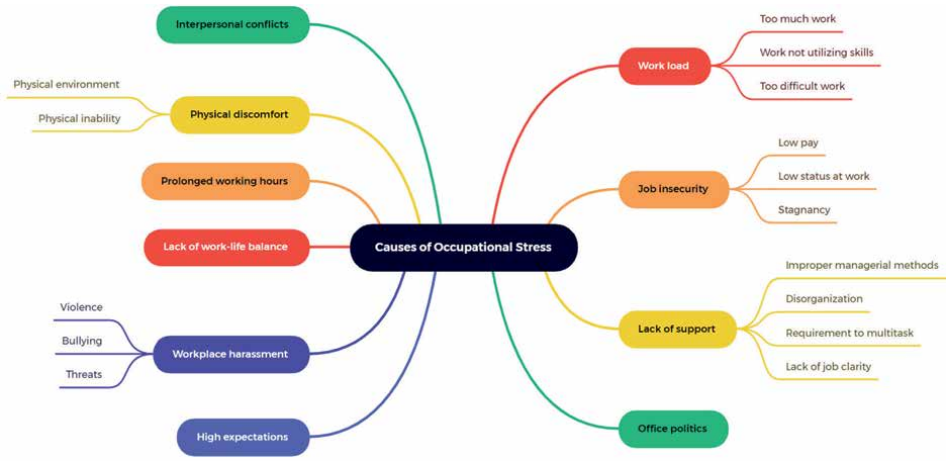

Figure 2.
Causes of occupational stress.

4. Coping strategies

In order to manage stress, it is essential to change ones' own cognitive and behavioral efforts in dealing with the external or internal stimuli that is causing the stress and this is referred to as coping. Coping strategies can be worked out at both organizational level and also at personal levels. When it comes to organizational levels, it is first important for the management to understand the causative factors in the organization and come up with suitable measures. NIOSH recommends the following strategies for organizations to help their employees cope with occupational stress [4]:

- Managers should keep monitoring the workload of sub-ordinates and see to it that the workers are allocated work that is well within their skills set and capabilities and can also be reasonably completed within the time frame given;

- Each job must come with a clear description of its scope of work and roles and responsibilities;

- Sufficient resources should be available for the employees to complete the tasks;

- If new tasks are to be performed, especially with advancements in technology require employees to do tasks that may be beyond their current capabilities, then, suitable training should be given to them before they can undertake those specific tasks;

- Communication channels must be transparent, and all employees should be given an opportunity to voice out their opinions and decisions;

- Different leadership styles can be explored to figure out which style works well for the organization and its employees.

On personal front, there are a few coping strategies that an individual can explore to overcome occupational stress. First among them is seeking social support—irrespective of what the social support can provide, be it in terms of advice or suitable contacts or material help or just a distraction, getting in touch with a human contact is valued when one is undergoing stress [5]. Seeking social support is also said to help an individual to overcome exhaustion and work–family conflicts [6]. The next strategy is the "problem-solving" strategy, wherein the individual can put up a fight against the stressor, and this goes beyond just identifying the stressor. Studies have also shown that the problem-solving strategy helps an individual to gain more control over the job and thus overcome occupational stress [7]. The last strategy is the "avoidance" strategy which is equated to running away from the stressor and is a form of escapism [8]. Even though studies have shown a positive correlation between avoidance and emotional exhaustion [9], certain longitudinal studies indicate that avoidance can potentially lead to depression 10 years down the road or more chronic and acute conditions 4 years later [10].

5. Conclusion

All kinds of work require some amount of physical and mental effort and hence when done over a long period of time can lead to stress. Mental wellbeing is being spoken about all over the world, and several leaders across the globe are coming up with strategies such as four-day workweek or remote working to reduce the amount of time that an individual spends at work and ensure that he or she is able to attain work–life balance. However, it is usually not the amount of time spent at workplace that is the stressor, but what happens during the work time, irrespective of whether it is at home (while working remotely) or at office is what matters. For example, it is almost impossible for an individual to forget a berating that he or she received during the day from his or her boss even after returning home and may even have a disturbed sleep due to that. Studies on burnout indicate that all the biggest sources of occupational stress come from an individual's boss—unreasonable timelines, lack of support, heavy workload, unfair treatment and unclear communication [3]. Hence, managers have to realize that with the mental wellbeing of their workers comes an increase in productivity and profit; hence, they must lend a listening ear to their issues at the workplace and try to sort things out so that it becomes a win-win situation for both parties. When coping strategies are implemented from both fronts, that is, from the management and from the employee, it would be much easier to get relieved from occupational stress.

Author details

Kavitha Palaniappan
Centre of Regulatory Excellence, Duke-NUS Medical School, Singapore

*Address all correspondence to: kavitha@duke-nus.edu.sg

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References

[1] APA. APA Dictionary of Psychology. 2023. Available from: https://dictionary.apa.org/

[2] Forastieri V. Why workplace stress is a collective challenge and what to do about it [News]. 2016, April 27. Available from: http://www.ilo.org/global/about-the-ilo/newsroom/comment-analysis/WCMS_475077/lang--en/index.htm

[3] Inc G. State of the Global Workplace Report. United States of America: Gallup; 2022. Gallup.com. Available from: https://www.gallup.com/workplace/349484/state-of-the-global-workplace-2022-report.aspx

[4] NIOSH. STRESS...At Work (99-101) – NIOSH – CDC. 2014, June 6. Available from: https://www.cdc.gov/niosh/docs/99-101/#What%20Can%20Be%20Done%20About%20Job%20Stress?

[5] Reid KM, Taylor MG. Social support, stress, and maternal postpartum depression: A comparison of supportive relationships. Social Science Research. 2015;**54**:246-262. DOI: 10.1016/j.ssresearch.2015.08.009

[6] Karatepe OM. The effect of positive and negative work-family interaction on exhaustion: Does work social support make a difference? International Journal of Contemporary Hospitality Management. 2010;**22**(6):836-856. DOI: 10.1108/09596111011063115

[7] Chiang FFT, Birtch TA, Kwan HK. The moderating roles of job control and work-life balance practices on employee stress in the hotel and catering industry. International Journal of Hospitality Management. 2010;**29**(1):25-32. DOI: 10.1016/j.ijhm.2009.04.005

[8] Amirkhan JH. A factor analytically derived measure of coping: The coping strategy indicator. Journal of Personality and Social Psychology. 1990;**59**(5):1066-1074. DOI: 10.1037/0022-3514.59.5.1066

[9] 'Sunny' Hu H-H, Cheng C-W. Job stress, coping strategies, and burnout among hotel industry supervisors in Taiwan. The International Journal of Human Resource Management. 2010;**21**(8):1337-1350. DOI: 10.1080/09585192.2010.483867

[10] Holahan CJ, Moos RH, Holahan CK, Brennan PL, Schutte KK. Stress generation, avoidance coping, and depressive symptoms: A 10-year model. Journal of Consulting and Clinical Psychology. 2005;**73**(4):658-666. DOI: 10.1037/0022-006X.73.4.658

Chapter 2

Impact of Occupational Stress and Its Associated Factors on Cognitive, Hormonal and Stress Responsive Protein in Mining Based Industrial Workers

Rajani G. Tumane, Shubhangi K. Pingle, Avinash S. Gaikwad and Beerappa Ravichandran

Abstract

Rapid globalization and technological advances have transformed the way of working. Occupational stress is psychological and physical condition that has potential to worsen a person's health in any workplace. Stress related productivity impairment were common in mining industries. Lack of skills, organizational issues, and a social support at workplace can all cause workers to experience stress. Therefore, hypothalamus-pituitary-adrenal (HPA) axis and sympathetic nervous system are activated as part of the body's physiological reaction. Hence chronic stress were linked to digestive, cardiovascular, atherosclerosis, and neurological issues. Numerous studies reported, several biochemical and pathophysiological factors were responsible for occupational, environmental, and workplace depression. This review chapter were included studied from PubMed, Google, book chapters, case reports, and other electronic databases, etc. Total (n = 104) articles were selected related to occupational stress and its impact on biochemical and pathophysiological were experienced in them. Workers who experienced occupational stress underwent pathophysiological changes that leads to changes in the stress hormones, sensitive stress protein and other significant variables. Finally, cortisol, stress hormones, PTH, HO-1, cytokines used as a panel of marker for stressful conditions evaluation in occupational settings. These findings, advice interventions that will be reduce, or eradicate some of these stressors in occupational settings.

Keywords: hormones, mining, neurological problems, occupational stress, pathophysiological changes, stress responsive protein

1. Introduction

World Health Organisation (WHO) reported that occupational stress is epidemic and characterised by the physical and mental toll that results from an imbalance between a people capability to manage with work-related stress and their objective

goals in occupational contexts [1, 2]. International Labour Organisation (ILO) reported, annually 2.34 million person die in occupational mishap and 25% deaths are attributable to dangerous and unhealthy occupational settings [3, 4]. Furthermore, non-fatal work-related disorders affected 160 million people. More than 200 million and 16 million workers exposed to various occupational toxic hazards and harmful exposures in factories respectively [5]. People are working harder than ever to improve society, jobs, education, health, and quality of life. Studies reported that the delicacy disorders brought via occupational related burnout in the US ranged from $500 to $1000 billion US dollar [6–8]. Other studies reported a favourable psychological and physiological condition in workers was maintained by factors like gender, age, and personality as well as self-perception, self-confidence, and stress tolerance [9, 10]. However, stress has a detrimental effect on employees' physical, emotional, and overall quality of life. These results into decreased output, job absenteeism, a loss of professional effectiveness, an increase in accident cases, a decline in morale, and interpersonal conflicts with subordinates [11–13]. Pilots, nurses, accountants, teachers, university employees, and managers have all been the subject of prior research that looked at occupational stress [14].

In occupational setting, miners and factory workers who were working in high stress condition and industrial demanding work environment. Exposure to hazardous substances in mining occupations affected biological system of human being. Several studies has been reported that metals, dust, noise, chemical factors, physical factors responsible for employees' psychological health problems leading to occupational burnout in humans but its cellular mechanism is still unclear in biochemical processes [15]. Further, hippocampus is the main part of the brain expresses the reaction of stressful stimuli which is responsible for involvement of distinct network reaction for occurrences of stress. Stress were also responsible for secretion of hormones including epinephrine and nor norepinephrine via by neuroendocrine mechanism. On the other hand, glucocorticoids were secreted by adrenal gland (hypothalamus pituitary adrenal). This leads to disturb oxidant and antioxidants levels responsible for development of oxidative stress in the human. Studies reported that the exposure to dust may cause various metabolic alterations in the biochemical, hormonal regulatory processes. These processes has potential to induce toxic effects in lung tissue of workers. Previous studies reported neurasthenia, anxiety disorder, and depression, occupational stress and psychological health problems due to occupational stress in different occupational groups [16, 17]. These findings necessitated further research on mine workers for evaluation of health risks due to occupational exposure to different pollutants. With this view, exposure markers, hemeoxygenase-1 (HO-1) and parathyroid hormones were targeted due to its special reference to occupational exposure to dust and development of job related stress in the workers. Studies reported that HO-1 was rate limiting enzyme which is induced in the lung during occupational stress condition. Other mechanism reported that parathyroid hormone (PTH) is involved in calcium regulation which is secreted by parathyroid gland and control by nervous endocrine system but overload of aluminium replaces calcium because of its same valence which suppression PTH levels in the Bauxite dust exposed workers in the occupational settings [18]. Limited attentions were noted to find out relationship between occupational stress and human individual factors were responsible for causing stress in the occupational setting workers. Studies on exposure biomarkers, aims to explore the occupational exposure to pollutants may be responsible for development of occupational stress through physiology, neurobiology, and stress proteins in the workers. It will also need to find out its impact on the quality of life of worker in the occupational settings.

2. Methodology

The MeSH (Medical Subject Headings) databases are the NLM controlled vocabulary thesaurus that were used for indexing articles such as occupational stress in workplaces, related diseases, factors affecting stress, consequences, occupational stress physiology and neurobiology, hormones involved in stress neurobiology and its mechanism of action, stress responsive parathyroid hormone (PTH) in occupational settings, stress responsive protein in occupational settings, oxidative stress markers in industrial based mining workers. Initial searches limited to materials available with complete abstracts and those available in the English language were included. Published articles were searched from numerous electronic databases including PubMed, Google, Cochrane library, free PMC article, koreamed, hinari publication, scopus indexed journal, virtual health library, audicus, NCBI databases, Indexing of Indian Medical Journals (INDMED), and PakMediNet—Medical Information Gateway of Pakistan etc. Systematic reviews, book chapters, review and research papers, and case studies pertaining to workplace stress in industrial settings were also included. Articles about stress in healthcare facilities, IT workplaces, academic institutions, and government institutions were omitted. Articles that only described the procedures or offered opinions or news were also disqualified. The review chapter were includes literature from 1986 to 2021 period (last 20 years) to study oxidative stress in mining based industrial subjects. A total of (n = 104) papers were chosen that discussed the effects of occupational stress on industrial employees' biochemistry and pathophysiology in stress conditions. According to the electronic database, very few published articles regarding stress protein expression in occupational stress conditions in mining based industrial workers from India were reported, This review chapter, discussed about occupational stress and its associated factors in workers which is continuously exposed to chemicals, dust, environmental pollutants, and hazardous toxicants had impact on their biochemical, pathophysiological, molecular, neurological, immunological, endocrine, and respiratory mechanisms alteration in them. These alteration may provide future insights regarding importance of occupational stress in them at workplace environment.

3. Factors affecting stress

Several industrial and organisational works related factors were found to be responsible for development of workplace stress. Bhatti et al. reported, 67% of the stress that employee's experiences were caused by both intra- and extra-organisational factors, with workload serving as the primary culprit [19]. Scientists had given more attention that one-third of the working population in affluent nations has moderate to severe levels of stress. Because of work environmental condition, its management and work consignment influences on employee physical and mental health. Similar research for newly industrialised nations also suggests that time constraints, unreasonable demands, role conflicts, poor ergonomics, job security, and relationships with customers are some of the most frequent sources of stress for workers in the financial services industry [20]. Furthermore, as a result of increased human involvement with computers, new stressors have emerged, including computer failures, computer slowdowns, and electronic performance monitoring etc. Many scientists reported that there are many moderate and non-moderated occupational stress factors that were contribute to occupational stress including working shifts,

sedentary, repetitive, lack of safety, monotonous work techniques, collaborative activities, uncontrollable jobs, physical elements (heat, noise, lighting, chemical elements like odour), interpersonal relationships of superiors at workplace, uncertainty, conflict, overwork, career development, reward, promotion, job security, and certainty of future employment [21–23]. Role of stress and key organisational outcomes have a complex link that can range from positive to negative results of various intensities responsible for affecting stress in humans at occupational settings [24].

4. Consequences of stress

A serious global problem is how occupational stress affects different occupational setting workers. A recent survey done by banker association found that 69% of banking and their staff were working in stressful condition and 50% reported psychological distress. Workers with low-back, hand, and arm issues as a result of linking musculoskeletal illnesses with the workplace, taking into account individuals, job tasks, and work environments, leave their positions and decrease the economic productivity of the country [25]. Workplace stress, way of life, and personal downtime have all been linked to the appearance of occupational stress in workers responsible for development of mental problems in them. Mining based industrial and factory workers were working relatively poor environment for longer period of time with no ventilation. Those workers belongs to below poverty line were responsible for varying degrees of job stress that affect workers quality of life [26]. Scientists have found that moderate and non-moderated occupational stress were responsible for hypertension, immune, nervous, and digestive impairment, depression, ischemic heart disease, psychological symptoms were responsible for reduction in the ability of employees to cope with their work [27–29]. Therefore, individuals may consume alcohol, reduction in appetite, and organisational performance [27–30]. Finally, individual, organisational-related components, behavioural disorders, family conflicts were might avoid people moving to do work, use drugs or drink excessively. Non moderated occupational stress was detrimental to professional workers' as well as disturb health and quality of life in job settings. Several studies were focused on workplace stress in medical staffs and banking employees who experienced higher levels of occupational stress had lower quality of life [29–31]. Therefore, occupational stress at workplace had described about unusual physiological, psychological, and behavioural reactions in workers due to occupational stress.

5. Occupational stress physiology and neurobiology

Technological advancements and rapid globalisation have changed the people how to work in ambient environmental conditions. In mining sectors, workers are constantly subjected to occupational and stress-related productivity degradation. The processing of work and coping with challenging situations needs the activation of intricate brain-body mechanisms. Neuroendocrine networks are involved in the different type mechanism and hippocampi expressed vide variety of stressful stimuli in the brain [32]. Homeostasis mechanism well maintained by the interactions among body organ systems and, its metabolic processes responsible for the release of free radicals including peroxynitrite radicals, hydrogen peroxides, superoxide anions, reactive oxygen species (ROS), and nitric oxide radicals in response to oxidative stress [33–36]. Studies well reported that stress condition were responsible for the

secretion of epinephrine, norepinephrine, and glucocorticoids hormones via neuroendocrine system in the brain. On the other hand, non-genomic, genomic, epigenetic processes, immune system stimulation, energy mobilisation, metabolic changes, and systemic inhibition were involved in the development of the oxidative stress in humans. Scientists placed more attention towards changes in cellular, synaptic and neural flexibility take place in combination with proinflammatory signals. Together, body-brain connection governs physiologic and behavioural changes were necessary for survival and sustainability [32, 37, 38]. Focusing on health hazardous problems and its impact on the workers in occupational settings disturbs mental and social health determinants in them. Studies reported that heavy metal fumes and dust exposure including, aluminium, lead, manganese, copper may get deposited into the brain. Excessive overload of heavy metals which cross the blood brain barrier and causes Alzheimer, Parkinson's schizophrenia and neurological diseases. The symptoms such as trembling slow motor movement, severe depression, anxiety, and loss of memory were well reported in them. Therefore, neuronal cells network mechanism was highly responsible for development of psychological problems due to oxidative stressors in them. However, neurotransmitter in the brain have neuronal connections which causes to release of proinflammatory cytokines directly responsible to disturb neurological mechanism and developed psychological issues in exposed workers [39, 40].

6. Hormones involved in stress neurobiology and its mechanism of action

Stress condition perturbs homeostasis of the human being gives large influences on human behavioural, endocrine system and cellular levels. Sympathetic (arousal) and parasympathetic (relaxation) nerve systems make up the autonomic nervous system. The automatic nervous system controls essential organs as well as visceral functions like respiration, digestion, circulation, and temperature regulation. In stress condition, the hypothalamus carries several distinct tasks which secretes arginine vasopressin, antidiuretic hormone, stimulates the hypothalamus gland. Scantamburlo et al. [41] claim that anterior pituitary gland results into production of ACTH in response to corticotropin releasing hormone (CRH) [40, 42]. Further, adrenal cortex (outer part) is stimulated by ACTH to release corticoids (glucocorticoids and mineralocorticoids). The main function of glucocorticoids is to release energy by conversion of glycogen into glucose and breakdown of fats into fatty acids and glycerol, which is needed to combat the negative consequences of a stressor [41, 43–45]. In addition, corticoids which inhibit the immune system, reduce hunger, aggravate gastrointestinal irritation, and associated feeling of depression and loss of control in stress conditions. On the other hand, aldosterone, a mineralocorticoid, encourages the retention of Na^+ and the removal of K^+. These reaction results into high blood pressure, heart rate, dilated pupils, constricted arteries to non-working muscles, and force to cardiac contraction. In addition, ADH known to maintain the blood pressure during stress when the body's equilibration is upset. Regulating fluid loss through the urinary system is the primary function of vasopressin (ADH), which is produced by the hypothalamus and released by the posterior pituitary. Further, the second significant alteration occurs during release of energy and distributions of energy to different organ system were needed. In addition, growth hormone (GH) and thyroid hormones played important role in stress condition. Due to stress condition, GH and thyroid hormones increased psychological stimuli in humans [46]. The thyroid gland secretes thyroxin and triiodothyronine which plays very important role

in the management of stress in the human body. Thyroid hormones' primary purpose is to boost basal metabolic rate, and raises heart rate and increase in the levels of catecholamines in stress situation. Despite, stress hormones, serotonin and melatonin are linked to mood. Depression is well connected with neurological problem and its reduction in stress in occupational setting is well reported [47–50].

Depression is well connected with neurological problem and its reduction in stress hormones in occupational setting are well reported [47–50].

7. Oxidative stress markers in mining workers

The oxidants and antioxidants imbalance causes oxidative stress, which disrupts redox signalling and physiological function of the cell in humans. OS executed redox signalling-induced alterations, which might alter transcriptional activity, kinases networks, and apoptosis [51–55]. Studies reported that s-nitrosation, disulfide linkages, s-nitrosylation, S-glutathionylation, and sulfenylation proteins undergo discrete, reversible, and site specific alterations of cysteine residues to create redox signalling [56–58]. Exploring their potential clinical applications, nevertheless, continues to spark growing interest. Studies on oxidative stress markers in a variety of human diseases are being reported in published manuscripts. Thus, lot of focus on the analytical challenges needs to validate oxidative stress indicators in stressful condition [59, 60]. Although numerous indicators and techniques are employed but many of them lack strong correlations, fail to accurately reflect oxidative stress, and lack of specificity in occupational diseases in dust exposed workers. Recent studies reported that black lung in coal workers is caused due to bioavailable iron (BAI) present in the coal dust. The iron occurs in the coal dust reacts with the oxygen and oxygen peroxide and forms ROS. The ROS acts as a mediators which stimulate the activation of alveolar macrophage, immune cells and tend to release cytokines. The lung is a vulnerable organ to exogenous ROS because of its anatomy, function, and location where development of pulmonary diseases due to endogenous ROS. The lower respiratory tract becomes clogged with inflammatory mediators and activated phagocytotic cells, which produces ROS to protect respiratory system from environmental pollutant in the occupational settings. However, deposition of dust particle in alveolar macrophages activates the lung oxidative stress mechanism through the release of pro-inflammatory marker by ROS which damages DNA, protein, lipids etc. which causing lung disease in exposed workers. Studies confirmed that OS and the pro-inflammatory cytokines were involved in the progression of fibrotic lung disease in coal dust-induced pneumoconiosis, and progressive massive fibrosis (PMF) [61–64]. Recently, oxidative stress markers were reported in developed in-vitro model of alveolar epithelial (A549) and monocytic lung (U937) cell line for pneumoconiosis along with antioxidant enzymes. Oxidative stress parameter in the alveolar macrophage and lung epithelial cells exposed to coal dust results in the significant elevation in the oxidative stress markers NADPH, MPO, MDA and PC & reduction of antioxidant content (i.e. SOD, CAT and GSH). Results indicated that imbalance in the generation of ROS species and antioxidant enzyme could be one of the key payers to initiate the inflammation causing chronic tissue damage and fibrosis in the lung tissue. Coal exposure played a key role in the aetiology of asthma and chronic bronchitis (CB) [65–67]. By looking at oxidation target products, such as malonoaldehyde (end product of Lipid peroxidation), DNA damage, protein carbonyls, 8-isoprostane, DNA oxidation, and other oxidative stress markers generated by ROS can be evaluated either directly or indirectly. They can be used to evaluate

oxidative stress in humans since they are molecules whose structures have been altered by ROS. Antioxidant molecules including glutathione, protein thiols, and enzymatic antioxidant activity are further biomarkers of oxidative stress and key players in the body's antioxidant defence mechanism and a subject of extensive research [68, 69]. Finally, antioxidant enzymes, oxidants and proinflammatory cytokine markers may be used for OS in occupationally developed diseases in exposed workers.

8. Stress responsive parathyroid hormone (PH) in occupational settings

Corticosterone (CORT) is stress regulating hormone in human and its reduction in cortisol levels causes low blood pressure, fatigue, weakness in stress condition. Addison's disease, damage adrenal gland, neurological, immunological and metabolic effects were reported in stress condition. Importantly, CORT is responsible to reduce calcium absorption levels and reabsorption from intestine, kidney by increasing the secretion of PH hormones [50, 70, 71]. Parathyroid hormone involved in the calcium regulation which is secreted by parathyroid gland and control via hypothalamus axis. The main mechanism of action of PTH that exerts its effects on kidney, bone and intestine via tubular reabsorbtion and absorption of calcium. Scientists reported that interconnection between parathyroid gland and CORT during first trimers were maintained via differentiation of bone cells and chondrocytes [72]. Recently, PTH suppression in occupationally Bauxite dust exposed workers were reported at the time smelting, mining operations, and beneficiation of Bauxite but its impact in response to stress were less approached by scientists [73, 74]. Therefore, experimental studies reported that aluminium overload supressed PTH levels but still not yet confirmed and indistinguishable that whether Al involved in decline in synthesis/release of PTH because aluminium toxicity effect on bone metabolism and changes in calcium and phosphorus can be modulated by PTH [75, 76]. Earlier reported that Aluminium suppresses PTH by increasing calcium levels and directly affected PTH synthesis this suggested that direct approach is frequent and important as compared to indirect PTH inhibition. Therefore, agreed with serious effects of aluminium in bones that is multi factorial which alters mineralisation, cellular activity of bone cells and leads to cell death because of alteration in cell metabolism [77–80]. The interconnection of aluminium, Calcium, and PTH were well reported but in context to occupational Bauxite dust exposed workers studies not yet reported. In-vitro and in-vivo studies showed that both indirect and direct methods helped evaluation of effect of Al on parathyroid function. Decreased level of PTH with increased Al levels were observed in the occupationally dust exposed bauxite workers. Further, significant negative correlation were observed between PTH and blood aluminium levels and inverse correlation were noted between PTH and calcium. Other studies reported that Al overload decreased PTH and calcium in circulating system [80, 81]. From this studies were suggested that direct and indirect PTH regulation mechanism and Al interferes in PTH secretion/release rather than its synthesis.

9. Stress responsive protein in occupational settings

Heme oxygenase-1 (HO-1) has been identified in many different cell types from lower to higher organisms to tolerate the different forms of stress. Environmental influence alters the pattern of cellular protein expression, performs physiological

activities by acting as a molecular chaperon [82]. Anti-inflammatory actions of HO-1 (rate limiting enzyme) in biochemical pathways are may be due to breakdown of the pro-oxidant heme by own, signal effects of carbon monoxide (CO), the antioxidant biliverdin/bilirubin, and the sequestration of free iron by ferritin in human. Stress responsive HO-1 protein has ability to inhibit inflammation and provide cytoprotection that can be attributed through by-product of HO-1. Heme oxygenase another form of protein, HO-2 were present in neurones and astrocytes, but HO-1 generally worked as inducible form in cell types of central nervous system and by product of HO-1 performs similar work [83, 84]. Numerous stimuli can induce HO-1 gene expression, including oxidative stress and Aβ peptides [85–88]. Induction of HO-1 occurs due to inflammatory processes insults of the cells by environmental factors and the activation of an oxidative stress generated by nuclear factor erythroid 2-related factor-2 (Nrf2), Interleukin-1 (IL-1), and other inflammatory markers. Induction of HO-1 were regulated through Nrf2 contain transcription factor BTB and CNC homology 1 (Bach1) competes with Nrf2 and represses transcription factors [89, 91]. The Nrf2 present in the cytoplasm which interacted with Kelch-like ECH associating protein 1 (Keap1). Keap1 which regulated Nrf2 activity and behave as a sensor for oxidative and electrophilic stresses, degraded by the ubiquitin proteasome pathway. Finally, Nrf2 slightly accumulated in the nucleus and inhibited transcription of the HO-1 gene. Thus, Nrf2-Keap1 complex system played as role in defence mechanism in human [92–95].

In occupational settings, high levels of HO-1 were reported due to bauxite dust exposure and responsible for catabolism of heme in aluminium exposed workers [96]. High levels of Al reported in bauxite exposed workers were assorted and its cellular mechanism fails to appear in published article. Other studies reported that decrease in the level of haemoglobin and high levels of HO-1 in Bauxite dust exposure group which may be due to increased catabolism of heme and generation of ROS and OS in them [97]. Previous study reported that HO-1 deficient and heavy metal exposure at cellular level were more prone to cytotoxicity injury. The functional role of HO-1 induction in OS is not well established in the occupational settings. HO-1 exerts protective role as neurodegenerative, cardiovascular, cancer, metabolic, iron metabolism disorders and various inflammatory diseases in human after oxidative injury [98]. Scientist gave more attention towards role of Ho-1 in silicotic patients, respiratory diseases, and asthma in sub mucosal macrophages and airway epithelium which helps to defend against the insults in lungs in the occupational settings [99–104]. However, induction and molecular regulation HO-1 acts as a anti-inflammatory, antioxidative and antiapoptotic and in response to oxidative stress.

10. Conclusion

The current chapter, assessed the trends in global research on stress at occupational settings. For the enrichment of life in the mining industries and other workplace areas, workers were continuously working in stressful job environments for the betterment of life in mining industries and other workplace areas. In stressful environment, subjects were exposed to chemicals, dust, environmental pollutants and hazardous toxicants ultimately alters biochemical, pathophysiological changes, molecular, neurological, immunological, endocrine, and respiratory mechanisms alteration in them. The deposition of dangerous pollutants in brain, kidney, lungs and

other part of human system and results into the occurrences of several serious health hazards and diseases in exposed workers. Its impact reported neurological, oxidant and antioxidant level changes, respiratory illnesses, Alzheimer's, Parkinson's, infectious issues, and immunological disturbances in exposed workers of occupational settings. This study's findings were significant for understand the epidemiological issues in occupational settings, which has drawn increased attention. According to reports, high income, control job categories that were linked to lower job stress. However, a psychological problem, which has a positive predictive impact on quality of life, is a mediator in the association between occupational stress and quality of life. Growing health concerns have raised awareness of the importance of researching difficult technologies that have not been used in India yet. Research suggests that cortisol, epinephrine, non-epinephrine, PTH, HO-1, antioxidant enzymes, proinflammatory cytokines, prooxidant levels were helpful as a panel of marker for evaluation of significant stressful conditions in exposed subjects. The growing health concern has been an increasing awareness about the need to do study on occupational stress factors yet not implemented fully in India. Study findings could help to advise interventions that reduce, minimise or eradicate some of these stressors in occupational settings.

Author details

Rajani G. Tumane, Shubhangi K. Pingle*, Avinash S. Gaikwad
and Beerappa Ravichandran
ICMR-Regional Occupational Health Centre (S), NIOH, Bengaluru, Karnataka, India

*Address all correspondence to: pingle.shubhangi@gmail.com

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References

[1] van der Meij L, Gubbels N, Schaveling J, Almela M, van Vugt M. Hair cortisol and work stress: Importance of workload and stress model (JDCS or ERI). Psychoneuroendocrinology. 2018;**89**:78-85

[2] Qian LJ. Strengthen the study of occupational stress in China. Chin. J. Occup. Dis. Lab. Health. 2003;**21**:1-2 (In Chinese)

[3] Lu Y, Zhang Z, Yan H, Rui B, Liu J. Effects of occupational hazards on job stress and mental health of factory workers and miners: A propensity score analysis. BioMed Research International. 2020;**2020**:1754897. DOI: 10.1155/2020/1754897

[4] Chartres N, Bero LA, Norris SL. A review of methods used for hazard identification and risk assessment of environmental hazards. Environment International. 2019;**123**:231-239

[5] Shafiei M, Ghasemian A, Eslami M, Nojoomi F, Rajabi-Vardanjani H. Risk factors and control strategies for silicotuberculosis as an occupational disease. New Microbes and New Infections. 2018;**27**:75-77

[6] Ivanka S. Structural changes of the brain in relation to occupational stress. Cerebral Cortex. 2013;**12**:321-324. [Google Scholar]

[7] Matić M, Jovanović J, Jovanović J, Mačvanin N. Effects of occupational stress on working ability of patients suffering from arterial hypertension. Medicinski Pregled. 2013;**66**:497-501. DOI: 10.2298/MPNS1312497M

[8] Cooper CL. Occupational stress among international interpreters. Occupational Medicine. 1993;**25**:889-895. DOI:10.1097/00043764-198312000-00012

[9] Zhu TJ. Investigation and Study on occupational tasks of dust-exposed workers in coal mines. Chinese Journal of Pharmaceutical Analysis. 2012;**8**:1007-1011 (In Chinese)

[10] Bhatti N, Shar AH, Shaikh FM, Nazar MS. Causes of stress in organization, a case study of Sukkur. International Journal of Business and Management. 2010;**5**(11):3-14

[11] Zhang Q. Occupational injury occurrence and related risk factors among Chinese migrant workers. Procedia Engineering. 2012;**43**:76-81

[12] Choi SD, Guo L, Kim J, Xiong S. Comparison of fatal occupational injuries in construction industry in the United States, South Korea, and China. International Journal of Industrial Ergonomics. 2019;**71**:64-74

[13] Cullen MR, Chmiack MG, Rosenstock L. Occupational medicine. New England Journal of Medicine. 1990;**322**:594-601. DOI: 10.1056/NEJM199003013220905

[14] Mani KP, Sritharan, Gayatri R. Impact of occupational stress on quality work life among railway station masters of Trichy division. Bonfring International Journal of Industrial Engineering and Management Science. 2014;**4**:165-169. DOI: 10.9756/BIJIEMS.6129

[15] Parent-Thirion, Biletta I, Cabrita J, Llave VO, Vermeylen G, Ilczynska A. 6th European Working Conditions Survey: Overview Report. Luxembourg: Publications Office of the European Union; 2017

[16] Rausch SM, Auerbach SM, Gramling SE. Gender and ethnic differences in stress reduction reactivity and recovery. Sex Roles. 2008;**59**:726-737. DOI: 10.1007/s11199-008-9460-0

[17] Quick JC, Tetrick LE. Handbook of Occupational Health Psychology. Washington, DC, USA: American Psychological Association; 2003. pp. 97-119

[18] Shultz KS, Wang M, Crimmins EM, Fisher GG. Age differences in the demand-control model of work stress: An examination of data from 15 European Countries. Journal of Applied Gerontology. 2010;**29**:21-47. DOI: 10.1177/0733464809334286

[19] Anderson ES, Coffey SB, Byerly TR. Formal organizational initiatives and informal workplace practices: Links to work-family conflict and job-related outcomes. Journal of Management. 2002;**28**(6):787-810

[20] Chou LP, Li CY, Hu SC. Job stress and burnout in hospital employees: Comparisons of different medical professions in a regional hospital in Taiwan. BMJ Open. 2014;**4**:e004185. DOI: 10.1136/bmjopen-2013-004185

[21] Dewa CS, Thompson AH, Jacobs P. Relationships between job stress and worker perceived responsibilities and job characteristics. International Journal of Occupational and Environmental Medicine. 2011;**2**:37-46. [Google Scholar]

[22] Härmä M. Workhours in relation to work stress, recovery and health. Scandinavian Journal of Work, Environment & Health. 2006;**32**:502-514. DOI: 10.5271/sjweh.1055

[23] Gangster, Logan. Effects of stress on workers. Indian Journal of Industrial Relations. 2005;**38**(5):280-287

[24] Kumar Das P. Work Related Stress among Coal Mine workers: A study on select coal mines of Dhanbad & Jharia regions. International Journal on Arts, Management and Humanities. 2018;**7**(1):56-70

[25] Malamardi SN, Kamath R, Tiwari R, Nair BVS, Chandrasekaran V, Phadnis S. Occupational stress and health-related quality of life among public sector bank employees: A cross-sectional study in mysore, Karnataka, India. Indian Journal of Occupational and Environmental Medicine. 2015;**19**:134-137

[26] Liu L, Wu H, Yang YL. The mediating effect of psychological capital of underground miners on the relationship between occupational stress and anxiety symptoms. China Health Statistics. 2016;**33**:209-211 214

[27] Deguchi Y, Inoue K. Relationships between occupational stress and depressive symptoms among prison officers in Japan. Osaka City Medical. 2013;**59**:91-98. [Google Scholar]

[28] Rutter DR, Loregrove MJ. Occupation Stress and its predictors in radiographer. Radiography. 2008;**14**:138-143. DOI: 10.1016/j.radi.2006.09.008

[29] Morita N, Wada I. Job stress and mental health of child counselling office worker. Journal of Occupational Health. 2007;**49**:125-133. DOI: 10.1539/joh.49.125

[30] Wang RG, Zhao XB. Analysis of occupational stress among medical workers. Occupational Health Injections. 2002;**17**:181-183. [Google Scholar]

[31] Zhang Y, Liang DH, Shi XZ, Geng QY, Liu Y. Survey on occupational stress and quality of life of medical staff in Shenyang. Occupational and Environmental Medicine. 2012;**29**:572-575

[32] Azimbagirad M, Junior LO. Tsallis generalized entropy for Gaussian mixture model parameter estimation on brain segmentation application. Neuroscience Informatics. 2021;**1**(1-2):100002

[33] Krumova K, Cosa G. Chapter 1: Overview of reactive oxygen species. In: Singlet Oxygen: Applications in Biosciences and Nanosciences. Vol. 1. Royal Society of Chemistry. 2016. pp. 1-21. DOI: 10.1039/9781782622208-00001

[34] Mittal M, Siddiqui MR, Tran K, Reddy SP, Malik AB. Reactive oxygen species in inflammation and tissue injury. Antioxidants & Redox Signaling. 2014;**20**(7):1126-1167. DOI: 10.1089/ars.2012.5149. Epub 2013 Oct 22

[35] Di Meo S, Reed TT, Venditti P, Victor VM. Role of ROS and RNS sources in physiological and pathological conditions. Oxidative Medicine and Cellular Longevity. 2016;**2016**:1245049. DOI: 10.1155/2016/1245049. Epub 2016 Jul 12

[36] Smith SM, Vale WW. The role of the hypothalamic-pituitary-adrenal axis in neuroendocrine responses to stress. Dialogues in Clinical Neuroscience. 2006;**8**(4):383-395. DOI: 10.31887/DCNS.2006.8.4/ssmith

[37] Becks MJ, Manniesing R, Vister J, Pegge SA, Steens SC, van Dijk EJ, et al. Brain CT perfusion improves intracranial vessel occlusion detection on CT angiography. Neuroradiology Journal. 2019;**46**(2):124-129

[38] Tchofo PJ, Balériaux D. Brain 1H-MR spectroscopy in clinical neuroimaging at 3T. Journal of Neuroradiology. 2009;**36**(1):24-40

[39] Cohen S, Janicki-Deverts D, Miller GE. Psychological stress and disease. JAMA. 2007;**298**(14):1685-1687

[40] Dayas CV, Buller KM, Crane JW, Xu Y, Day TA. Stressor categorization: Acute physical and psychological stressors elicit distinctive recruitment patterns in the amygdala and in medullary noradrenergic cell groups. The European Journal of Neuroscience. 2001;**14**(7):1143-1152

[41] Scantamburlo G, Ansseau M, Legros JJ. Implication de la neurohypophysedans le stress psychique [Role of the neurohypophysis in psychological stress]. Encephale. 2001;**27**(3):245-259. French

[42] Herman JP, McKlveen JM, Ghosal S, Kopp B, Wulsin A, Makinson R, et al. Regulation of the hypothalamic-pituitary-adrenocortical stress response. Comprehensive Physiology. 2016;**6**(2):603-621. DOI: 10.1002/cphy.c150015

[43] Sharma DK. Physiology of stress and its management. Journal of Medicine Study & Research. 2018;**1**:001

[44] Hinson AV, Aguèmon B, Adjobimey M, Damien GB, Ouili I, Mikponhoue R, et al. Prevalence and associated factors of occupational stress in the mining sector: The case study of the Youga Mine at Zabre in Burkina Faso. Occupational Diseases and Environmental Medicine. 2021;**9**:185-198

[45] Selye H. The Stress of Life. New York: McGraw-Hill; 1956

[46] Ranabir S, Reetu K. Stress and hormones. Indian Journal of Endocrinology. 2011;**15**(1):18-22. DOI: 10.4103/2230-8210.77573

[47] Himi T, Takano K, Yamamoto M, Naishiro Y, Takahashi H. A novel concept of Mikulicz's disease as IgG4-related disease. Auris Nasus Larynx. 2012;**39**(1):9-17. DOI: 10.1016/j.anl.2011.01.023. Epub 2011 May 14

[48] Munck A, Naray-Fejes-Toth A. Glucocorticoid action. In: DeGroot LJ, editor. Endocrinology. 3rd ed. Philadelphia: W B Saunders; 1995

[49] Mayer EA. The neurobiology of stress and gastrointestinal disease. Gut. 2000;**47**(6):861-869. DOI: 10.1136/gut.47.6.861

[50] Goncharova ND. Stress responsiveness of the hypothalamic-pituitary-adrenal axis: Age-related features of the vasopressinergic regulation. Frontiers in Endocrinology. 2013;**4**:26. DOI: 10.3389/fendo.2013.00026

[51] Sies H. Biochemistry of oxidative stress. Angewandte Chemie. 1986;**25**: 1058-1071

[52] Sies H. Oxidative stress: A concept in redox biology and medicine. Redox Biology. 2015;**4**:180-183

[53] Foster DB, Van Eyk JE, Marbán E, O'Rourke B. Redox signalling and protein phosphorylation in mitochondria: Progress and prospects. Journal of Bioenergetics and Biomembranes. 2009;**41**:159-168

[54] Frijhoff J, Dagnell M, Godfrey R, Ostman A. Regulation of protein tyrosine phosphatase oxidation in cell adhesion and migration. Antioxidants & Redox Signaling. 2014;**20**:1994-2010

[55] Hool LC, Corry B. Redox control of calcium channels: From mechanisms to therapeutic opportunities. Antioxidants & Redox Signaling. 2007;**9**:409-435

[56] Vita JA, Brennan M-L, Gokce N, Mann SA, Goormastic M, Shishehbor MH, et al. Serum myeloperoxidase levels independently predict endothelial dysfunction in humans. Circulation. 2004;**110**:1134-1139

[57] Janssen-Heininger YMW, Mossman BT, Heintz NH, Forman HJ, Kalyanaraman B, Finkel T, et al. Redox-based regulation of signal transduction: principles, pitfalls, and promises. Free Radical Biology and Medicine. 2008;**45**:1-17

[58] Jones DP, Go Y-M. Mapping the cysteine proteome: Analysis of redox-sensing thiols. Current Opinion in Chemical Biology. 2011;**15**:103-112

[59] Dalle-Donne I, Rossi R, Colombo R, Giustarini D, Milzani A. Biomarkers of oxidative damage in human disease. Clinical Chemistry. 2006;**52**:601-623

[60] Leiper J, Nandi M. The therapeutic potential of targeting endogenous inhibitors of nitric oxide synthesis. Nature Reviews. Drug Discovery. 2011;**10**:277-291

[61] Tkaczyk J, Vizek M. Oxidative stress in the lung tissue—Sources of reactive oxygen species and antioxidant defence. Prague Medical Report. 2007;**108**:105-114

[62] Bargagli E, Olivieri C, Bennett D, Prasse A, Muller-Quernheim J, Rottoli P. Oxidative stress in the pathogenesis of diffuse lung diseases: A review. Respiratory Medicine. 2009;**103**:1245-1256. DOI: 10.1016/j.rmed.2009.04.014

[63] Villegas L, Stidham T, Nozik-Grayck E. Oxidative stress and therapeutic development in lung diseases. Journal of Pulmonary & Respiratory Medicine. 2014;**4**:194. DOI: 10.4172/2161-105X.1000194

[64] Zosky GR, Hoy RF, Silverstone EJ, Brims FJ, Miles S, Johnson AR, et al. Coal workers' pneumoconiosis: An Australian perspective. The Medical Journal of Australia. 2016;**204**(11):414-418

[65] Fujimura N. Pathology and pathophysiology of pneumoconiosis. Current Opinion in Pulmonary Medicine. 2000;**6**(2):140-144

[66] Huang C et al. Role of bioavailable iron in coal dust-induced activation of activator protein-1 and nuclear factor of activated T cells: Difference between Pennsylvania and Utah Coal Dusts. American Journal of Respiratory Cell and Molecular Biology. 2002;**27**(5):568-574

[67] Zhang Q, Dai J, Ali A, Chen L, Huang X. Roles of bioavailable iron and calcium in coal dust-induced oxidative stress: Possible implications in coal workers' lung disease. Free Radical Research. 2002;**36**(3):285-294

[68] Nagaraj Priyadarshini MD. Systemic oxidative stress and antioxidant status in chronic bronchitis patients. Journal of Scientific and Innovative Research. 2014;**3**:234-238

[69] Zinellu E, Zinellu A, Fois AG, Fois SS, Piras B, Carru C, et al. Reliability and usefulness of different biomarkers of oxidative stress in chronic obstructive pulmonary disease. Oxidative Medicine and Cellular Longevity. 2020;**2020**:1-12. DOI: 10.1155/2020/4982324

[70] Chrousos G, Pavlaki AN, Magiakou MA. Glucocorticoid therapy and adrenal suppression. In: De Groot LJ, Chrousos G, Dungan K, Feingold KR, Grossman A, Hershman JM, et al., editors. Endotext [Internet]. South Dartmouth (MA): 2000. MDText.com. [Google Scholar]

[71] Zhang H, Zhou Z, Luo J, Hou J. Effects of corticosterone on the metabolic activity of cultured chicken chondrocytes. BMC Veterinary Research. 2015;**11**:86. DOI: 10.1186/s12917-015-0398-5

[72] Poole KE, Reeve J. Parathyroid hormone—A bone anabolic and catabolic agent. Current Opinion in Pharmacology. 2005;**5**(6):612-617. DOI: 10.1016/j.coph.2005.07.004

[73] Nieboer E, Gibson BL, Oxman AD, et al. Health effects of aluminum: A critical review with emphasis on aluminum in drinking water. Environmental Reviews. 1995;**3**:29-81

[74] CannataAndia JB. Aluminium toxicity: Its relationship with bone and iron metabolism. Nephrology Dialysis Transplantation. 1996;**11**(Suppl 3):69-73. DOI:10.1093/ndt/11.supp3.69. PMID: 8840317

[75] Carmen DC, Jose LF, Barreto S, et al. Effect on aluminium load on parathyroid hormone synthesis. Nephrology Dialysis Transplantation. 2001;**16**(4):742-745. DOI: 10.1093/ndt/16.4.742. PMID: 11274267

[76] Jeffery EH, Abreo K, Burgess E, et al. Systemic aluminum toxicity: Effects on bone, hematopoietic tissue, and kidney. Journal of Toxicology and Environmental Health. 1996;**48**(6):649-665

[77] Cournot WG, Plachot JJ, Bordeau A. Effect of aluminium on bone and cell localization. Kidney International. 1986;**37**:-40

[78] Sua'rez-Ferna'ndez MB, Soldado AB, Sanz-Medel A, et al. Aluminum-induced degeneration ofastrocytes occurs via apoptosis and results in neuronal death. Brain Research. 1999;**835**(2):125-136. DOI: 10.1016/s0006-8993(99)01536-x

[79] Pan JW, Zhu MY, Chen H. Aluminum-induced cell death in root-tip cells of barley. Environmental and Experimental Botany. 2001;**46**(1):71-79

[80] Aremu DA, Meshitsuka S. Accumulation of aluminum by primary cultured astrocytes from aluminum amino acid complex and its apoptotic effect. Brain Research. 2005;**1031**(2):284-296

[81] Jorde R, Saleh F, Figenschau Y, Kamycheva E, Haug E, Sundsfjord J. Serum parathyroid hormone (PTH) levels in smokers and non-smokers. The fifth Tromsø study. European Journal of Endocrinology. 2005;**152**:39-45

[82] Schipper HM. Heme oxygenase expression in human central nervous system disorders. Free Radical Biology and Medicine. 2004;**37**:1995-2011

[83] Kim HP, Ryter SW, Choi AM. CO as a cellular signaling molecule. Annual Review of Pharmacology and Toxicology. 2006;**46**:411-449

[84] Ryter SW, Alam J, Choi AM. Heme oxygenase-1/carbon monoxide: From basic science to therapeutic applications. Physiological Reviews. 2006;**86**:583-650

[85] Wu L, Wang R. Carbon monoxide: endogenous production, physiological functions, and pharmacological applications. Pharmacological Reviews. 2005;**57**:585-630

[86] Dennery PA. Regulation and role of heme oxygenase in oxidative injury. Current Topics in Cellular Regulation. 2000;**36**:181-199

[87] Dwyer BE, Nishimura RN, Lu SY. Differential expression of heme oxygenase-1 in cultured cortical neurons and astrocytes determined by the aid of a new heme oxygenase antibody. Response to oxidative stress. Brain Research. Molecular Brain Research. 1995;**30**:37-47

[88] Pappolla MA, Chyan YJ, Omar RA, Hsiao K, Perry G, Smith MA, et al. Evidence of oxidative stress and in vivo neurotoxicity of beta-amyloid in a transgenic mouse model of Alzheimer's disease: A chronic oxidative paradigm for testing antioxidant therapies in vivo. The American Journal of Pathology. 1998;**152**:871-877

[89] Jaiswal AK. Nrf2 signaling in coordinated activation of antioxidant gene expression. Free Radical Biology & Medicine. 2004;**36**:1199-1207. DOI: 10.1016/j.freeradbiomed.2004.02.074

[90] Ogawa K, Sun J, Taketani S, Nakajima O, Nishitani C, Sassa S, et al. Heme mediates derepression of Maf recognition element through direct binding to transcription repressor Bach1. The EMBO Journal. 2001;**20**:2835-2843. DOI: 10.1093/emboj/20.11.2835

[91] Tian W, Rojo de la Vega M, Schmidlin CJ, Ooi A, Zhang DD. Kelch-like ECH-associated protein 1 (KEAP1) differentially regulates nuclear factor erythroid-2-related factors 1 and 2 (NRF1 and NRF2). The Journal of Biological Chemistry. 2018;**293**(6):2029-2040. DOI: 10.1074/jbc.RA117.000428. Epub 2017 Dec 18

[92] Igarashi K, Sun J. The heme-Bach1 pathway in the regulation of oxidative stress response and erythroid differentiation. Antioxidants & Redox Signaling. 2006;**8**:107-118

[93] Morse D, Lin L, Choi AM, Ryter SW. Heme oxygenase-1, a critical arbitrator of cell death pathways in lung injury and disease. Free Radical Biology and Medicine. 2009;**47**:1-12. [Google Scholar]

[94] Jang S, Piao S, Cha YN, Kim C. Taurine chloramine activates Nrf2, increases HO-1 expression and protects cells from death caused by hydrogen peroxide. Journal of Clinical Biochemistry and Nutrition. 2009;**45**:37-43. [Google Scholar]

[95] Cho HY, Reddy SP, Kleeberger SR. Nrf2 defends the lung from oxidative stress. Antioxidants & Redox Signaling. 2006;**8**:76-87

[96] Danielle M, Augustine MKC. Heme Oxygenase-1 from Bench to Bedside. American Journal of

Respiratory and Critical Care Medicine. 2005;**172**:660-670

[97] Murakami T, Watanabe M, Tezuka M. Induction of heme oxygenase-1 by aluminium and lack of effects of antioxydants. Journal of Health Science. 1999;**45**:33

[98] Dunn LL, Midwinter RG, Ni J, Hamid HA, Parish CR, Stocker R. New insights into intracellular locations and functions of heme oxygenase-1. Antioxidants & Redox Signaling. 2014;**20**:1723-1742. DOI: 10.1089/ars.2013.5675

[99] Lim S, Groneberg D, Fischer A. Expression of heme oxygenase isoenzymes 1 and 2 in normal and asthmatic airways effect of inhaled corticosteroids. American Journal of Respiratory and Critical Care Medicine. 2000;**162**:1912-1918

[100] Sato T, Takeno M, Honma K, et al. Heme-oxygenase-1, a potential biomarker of chronic silicosis, attenuates silica-induced lung injury. American Journal of Respiratory and Critical Care Medicine. 2006;**174**:906-914

[101] Fredenburgh LE, Perrella MA, Mitsialis SA. The role of heme oxygenase-1 in pulmonary disease. American Journal of Respiratory Cell and Molecular Biology. 2007;**36**:158-165

[102] Wagner M, Hermanns I, Bittinger F. Induction of stress proteins in human endothelial cells by heavy metal ions and heat shock. The American Physiological Society. 1999;**277**(5):L1026-L1033

[103] Yachie A. Heme oxygenase-1 deficiency and oxidative stress: A review of 9 independent human cases and animal models. International Journal of Molecular Sciences. 2021;**22**(4):1514. DOI: 10.3390/ijms22041514

[104] Hettiarachchi N, Dallas M, Al-Owais M, Griffiths H, Hooper N, Scragg J, et al. Heme oxygenase-1 protects against Alzheimer's amyloid-β1-42-induced toxicity via carbon monoxide production. Cell Death & Disease. 2014;**5**(e1569). DOI: 10.1038/cddis.2014.529

Chapter 3

Occupational Stress among Health Care Workers

Krupal Joshi, Bhautik Modi, Sanjay Singhal and Sanjay Gupta

Abstract

Occupational stress is a harmful response particularly physical and emotional, due to a mismatch between job requirements and the qualifications, resources, and worker's needs; its chronic form is termed "Burnout." Stress among health care workers is multifactorial. Its prevalence among healthcare professionals ranges from 27–87.4%. Occupational stress is a significant reason for physical and mental health, substance use, work-related delay, absenteeism, and emigration rate. Additionally, it can lead to patient safety concerns and poor quality of care. The mismatch between job requirements and the available resources, work overload, working environment, work experience, workplace conflict, gender discrimination, marital status, educational status, job satisfaction, and not being rewarded were some of the factors significantly associated with occupational stress among health care professionals. Moreover, the coronavirus disease 2019 (COVID-19) pandemic introduced additional stressors, such as staff redeployment and the fear of infection. WHO identified good primary health care as fundamental for achieving universal health coverage without financial hardship. Healthcare professionals' physical and mental well-being is crucial for attaining this. Developing culturally and organizationally appropriate early interventions is the need of the hour to prevent a health care worker from entering a stress level that is non-adaptable beyond their coping abilities.

Keywords: occupational, stress, burnout, physicians, health care workers

1. Introduction

The term "stress" was derived from the Latin word "stringere," meaning the experience of physical hardship, starvation, torture, and pain. Its chronic form is termed 'Burnout.' Stress at the workplace has gained much attention recently. It has been recognized as a global disease due to its negative impact on the physical, emotional, and psychological well-being of people in various occupational groups.

Stress has become an endemic problem in healthcare, contributing to health-related challenges which decrease efficiency and productivity. Stress among health care workers is multifactorial. The mismatch between job requirement and the available resources, work overload, working environment, work experience, workplace conflict, gender discrimination, marital status, educational status, job satisfaction, and not being rewarded were some of the factors significantly associated with

occupational stress among health care professionals [1]. Moreover, the coronavirus disease 2019 (COVID-19) pandemic introduced additional stressors, such as staff redeployment and the fear of infection [2]. Occupational stress is a significant reason for physical and mental health, substance use, work-related delay, absenteeism, and emigration rate [3, 4]. World Health Organization (WHO) recognized good primary health care as fundamental for achieving universal health coverage (UHC) without financial hardship [5]. Healthcare professionals' physical and mental well-being is crucial for attaining this [1]. Maslach Burnout Inventory (MBI) is still the gold standard for assessing burnout among HCWs [6]. Developing culturally and organizationally appropriate early interventions is the need of the hour to prevent a health care worker from entering a stress level that is non-adaptable beyond their coping abilities.

2. Measuring burnout

Maslach Burnout Inventory (MBI) is the most widely accepted standard for burnout assessment. It includes a Human Services Survey applicable to healthcare professionals.

MBI is comprised of 22 items, out of which emotional exhaustion domain consists of nine items, depersonalization domain consists of five items, and accomplishment domain consists of eight items. Each domain scored from 0 to 6 based on self-reported frequency of the feeling addressed by each item.

Conceptions of burnout that address only emotional exhaustion are incomplete [7, 8] as depersonalization may actually align more strongly with the most negative consequences of burnout [9].

As studies on physicians have often found the personal accomplishment domain of burnout to correlate only weakly with outcomes, overall burnout has commonly been defined as a high level of either emotional exhaustion or depersonalization. Main drawback of using MBI outside of structured research studies is its length. For larger survey, a short assessment tool is developed and used in some studies.

One study of more than 10,000 medical students and physicians found strong correlations between single item tool and their respective emotional exhaustion and depersonalization domain scores from the full MBI, and area-under-the-curve measures of 0.94 and 0.93, respectively, against the full MBI domains [10].

In addition, replacing the full MBI with these single items in physician studies yielded similar estimates of burnout. Many physicians have applied this shorter version of tool in different burnout studies. Alternative abbreviated assessments have been proposed. McManus applied a shortened MBI using three items from each domain, but validity of this approach is lacking.

The Physician Work Life and MEMO studies use a single item, "how severe is my burnout", on a scale of 1–5 [11].

This indicates Correlations with the emotional exhaustion domain of the full MBI have been demonstrated to be moderate. The Copenhagen Burnout Inventory [12] and the Oldenburg Burnout Inventory [13] are also examples of tool developed as a response to debate concerning the optimal conceptualization of physician burnout. However, despite ongoing efforts to refine burnout instruments, the MBI remains the current "gold standard" for burnout assessment, with the full MBI representing the preferred version when possible.

3. Prevalence

Many studies in different countries quoted tremendous stress among health care workers, resulting in burnout. In the Coping with COVID study, a US national survey was administered by multiple healthcare organizations covering 20,947 respondents in 42 organizations and reported that daily stress was scored as high or very high by 30% of healthcare workers [14]. Anxiety or depression was described by 38% of workers in the health care sector [14]. A stress summary score (SSS) was 9.52 (SD 2.82, possible range 4–16), with burnout (present, high, or very high) in 49% of the healthcare workers [14]. Women workers described more challenging work environments than men. Work overload, fear of exposure to infection, and self-reported anxiety/depression are some of the factors related to burnout [15]. Other studies suggest that the mean prevalence of burnout among physicians in the United States is between 40% and 50% [15]. The burnout rate in US physicians is about 1.5 to 2.5 times higher than it is for US workers in other professions [16, 17].

Studies in low- and middle-income countries among primary health-care professionals suggest that burnout is substantial, mainly because of the workforce and resource shortages in these countries. Estimates ranged from 2.5% for severe burnout among family physicians in China to 87.9% for burnout among midwives in Uganda [18].

Factors associated with HCWs burnout: Burnout among HCWs is multifactorial. Individual and workplace-related factors act independently and synergistically for HCW's burnout.

a. **Individual Factors**: Various studies have shown an association between gender, age, education level, education debt, marital status, spouse occupation, and children's age with HCW burnout1 [1, 19, 20]. High burnout among females in one study was linked to work-home conflict, domestic violence, and non-engagement of men in household work [21–24]. Burnout among younger physicians was found to be more than among older physicians in most studies; however, few studies report a positive association with age [1, 19]. Higher educational level, marriage, children younger than 21 years, and non-physician HCW were associated with increased burnout [1, 19, 20]. Individual characteristics like personality, interpersonal relationships, and personal experiences may also help modify burnout's impact [25].

b. **Work factors**: An imbalance between job demands and the available resources, understaffed, work overload (including overtime, shift work, and high patient turnover), working environment, inadequate breaks for food, work experience, workplace conflict, violence, gender discrimination, job insecurity, job dissatisfaction, working in a rural or economically deprived places with poor infrastructure and not being rewarded were some of the factors significantly associated with occupational stress among HCWs [5, 17, 20]. Moreover, the coronavirus disease 2019 (COVID-19) pandemic introduced additional stressors, such as staff redeployment, lack of personal protective equipment, and the fear of infection [2].

c. **Social factors**: Wide availability of negative behavior in social media, decreasing respect toward Health care workers, increasing violence against HCWs by

patient's relatives, lack of adequate Government policies to protect the HCWs, and limited interprofessional collaboration also influence burnout [2]. Moreover, discrimination in society against HCWs during the initial month of Covid-19 pandemics was an additional stressor.

4. Pathophysiology

The burnout and its contributing factors can be related to a microbiologic disease process in which burnout is the disease, environment works as a pathogen and an individual's resilience works as an immune system. As such, an individual working in a negative or negative environment (aggressive pathogen) is having hazards of burnout despite personal resilience, whereas an individual having poor resilience (immunosuppressed) may be having hazards for burnout even in a positive environment. This concept may help in understanding the reason for not developing burnout with same challenges. Considering this resemblance, environment could be considered as the pathogen for burnout. However, working as well as home environment is helpful in building our resilience, similar to the preparedness of immune system by vaccine against different diseases. A positive-working environment can have features like opportunities for personal growth, meaningful work, recognition from leaders, psychological safety, supportive colleagues, and adaptability. Personal physical, social, mental health, and positive interactions are other factors outside work environment that build resilience.

Thus, there are multiple factors taking part in the interactions contributing to developing burnout, it can be categories in two broad headings: institutional factors and individual (or personal) factors.

Institutional factors include the work environment, work culture, work schedule, growth opportunities, participation in decision making and peer support. Individual factors include self-care, work-life balance, and supportive relationships. Absence of these factors is predisposing factor for burnout.

5. Strategies to prevent and manage burnout

Burnout among healthcare workers (HCWs) is a complex issue with no clear solution despite nearly a decade's efforts. This necessitates the expansion of the Triple Aim approach of improving health system performance (health of populations, the experience of health care, and reducing per capita costs of health care) to a Quadruple Aim by adding the aim of improving the work lives of HCWs and their experience of providing health care [26–28]. Given the history of well-being in medicine, the initial steps leaned heavily on the individual. As workplace culture and environment affect burnout, individual-focused interventions alone cannot sufficiently address the issue. Although well-intentioned, individual-focused interventions can hurt physician well-being efforts by promoting quick fixes rather than long-term solutions. Ignoring organizational contributors and potential interventions could percolate the message that individuals face burnout due to poor resilience and strength. Such messages can complicate the underlying problem by making individuals feel unsupported by their organization and losing trust in leadership. In medical school, we were taught that "where there is pus, must be evacuated" even though bandaging is easier and faster

than draining the pus, bandaging can make things worse. Likewise, we must fix the system to prevent future burnout and help those who are suffering currently.

Moreover, because of the various etiology of burnout, it is essential to understand each factor before selecting any specific intervention to avoid its futility. Organizational interventions alone will not be able to address burnout among a significant population of HCWs; an added personal intervention would enhance the effectiveness of organizational efforts. A growing body of evidence confirmed the efficacy of organizational interventions targeting the work environment and interventions targeting individuals in managing burnout [29–31].

6. Organizational interventions

Organizational interventions focus primarily on making systematic changes to the work environment, including demands and resources, duty schedules, and interactions with leaders and colleagues.

a. **Work environment intervention**: High demands on HCWs is a primary contributing factor to increased burnout. The 24/7 nature of professional duties affecting personal and family life, the complexity of patients' medical and social needs, increased medical documentation requirements, financial constraints, and lack of administrative support for clerical tasks are adding to the daily demand. Burnout has also been linked to the number of working hours, the number of night duty, longer duration shifts, and consecutive working days.

   Interventions like adding medical assistants, offloading clerical tasks, reducing patient–nurse ratios, and improving workload by streamlining workflow or adding clinical support are the most common strategies for burnout reduction, particularly for physicians [32]. Studies have shown improvement in burnout by reducing resident duty hours, physician hours in intensive care units, and teaching rotations [19, 31]. These approaches resonate with the excessive workload as a contributor to burnout. HCW burnout is not simply because of the increased workload. It also occurs when high demands are not in concurrence with resources and organizational support. Leaders can use this knowledge to reduce burnout by balancing new needs with allocated resources.

b. **Improving HCW voice**: Feeling these highly trained professionals as cogwheels rather than partners can result in decreased engagement and increased burnout [33, 34]. Intentionally involving HCWs in decision-making and problem-solving is an essential strategy for their empowerment. So, engaging HCWs in decisions making at their working place and according to a degree of autonomy to their schedule can help in reducing burnout.

c. **Staff support**: The patient experiencing a medical error is the primary victim, and the HCW involved in the error is described as the second victim [35]. Leadership support plays an important role when a medical error or an unexpected bad outcome has led to a "second victim [36, 37]." Along with guilt, shame, moral distress, professional incompetency, burnout, and in some cases, posttraumatic stress disorder, "second victims" would also fear punitive action or leave the

profession altogether [35–37]. Organization support can lead to significantly less emotional exhaustion and better safety culture among these HCWs [37].

d. **Interactions with colleagues**: Improving teamwork can profoundly affect HCW interactions with colleagues and their overall work environment. A study among almost 8000 HCWs demonstrated that HCWs routinely exposed to rudeness in their workplace had significantly higher levels of exhaustion emotionally and depression than those not exposed [38].

7. Individual interventions

Evidence-based individual interventions include mindfulness, stress management, communication skills training, exercise programs, self-care efforts, and participation in small-group programs that promote connectedness and meaning.

a. **Mindfulness and stress management**: The human brain has a hard-wired "negativity bias" in which negative stimuli capture and hold much more attention than positive ones [39]. Barbara Fredrickson, an expert in this field, states, "The negative screams whereas the positive just whispers[39]." Therefore, it is essential to deliberately increase positive emotions to counteract the flood of negative emotions accompanying burnout. Psychologic techniques, gratitude, giving to others, and mindful meditation are helpful to combat burnout by retraining positive experiences and social connections [32, 40].

b. **Self-care:** Self-care practices like exercise, yoga, meditation, and adequate sleep are effective in enhancing well-being and reducing burnout, but it all depends on whether these practices are carefully developed over a long period or attempted only during a crisis [32]. In other words, you cannot learn to swim at the time of drowning. So, these practices are more helpful in preventing burnout.

c. **Strengthening social relationships**: Social relationships are vital in improving cardiovascular health and immune function and reducing rates of anxiety and depression [41].

8. A framework for improving well-being in HCWS

8.1 Preventive measures and proactive interventions

The perception of the general population toward healthcare workers needs to be changed. HCWs are also to be recognized as human beings. The human body is full of complexity and each individual is different. Complications are inevitable and these are byproducts of any procedure and medical intervention. Public awareness by judicious use of different electronic and print media is a need of the hour.

8.2 Work culture

Work culture is directly or indirectly a significant factor for generating stress and burnout among health care workers. This is not only related to the type of

work but also equally important is the type of work culture. A conducive environment and positive work culture can be an important stress buster. Work culture is not God-gifted, it is created by effective leadership and team efforts by each one in a positive direction. Good work culture is not just a stress buster but also magnify productivity and decrease complication in patient care. A work culture of trust, transparency, respect, and openness is always helpful to reduce stress among healthcare workers.

8.3 The synergic approach between health worker strategies and patient safety policies

- Development of linkages between various quality improvement programs related to health workers' safety as well as patient safety [42, 43].

- Education and training programs for health workers should be organized to inculcate skills related to personal as well as patient safety.

- Incorporate health worker and patient safety requirements in Health care licensing and accreditation standards.

- Integration of various metrics of patient safety, health worker safety, and quality care indicators, with the health information system.

8.4 Implementation of national programs for occupational health and safety of health workers

- Design and proper implementation of national programs for occupational health pertaining to health workers in congruence with various national occupational health and safety policies.

- To ensure protection of health and safety of all health workers, national regulations and laws for occupational health and safety are to be reviewed and updated.

- A designated authority can be appointed to ensure the occupational health and safety of health workers.

- Intersectoral collaboration need to be strengthened for health worker and patient safety, with appropriate representation from worker and management, including gender, diversity, and all occupational groups.

8.5 Stringing lawful measures to prevent violence against health care workers

- Adoption and implementation of prevailing national law, important policies, and mechanisms to prevent and eliminate violence in the health sector that is serving humanity.

- Zero tolerance toward violence against health care workers.

- Periodic review and amendments of labor laws and relevant legislation.

- Monitoring and strict supervision to ensure effective implementation of a law to prevent violence and protect health workers.

- Implement helplines to enable free and confidential reporting and support for any health worker facing violence.

8.6 Set priority for the Mental health of HCW

- Transparent policy to ensure the appropriate and fair duration of deployments, working hours, rest breaks, and minimizing the administrative burden on health workers.

- Define and maintain appropriate minimum staffing levels within health care facilities. The minimum number should be prepared to keep in mind rotational duties.

- An insurance should be covered for work-related risks. Indemnity insurance to support and compensated professional and personal losses [44].

- Inculcate a healthy, ethics-based working culture through extended communication, including legal and administrative protection from punitive action for reporting adverse and therapeutic misadventures.

- Provide access and opportunities to mental well-being and social support services for health care workers through the process of socialization and necessary support.

8.7 Protection from physical and biological hazards

- Vaccination of all health workers should be undertaken for all vaccine-preventable infections in accordance with the national immunization policy.

- In emergency or pandemic situations, health workers to newly licensed and available vaccines should be prioritized

- Provide adequate protective equipment to prevent health workers from all types of injuries and exposures;

- Strict implementation of minimum patient safety guidelines, infection prevention, and control practices, universal precautions, and adherence to occupational safety standards in all health care facilities and health systems.

- Efficient health care systems are not sustainable without HCW's well-being. So, pressurizing HCWs to do more with fewer resources needs to be stopped as this can lead to moral injury when they feel that patient care is compromised [45]

- Physicians know well their stressors in the working environment that threaten well-being yet often feel helpless in suggesting improvisation [46, 47]

- Ensure availability of good quality personal protective equipment (PPE) keeping in mind the roles and tasks performed by HCWs.
- PPE shall be in adequate quantity and appropriate fit and of acceptable quality.
- Provide and ensure environmental services such as safe water, sanitation, proper hygiene, disinfection, and adequate ventilation at all healthcare facilities.

Author details

Krupal Joshi[1*], Bhautik Modi[1], Sanjay Singhal[2] and Sanjay Gupta[3]

1 Department of Community and Family Medicine, All India Institute of Medical Sciences, Rajkot

2 Department of Pulmonary Medicine, All India Institute of Medical Sciences, Rajkot

3 Department of Forensic Medicine All India Institute of Medical Sciences, Rajkot

*Address all correspondence to: krupal.joshi@gmail.com

References

[1] Wright T, Mughal F, Babatunde OO, Dikomitis L, Mallen CD, Helliwell T. Burnout among primary health-care professionals in low- and middle-income countries: Systematic review and meta-analysis. Bulletin of the World Health Organization. 2022;**100**(6):385-401A

[2] Irfan M, Naeem F, Afridi MI, Javed A. Prevention of occupational stress in health-care workers during COVID-19 pandemic. Indian Journal of Psychiatry. 2020;**62**:S495-S497

[3] Bernal D, Campos-Serna J, Tobias A, Vargas-Prada S, Benavides FG, Serra C. Work-related psychosocial risk factors and musculoskeletal disorders in hospital nurses and nursing aides: A systematic review and meta-analysis. International Journal of Nursing Studies. 2015;**52**:635-648

[4] Yaribeygi H, Panahi Y, Sahraei H, Johnston TP, Sahebkar A. The impact of stress on body function: A review. EXCLI Journal. 2017;**16**:1057

[5] Universal health coverage (UHC). Geneva: World Health Organization; 2019. Available from: https://www.who.int/newsroom/fact-sheets/detail/universal-health-coverage. (UHC) [cited 2021 May 10]

[6] Schaufeli WB, Leiter MP, Maslach C. Burnout: 35 years of research and practice. Career Development International. 2009;**14**:204-220

[7] Schaufeli W, Bakker A, Hoogduin K, Schaap C, Kladler A. On the clinical validity of the Maslach burnout inventory and the burnout measure. Psychology & Health. 2001;**16**:565-582

[8] Doulougeri K, Georganta K, Montgomery M. "Diagnosing" burnout among healthcare professionals: Can we find consensus? Cogentive Medicine. 2016;**3**:1237605

[9] Maslach C, Leiter MP. Early predictors of job burnout and engagement. Journal of Applied Psychology. 2008;**93**:498-512

[10] West CP, Dyrbye LN, Sloan JA, Shanafelt TD. Single item measures of emotional exhaustion and depersonalization are useful for assessing burnout in medical professionals. Journal of General Internal Medicine. 2009;**24**:1318-1321

[11] Freeborn DK. Satisfaction, commitment, and psychological well-being among HMO physicians. The Western Journal of Medicine. 2001;**174**:13-18

[12] Kristensen TS, Borritz M, Villadsen E, Christensen KB. The Copenhagen burnout inventory: A new tool for the assess- ment of burnout. Work and Stress. 2005;**19**:192-207

[13] Halbesleben JR, Demerouti E. The construct validity of an alternative measure of burnout: Investigating the English translation of the Oldenburg burnout inventory. Work and Stress. 2005;**19**:208-220

[14] Prasad K, McLoughlin C, Stillman M, Poplau S, Goelz E, Taylor S, et al. Prevalence and correlates of stress and burnout among U.S. healthcare workers during the COVID-19 pandemic: A national cross-sectional survey study. E Clinical Medicine. 2021;**35**:100879

[15] Shanafelt TD, West CP, Sinsky C, Trockel M, Tutty M, Satele DV, et al. Changes in burnout and satisfaction

with work-life integration in physicians and the general US working population between 2011 and 2017. Mayo Clinic Proceedings. 2019;**94**:1681-1694

[16] Shanafelt TD, Balch CM, Bechamps GJ, Russell T, Dyrbye L, Satele D, et al. Burnout and career satisfaction among American surgeons. Annals of Surgery. 2009;**250**:463-471

[17] Gan Y, Jiang H, Li L, Yang Y, Wang C, Liu J, et al. Prevalence of burnout and associated factors among general practitioners in Hubei, China: A cross-sectional study. BMC Public Health. 2019;**19**:1607

[18] Muliira RS, Ssendikadiwa VB. Professional quality of life and associated factors among Ugandan midwives working in Mubende and Mityana rural districts. Maternal and Child Health Journal. 2016;**20**:567-576

[19] West CP, Dyrbye LN, Shanafelt TD. Physician burnout: Contributors, consequences and solutions. Journal of Internal Medicine. 2018;**283**:516-529

[20] Wong AMF. Beyond burnout: Looking deeply into physician distress. Canadian Journal of Ophthalmology. 2020;**55**:7-16

[21] Toyry S, Kalimo R, Aarimaa M, Juntunen J, Seuri M, Rasanen K. Children and work-related stress among physicians. Stress and Health. 2004;**20**:213-221

[22] Houkes I, Winants Y, Twellaar M, Verdonk P. Development of burnout over time and the causal order of the three dimensions of burnout among male and female GPs: A three-wave panel study. BMC Public Health. 2011;**11**:240

[23] Wang Z, Xie Z, Dai J, Zhang L, Huang Y, Chen B. Physician burnout and its associated factors: A cross-sectional study in Shanghai. Journal of Occupational Health. 2014;**56**:73-83

[24] Lanballe EM, Innstrand ST, Aasland OG, Falkum E. The predictive value of individual factors, work-related factors, and work-home interaction on burnout in female and male physicians; a longitudinal study. Stress and Health. 2011;**27**:73-87

[25] Rushton CH, Kaszniak AW, Halifax JS. A framework for understanding moral distress among palliative care clinicians. Journal of Palliative Medicine. 2013;**16**:1074-1079

[26] Berwick DM, Nolan TW, Whittington J. The triple aim: Care, health, and cost. Health Affairs (Millwood). 2008;**27**:759-769

[27] Bodenheimer T, Sinsky C. From triple to quadruple aim: Care of the patient requires care for the provider. Annals of Family Medicine. 2014;**12**:573-576

[28] Sikka R, Morath JM, Leape L. The quadruple aim: Care, health, cost and meaning in work. BMJ Quality and Safety. 2015;**24**:608-610

[29] Ruotsalainen JH, Verbeek JH, Marine A, Serra C. Preventing occupational stress in healthcare workers. Cochrane Database of Systematic Reviews. 2015;**4**:CD002892

[30] West CP, Dyrbye LN, Erwin PJ, Shanafelt TD. Interventions to prevent and reduce physician burnout: A systematic review and meta-analysis. Lancet. 2016;**388**:2272-2281

[31] Panagioti M, Panagopoulou E, Bower P, Lewith G, Kontopantelis E, Chew-Graham C, et al. Controlled interventions to reduce burnout in physicians: A systematic review and

Meta-analysis. JAMA Internal Medicine. 2017;**177**:195-205

[32] Rehder K, Adair KC, Sexton JB. The science of health care worker burnout: Assessing and improving health care worker well-being. Archives of Pathology & Laboratory Medicine. 2021;**145**:1095-1109

[33] Shanafelt TD, Gorringe G, Menaker R, Storz KA, Reeves D, Buskirk SJ, et al. Impact of organizational leadership on physician burnout and satisfaction. Mayo Clinic Proceedings. 2015;**90**:432-440

[34] Linzer M, Poplau S, Prasad K, Khullar D, Brown R, Varkey A, et al. Healthy work place investigators. Characteristics of health care organizations associated with clinician trust: Results from the healthy work place study. JAMA Network Open. 2019;**2**:e196201

[35] Seys D, Wu AW, Van Gerven E, Vleugels A, Euwema M, Panella M, et al. Health care professionals as second victims after adverse events: A systematic review. Evaluation & the Health Professions. 2013;**36**:135-162

[36] Van Gerven E, Vander Elst T, Vandenbroeck S, Dierickx S, Euwema M, Sermeus W, et al. Increased risk of burnout for physicians and nurses involved in a patient safety incident. Medical Care. 2016;**54**:937-943

[37] Sexton JB, Adair KC, Profit J, Milne J, McCulloh M, Scott S, et al. Perceptions of institutional support for "second victims" are associated with safety culture and workforce well-being. Joint Commission Journal on Quality and Patient Safety. 2021;**47**:306-312

[38] Rehder KJ, Adair KC, Hadley A, McKittrick K, Frankel A, Leonard M, et al. Associations between a new disruptive Behaviors scale and teamwork, patient safety, work-life balance, burnout, and depression. Joint Commission Journal on Quality and Patient Safety. 2020;**46**:18-26

[39] Fredrickson B. Positivity. New York, NY: Three Rivers Press; 2009

[40] Seligman ME, Steen TA, Park N, Peterson C. Positive psychology progress: Empirical validation of interventions. The American Psychologist. 2005;**60**: 410-421

[41] Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: A meta-analytic review. PLoS Medicine. 2010;**7**:e1000316

[42] Parsa-Parsi RW. The revised declaration of Geneva: A modern-day Physician's pledge. JAMA. 2017;**318**:1971-1972

[43] Sinskey JL, Margolis RD, Vinson AE. The wicked problem of physician well-being. Anesthesiology Clinics. 2022;**40**:213-223

[44] Kass JS, Rose RV. Medical malpractice reform: Historical approaches, alternative models, and communication and resolution programs. AMA Journal of Ethics. 2016;**18**:299-310

[45] Shanafelt T, Trockel M, Ripp J, Murphy ML, Sandborg C, Bohman B. Building a program on well-being: Key design considerations to meet the unique needs of each organization. Academic Medicine. 2019;**94**:156-161

[46] Shanafelt T, Trockel M, Rodriguez A, Logan D. Wellness-Centered leadership: Equipping health care leaders to cultivate physician well-being and professional

Fulfillment. Academic Medicine. 2021;**96**:641-651

[47] Leiter MP, Maslach C. Latent burnout profiles: a new approach to understanding the burnout experience. Burnout Research. 2016;**3**:89-100

Chapter 4

Occupational Stress-Related Sleep Anomaly in Frontline COVID-19 Health Workers: The Possible Underlying Mechanisms

Mayowa J. Adeniyi, Ayoola Awosika, Richard M. Millis and Serah F. Ige

Abstract

COVID-19 is a highly contagious viral illness that has claimed millions of lives worldwide. Since its emergence, it has exerted a negative impact on many sectors globally without the exception of frontline COVID-19 healthcare providers. Specifically, in frontline COVID-19 healthcare workers, occupational stress-related sleep disorders such as insomnia and daytime somnolence have been extensively reported and were characterized by neuro-immunological changes. However, the possible mechanisms that underlie the sleep disorders have not been elucidated. The review was designed to highlight possible sleep mechanisms responsible for insomnia and daytime somnolence reported in frontline COVID-19 health workers. Available evidence shows that emotional perturbation, hypertension, chronobiological disruption and prolonged exposure to artificial light are among the events orchestrating occupational-stress-related sleep disorders in frontline COVID-19 healthcare workers. Anxiety-associated sleep anomaly is attributable to stimulation of the reticular activating system which occurs as a result of activation of noradrenergic fiber and sympatho-adrenal axis. Another mechanism includes depletion of hippocampal and brain glycogen by anxiety-induced activation of corticotropin releasing hormone (CRH)-secreting brain neurons and hypothalamic-corticotropic-adrenal cortex axis. Spontaneous discharge of noradrenergic fiber during basal state and changes in normal secretory rhythm of hypnosis-related chemical messengers may be responsible for hypertension- and chronobiological disruption-induced sleep disorders, respectively. Lastly, prolonged light exposure-induced suppression of melatonin secretion may elicit disruption of normal circadian sleep.

Keywords: COVID-19, occupational stress, sleep disorders, insomnia, daytime somnolence

1. Introduction

Stress can be defined as any sensation that indicates physical, psychological, or physical-psychological discomforts [1–3]. Climaxing stress is the sensation of

discomfort and the sensations may be described as unimodal when one major sensation of discomfort is involved [2]. Psychological sensations of discomfort may be characterized by emotional and behavioral swings [1]. When there is more than one strain sensation, stress is said to be polymodal. Examples of such are fluctuations in vital signs, body functions, and physical states manifesting as digestive disorders (diarrhea, vomiting, and nausea), headache, hyperthermia, palpitations, muscle fatigue, aches, and reduced libido [2] among others. Gravitational stress can cause dizziness, pedal pain, muscle fatigue, anger, and sleep deprivation. It is important to add that stress occurs when there is a deviation from what the body has perceived as normal or homeostatic. In fact, it is typically characterized by a non-specific response to any deviation from the homeostatic state.

Any strain sensations occurring either physically, psychological, or both in relation to one's job or profession is referred to as occupational stress [3]. Occupational stress is a type of stress that occurs when employees are overwhelmed by the dictates of their jobs or by institutional, organizational, and personal targets. Usually, the stress ensues when demands, expectations, and projections are incapable of being met at the set time. Switching from one job to another and exposure to long working periods are heavily implicated in occupational stress. Occupational stress also bouts where and when employees feel inadequately rewarded, appraised, and motivated [3]. During occupational stress, hemodynamic changes occur such that blood is diverted more to the central nervous system and some skeletal muscles at the expense of other body systems. This invariably results in cerebral vascular changes, and headache, among others culminating in increased sleep latency and delay in sleep onset. It is not unusual that the hypothalamo-hypophyseal-adrenal axis is activated leading to the release of cortisol. The sympatho-adrenal axis, the rapid response mechanism, is unarguably largely perturbed during occupational stress, manifesting as an increase in epinephrine, norepinephrine, and dopamine levels [4]. Non-hormonal consequences of sympatho-adrenal activation include increases in heart rate, respiratory rate and blood pressure, blood glucose, blood urea nitrogen, urine specific gravity, changes in heart rhythms, skin conductance, and sleep disturbances. Others include changes in brain activities and mood swings. Long-term exposure to occupational stress results in musculoskeletal impairments and cardiovascular adversities. Apart from musculoskeletal and cardiovascular impairments, occupational stress has a connection with posttraumatic stress syndrome, anxiety, depression, drug misuse, and insomnia [5]. Occupational stress is one of the underlying causes of morbidity and mortality [2], responsible for around 10% of job-induced ailments and diseases [6].

Sleep disruption, as one of the features of occupational stress, can be described as an impediment to normal sleep pattern. It has been implicated in occupational stress-induced injuries, accidents, and diseases [5, 6]. COVID-19 (severe acute respiratory syndrome-2) is a transmissible disease of the viral clan that belongs to the Coronaviridae family [7–10]. It is caused by a new coronavirus strain that was discovered in 2019 in Wuhan, China. COVID-19 has affected millions of people worldwide [7–9]. It has claimed many lives globally [7–10]. The disease is contagious and can be contracted through respiratory droplets, contact, and interface with COVID-19 contaminated surfaces [11, 12]. Currently, there is no specific cure but COVID-19 patients benefit from secondary treatments though vaccines are now available to induce an active artificial immune defense [12].

COVID-19 outbreak created huge pressure on frontline health workers owing to many reasons [12, 13]. First, the novelty of the disease elicited an unprecedented increase in the number of healthcare seekers from the usual counts. Since there was no specific forewarning and preparation across the globe in terms of boosting the

capacity of healthcare providers, hospital facilities, diagnostic and management sectors, the whole tension mounted on healthcare personnel. In fact, there was a subjective increase in expectation of health seekers and the general public from the healthcare providers. Another important concern was the contagiousness of the disease. All of these culminated significantly in mounting tension on healthcare providers resulting in adverse health consequences including alteration in their normal sleep pattern. Many primary studies have been done to examine the sleep pattern of healthcare providers during COVID-19. The review was designed to highlight the possible mechanisms that underlie occupational stress-related sleep impairment in frontline healthcare workers during COVID-19 outbreak.

2. Methodology

A narrative literature search was done using Web-based databases like Google Scholar, Pubmed, Scopus, and Web of Science. The search was done using several terms and text words such as occupational stress, COVID-19, sleep, sleep disorders relating to occupational stress, sleep mechanisms and stress. Inclusion and exclusion criteria were set to filter relevant articles. Articles that were not directly related with the topic are excluded. Each of the filtered articles was independently examined to ascertain the eligibility to the study.

3. Structure of human stress control

Although stress response is not specific, there are distinct neural and non-neural mechanisms that are in charge. These can be divided into intrinsic and extrinsic stress controls with the latter modulated by the former.

4. Intrinsic stress control

The intrinsic stress control includes brainstem, hypothalamus, noradrenergic neurons, histaminergic neurons, orexinergic neurons, opioid peptide-secreting neurons, serotonergic neurons, corticotropin releasing hormone (CRH)—secreting neurons, cholinergic neurons and dopaminergic neurons of the brain [14, 15].

Dopaminergic pathways including the mesolimbic and tuberoinfundibular dopamine pathway are influenced by stress. Signal from tuberoinfundibular dopamine pathway is widely known to cause inhibition of prolactin secretion. This is mediated through the interaction of dopamine with the D2 receptor on the surface of lactotrophs via decreased cyclic adenosine monophosphate. The absence of dopamine removes inhibition on prolactin secretion.

Conversely, increased prolactin secretion occasioned by stress represents a response to an increase in metabolic demand and hypoglycemia [16]. Although the specific contribution of prolactin during stress is not well understood, the hormone may increase blood glucose. It may also act on the brain and elicits a euphoric state, thereby helping relieve stress [17]. Despite insufficiency of evidence from human studies, a study has shown that prolactin may increase erythrocyte count in mice [18]. An increase in erythrocytes during stress is an important compensatory mechanism as it leads to an improvement in tissue oxygen supply.

Ghrelin level has been reported to increase during stress [19]. Ghrelin acts on the hypothalamus to induce secretion of growth hormone releasing hormone (GHRH) and inhibit growth hormone inhibiting hormone (somatostatin). GHRH in turn binds with its receptors on somatotroph causing growth hormone secretion. Growth hormone mobilizes free fatty acid and reduces peripheral tissue utilization of glucose. These actions help in maintaining blood glucose for ATP production. Another hormone elicited by stress is glucagon. Like growth hormone, glucagon helps in maintaining blood glucose levels.

Other intrinsic stress controls include increased levels of prostaglandins E2 [20], arginine vasopressin, heat shock proteins, interleukins-6, 10, and 19 [21] and adrenal progesterone [22]. Increased level of adrenal progesterone during stress might help in improving blood flow since progesterone is a vasodilator. However, it is unlikely the increased adrenal progesterone affects extracellular progesterone significantly under physiological conditions especially during active reproductive life. Like progesterone, adenosine is another chemical messenger that has been reported to increase during stressful situations [23].

The outcomes of stimulation of intrinsic stress control include modulation of stress which can manifest as increase in mood, stress-alleviating behavioral changes (like swaying or sitting down after prolonged standing), alterations in consciousness and sensory perception, change in blood flow, and maintenance of energy production among others.

5. Extrinsic stress control

The extrinsic component consists of autonomic-adrenal medulla axis, which connects the spinal cord and lower brain areas to peripheral organs through adrenal medulla. Epinephrine and norepinephrine secreted from the medium exert their effect on peripheral organs by binding with adrenergic receptors [4] and the effects are discussed in **Table 1**.

Another part of the extrinsic neural stress control is the hypothalamic-corticotropin-adrenal cortex axis. The parvocellular neurosecretory cells of the paraventricular nucleus of the anterior hypothalamus communicate via arginine vasopressin with the corticotroph of adenohypophysis to form a central unit [15, 24]. Unlike the autonomic-adrenal medulla axis, the axis connects the control area with the peripheral organs through the adrenal cortex. Glucocorticoid and dehydroepiandrosterone sulfate (DHEAS) released from the adrenal cortex bind with their expressed receptors in the peripheral organs.

6. History of COVID-19

It was on record that animal respiratory infections linked to the coronavirus group had occurred precisely in chickens earlier in the 1920's, with a mortality rate of 40–90% [25]. The virus, identified as infectious bronchitis virus, was then cultivated in 1937 as Beaudette strain. Two other viruses of the coronavirus group responsible for murine encephalitis and mouse hepatitis virus were detected in the later part of 1940 [26]. However, scientists did not realize that these three viruses had similarities [26, 27]. In the course of research activities on common cold, a group of Scientists namely David Tyrrell, C. Kendall and Malcolm Bynoe, and David Tyrrell in 1961

S/N	Peripheral organ/system	Effect of stimulation of autonomic-adrenal medulla axis	Effect of stimulation of hypothalamic-corticotroph-adrenal cortex axis
(1)	Heart and arteries (cardiovascular system)	Increased heart rate and cardiac output, vasoconstriction of peripheral arteries, Increased blood pressure	Needed for constrictor and calorigenic effects of norepinephrine and epinephrine, Gluconeogenesis, glycogenolysis, lipolysis, increased hepatic glucose output, maintenance of blood glucose level.
(2)	Eyes (Visual system)	Pupillary dilation	
(3)	Liver (Hepatobiliary system)	Increased hepatic glucose output; constriction of sphincter of oddi	
(4)	Kidney (urinary system)	Decreased glomerular filtration rate	
(5)	Skin (integumentary system)	Constriction of cutaneous arterioles causes decreased perspiration. This reverses as more heat is produced.	
(6)	Muscles (musculoskeletal system)	Increased blood flow to active muscles	
(7)	Lungs (respiratory system)	Increased in blood flow to lung for gas exchange; rise is respiratory rate and pulmonary ventilation	
(8)	Brain (nervous system)	Increase in activity of cortical neurons; increased alertness. Inhibition of sleep.	
(9)	Gastrointestinal tract (digestive system)	Inhibition of GIT motility and secretion. Increase in salivary alpha amylase	
(10)	Blood and immune system	Increase in erythrocyte count, interlukins 6 and 10	
(11)	Endocrine glands (endocrine system)	Alpha cells of islet secret glucagon, increase growth hormone secretion, Increased secretions from adrenal gland; increased adrenal progesterone and androgen	
(12)	Reproductive organs (reproductive system)	Inhibition of tumescence	

Table 1.
Extrinsic stress control in human body.

isolated a distinct virus and was designated as B814 [28, 29]. Unfortunately, the virus could not be cultivated using the same methods which were used for adenoviruses, rhinoviruses, and many more. It was not until 1965 that the new virus was grown courtesy of a technique that involves serial passage through human embryonic trachea organ culture [30]. It was observed that inoculation of the novel virus into volunteers through the intranasal route resulted in cold. However, inactivation of the virus occurs in the presence of ether showing the virus exhibits lipid envelope. Thereafter, the isolate was grown in kidney tissue culture and designated as 229E [31]. 229E was capable of being inactivated just like B814 by ether [32]. In 1967, Scientists were able to compare 229E, B814, and infectious bronchitis virus and with the aid of an electron microscope, they were found to be related [26]. Specifically, they were observed to exhibit a crown-like presentation [33]. Therefore, the word 'corona' is a Greek meaning 'crown or wreath' in English and was formulated to describe the signatory appearance of a group of viruses [34]. OC43 was another novel respiratory virus with similar morphology as infectious bronchitis virus, 229E, and EB814. Exclusive investigations on these strains dated over 20 years after the discovery and it was shown that while the latter demonstrated a tendency of orchestrating epidemic in the entire United States, the former was more associated with local outbreak. It was later clear that apart from these strains, other respiratory viruses exist.

Over the years, many other strains have been discovered. For instance, in 2003, a human coronavirus named severe acute respiratory syndrome-coronavirus (SARCOV-1) was identified. This virus infects pulmonary epithelial cells [35] in bats, palm civets and humans [36, 37] using angiotensin-converting enzyme 2 (ACE2) [38]. Human Coronavirus NL63, another positive sense single-stranded enveloped RNA which invades the host cell through ACE2 was also detected in 2013. Human coronavirus HKU1 was detected in 2004 in Hongkong using N-acetyl-9-O-acetylneuraminic acid receptor [39]. In 2013, Middle East coronavirus (MERS-COV) was discovered [10]. This virus was found to infect bats, humans, and camels by binding to Dipeptidyl peptidase 4 (DPP4) receptors. In 2019, severe acute respiratory syndrome-coronavirus-2 was discovered in Wuhan, China [40].

Coronaviruses are responsible for 15% of common cold [41]. Other features signifying coronavirus infection are swollen adenoids, pneumonia, sore throat, bronchitis, fever, and many more [42]. Human coronavirus OC43, human coronavirus HKU1, human coronavirus 229E, and human coronavirus NL63 produce mild symptoms while Middle East respiratory syndrome-coronavirus, severe acute respiratory syndrome-1 coronavirus, and severe acute respiratory syndrome-2 coronavirus produce potentially severe problems [11].

7. Effect of occupation stress on sleep pattern IN frontline health workers during COVID-19 outbreak

A number of studies indicated the effects of occupational stress on sleep patterns in frontline healthcare providers during COVID-19. For instance, Hassinger et al. [13] reported that 68% of frontline healthcare workers exhibited aberration in their normal sleep patterns such as insomnia and daytime somnolence during COVID-19 outbreak with physicians being more affected than nurses. A total of 43% had increased daytime somnolence and 37 experienced a reduction in sleep efficiency. An increase in daytime sleepiness occurs when normal circadian nocturnal sleep is insufficient.

Jahrami et al. [43] conducted a systematic review in 13 countries with the aim of evaluating how COVID-19 pandemic had affected the sleep of the general population including frontline healthcare providers in the previous eight-month from July 2020. Although the review showed that the rate of sleep problems such as insomnia was 36%, there was no specific information about the prevalence of the abnormality across frontline healthcare workers. Sanghera et al. [44] concluded that insomnia was one of the negative impacts of SARS-CoV-2, with a prevalence range of 7.4–37.4%. Marvaldi et al. [45] in their systematic review identified sleep disorders as one of the prevalent health problems among frontline health workers accounting for 44.0%. However, the nature of sleep disorder was not too clear. In China, Jing et al. [46] assessed sleep disorders among 801 frontline healthcare workers using the Pittsburgh Sleep Quality Index, Visual Analogue Scale, and Athens Insomnia Scale. Frontline healthcare workers were shown to have a greater Pittsburgh Sleep Quality Index when compared with non-frontline workers.

Conroy et al. [47] utilized internet-based cross-sectional survey data retrieved from frontline healthcare personnel over a period of 1 month in the United States of America. There was a reduction in total sleep time in workers who reported to work continuously when compared with workers who work from home. According to the trend of the study, it was much more possible for the sleeping length of personnel who worked from home as a circadian rhythm to be entrained. In France, Germany, United Kingdom, USA, Italy, and Spain, Kim et al. [48] conducted an internet-based survey among frontline healthcare workers to identify the association between sleep pattern and COVID-19 susceptibility. The study was for 2 months and a total of 2884 frontline healthcare workers drawn from the countries were used. It was reported that the more sleep disorders such as insomnia, the more the risk of COVID-19. In Bahrain, Jahrami et al. [49] investigated the quality of sleep of frontline personnel during COVID-19 outbreak using 280 healthcare personnel through internet-based Pittsburgh Sleep Quality Index. While 75% of frontline health personnel and 76% of non-frontline health personnel claimed that they did not sleep well, respectively. In India, Gupta et al. [50] assessed the impact of COVID-19 pandemic on sleep quality among healthcare personnel and noted that 31.5% of the healthcare workers experienced poor sleep quality. In frontline healthcare workers, Rossi et al. [51] conducted an internet-based cross-sectional investigation through web-based questionnaires and reported that 8.27% of respondents experienced insomnia. Wang et al. [52] investigated the effect of COVID-19 on sleep quality of healthcare personnel in Wuhan Pediatric healthcare center using a self-reported questionnaire. The questionnaire contained the Pittsburgh Sleep Quality Index and the result indicated that 38% of the respondents experienced sleep disturbance. Shaukat et al. [53] noted in their review that frontline healthcare personnel were at risk of COVID-19-induced insomnia. Zeng et al. [54] reported in their review that the prevalence of abnormal sleep patterns was 61% in nursing staff. Among the sleep patterns taken into consideration include daytime dysfunction, sleep latency, and sleep duration. Stewart et al. [55] evaluated the sleep pattern in USA frontline health professionals during COVID-19 outbreak using online platforms such as Instagram, Facebook, and Twitter. The result indicated that 95.5% of respondents reported sleep abnormalities. Thirty percent indicated moderate or severe insomnia and 60.9% experienced sleep disruptions attributable to device utilization. In a systematic review by Salari et al. [56] the prevalence of sleep abnormalities in frontline physicians and nurses during COVID-19 pandemic was found to be 41.6 and 34.8%, respectively. In Western China, Yue et al. [57] in

their cross-sectional investigation discovered via self-administered questionnaire that out of 543 respondents who were frontline medical staff, nearly 40% claim to experience insomnia.

8. Neuro-immunologic effects of COVID-19 induced sleep disruption IN frontline health workers

Quality of sleep is an important determinant of a person's physical and psychological well-being, including the capacity of a person to respond to environmental challenges such as those posed by microbes and toxins [58]. Virtually all the body's physiological systems are affected by the daily and seasonal changes in the timing, intensity, and spectral frequency composition of environmental light known as circadian rhythm [59]. The suprachiasmatic nucleus (SCN) is the brain's sensor of light-dark cycles and, therefore, a regulator of circadian rhythm. Light sensed by the SCN modulates sympathetic activity and release of the sleep-promoting hormone melatonin, which, in turn, modulates the production, and release of the hypothalamic-pituitary-adrenal (HPA) axis hormones CRH, ACTH, and cortisol [60]. Some viruses, including the SARS-Cov2 variants, appear to suppress pineal gland production of melatonin which, in turn, disinhibits neutrophil activity thereby contributing to a pro-inflammatory "cytokine storm," thought to be the main source of inflammation and Covid-related tissue damage in Covid19 [61]. Melatonin suppression, in turn, down-regulates expression of *Bmal1*, the body's "molecular timekeeper," known to generate circadian rhythms. Down-regulation of *Bmal1* pyruvate dehydrogenase complex and conversion of pyruvate to acetyl-coenzyme A (acetyl-CoA) and ATP production by mitochondrial oxidative phosphorylation shifts the redox balance toward glycolysis as the main source of ATP for immune cells [62]. This inhibition of mitochondrial ATP production and shift toward cytosolic ATP production by glycolysis in granulocytes, dendritic cells, macrophages, and other immune cells is known to maintain a high level of immunological reactivity, thereby contributing to a strong inflammatory response and immune-related tissue damage in a wide variety of body organs [63] and cause sleep disruption. One of the more interesting aspects of Covid19 is the heightened anxiety and emotional responses associated with the changes in psychosocial interactions imposed by the Covid19 pandemic. Such emotional imbalances, therefore, have similar effects on the HPA axis and melatonin as exposure to the virus, thereby creating a potential to augment and exacerbate the effects of Covid19 [64].

Another interesting aspect is that geriatric age appears to be a risk factor for the more serious, lethal manifestations of Covid19 [65]. It has been shown that sleep architecture changes with age. Deep sleep, characterized by the appearance of delta-waves in the electroencephalogram (EEG) decreases in the elderly [66]. Delta-wave sleep is also known as slow-wave sleep. Because the dura mater appears to be the only source of lymphatics for the brain, the brain parenchyma has evolved a lymphatic system of neuroglia referred to as the "glymphatic" clearance system to rid the brain of toxic metabolites. Glymphatic clearance is shown to occur mainly during slow-wave sleep [67]. In addition to metabolite clearance, slow-wave sleep has numerous other functions including learning and memory consolidation [68, 69]. Slow-wave EEG activity is also associated with blood-brain barrier opening which facilitates clearance of macromolecules from the brain parenchyma [70]. During the slow-wave EEG activity associated with sleep, the chemosensory functions of microglia, subserved by

purinergic receptors, are directed toward binding the ATP and adenosine released by degenerating neurons [71, 72]. This phagocytic activity of microglia appears to be critical for pruning synapses during cortical maturation and memory formation or preservation [73]. During slow-wave sleep, brain levels of adenosine, the main metabolite of ATP, and TNF-alpha, a primary pro-inflammatory mediator of immunity, appear to increase; whereas the brain's acetylcholine and monoamines (norepinephrine, dopamine, and serotonin) decrease. Adenosine and TNF receptor signaling are known to disrupt the blood-brain barrier [74, 75]. Taken together, these findings are consistent with the concept that slow-wave sleep serves mainly a metabolic waste-clearance, restorative function for the brain. Still another interesting aspect of Covid19 pathophysiology is the "brain fog" and cognitive decline, often associated with elevation of pro-inflammatory serum markers such as TNF-alpha, which a significant proportion of individuals appear to experience for months to years after recovery from the acute manifestations of Covid infection [76]. These findings concerning neuro-immunological interactions do not bode well for the long-term consequences and health care manpower shortage when frontline health care workers contract Covid19.

9. Occupational stress-related sleep disorders in frontline healthworkers during COVID-19 pandemic: Roles of emotional perturbations

Studies provide evidence that COVID-19 caused emotional perturbation in frontline healthcare workers. Serrano-Ripoll et al. [77] in a systematic review noted that the prevalence of anxiety in frontline healthcare workers during COVID-19 pandemic stood at 30%. Mrklas et al. [78] conducted a six-week cross-sectional investigation to ascertain the prevalence of anxiety and depression in frontline healthcare workers during COVID-19 pandemic. They found that the prevalence of anxiety and depression was 47 and 46%, respectively. Using a structured internet-based questionnaire method, Ghio et al. [79] documented that there was a rise in the quanta of depression and anxiety with values of 62 and 61%, respectively in frontline health workers during COVID-19. Saragih et al. [80] indicated that the prevalence of depression and anxiety in Doctors and Nurses stood at 40 and 37%, respectively during COVID-19 pandemic. In a review by Sofia et al. [81] about 23.2 and 22.8% of healthcare professionals who faced COVID-19 patients experienced anxiety and depression in India, respectively. Ching et al. [82] showed in their review that 37.5 and 39.7% of healthcare workers suffered from depression and anxiety, respectively during COVID-19 pandemic in Asia. Health Professionals managing COVID-19 were studied by Magnavita et al. [83]. The result of the study showed that 27.8% of the respondents experienced anxiety and 51.1% had depression in Italy.

Emotional arousal induced sleep disorders may be mediated through increased sympathetic activation [84]. In the rat model, an increase in sympathetic nervous system index has been documented [85]. Activation of noradrenergic neurons and sympatho-adrenal axis by anxiety leads to increased secretion of epinephrine and norepinephrine, neurotransmitters which stimulate reticular activating system, and result in increased wakefulness. For many years, interruption of upper thoracic sympathetic ganglions has been reported to lead to elevated perspiration occurring in the arms and palms, blushing, and trembling [86]. Activation of the sympathetic nervous system results in increased expression of Cannabinoid type-1 (CB1) receptors [87]. CB1 receptors are expressed in the brain where they modulate GABA release. Wilkinson et al. [88] showed an increase in muscle sympathetic activity and

plasma epinephrine in panic patients. Reduction in basal forebrain brain-derived neurotrophic factor (BDNF) and adenosine and a rise in nitric oxide in animal models have been linked with emotional disorder-related alteration in sleep pattern [89].

Apart from the involvement of brain derived neurotrophic factor, nitric oxide, adenosine, and sympathoadrenal axis, occupational stress-related sleep disorders in frontline health workers during COVID-19 pandemic may be due to elevation in glucocorticoid and corticotropin releasing hormone profile. CRH and cortisol are integrated through ACTH. ADH from parvocellular hypothalamic neuro-secretory cells induces the secretion of ACTH by binding V1bR of hypophyseal corticotroph. ACTH acts on its receptors on the adrenal cortex. A study by D'Angelo et al. [90] showed that there was marked disruption of sleep in Cushing Syndrome patients. However, the study found no correlation between urinary free cortisol and sleep impairment. In another development, there is increasing evidence that occupational stress-induced sleep disorders may be characterized by changes in EEG. Holsboer et al. [91] investigated the electroencephalographic effects of exogenous corticotropin-releasing hormone (CRH) and reported a reduction in slow wave sleep and an increase in wakefulness. The possibility that sleep disorders associated with frontline health workers might be due to glucocorticoid-induced changes in hippocampal glycogen is increasing. Gip et al. [92] reported that sleep-deprived rats, characterized by elevated glucocorticoid, exhibited decreased hippocampal glycogen and brain glycogen. Depression in hippocampal glycogen and brain glycogen has been linked with EEG waves [93]. Bradbury et al. [94] demonstrated the possible role of CRH and glucocorticoids on hypnotic EEG. Suppression of adrenal glucocorticoid secretion via adrenal gland removal led to decreased delta waves but alpha waves increased. While reversion occurs with physiological glucocorticoid treatment, the quantity of non-rapid eye movement was depressed with extra-physiological glucocorticoid administration. Furthermore, administration of REM-prolonging peptide secreted by the intermediate lobe of the hypophysis known as corticotropin-like intermediate lobe peptide raised the latency of sleep [95, 96]. Another way through which CRH may disrupt sleep is the inhibition of spontaneous reticular thalamic discharge implicated in synchronizing NREM waves (**Figure 1**). Injection of CRH has been reported to suppress NREM waves in C57BL/67 and CRH-R1 CL mice [97].

10. Occupational stress-related sleep disorders IN frontline health workers during COVID-19 pandemic: roles of hypertension

Among the frontline healthcare workers recruited by Gupta et al. [98] 28.8% who had no history of hypertension were reported to be hypertensive during COVID outbreak. Gopal et al. [99] measured blood pressure among frontline male healthcare workers especially those whose body fat was 26.06. The study results showed that 52.4% of these people exhibited stage I hypertension with a heart rate of 92.5 BPM.

Evidence abounds on how hypertension may impair normal hypnosis. In animal studies, spontaneous hypertensive rats were shown to exhibit fewer quiet sleeps and paradoxical sleep, very mild accumulated REM and NREM sleep, and more transition from quiet sleep to active waking when compared to Wistar rats [100]. They also have lower R-R interval, higher low frequency/high-frequency ratio, higher low frequency, and lower high frequency during REM sleep when compared with Wistar rats [100]. Norepinephrine and epinephrine are excitatory neurotransmitters in the cerebral cortex and the neurotransmitter mediates wakefulness, consciousness, and alertness. Increased concentration of norepinephrine in body fluid including cerebrospinal

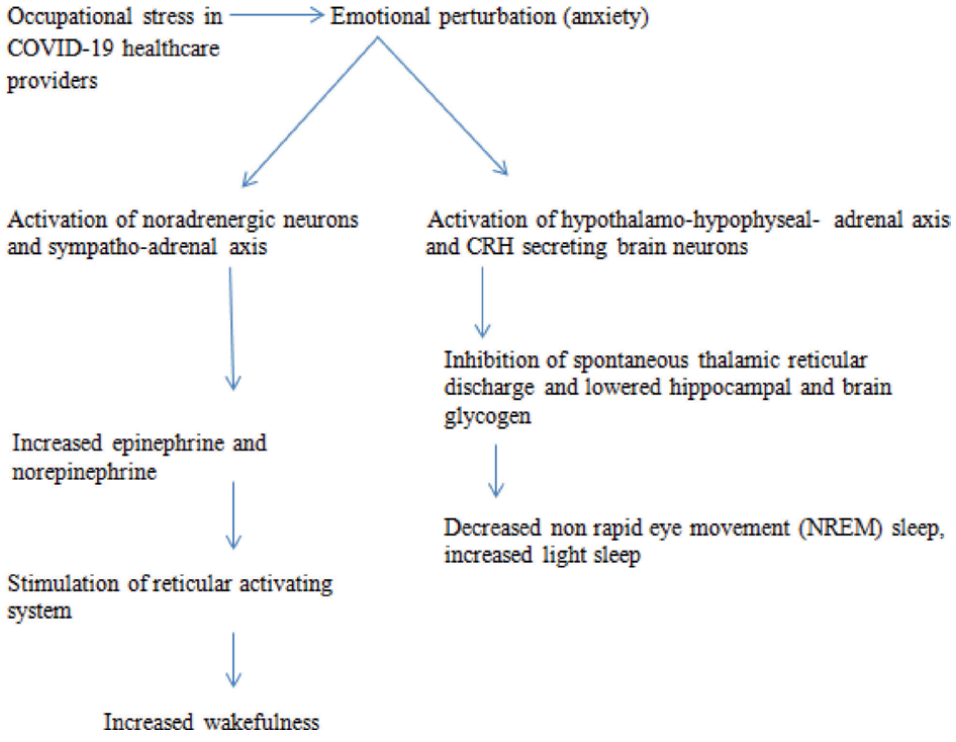

Figure 1.
Connection between occupational stress-induced emotional perturbation (anxiety) and sleep disorders in frontline COVID-19 healthcare providers. Activation of noradrenergic neurons and sympatho-adrenal axis by anxiety leads to increased secretion of epinephrine and norepinephrine, neurotransmitters which stimulate reticular activating system, and result in increased wakefulness. Furthermore, Hypothalamo-hypophyseal-adrenal axis and CRH secreting brain neurons become activated by anxiety resulting into inhibition of spontaneous thalamic reticular discharge and lowered hippocampal and brain glycogen. This then culminate into decreased non rapid eye movement sleep and increased light sleep.

fluid [101] could lead to sleep problems. Increased norepinephrine and serotonin in the brainstem and adrenal epinephrine and norepinephrine might be implicated in high blood pressure induced insomnia [102]. In adult spontaneous hypertensive rats, hypertension is mediated by selective stimulation of the intermediolateral area, locus coeruleus and peripheral sympathetic nerves [103]. Once these areas are activated, the ascending reticular activating fibers become active leading to increased awareness and impaired hypnosis. Noradrenergic fibers are one of the examples of ascending reticular activating fibers. Studies by Russell et al. [104] revealed noradrenergic neurons are activated while inhibitory dopaminergic neurons are suppressed in spontaneous hypertensive rats. Therefore, in hypertensive cases, spontaneous discharge of noradrenergic fibers during basal state may explain how hypertension causes insomnia in frontline COVID-19 healthcare workers.

11. Occupational stress-related sleep disorders IN frontline health workers during COVID-19 pandemic: roles of chronobiological disruption

One of the important attributes of physiological processes is rhythmicity. Physiological processes occur in distinct patterns, reaching peak level (acrophase) at

a phase of 24 hour day and nadir (bathophase) during the other phase of 24 hour day. The periodic variation in physiological processes is known as chronobiology. Some processes are completed (reaching both acrophase and bathophase) in appropriately 24 hours (circadian rhythms). Others require either less than 24 hours (ultradian rhythms) or greater than 24 hour (infradian rhythms) to be completed [105]. Interestingly, all internal biological rhythms are serviced by external rhythms which can range from environmental factors to physico-mental situations like occupational demand. Studies from shift workers are enormous in support of the deleterious impact of work schedules on sleep pattern and body temperature (circadian), hormone secretions (ultradian and circadian), and reproductive cycle (infradian). Wan and Chung [106] showed that nurses on a rotatory schedule had a greater proportion of irregular ovarian cycle. In Sweden, midwives on irregular duty schedules showed reduced fecundity.

In Night shift workers, there was a change in the timing of LH surge [107–109]. Ning et al. [110] reported that oil workers on different work schedules exhibited sleep disorders and noted that cortisol level, Per3 gene, and rs680 loci of CLOCK influence sleep quality in these workers. Specifically, they discovered that CLOCK rs1801260 locus bearing TC and CLOCK rs680524 bearing GC and CC exhibited lower sleep disorders. The change in sleep pattern reported by Ning et al. [110] and many other investigators are significant viewing from the perspectives of the human activity cycle. Human beings are diurnal, designed to be active in the daytime and passive at night, working during the daytime and resting in the nighttime. Prolongation of working period to nighttime due to need, incentive, or disease adversely affects sleep quantity and quality.

In people whose work schedules extend into night, the ascending reticular fibers continue to release excitatory neurotransmitters (norepinephrine, epinephrine, serotonin, acetylcholine, histamine, orexin among others). Under the influence of these hormones, it is very difficult for sleep to be induced. In addition, shift workers experience changes in normal secretory pattern and rhythm of hypnotic hormones including melatonin, leptin, Gamma Amino Butyric Acid (GABA) among others [111]. This, in part, explains the importance of sleep hygiene. Sleep hygiene is simply defined as a sleep-promoting lifestyle. One of these lifestyles is voluntary withdrawal from active engagements [107, 109, 112]. Prolongation of activity is not only common in workers. Students exhibit this habit before, during, and after examination or contest [107, 109]. Ghrelin and leptin are chemical messengers that strongly influence feeding patterns and sleep and their secretions follow circadian pattern. Ghrelin peaks in the daytime and falls in the nighttime while leptin rises during nighttime/sleep and falls in daytime (usually in the absence of meal ingestion), respectively [113]. In people whose activities extend into night, nocturnal secretions of ghrelin and leptin rise and fall respectively. This results in hunger perception and nighttime eating which culminate in sleep and health problems. People who travel across latitude and shift workers exhibit a deranged sleep/wakefulness cycle [114, 115]. Other health issues that may co-exist with deranged sleep/wakefulness cycle include mood disorders, cardiovascular diseases, menstrual cycle anomaly, and breast cancer risk [116, 117].

In addition to leptin, disruption of secretory rhythm of Gamma Amino Butyric Acid (GABA) may be implicated in sleep abnormality [118]. A study by Junkermann et al. [119] supports the possibility that night work induced- alteration in progesterone secretory rhythm may participate in sleep abnormality that characterizes frontline COVID-19 health workers.

12. Occupational stress-related sleep disorders IN frontline health workers during COVID-19 pandemic: roles of prolonged exposure to artificial light

Work at night is practically impossible without light exposure. Sequel to the advent of light in 1860, exposure to anthropogenic light has been one of the major challenges in the modern world. Besides being an electromagnetic wave, ambient light is one of the most potent synchronizers of internal rhythms [120]. Shift in light/dark cycle by 6 hours orchestrated desynchronization that spanned for more than 6 days in rodents [116]. This indicates the tendency of light to shift circadian phase. In other studies, exposure to irregular lighting schedules have been claimed to cause prolongation of estrous cycle, lengthening of follicular phase, and an increase in estrous cycle ratio [121–124].

Furthermore, exposure to light is one of the underlying mechanisms of shift work induced sleep problems. Exposure to anthropogenic nocturnal light causes repression of Arylalkylamine N-acetyltransferase (ANAT), an enzyme that is responsible for melatonin secretion by the pineal gland. The absence of melatonin inhibits normal nocturnal sleep. Studies in both human and animal studies have extensively documented the adversities associated with light-induced suppression of melatonin [124]. Melatonin is known to interact with its MTI and MT2 receptors resulting in a decrease in cyclic adenosine monophosphate (CAMP). MTI is found in hypothalamic nuclei where it decreases neural discharge. Melatonin reduces the firing of ascending reticular fibers which project via hypothalamus to the cerebral cortex and thus inhibit consciousness and alertness while promoting sleep [123, 124]. This results in disruption of normal circadian sleep (**Figure 2**).

The hormonal consequences of light-induced melatonin suppression have been reported. Davis et al. [111] showed that health workers on night shift duty exhibit low levels of urinary sulfatoxymelatonin and since melatonin exerts regulatory influence on gonadotropins. The authors also found high urinary levels of FSH and LH in the same people. Increased prolactin level was recorded in women exposed to lengthened lighting period [125, 126]. In rat studies, exposure to constant light may modulate suprachiasmatic *PER2* expression. *PER2* is a member of the PERIOD protein. PERIOD is a circadian protein that combines with cryptochrome (*CRP)* to form a dimer which then acts in a negative loop to inhibit brain and muscle arnt like protein (BMAL) and circadian locomotor oscillator cycles of kaput (CLOCK), which positively promotes the production of PERIOD and Cryptochrome [115]. Blue light has been reported to exert the greatest suppressive effects on melatonin because blue light provides sufficient stimulus for the suppression of ANAT [117]. Light-related suppression in melatonin is due to a reduction in postganglionic noradrenergic neural discharge to the pineal gland.

13. Discussion

Sleep doubles as an important component of activity cycle and a restoration-driven physiological state [107, 109, 127]. Inability to sleep or insufficiency of sleep in frontline health workers managing COVID patients is caused by and has been associated with a number of adverse consequences [83]. Anxiety either due to fear of infection or an increase in job demand, hypertension, chronobiological disruption, prolonged exposure to artificial light, and stress are important contributing factors to insomnia experienced by frontline COVID-19 health workers. Sleep disruption

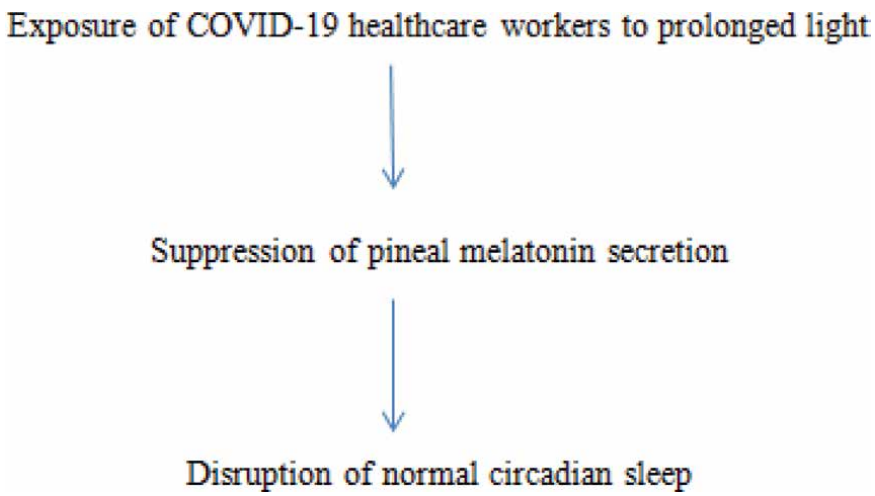

Figure 2.
Prolonged light exposure and sleep disorders in frontline health workers during COVID-19. Pineal melatonin becomes suppressed by prolonged exposure to light resulting into disruption of normal circadian sleep.

in frontline health workers may present a number of ugly consequences including neurocognitive decline. This is due to a number of reasons. The dura mater appears to be involved in the clearance of brain toxins via a novel lymphatic system of neuroglia referred to as the "glymphatic" clearance system. Glymphatic clearance is shown to occur mainly during slow-wave sleep [67]. During slow-wave sleep, brain levels of adenosine, the main metabolite of ATP, and TNF-alpha, a primary pro-inflammatory mediator of immunity, appear to increase; whereas the brain's acetylcholine and monoamines (norepinephrine, dopamine, and serotonin) decrease. Disruption of slow wave sleep experienced by frontline COVID-19 health workers makes it difficult to eliminate brain toxins and increases the risk of diseases including sleep disorders.

Anxiety in frontline COVID-19 health workers is another concern. Generally, anxiety is characterized by sympathetic activation. Increased expression of Cannabinoid type-1 (CB1) receptors owing to activation of the sympathetic nervous system has been documented [87]. CB1 receptors are expressed in the brain where they modulate GABA release culminating in sleep deprivation. Moreover, decline in basal forebrain brain derived neurotrophic factor (BDNF) and adenosine and a rise in nitric oxide in animal models have been linked with emotional disorder-related alteration in sleep pattern [89]. Hippocampus, a birthplace of theta waves, plays an important role during sleep. Depletion of hippocampal glycogen and attendant alteration in EEG waves may atone for sleep disruption that characterizes COVID-19 frontline health workers [92]. CRH is released during stress and anxiety and this hormone has been shown to depress NREM waves in C57BL/67 and CRH-R1 CL mice [97]. Spontaneous reticular thalamic discharges, implicated in synchronizing NREM waves, are known to suppress cortical activation by peripheral stimuli. Disruption of sleep occasioned by Inhibition of spontaneous reticular thalamic discharge has been reported following CRH injection [94].

Spontaneous discharge of noradrenergic fibers during basal state may explain how hypertension causes insomnia in frontline COVID-19 healthcare workers [104]. Disruption of normal secretory rhythm of hormones and chemical messengers and presence of circadian genes such as CLOCK rs1801260 locus bearing TC and CLOCK

rs680524 bearing GC and CC may contribute in substantive level to sleep disruption in frontline COVID-19 health workers. At least, studies have indicated an alteration in the circadian rhythm of leptin in people with sleep deprivation [113]. Changes in the normal secretory rhythm of Gamma Amino Butyric Acid (GABA) have also been implicated in sleep abnormality [118]. Like circadian disruption, prolonged exposure to ambient light may increase sleep latency. Light is known to suppress nocturnal melatonin synthesis making initiation of sleep difficult. Blue light has been shown to exert the greatest suppressive effect on melatonin secretion [117]. Light-related suppression in melatonin is due to a reduction in postganglionic noradrenergic neural discharge to the pineal gland. The ability of light to suppress melatonin secretion is known as the negative masking effect of light.

In summary, the review highlighted the possible mechanisms that underlie sleep anomaly that characterized frontline COVID-19 workers using existing information from experimental studies. Presence of CLOCK rs1801260 locus bearing TC and CLOCK rs680524 bearing GC and CC and stress-induced elevation of cannabinoid receptors, depletion of adenosine and forebrain derived neurotrophic factor, depletion of hippocampal glycogen and a rise in nitric oxide suppress spontaneous thalamic discharges which are involved in sleep induction are possible underlying mechanisms.

14. Conclusion

COVID-19 emergence and the attendant waves of responses from frontline healthcare officers have been very remarkable. The review has highlighted the possible underlying mechanisms associated with occupational stress-induced sleep disorders in frontline healthcare providers managing COVID-19. It is very glaring from primary studies that COVID-19-induced occupational stress causes sleep disorders most especially insomnia in both male and female frontline healthcare workers which are connectable to a number of underlying factors including anxiety leading to neuro-immunological changes. Anxiety-associated sleep anomaly is attributable to stimulation of the reticular activating system which occurs as a result of activation of noradrenergic fiber and sympatho-adrenal axis. Depletion of hippocampal and brain glycogen by anxiety-induced activation of corticotropin releasing hormone (CRH)-secreting brain neurons and hypothalamic-corticotropic-adrenal cortex axis are important implicating mechanisms. Spontaneous discharge of noradrenergic fiber during basal state and changes in the normal secretory rhythm of hypnosis-related chemical messengers may be responsible for hypertension- and chronobiological disruption-induced sleep disorders respectively. Lastly, prolonged light exposure-induced suppression of melatonin secretion may elicit disruption of normal circadian sleep.

Conflict of interest

The authors declare no conflict of interest.

Author details

Mayowa J. Adeniyi[1*], Ayoola Awosika[2,3,4], Richard M. Millis[3] and Serah F. Ige[5]

1 Department of Physiology, Federal University of Health Sciences, Otukpo, Nigeria

2 College of Medicine, Ohio State University, Columbus, OH, USA

3 College of Medicine, American University of Antigua, Antigua & Barbuda

4 College of Health Sciences and Profession, Ohio University, Columbus, OH, USA

5 Department of Physiology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

*Address all correspondence to: 7jimade@gmail.com

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References

[1] Adeniyi M. Impacts of environmental stressors on the autonomic nervous system. In: Aslanidis T, editor. Autonomic Nervous System-Special Interest Topics. London, UK: IntechOpen; 2022. DOI: 10.5772/intechopen.101842

[2] Pega F, Nafradi B, Momen N, Ujita Y, Kai S, Annette P-Ü, et al. Global, regional, and national burdens of ischemic heart disease and stroke attributable to exposure to long working hours for 194 countries, 2000-2016: A systematic analysis from the WHO/ILO joint estimates of the Work-related burden of disease and injury. Environment International. 2021;**154**:106595

[3] Quick JC, Henderson DF. Occupational stress. Preventing suffering, enhancing wellbeing. International Journal of Environmental Research and Public Health. 2016;**13**:459

[4] Licht CM, Vreeburg SA, van Reedt Dortland AK, Giltay EJ, Hoogendijk WJ, et al. Increased sympathetic and decreased parasympathetic activity rather than changes in hypothalamic-pituitary-adrenal axis activity is associated with metabolic abnormalities. The Journal of Clinical Endocrinology and Metabolism. 2010;**95**:2458-2466

[5] Naghieh A, Montgomery P, Bonell CP, Marc T, Aber JL. Organisational interventions for improving wellbeing and reducing work-related stress in teachers. Cochrane Database of Systematic Reviews. 2015;**4**:CD010306

[6] Ruotsalainen JH, Verbeek JH, Mariné A, Serra C. Preventing occupational stress in healthcare workers. The. Cochrane Database of Systematic Reviews. 2015;**4**:CD002892

[7] Adetunji CO et al. Diverse techniques applied for effective diagnosis of COVID-19. In: Pani SK, Dash S, dos Santos WP, Chan Bukhari SA, Flammini F, editors. Assessing COVID-19 and Other Pandemics and Epidemics Using Computational Modelling and Data Analysis. Cham: Springer; 2022a. DOI: 10.1007/978-3-030-79753-9_3

[8] Adetunji CO et al. Machine learning approaches for COVID-19 pandemic. In: Pani SK, Dash S, dos Santos WP, Chan Bukhari SA, Flammini F, editors. Assessing COVID-19 and Other Pandemics and Epidemics Using Computational Modelling and Data Analysis. Cham: Springer; 2022b. DOI: 10.1007/978-3-030-79753-9_8

[9] Adetunji CO et al. Smart sensing for COVID-19 pandemic. In: Pani SK, Dash S, dos Santos WP, Chan Bukhari SA, Flammini F, editors. Assessing COVID-19 and Other Pandemics and Epidemics Using Computational Modelling and Data Analysis. Cham: Springer; 2022c. DOI: 10.1007/978-3-030-79753-9_9

[10] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. The New England Journal of Medicine. 2020;**382**(8):727-733. DOI: 10.1056/NEJMoa2001017

[11] King A. An uncommon cold. New Scientist. 2020;**246**(3280):32-35. DOI: 10.1016/S0262-4079(20)30862-9

[12] Nigeria Center for Disease Control (NCDC). 2021. Available from: https://covid19.ncdc.gov.ng/laboratory/ [Accessed: April 16, 2021]

[13] Hassinger AB, Breuer RK, Mishra A. Sleep patterns of US healthcare workers

during the first wave of the COVID-19 pandemic. Sleep & Breathing. 2021;**26**:1351-1361. DOI: 10.1007/s11325-021-02515-9

[14] Chrousos GP, Gold PW. The concepts of stress and stress system disorders. Overview of physical and behavioral homeostasis. JAMA. 1992;**267**:1244-1252

[15] Chrousos GP. Stress and disorders of the stress system. Nature Reviews. Endocrinology. 2009;**5**:374-381

[16] May PB, Burrow GN, Kayne RD, Donabedian RK. Hypoglycemia-induced prolactin release. Archives of Internal Medicine. 1978;**138**(6):918-920

[17] Haake P, Exton MS, Haverkamp J, Krämer M, Leygraf N, Hartmann U, et al. Absence of orgasm-induced prolactin secretion in a healthy multi-orgasmic male subject. International Journal of Impotence Research. 2002;**14**:133-135

[18] Jepson JH, Lowenstein L. Effect of prolactin on erythropoiesis in the mouse. Blood. 1964;**24**:726-738

[19] Chuang J-C, Zigman JM. Ghrelin's roles in stress, mood, and anxiety regulation. International Journal of Peptides. 2010;**460549**:5

[20] Furuyashiki T, Narumiya S. Stress responses: The contribution of prostaglandin E2 and its receptors. Nature Reviews. Endocrinology. 2011;**7**:163-175

[21] Koelsch S, Boehlig A, Hohenadel M, et al. The impact of acute stress on hormones and cytokines and how their recovery is affected by music-evoked positive mood. Scientific Reports. 2016;**6**:23008

[22] Herrera AY, Nielsen SE, Mather M. Stress-induced increases in progesterone and cortisol in naturally cycling women. Neurobiology of Stress. 2016;**3**:96-104. DOI: 10.1016/j.ynstr.2016.02.006

[23] Fredholm B. Adenosine, an endogenous distress signal, modulates tissue damage and repair. Cell Death and Differentiation. 2007;**14**:1315-1323

[24] Joels M, Baram TZ. The neuro-symphony of stress. Nature Reviews. Neuroscience. 2009;**10**:459-466

[25] Fabricant J. The early history of infectious bronchitis. Avian Diseases. 1998;**42**(4):648-650

[26] McIntosh K. Coronaviruses: A comparative review. In: Arber W, Haas R, Henle W, Hofschneider PH, Jerne NK, Koldovský P, Koprowski H, Maaløe O, Rott R, editors. Current Topics in Microbiology and Immunology/Ergebnisse der Mikrobiologie Und Immunitätsforschung. Current Topics in Microbiology and Immunology/Ergebnisse der Mikrobiologie Und Immunitätsforschung. Berlin, Heidelberg: Springer; 1974. p. 87

[27] Lalchhandama K. The chronicles of coronaviruses: The bronchitis, the hepatitis and the common cold. Science Vision. 2020;**20**(1):43-53

[28] Giaimo C. The Spiky Blob Seen around the World. The New York Times; 2020

[29] Kendall EJ, Bynoe ML, Tyrrell DA. Virus isolations from common colds occurring in a residential school. British Medical Journal. 1962;**2**(5297):82-86. DOI: 10.1136/bmj.2.5297.82

[30] Tyrrell DA, Bynoe ML. Cultivation of a novel type of common-cold virus in organ cultures. British Medical Journal. 1965;**1**(5448):1467-1470

[31] Knapp A. The Secret History of the First Coronavirus. Forbes; 2020

[32] Hamre D, Procknow JJ. A new virus isolated from the human respiratory tract. Proceedings of the Society for Experimental Biology and Medicine. 1966;**121**(1):190-193

[33] Almeida J. June Almeida. BMJ. 2008;**336**(7659):1511.1-1511. DOI: 10.1136/bmj.a434

[34] Tyrrell DA, Fielder M. Cold Wars: The Fight against the Common Cold. Oxford University Press; 2002. p. 96

[35] Fehr AR, Perlman S. Coronaviruses: An overview of their replication and pathogenesis. In: Coronaviruses. Methods in Molecular Biology. New Jersey, USA: Humana Press; 2015. pp. 1-23. DOI: 10.1007/978-1-4939-2438-7_1

[36] Fang L. Receptor recognition and cross-species infections of SARS coronavirus. Antiviral Research. 2013;**100**(1):246-254

[37] Wong ACP, Xin L, Lau Susanna KP, Woo Patrick CY. Global epidemiology of bat coronaviruses. Viruses. 2019;**11**(2):174

[38] Ge X-Y, Li J-L, Yang X-L, et al. Isolation and characterization of a bat SARS-like coronavirus that uses the ACE2 receptor. Nature. 2013;**503**(7477):535-538

[39] Xinyi LY, Ling NY, Tam James P, Xiang LD. Human coronaviruses: A review of virus–host interactions. Diseases. 2016;**4**(3):26. DOI: 10.3390/diseases4030026

[40] de Groot RJ, Baker SC, Baric R, Enjuanes L, Gorbalenya AE, Holmes KV, et al. "Family Coronaviridae". In: King AM, Lefkowitz E, Adams MJ, Carstens EB, International Committee on Taxonomy of Viruses, International Union of Microbiological Societies. Virology Division, editors. Ninth Report of the International Committee on Taxonomy of Viruses. Oxford: Elsevier; 2011; pp. 806-828

[41] Pelczar. Microbiology: Application Based Approach. McGraw Hill Education; 2010. p. 656

[42] Forgie S, Marrie TJ. Healthcare-associated atypical pneumonia. Seminars in Respiratory and Critical Care Medicine. 2009;**30**(1):67-85. DOI: 10.1055/s-0028-1119811

[43] Jahrami H, BaHammam AS, AlGahtani H, Ebrahim A, Faris M, AlEid K, et al. The examination of sleep quality for frontline healthcare workers during the outbreak of COVID-19. Sleep & Breathing. 2021a;**25**(1):503-511

[44] Sanghera J, Pattani N, Hashmi Y, Varley KF, Cheruvu MS, Bradley A, et al. The impact of SARS-CoV-2 on the mental health of healthcare workers in a hospital setting-a systematic review. Journal of Occupational Health. 2020;**62**:e12175

[45] Marvaldi M, Mallet J, Dubertret C, Moro MR, Guessoum SB. Anxiety, depression, trauma- related, and sleep disorders among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. Neuroscience and Biobehavioral Reviews. 2021;**126**:252-264

[46] Jing Q, Jing X, Bo-Zhi L, Jin-Sha H, Yuan Y, Zhen-Tao Z, et al. The evaluation of sleep disturbances for Chinese frontline medical workers under the outbreak of COVID-19. Sleep Medicine. 2020;**72**:1-4

[47] Conroy DA, Hadler NL, Cho E, Moreira A, MacKenzie C, Swanson LM, et al. The effects of COVID-19 stay-at-home order on sleep, health, and working patterns: A survey study of US health care workers. Journal of Clinical Sleep Medicine. 2021;**17**:185-191

[48] Kim H, Hegde S, LaFiura C, et al. COVID-19 illness in relation to sleep and burnout. BMJ Nutrition, Prevention & Health. 2021;**4**:8. DOI: 10.1136/bmjnph-2021-000228

[49] Jahrami H, BaHammam AS, Bragazzi NL, Saif Z, Faris M, Vitiello MV. Sleep problems during the COVID-19 pandemic by population: A systematic review and meta-analysis. Journal of Clinical Sleep Medicine. 2021b;**17**:299-313

[50] Gupta B, Sharma V, Kumar N, Mahajan A. Anxiety and sleep disturbances among health care workers during the COVID-19 pandemic in India: Cross-sectional online survey. JMIR Public Health and Surveillance. 2020;**6**(4):e24206

[51] Rossi R, Socci V, Pacitti F, et al. Mental health outcomes among frontline and second-line health care workers during the coronavirus disease 2019 (COVID-19) pandemic in Italy. JAMA Network Open. 2020;**3**(5):e2010185

[52] Wang S, Xie L, Xu Y, Yu S, Yao B, Xiang D. Sleep disturbances among medical workers during the outbreak of COVID-2019. Occupational Medicine. 2020;**70**:364-369

[53] Shaukat N, Ali DM, Razzak J. Physical and mental health impacts of COVID-19 on healthcare workers: A scoping review. International Journal of Emergency Medicine. 2020;**13**:40

[54] Zeng L, Yang Y, Wang C, Li X, Xiang Y, Hall BJ, et al. Prevalence of poor sleep quality in nursing staff: A meta-analysis of observational studies. Behavioral Sleep Medicine. 2020;**18**:746-759

[55] Stewart NH, Koza A, Dhaon S, Shoushtari C, Martinez M, Arora VM. Sleep disturbances in frontline health care workers during the COVID-19 pandemic: Social media survey study. Journal of Medical Internet Research. 2021;**23**:e27331

[56] Salari N, Khazaie H, Hosseinian-Far A, et al. The prevalence of sleep disturbances among physicians and nurses facing the COVID-19 patients: A systematic review and meta-analysis. Globalization and Health. 2020;**16**:92

[57] Yue L, Zhao R, Xiao Q, Zhuo Y, Yu J, Meng X. The effect of mental health on sleep quality of front-line medical staff during the COVID-19 outbreak in China: A cross-sectional study. PLoS One. 2021;**16**:e0253753

[58] Smith RP, Easson C, Lyle SM, Kapoor R, Donnelly CP, Davidson EJ, et al. Gut microbiome diversity is associated with sleep physiology in humans. PLoS One. 2019;**14**(10):e0222394

[59] Blume C, Garbazza C, Spitschan M. Effects of light on human circadian rhythms, sleep and mood. Somnologie (Berl). 2019;**23**(3):147-156

[60] von Gall C. The effects of light and the circadian system on rhythmic brain function. International Journal of Molecular Sciences. 2022;**23**(5):2778. DOI: 10.3390/ijms23052778

[61] Martín Giménez VM, de Las HN, Ferder L, Lahera V, Reiter RJ, Manucha W. Potential effects of melatonin and micronutrients on mitochondrial dysfunction during a cytokine storm typical of oxidative/inflammatory diseases. Diseases. 2021;**9**(2):30

[62] Rana S, Munawar M, Shahid A, Malik M, Ullah H, Fatima W, et al. Deregulated expression of circadian clock and clock-controlled cell cycle genes in chronic lymphocytic leukemia. Molecular

Biology Reports. 2014;**41**(1):95-103. DOI: 10.1007/s11033-013-2841-7

[63] Pearce EL, Pearce EJ. Metabolic pathways in immune cell activation and quiescence. Immunity. 2013;**38**(4):633-643. DOI: 10.1016/j.immuni.2013.04.005

[64] Pourriyahi H, Saghazadeh A, Rezaei N. Altered immunoemotional regulatory system in COVID-19: From the origins to opportunities. Journal of Neuroimmunology. 2021;**356**:577578

[65] Damayanthi HDWT, Prabani KIP, Weerasekara I. Factors associated for mortality of older people with COVID 19: A systematic review and meta-analysis. Gerontology and Geriatric Medicine. 2021;**7**. DOI: 10.1177/23337214211057392

[66] Roth T. Insomnia: Definition, prevalence, etiology, and consequences. Journal of Clinical Sleep Medicine. 2007;**15**(Suppl. S5):S7-S10. DOI: 10.5664/jcsm.26929

[67] Benveniste H, Heerdt PM, Fontes M, Rothman DL, Volkow ND. Glymphatic system function in relation to anesthesia and sleep states. Anesthesia and Analgesia. 2019;**128**:747-758

[68] Léger D, Debellemaniere E, Rabat A, Bayon V, Benchenane K, Chennaoui M. Slow-wave sleep: From the cell to the clinic. Sleep Medicine Reviews. 2018;**41**:113-132

[69] Mistlberger R, Kent BA. F1000 prime recommendation of coupled electrophysiological, hemodynamic, and cerebrospinal fluid oscillations in human sleep. F1000—Post-Publ. Peer Rev. Biomed. Lit. 2019. DOI: 10.3410/f.736832585.793568954

[70] Kaur J, Fahmy LM, Davoodi-Bojd E, Zhang L, Ding G, Hu J, et al. Waste clearance in the brain. Frontiers in Neuroanatomy. 2021;**15**:665803

[71] Koizumi S, Ohsawa K, Inoue K, Kohsaka S. Purinergic receptors in microglia: Functional modal shifts of microglia mediated by P2 and P1 receptors. Glia. 2013;**61**(1):47-54

[72] Silva I, Silva J, Ferreira R, Trigo D. Glymphatic system, AQP4, and their implications in Alzheimer's disease. Neurology Research & Practice. 2021;**3**(1):5. DOI: 10.1186/s42466-021-00102-7

[73] Illes P, Rubini P, Ulrich H, Zhao Y, Tang Y. Regulation of microglial functions by purinergic mechanisms in the healthy and diseased CNS. Cell. 2020;**9**(5):1108. DOI: 10.3390/cells9051108

[74] Bynoe MS, Viret C, Yan A, Kim DG. Adenosine receptor signaling: A key to opening the blood- brain door. Fluids Barriers CNS. 2015;**12**:20. DOI: 10.1186/s12987-015-0017-7

[75] Chen AQ, Fang Z, Chen XL, et al. Microglia-derived TNF-α mediates endothelial necroptosis aggravating blood brain–barrier disruption after ischemic stroke. Cell Death & Disease. 2019;**10**:487. DOI: 10.1038/s41419-019-1716-9

[76] Ceban F, Ling S, Lui LMW, Lee Y, Gill H, Teopiz KM, et al. Fatigue and cognitive impairment in post-COVID-19 syndrome: A systematic review and meta-analysis. Brain, Behavior, and Immunity. 2022;**101**:93-135

[77] Serrano-Ripoll MJ, Meneses-Echavez JF, Ricci-Cabello I, Fraile-Navarro D, Fiol-deRoque MA, Pastor-Moreno G, et al. Impact of viral epidemic outbreaks on mental health of healthcare workers: A rapid systematic review and meta-analysis. Journal of Affective Disorders. 2020;**277**:347-357

[78] Mrklas K, Shalaby R, Hrabok M, Gusnowski A, Vuong W, Surood S, et al. Prevalence of perceived stress, anxiety, depression, and obsessive-compulsive symptoms in health care workers and other Workers in Alberta during the COVID-19 pandemic: Cross-sectional survey. JMIR Mental Health. 2020;**7**(9):e22408. DOI: 10.2196/22408

[79] Ghio L, Patti S, Piccinini G, Modafferi C, Lusetti E, Mazzella M, et al. Anxiety, depression and risk of post-traumatic stress disorder in health workers: The relationship with burnout during COVID-19 pandemic in Italy. International Journal of Environmental Research and Public Health. 2021;**18**(18):9929. DOI: 10.3390/ijerph18189929

[80] Saragih ID, Tonapa SI, Saragih IS, Advani S, Batubara SO, Suarilah I, et al. Global prevalence of mental health problems among healthcare workers during the Covid-19 pandemic: A systematic review and meta-analysis. International Journal of Nursing Studies. 2021;**121**:104002

[81] Pappa S, Ntella V, Giannakas T, Giannakoulis VG, Papoutsi E, Katsaounou P. Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. Brain, Behavior and Immunity. 2020;**88**:901-907

[82] Ching SM, Ng KY, Lee KW, Yee A, Lim PY, Ranita H, et al. Psychological distress among healthcare providers during COVID-19 in Asia: Systematic review and meta-analysis. PLoS One. 2021;**16**(10):e0257983

[83] Magnavita N, Soave PM, Ricciardi W, Antonelli M. Occupational stress and mental health among anesthetists during the COVID-19 pandemic. International Journal of Environmental Research and Public Health. 2020;**17**(21):8245. DOI: 10.3390/ijerph17218245

[84] Hoehn-Saric R, McLeod DR. The peripheral sympathetic nervous system. Its role in normal and pathologic anxiety. The Psychiatric Clinics of North America. 1988;**11**(2):375-386

[85] Mouchtouri E, Lekkas P, Delis F, et al. Sympathetic and vagal responses elicited by acute stress in rats. Cureus. 2020;**12**(11):e11602. DOI: 10.7759/cureus.11602

[86] Pohjavaara P, Telaranta T, Väisänen E. The role of the sympathetic nervous system in anxiety: Is it possible to relieve anxiety with endoscopic sympathetic block? Nordic Journal of Psychiatry. 2003;**57**(1):55-60. DOI: 10.1080/08039480310000266

[87] Bellocchio L, Soria-Gómez E, Quarta C, Metna-Laurent M, Cardinal P, Binder E, et al. Activation of the sympathetic nervous system mediates hypophagic and anxiety-like effects of CB_1 receptor blockade. Proceedings of the National Academy of Sciences of the United States of America. 2013;**110**(12):4786-4791

[88] Wilkinson DJC, Thompson JM, Lambert GW, et al. Sympathetic activity in patients with panic disorder at rest, under laboratory mental stress, and during panic attacks. Archives of General Psychiatry. 1998;**55**(6):511-520. DOI: 10.1001/archpsyc.55.6.511

[89] Savelyev SA, Rantamäki T, Rytkönen KM, Castren E, Porkka-Heiskanen T. Sleep homeostasis and depression: Studies with the rat clomipramine model of depression. Neuroscience. 2012;**212**:149-158. DOI: 10.1016/j.neuroscience.2012.03.029

[90] D'Angelo V, Beccuti G, Berardelli R, Karamouzis I, Zichi C, Giordano R,

et al. Cushing's syndrome is associated with sleep alterations detected by wrist actigraphy. Pituitary. 2015;**18**(6):893-897. DOI: 10.1007/s11102-015-0667-0

[91] Holsboer F, Von Bardeleben U, Steiger A. Effects of intravenous cortisotropin releasing releasing hormone upon sleep-related growth hormone surge and sleep EEG in man. Neuroendocrinology. 1988;**48**:32-38

[92] Gip P, Hagiwara G, Sapolsky RM, Cao VH, Heller HC, et al. Glucocorticoids influence brain glycogen levels during sleep deprivation. American Journal of Physiology. Regulatory, Integrative and Comparative Physiology. 2004;**286**:R1057-R1062

[93] Feise G, Kogure K, Busto KR, Scheinberg P, Reinmuth OM. Effect of insulin hypoglycemia upon cerebral energy metabolism and EEG activity in the rat. Brain Research. 1977;**126**:263-280

[94] Bradbury MJ, Dement WC, Edgar DM. Effects of adrenalectomy and subsequent corticosterone replacement on rat sleep state and EEG power spectra. The American Journal of Physiology. 1998;**275**:R555-R565

[95] Day R, Schafer MK, Watson SJ, Chretien M, Seidah NG. Distribution and regulation of the prohormone convertases PC1 and PC2 in the rat pituitary. Molecular Endocrinology. 1992;**6**:485-497

[96] Machado RB, Tufik S, Suchecki D. Role of corticosterone on sleep homeostasis induced by REM sleep deprivation in rats. PLoS One. 2013;**8**(5):e63520. DOI: 10.1371/journal.pone.0063520

[97] Romanowski CP, Fenzl T, Flachskamm C, Wurst W, Holsboer F, et al. Central deficiency of corticotropin-releasing hormone receptor type 1 (CRH-R1) abolishes effects of CRH on NREM but not on REM sleep in mice. Sleep. 2010;**33**:427-436

[98] Amit G, Anuj M, Narsingh V, Aravinda J, Dariya SS, Amit S, et al. Impact of covid 19 pandemic on blood pressure of healthcare professionals during lockdown - an indian study. Journal of Hypertension. 2021;**39**:e203

[99] Gopal K, Alagesan J, Kishore Jebasingh T, Suganthirababu P, Kandakurti PK, Anitha A, et al. Turkish Journal of Physiotherapy and Rehabilitation. 2021;**32**(3):424-429

[100] Kuo TB, Shaw FZ, Lai CJ, Lai CW, Yang CC. Changes in sleep patterns in spontaneously hypertensive rats. Sleep. 2004;**27**(3):406-412. DOI: 10.1093/sleep/27.3.406

[101] Lake CR, Gullner HG, Polinsky RJ, Ebert MH, Ziegler MG. Bartter FC essential hypertension: Central and peripheral norepinephrine. Science. 1981;**211**:955-957

[102] Uchida T, Nishimura Y, Suzuki A. Age-related changes in cerebral and peripheral monoamine contents in stroke-prone spontaneously hypertensive rats. Clinical and Experimental Pharmacology & Physiology. Supplement. 1995;**22**(1):S80-S82. DOI: 10.1111/j.1440-1681.1995.tb02979.x

[103] Nakamura K, Nakamura K. Role of brainstem and spinal noradrenergic and adrenergic neurons in the development and maintenance of hypertension in spontaneously hypertensive rats. Naunyn-Schmiedeberg's Archives of Pharmacology. 1978;**1978**(305):127-133

[104] Russell V, Allie S, Wiggins T. Increased noradrenergic activity in prefrontal cortex slices of an animal model for attention-deficit hyperactivity disorder--the spontaneously hypertensive rat. Behavioural Brain

Research. 2000;**117**(1-2):69-74. DOI: 10.1016/s0166-4328(00)00291-6

[105] Cosic I, Fang Q, Pirogova E, Rudolph H. Biorhythms – Periodicity in Living Systems. NHMRC Centre of Research Excellence: Australian Centre for Electromagnetic Bio-effects Research, (2013-2017); 2005

[106] Wan GH, Chung FF. Working conditions associated with ovarian cycle in a medical center nurses: A Taiwan study. Japan Journal of Nursing Science. 2012;**9**(1):112-118

[107] Adeniyi MJ, Agoreyo FO, Olorunnisola OL, Olaniyan OT, Seriki SA, Ozolua PO, et al. Photo-pollution disrupts reproductive homeostasis in female rats: The duration-dependent role of selenium administrations. The Chinese Journal of Physiology. 2020a;**63**:235-243

[108] Hall JE, Sullivan JP, Richardson GS. Brief wake episodes modulate sleep-inhibited luteinizing hormone secretion in the early follicular phase. The Journal of Clinical Endocrinology and Metabolism. 2007;**90**(4):2050-2055

[109] Adeniyi MJ, Fabunmi O, Okojie AK, Olorunnisola OL, Odetola AO, Olaniyan OT, et al. Impact of night study frequency on sleep pattern, anthropometrical indices and peripheral oxygen saturation in age-matched Nigerian female students prior to semester examination. International Journal of Biomedical Sciences. 2020b;**16**(3):37-42

[110] Ning L, Shi L, Tao N, Li R, Jiang T, Liu J. Effects of occupational stress and circadian CLOCK gene polymorphism on sleep quality of oil Workers in Xinjiang, China. Medical Science Monitor. 2020;**26**:e924202. DOI: 10.12659/MSM.924202

[111] Scott D, Mirick DK, Chen C, Stanczyk FZ. Night shift Work and hormone levels in women cancer. Epidemiology Biomarkers & Prevention. 2012;**21**(4):609-618

[112] Adeniyi MJ, Ige SF, Adeyemi WJ, Oni TJ, Ajayi PO, Odelola SO, et al. Changes in body temperature and intestinal antioxidant enzymes in healthy and colitis male rats: Roles of *Garcinia kola* (bitter Kola). International Journal of Physiology. 2016;**4**(2):36-41

[113] Taheri S, Lin L, Austin D, Young T, et al. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Medicine. 2004;**1**(3):e62

[114] Horowitz TS, Cade BE, Wolfe JM, Czeisler CA. Efficacy of bright light and sleep/darkness scheduling in alleviating circadian maladaptation to night work. American Journal of Physiology. 2001;**281**(2):E384-E391

[115] Mahoney MM, Work S. Jet lag, and female reproduction. International Journal of Endocrinology. 2010;**2010**:813764

[116] Gamble KL, Resuehr D, Johnson CH. Shift Work and circadian dysregulation of reproduction. Frontiers in Endocrinology (Lausanne). 2013;**4**:92

[117] Abraham H, Portnov BA. Light Pollution as a New Risk Factor for Human Breast and Prostate Cancers. Dordrecht Heidelberg New York, London: Springer; 2013

[118] Park S, Kang I, Edden RAE, Namgung E, Kim J, Kim J. Shorter sleep duration is associated with lower GABA levels in the anterior cingulate cortex. Sleep Medicine. 2020;**71**:1-7

[119] Junkermann H, Mangold H, Vecsei P, Runnebaum B. Circadian rhythm of serum progesterone levels in human pregnancy and its relation

to the rhythm of cortisol. Acta Endocrinologica. 1982;**101**:98-104. DOI: 10.1530/acta.0.1010098

[120] Adeniyi MJ, Agoreyo FO. Duration-related modulation of body temperature rhythm and reproductive cycle in rats by photoperiodic perturbation. DRJHP. 2020;**8**(1):1-6

[121] Adeniyi MJ, Agoreyo FO, Ige SF, Fabunmi OA, Ozolua OP, Biliaminu SA. Physiological implications of prolonged selenium administrations in Normal and desynchronized adult female rats. The Journal of Krishna Institute of Medical Sciences University. 2021;**10**(4):21-36

[122] Agoreyo FO, Adeniyi MJ. Pattern of estrous cycle and ovarian Antiperoxidative activity in light deprived Sprague-Dawley rats treated with sodium selenite. Journal of Medicinal Research and Biological Studies. 2018;**1**(1):103

[123] Adeniyi MJ, Agoreyo FO. Estrous cycle ratio as a reproductive index in the rats. American Journal of Biomedical Sciences & Research. 2019;**4**(2):100-103

[124] Yorshinaka K, Yamaguchi A, Matsumura R, Node K, Tokuda I, Akashi M. Effect of different light-dark schedules on estrous cycle in mice and implications for mitigating the adverse impact of night work. Genes to Cells. 2017;**22**(10):876-884

[125] Mirsaeed A, Darkhi H, Kashanian M, Khodarahmian M, Dolati M, Ghaffari M, et al. Characteristics of menstrual cycle in shift workers. Global Journal of Health Science. 2013;**5**(3):163-172

[126] Miyauchi F, Nanjo K, Otsuka K. Effect of continuous lighting on secretion of melatonin and pituitary hormones in women. Pubmed. 1991;**43**(5):529-534

[127] Adeniyi M, Olaniyan O, Fabunmi O, Okojie A, Ogunlade A, Ajayi O. Modulatory role of pre-exercise water ingestion on metabolic, cardiovascular and autonomic responses to prolonged exercise in Young mildly active male. International Journal of Biomedical Sciences. 2022;**18**(2):24-34

Chapter 5

What Makes It Tip Over and How Can It Be Prevented?: Challenges in Psychosocial and Organisational Work Environment Faced by Perioperative Nurses, Anaesthesiologists and Nurse Assistants

Erebouni Arakelian

Abstract

Healthcare is facing new challenges today; accordingly, staffing and work environment are important for healthcare to work smoothly. The limitations in the perioperative physical work environment, for employees to not have an impact, are unique. Thus, the psychosocial work environment becomes even more important, where colleagues and nurse managers, relational justice and organisational justice play an important role in staff's well-being and decision to leave or stay. Moreover, interest in those who train to work in perioperative settings is decreasing for various reasons. It is, therefore, important to make perioperative departments healthy and attractive workplaces, where the demands and control in one's work are in balance, where support is offered by colleagues and managers as well as good salary, possibility for development in the profession and satisfactory work schedules with respect to recovery.

Keywords: perioperative, psychosocial, organisational, work environment, nurses, anaesthesiologists, work demands, healthy workplace

1. Introduction

Shortage of specialist nurses in perioperative settings has been a commonly discussed issue during the past years and is of larger significance today; furthermore, it affects quality of patient care [1], as planned surgeries may be cancelled [2, 3]. Perioperative settings or operating departments offer unique and demanding working conditions for perioperative nurses, that is, nurse anaesthetists, operating room nurses, nurse assistants, and anaesthesiologists, due to which some of them decide to leave [4]. The pressure to work quickly is high and stressful in perioperative settings due to high patient turnover [5].

The decreasing interest in training to become specialist nurses in perioperative settings makes it even more urgent to address the issues in connection with the perioperative work environment. Studies show that colleagues and nurse managers, among others, are important in perioperative nurses' decision to stay or leave [4]. Moreover, female gender, younger age and parents with children are reasons for burnout among anaesthesiologists [6]. Studies also show that when there is a peak in demand, employees need recovery the most. This chapter provides insights into the unique challenges in the work environment faced by the perioperative staff and how the perioperative environment can be a better workplace by just implementing some simple measures. This chapter comprises three main parts presenting: a) the uniqueness of perioperative work environment, b) psychosocial and organisational work environment and c) how the work environment can be improved by simple means. In the first part, the chapter explains the work of the perioperative nurses, including their education. Moreover, it describes the work environment of nurse assistants and anaesthesiologists. In the second part, insights are given into challenges in psychosocial and organisational work environments, the nurse managers' role in perioperative nurses' satisfaction with work, and how job demand-control affects work for professionals in perioperative settings. The final part describes measures that can be taken to make the psychosocial work environment better for the employees working in the perioperative context.

1.1 Methodology

To write each part of this chapter, a literature search was conducted in the database PUBMED with different combinations of the following keywords: perioperative settings or departments, perioperative care, perioperative dialogue, work environment, air temperature in operating room, noise level in operating room, regulations, nurse anaesthetist, scrub nurse, operating room nurse, assistant nurse, formal education (Europe, Nordic and the USA), work tasks, professional responsibilities, role description, skills, non-technical skills, competences, person-centered care, anaesthesiologists, experience, burnout, work place incivility, work stress, work-life balance, psychological work environment, nurse turnover (global and perioperative), nurse shortage, leave one's workplace, stay or remain at workplace, job satisfaction/dissatisfaction, organisational justice, nurse managers, caritative leadership, caritative caring, digitalization, job-demand-control- support model, organisational justice and relational justice. The inclusion criteria were articles about perioperative staff (nurses, nurse assistants, and anaesthesiologists) or nursing and perioperative environment. Research articles after year 2000 were used, with the exception of key references in specific areas, for example, in perioperative dialogue, where articles published before year 2000 were also included. In conclusion, this chapter reminds of an integrative review as research using multiple methodologies were utilised.

2. Perioperative work environment and working conditions: why is it unique?

2.1 Perioperative settings and perioperative care

A perioperative setting refers to operating departments where multidisciplinary teams, comprising perioperative nurses, nurse assistants, anaesthesiologists, surgeons and surgical assistants work together. Perioperative nurses are specialist nurses, that

is, nurse anaesthetists (NA) and operating room nurses (OR nurses), who provide care to patients during the perioperative period: pre- (before), intra- (during) and post (after) operative phases of anaesthesia and surgery. Special training is required for those who work in perioperative settings, which varies in different countries [7].

2.2 The physical work environment

The physical work environment in operating departments and operating rooms is unique. These are special rooms requiring a clean environment, with the least number of microorganisms in the air; therefore, the airflow is regulated to minimise airborne microorganisms and to reduce the occurrence of infections. In other words, operating rooms are closed rooms, sometimes without windows; thus not always allowing access to daylight, where the air is exchanged 15–20 times per hour [8, 9], with an air temperature between 20°C to 23°C and as low as 17°C [10]. This can result in operating rooms being experienced as cold rooms for those working in them. As Golvani and Roos [11] described, access to daylight can lead to feelings of joy and a sense of time, whereas a lack thereof contributes to feelings of fatigue and stress among OR nurses. Moreover, perceived incompetence, lack of confidence, relational problems with regard to the surgeon, and team members' disruptive behaviour were described as sources of stress for OR nurses.

Operating rooms are high-tech environments. There are several devices and apparatus in the environment, for example, a ventilator/respirator to help the anaesthetised patient breathe; equipment to monitor the patient's vital parameters, such as blood pressure, heart rate and saturation; a device for blood suction; a tourniquet; a device to burn the micro blood vessels and control the blood loss and a device that keeps the patient warm by blowing hot air into a blanket that is placed on the patient. Each device has its own alarm system to give a warning when, for example, the vital signs are not in the normal range and when something is wrong with the device; they also make a noise when turned on for use. There are also computers used for documentation, x-ray devices and other apparatus needed for specific surgeries. Despite the World Health Organisation's (WHO) recommendations regarding maximum noise levels at workplaces (including ORs) of 55 decibels (dB), operating rooms reach mean, median and maximum decibel levels of 71.7 dB, 69.4 dB and 90.3 dB, respectively, as shown in a study by Dornbusch, Boston [12]. In their study, the author collected data from surgical oncology surgery, soft tissue surgery, ophthalmologic procedures and orthopaedic and neurologic surgeries, among which the neurologic surgeries were associated with higher levels of noise. The authors indicated that in operating rooms where music was played, greater noise levels (mean 73.3 and median 71.3 dB) were measured compared to those without music (mean 70.6 dB and median 68.2 dB). It is also important to consider that besides the type of surgery, the number of people in the room, comprising scrubs and anaesthesia personnel, also adds to the noise levels [12].

2.3 Nurse anaesthetist and operating room nurses and their professional responsibilities

In 40 low- and middle-income countries, NAs provide induction, maintenance and emergence of anaesthesia, independently, and in close collaboration with anaesthesiologists [13]. The International Federation of Nurse Anaesthetists (IFNA) identified the following components, among others, in the role described as "Nurse anaesthetist expert": anaesthetic management, pre-anaesthetic pain management, risk management, advanced life support, monitoring, termination of anaesthesia,

post-operative care and pain management, infection control, communication, collaboration and teamwork, task and quality management, patient information, patient education, patient advocacy, continuous professional development, research and education. IFNA is a global organisation, representing over 40 member countries and is an affiliate of the International Council of Nursing (ICN) [14].

The roles and education of nurse anaesthetists vary. The Nordic countries have different types of anaesthesia nursing education, ranging from non-degree supplementary programmes to master's degree programmes [15]. In Sweden, to become a specialist nurse in anaesthesia care or operating room nursing care requires a university training of 60 credits at an advanced level (in addition to a registered nurse degree, which is a three-year bachelor's degree in university education), and a master's degree in nursing. According to the competence description for nurse anaesthetists, they should have good knowledge in both nursing and medical sciences, ethics, medical technology, pedagogy, scientific theory, laws and regulations and working during major crises. According to their competency description, two nurse anaesthetists may independently start a case or terminate the anaesthesia when the patient is healthy (ASA 1–2), with approval from the responsible anaesthesiologist. Furthermore, the nurse anaesthetist may assess the patient's airway and intubate the patient. ASA stands for the American Society of Anaesthesiologists: ASA 1 is a healthy patient and ASA 2 stands for patients with a mild systemic disease without significant functional limitations. In Switzerland, the role of a nurse anaesthetist requires a 2-year nurse anaesthesia programme, and a nurse diploma is also mandatory. The education includes at least 900 h of additional didactic training. To become a Certified Registered Nurse Anaesthetist (CRNA) in the US, a master's degree from an accredited nurse anaesthesia educational programme is required [16].

According to the European Operating Room Nurse Association (EORNA), education for OR nurses should contain the following five core competencies: professional, ethical and legal practice; nursing care and perioperative nursing practice; interpersonal relationships and communication; organisational, managerial and leadership skills; and educational, research and professional development. As stated in the competence description for OR nurses (also called scrub nurses), their responsibilities include ensuring that the operating room is aseptic; being responsible for correct ventilation in the operating room; patient preparation and safety; control of instruments and instrumentation; infection prevention and complication prevention measures in connection with surgery and handling of biological material. OR nurses may work in operating rooms, ambulatory day surgery units, and in other fields where invasive techniques are used (Endoscopy Unit, interventional radiology, etc) [17]. OR nurses possess unique non-technical skills (which are decision-making, situation awareness, communication, teamwork and leadership); thus by listening to the tone of someone's voice, observing expressions in surgeon's eyes or paying attention to the changing sounds of the instruments, they anticipate what the surgeon will do next. NAs and OR nurses must work according to six competencies, besides verifying patient id, and ensuring that the correct body part is marked for surgery (NAs also verify fasting): a) person-centred care, b) teamwork, c) evidence-based care, d) improvement knowledge and quality development, e) safe care for the patients and f) informatics (IT and digitalisation).

2.4 How do perioperative nurses work?

The work of perioperative nurses starts when the patient arrives in the operating room. From preparation and start of anaesthesia till termination, and handover of

responsibility of care to the post-operative ward nurse, NAs oversee anaesthesia care. They work independently, consulting anaesthesiologists and providing the patient with analgesia and anaesthesia. OR nurses are responsible for aseptic procedures and assisting the surgeons with suitable surgical instruments during surgeries. Both the professions are equally responsible for the patient's nursing care, for example, positioning the patient on the operating bed and patient safety. This means that perioperative nurses are locked in the operating room. Breaks are planned for lunch. NAs may have short coffee breaks, but OR nurses take their coffee breaks between patients or during preparation of anaesthesia. Work schedules include day work, afternoon and night shifts and during unsocial hours (e.g. between 4 p.m. and 7 a.m. and during weekends). The number of cases per operating room varies from one to multiple cases; also, during a work shift, perioperative nurses usually are responsible for one operating room, including all the cases planned for that room, but they can be removed to other operating rooms whenever needed. These unique working conditions in this unique environment, during long hours of work along with high demands on concentration, place high demands on both specialist nurses.

2.5 Anaesthesiologists

According to Matsusaki and Sakai [16], in 1910, in the USA, a campaign was started by physician anaesthetists in order for anaesthesia to become solely physicians' work, where NAs had already been working for 150 years in their profession. Studies indicate that specific knowledge and skills are required for anaesthesiologists to undertake perioperative patient care [18] and that a majority believe that their current training must advance to support this aspect of their professional development. Being airway experts, providing vascular access, performing triage and resuscitation, and managing hemodynamic triage are some of the work tasks performed by anaesthesiologists [19]. Moreover, Zacharowski and Filipescu [20] stated that anaesthesiologists in Europe care for approximately 70% and in Scandinavia for 100% of ICU patients, whereas the remaining 30% of the ICU patients are being managed by other medical or surgical specialities.

In perioperative settings in Sweden, anaesthesiologists are located outside the operating rooms [21], and they are responsible for more than one patient or operating room at the same time; in other words, they carry a heavy responsibility for patients' lives during anaesthesia and surgery [22]. They are responsible for assessment, preparation, maintenance and termination of anaesthesia and monitoring the patients. Moreover, they apply blockades. Anaesthesiologists work closely with nurse anaesthetists who are with the patient in the operating room. Parallel with their work in the operating room, anaesthesiologists assess new patients who are scheduled for surgery on the same day or in advance. In addition to working in operating departments and intensive care units, anaesthesiologists work in the radiology department, pos-toperative departments, acute and chronic pain management departments and emergency departments [21, 23]. In other countries, for example in the UK and in Germany, anaesthesiologists are the ones who stay with the patients in the operating rooms. Thus, the work tasks of anaesthesiologists vary in different countries.

The work environment for anaesthesiologists is characterised by working under time pressure, delayed or cancelled breaks, frequent overtime, high levels of stress and high risk of emotional exhaustion [24]. Burnout among anaesthesiologists and intensivists (who work in intensive care units) is one issue studied by Vittori and Marinangeli [25], who emphasised that one-third of the respondents scored at high risk of emotional exhaustion, and that anaesthesiologists who practised in intensive

care had the highest rate of burnout. Female gender, high workload, younger physicians with children, academic physicians [6] and anaesthesiology residents [26] are, according to literature, at high risk of burnout. Female gender seems to be more at risk of higher stress levels than males; nonetheless, they tend to prioritise home/work commitments better than males [27]. Besides stress, burnout and high emotional exhaustion, high levels of depersonalisation, and low levels of achievement have been reported among anaesthesiologists [28]. On a more psychosocial level, anaesthesiologists reported fatigue, lack of collegiality and respect and lack of training, as areas of job satisfaction, of which lack of respect was a contributor to burnout [29].

2.6 Nurse assistants

There is a lack of literature studying nurse assistants, who are also called unlicensed assistive personnel (in Sweden) or nursing support workers. Nurse assistants provide basic care to patients and work under the direction of registered nurses. In Sweden, the training period is 1.5 years of high school education. Also, Nurse assistants may work in operating rooms as circulating nurses, assisting the operating room nurse with additional instruments needed during surgery (as the OR/scrub nurse cannot open nonsterile packages such as autoclaved packages with sterile tools inside), documentation, patient positioning, preparing the operating room or table and assisting with draping the patients. In anaesthesia care, the assistant nurse assists NAs and anaesthesiologists with the preparation and termination of anaesthesia. They do not have formal responsibility for patient care and work under delegation of the perioperative nurses. In operating room care, they always stay in the operating room together with the OR nurse. If they work with nurse anaesthetists, they leave the room after preparation and start of anaesthesia, and they come back for termination and transportation of the patient to the post-operative ward. During the maintenance of anaesthesia, nurse assistants supply the nurse anaesthetist with what is needed in the operating room and help with the analysis of blood samples taken/arterial gases. Additional training is offered on-site, in the department, where the nurse assistants work.

In summary, strict regulations of the work environment in operating rooms make it difficult for the perioperative nurses to open a window (if there is one) when it is hot or increase the room temperature when it is cold, or take a break when one feels the need for it. One eats or goes to the restroom when someone else decides or takes a break when it is allowed. As the perioperative nurses have too little to say about their physical environment in the operating rooms, the psychosocial environment becomes even more important in the nurses' and other staff's well-being.

3. Psychosocial and organisational work environment

Job satisfaction and dissatisfaction are concepts frequently discussed to describe how satisfied healthcare workers are with their work environment and working conditions. The endpoint of these discussions is voluntary or non-voluntary turnover, or adequate staffing within the organisation. Organisations such as operating departments, which are complex adaptive systems, should always be prepared, making the workplace as attractive as possible, as turnover and training of new staff are costly and require thoughtful planning and resources from the organisation. Turnover within the organisation is common, for example, when employees change

their residence (voluntary turnover), choose to study further (voluntary turnover) or retirements (could be voluntary or non-voluntary turnover). However, voluntary turnover, when nurses with good skills, competencies, experiences and of working age leave their workplace due to job dissatisfaction, is serious and needs to be addressed.

Psychosocial and organisational factors in the healthcare environment interact, and they may contribute to nurses' and other professionals' decisions to stay or leave. On a psychosocial level, personal health [30] and possibilities to develop one's skills and knowledge at one's workplace, feeling that one's work has a meaning and relationships [31] with colleagues and managers are some factors, which affect job satisfaction. Lee and MacPhee [32] explained that nurse-physician relationship in perioperative settings was related to nurses' job satisfaction, and emotional exhaustion was the key predictor for nurses' job satisfaction and intention to leave. Furthermore, perioperative nurse-to-nurse violence [33] and physician-to-nurse mistreatment [34] have been shown to cause high-stress levels [34] and depressive symptoms [33] in perioperative settings. Incivility or bullying leads to stress at work, impacting patient safety [35]. In contrast, perioperative nurses report that resolving issues leads to better patient outcomes, greater satisfaction in the workplace and heightens organisational commitment [36]. Villafranca and Hiebert [37] stated that the young clinicians who were inexperienced, female, non-heterosexual, worked as a nurse and worked in private care were groups that were more likely to be exposed to disruptive behaviour in their workplace.

On a personal level, Clausen and Burr [38] pointed out that not finding any meaning in one's work and not having any organisational commitment were associated with long-term sickness. Moreover, demanding work schedules, working night shifts and unsocial hours have been shown to have a negative impact on sleep [39]. According to Zhao and Bogossian [40], shift worker nurses are 1.15 times more likely to develop low back pain. In a more organisational level, factors such as re-organisation, meaning (ever-) changing structure in the organisation versus stability in the organisation, working schedule or hours [41] and recovery [42, 43], salary [30], number of people working at one's workplace [44] and leadership have further impact on whether one feels satisfied with his or her work. In summary, operating rooms are complex systems. Preventing perioperative nurses, nurse assistants or anaesthesiologists from leaving their workplace prematurely often requires several parallel measures.

3.1 Nurse managers' role in staff's well-being

As studies by Logde, Rudolfsson [4] and Arakelian, Rudolfsson [45] pointed out, the first-line manager can be someone who, by his or her actions or lack thereof, is experienced as a facilitator and someone who contributes to staff's well-being or someone who is the reason for perioperative nurses leaving their workplace. This is valuable knowledge for leaders and managers in healthcare in perioperative departments, namely knowing that their role is crucial and that they can prevent loss of personnel. Leaving one's workplace was described as a process, where perioperative nurses had considered talking to their closest managers about it for a while. Nonchalance on the part of the managers and feeling that they were not needed in the organisation made the nurses take the step to quit their jobs. However, the nurses argued that when the decision was made to leave one's workplace, nothing, not even the best salary in the world, could change their mind. That is why nurse managers should be present and in close contact with their staff, being aware of their staff's needs on a personal level.

Nurse managers are important for both quality of patient care [46] and the staff's well-being [45, 47]; they desire to become nurse managers to do their best for the patients and their fellow employees, finding strength in their employees [47]. Nurse managers have described challenges they encounter, which are unique to perioperative settings [48]. Some challenges mentioned were that the nurse manager felt burdened by tasks that could be performed by other professions, for example, planning staff work schedules and lunch breaks, working as clinical nurses, being in the middle of the staff's personal needs and the organisational needs, challenges described with the ever-changing organisation and need to find tasks suitable for staff who physically were not able to work with the physical demands of static work of, for example, operating room nurses (this is the case of nurses who are getting closer to retirement).

Unfortunately, not all nurse managers have the proper university education in management. This is a serious issue that should be addressed in health care, namely, to educate and require that they have proper education and training in future. From a caring science perspective, Bondas [49] discussed the concept of "caritative leadership", which is derived from Eriksson's theory of "caritative caring" [50]. The core of caritative leadership is the Caritas concept of human love and mercy, which in caritative leadership is directed towards both patients and employees. In other words, it means seeing the uniqueness of the employees and their abilities to "minister to" or help the patients. Fredriksson and Eriksson [51] pointed out the importance of a caritative conversation between the nurse managers and their employees, by creating a room or space between them. Such a conversation metaphorically serves as "compassionate love" in professional commitment and organisational tasks [49]. Solbakken and Bergdahl [52] emphasised the importance of reflection, time and space and a balance between these for nurse managers, which metaphorically was discussed as rooms in the "house of leadership". The rooms were the patients' room, the staff room, the organisational room, the superior's room and the secret room. Caring in caritative leadership, according to Solbakken and Bergdahl [52], is a conscious movement or a metaphoric walk between the different rooms, as described above, to create a caring atmosphere. The secret room is a place where the managers have the opportunity to be alone with their own reflections and think things over.

3.2 Job demand-control-support and organisational and relational justice

Karasek [53] introduced the demand-control-support model, explaining that employees that receive support (both managerial and collegial) and feel high control and have low demands in their work are more likely to be healthy, or are in a healthy workplace. In contrast, those who do not receive support and feel high demands with no control, are in the high strain and more likely to become sick (burnout and other physical diseases). The latter presents risks for unhealthy or dangerous work. Those individuals who reported low well-being, low zest for work (meaning emotions about one's work, low means feeling discomfort or aversion towards work) and high intention to leave are the ones in the high strain field, experiencing high demands and low control. These individuals are, in other words, in unhealthy environments. Moreover, Karasek and Theorell [54] pointed out that employee health is positively related to feelings of high job control and to receiving social support in the workplace and is negatively influenced by high work demands [53]. Job demand, job control and perceived fairness in the organisation (in organisational and social work environment) are important in the work environment [55, 56]. These factors affect sleep quality and short-term recovery. Furthermore, high work demands and low sense of

control affect the blood pressure negatively [57, 58]. Moreover, effort-reward imbalance may lead the nurses to quit their jobs [59]. Perioperative nurses, nurse assistants and anaesthesiologists have an imbalance in their job demand and job control, as they do not have control over the physical work environment or working conditions (for example, lunch breaks, which patients they care for, order of patients and anaesthesia methods changing with short notice); perioperative nurses and nurse assistants must adapt to changes in anaesthesiologists and the surgeons' decisions in patient care, and the changes occurring in the organisation. The workload is often high due to the growing number of surgeries, long work hours and personnel loss [4, 60], now more than ever, after COVID-19.

A study using Karasek's demand-control-support model [61], performed in perioperative settings, emphasised that 30% of the approximately 955 respondents (perioperative nurses, nurse assistants and anaesthesiologists) sometimes had thoughts of leaving their workplace during at least one month in the last year. Lower social support, lower zest for work or feelings about one's work, and thoughts about leaving one's workplace were interconnected. None of the perioperative nurses, nurse assistants, nor anaesthesiologists was in the high strain (low support, high demands and low control). Operating room nurses were in the "active field", according to the model, which means they felt they were in high control, despite feeling high demands. Nurse anaesthetists and nurse assistansts nurses were in a passive field with low demands and low control, and the anaesthesiologists, younger employees, and those with good well-being and high zest for work reported feeling low demands and high control (thus, being in the low-strain field).

Relation with one's superior manager is one of several factors in the work environment affecting employee health, and organisational justice and relational justice describe two of them [62]. There are four dimensions in organisational justice (or fairness in the organisation or being treated fairly), and interpersonal justice or relational justice (also referred to as interactional justice) is one of them. It highlights the superior's relationship with his or her employees, or how superior managers treat their employees. In other words, it means how employees' personal views and rights are treated by superior managers, or whether the employees are treated impartially, truthfully and with kindness. Relational justice or being treated fairly at the workplace is also linked to employee health in the workplace [63–67].

First-line managers, who offer support to their nurse employees, play an important role in their well-being [68] and job satisfaction [45], and employees who are content with their work are more engaged in their workplace [54, 69]. Employees with higher organisational justice also have higher well-being [64, 65]. On the other hand, low organisational justice affects quality of sleep negatively [55], causing stress and employee's possibility for recovery [70]. Working with work environment management systematically, a cohort of 500 employees in perioperative settings indicated higher scores of organisational justice, which means positive or good organisational justice (a higher number of total scores between 6 and 30 indicates good organisational justice, and the group had 25 and 26 at measurement in two-time points). A closer look at relational justice in the same cohort showed that timely feedback about decisions and being treated kindly by one's supervisors who showed consideration had the most impact on employees' well-being [71]. It is essential that supervisors treat their employees with fairness and create a friendly, welcoming workplace, where employees feel a balance in work demands and control of their work tasks, receive support from supervisors and colleagues and want to remain, and newcomers want to come and stay. Supervisors have the power to affect their employees' health and well-being.

4. How can work environment be improved by simple means?

To increase work attractiveness, according to Bjorn and Josephson [41], special attention should be paid to salary, organisation and physical work environment. Logde, Rudolfsson [4] and Arakelian, Rudolfsson [45] indicated that simple means, such as creating a non-violent atmosphere between colleagues and professionals, the first-line managers being present, stressing everyone's value in the team, giving timely feedback to one's employees, providing healthy work schedules and working with employees' salaries and allowing time to develop in one's profession in the workplace were important steps in working in the right direction.

On a psychosocial level, a friendly and permissive atmosphere can be created by making a workplace a safe place, where one wants to be oneself and develop, namely a homelike place. Simple acts of knowing one's colleagues on a personal level and creating relations, greeting each other every morning when coming to work and thanking each other before going home also played an important role. In such a workplace, where one has a voice, there is joy, a positive learning culture and creativity, all of which impact patient care positively.

Because of the nature of work in perioperative environments, small and smart planned breaks [72], microbreaks (short breaks) and passive- (just for rest) or active breaks (to walk or do small physical exercises) [73], which give an opportunity to change focus between two patients, are very important. In turn, breaks require planning and relevant staffing with relevant competencies to allow the NA or OR nurse to leave the operating room to change focus and be able to drink some water or use the restrooms. Operating settings and aviation settings have been compared in literature. Whereas in aviation, shifts and breaks are strictly regulated, as the staff's focus and full concentration are always required during the flight, there is no consensus about breaks in operating rooms. Even in the transportation sector, there are also rules about taking breaks during a work shift. One has the right to have a meal or lunch 4 hours after starting to work in operating departments, which is not always followed due to hygiene regulations (the rule of not opening doors in, for example, orthopaedic surgery, where prostheses are being operated into patient's body), safety reasons (the risk of missing information when reporting the patient to another nurse, so that one can leave the room) or staff shortage. This directly affects staff's long-term well-being and ability to work.

Healthy work scheduling, with a focus on safety and recovery, is another measure that should be communicated to the staff, teaching them the benefits of correct planning of one's work schedule so that one can feel a work-life balance and recovery, for example, not planning early morning shifts after late evening shifts, which gives less than 11 hours of sleep/recovery or to spread out days off, instead of working more than six or seven days in a row and taking a week off thereafter. According to research results, personal preferences in the workforce should be in balance with the organisational needs of staffing [42, 43]. There have been attempts to shorten the workday from eight to six hours for the workforce in operating departments, by planning the breaks at the end of the work shift, instead of spreading them out during the work shift. This, in the long run, tires the workforce, placing maximal demand on them during the shift. In other words, the idea is to reduce the tips of the iceberg (the peaks of high workload), with smartly placed breaks. It is also important to take into consideration that the staff need breaks more when the workload is the highest. Breaks can be planned during each work shift, but they can also be planned, for example, by mixing multiple tasks so that, for example, OR nurses do not statically stand and assist the surgeon with surgical instruments throughout their entire career every

week, but to give the person an opportunity during the week to work with other tasks or responsibilities, for example, to work with students, to work with hygiene issues or to contact different firms and order and pack surgical instruments. This way, the person does not have to work statically every day, preserving his/her back, neck and shoulders for more years to come. For NAs, other tasks can include developing nursing care for the patients, taking responsibility for students and organising internal competence development for nurse anaesthetists or nurse assistants. Another way to both offers breaks and allow for competence development is to give time for reflection, where experienced nurses can guide newcomers in their professional development. As almost every minute of perioperative nurses' workday is planned with tasks and the fact that working as a NA or OR nurse is a solitary work (there is just one nurse anaesthetist or operating room nurse per operating room), they need to process and reflect together with other colleagues about nursing care for the patients and how it can be improved, sharing knowledge together. This is a part of one's development process in the profession, needing time and space from one's clinical work.

Perioperative dialogue is a model, a way of working, to guarantee continuity, patient safety and person-centred care in perioperative settings. The model was first described by von Post [74] and developed further [75–78]. According to perioperative dialogue, the same NA or OR nurse should meet the patient before, during and after surgery and anaesthesia. The purpose of this meeting before (pre) is to assess, to have a dialogue, to take in the patient's story and experiences in planning the nursing actions during and after surgery and anaesthesia and give the patient a voice. These are the cornerstones in person-centred care, as described by Ekman [79]. Thereafter, a care plan is formed together with the patient. Meeting the same nurse during surgery and anaesthesia guarantees continuity, a familiar face who welcomes the patient into the operating room, and a nurse who guarantees that she/he is and will be there for the patient, seeing to the patient's best interests [80]. During (perioperatively) surgery and anaesthesia, the nurse guarantees that the plan that was agreed upon with the patient will be carried out. After termination of surgery and anaesthesia (post-operatively), the nurse follows up on the plan with his/her patient. The departments that give the perioperative nurses the opportunity to perform perioperative dialogue will have better-prepared patients and more satisfied nurses, and benefits of perioperative dialogue are known for both patients and nurses who perform it [75, 76, 78, 81–85]. Moreover, perioperative nurses will feel that their unique and specific nursing knowledge will be a force to count on in patient care in perioperative departments. This will lift their pride and increase joy at work, and perioperative nurses will feel less like a secretary for electronic documentation, putting additional demands on their work [86]. The focus has changed in recent years towards digitalisation, and electronic documentation, with systems that do not always interact with each other. Hence, perioperative nurses, especially, must log into different systems, sometimes documenting the same information in several IT journal sights/systems. Furthermore, they have to struggle to find correct information [86, 87] when working with their patients in the operating room. The perioperative nurses describe this shift in focus from the valuable patient care to being forced to act as a secretary for electronic documentation. Working with and increasing the perioperative nurses' pride and joy, lifting their specific competence and specific knowledge in nursing care of the patients should be the number one priority of the operating departments.

Possibilities to continuously develop one's competence at work is another factor to increase job satisfaction. There should be paths of development in one's workplace, both in the academic field and in the clinical field. In the academic field, there should

be a plan (three-year or five-year plan) for how many NAs or OR nurses should study on PhD-level, or how many perioperative nurses, who also are associate professors or professors, should be employed and active within each operating department. Furthermore, to be an attractive workplace, nurses with high(er) academic grades should be involved in research and education of the departments, and in management from department levels to the highest level of the organisation at the hospital. There should be a carefully considered competence development plan and tools for assessing everyone's competence and how it can be improved further at the workplace. The competence plan should be connected to and work hand in hand with a salary development plan, and the message should be "development pays off". Salary is costly, but it is an incentive for the workforce to remain in the workplace. While employing new employees is associated with financial challenges, losing staff and being forced to hire temporary staff are even more costly, and training new staff also requires human and financial recourses. Economic means should be invested in the existing staff, as it pays off in the long run when they remain in the workplace. Not everyone is interested in developing an academic career. There should, therefore, be paths to work clinically, and in leadership, and reach the "next level". For example, perioperative nurses or assistant nurses may work in different operating departments, with adult patients or children, and develop their clinical skills, meeting new challenges with new patient groups. Intensive care units and airborne intensive care (used for care of patients, for example, during transportation from one hospital to another and from the scene of injury to hospital) are other clinical work developments, which can be offered to nurse anaesthetists. The third path of development is in leadership and management.

Shortage of time is frequently discussed at the hospitals, and to compensate for that, mandatory education or meetings, which are essential for patient safety are shortened. For example, yearly training in CPR (cardiopulmonary resuscitation), important meetings about changes in surgical routines, instruments or new routines or medications in how to anaesthetise a pregnant woman have a direct impact on the outcome of care and should be prioritised in the organisation. This is not a matter of 'whether we should' but 'how should it be done' systematically! In addition, team training that increases psychosocial well-being, bonds the staff who work together on an everyday basis and gives them a well-deserved break from monotonous work are important means. During team training, time should be allotted for reflection and improvements in care for patients.

Finally, systematic work environment management can improve work environments in perioperative settings for perioperative nurses, nurse assistants [88] and anaesthesiologists [89]. Using a support model for systematic environment management gives the staff (nurses and assistant nurses) in the perioperative context an opportunity to discuss problems with collaboration, work organisation and how to treat each other. Moreover, it gives them the opportunity to be engaged in their work environment issues, helping first-line managers in work environment management [90].

5. Conclusion

Despite the challenges in perioperative work environment, many choose to work in such an environment. As the physical environment is difficult to affect, the psychosocial and organisational environment become more important in the staffs' work life. There are several simple measures that can be used, and actions must be taken today to make perioperative settings healthy and attractive. Actions should be taken

against incivility or bullying at work; nurse managers should have proper university education and training to be able to conduct caritative caring for their staff members; salaries for perioperative staff, among the nurses, should be revised and increased; and they should be given the opportunity to use their full competence and advanced nursing knowledge in patient care, and possibilities to develop in their profession in their workplace. This way, newcomers and ordinary staff may choose to stay, develop themselves and their workplace further, as losing perioperative nurses results in cancelled surgeries and suffering for patients.

Conflict of interest

The author declares no conflict of interest.

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Author details

Erebouni Arakelian[1,2]

1 Department of Surgical Sciences, Uppsala, Sweden

2 Department of Clinical Neurosciences, Section of Psychology, Karolinska Institute, Solna, Sweden

*Address all correspondence to: erebouni.arakelian@surgsi.uu.se; erebouni.arakelian@ki.se

References

[1] Woo BFY, Lee JXY, Tam WWS. The impact of the advanced practice nursing role on quality of care, clinical outcomes, patient satisfaction, and cost in the emergency and critical care settings: A systematic review. Human Resources for Health. 2017;**15**:63. DOI: 10.1186/s12960-017-0237-9

[2] Oulton JA. The global nursing shortage: An overview of issues and actions. Policy, Politics & Nursing Practice. 2006;**7**:34s-39s. DOI: 10.1177/1527154406293968

[3] Gillespie BM, Wallis M, Chaboyer W. Operating theater culture: Implications for nurse retention. Western Journal of Nursing Research. 2008;**30**:259-277; discussion 78-83. DOI: 10.1177/0193945907303006

[4] Logde A, Rudolfsson G, Broberg RR, Rask-Andersen A, Walinder R, Arakelian E. I am quitting my job. Specialist nurses in perioperative context and their experiences of the process and reasons to quit their job. International Journal for Quality in Health Care : Journal of the International Society for Quality in Health Care. 2018;**30**:313-320. DOI: 10.1093/intqhc/mzy023

[5] Vowels A, Topp R, Berger J. Understanding stress in the operating room: A step toward improving the work environment. Kentucky Nurse. 2012;**60**:5-7

[6] Downey RL, Farhat T, Schumann R. Burnout and coping amongst anesthesiologists in a US metropolitan area: A pilot study. Middle East Journal of Anaesthesiology. 2012;**21**:529-534

[7] Kumar G, Wong B, Walker D. Identifying training requirements in perioperative Care for Anaesthetists. Journal of Biomedical Education. 2013;**2013**:534245. DOI: 10.1155/2013/534245

[8] Spagnolo AM, Ottria G, Amicizia D, Perdelli F, Cristina ML. Operating theatre quality and prevention of surgical site infections. Journal of Preventive Medicine and Hygiene. 2013;**54**:131-137

[9] Sehulster L, Chinn RY. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the healthcare infection control practices advisory committee (HICPAC). MMWR Recommendations and Reports : Morbidity and Mortality Weekly Report Recommendations and Reports. 2003;**52**:1-42

[10] Katz JD. Control of the environment in the operating room. Anesthesia and Analgesia. 2017;**125**:1214-1218. DOI: 10.1213/ane.0000000000001626

[11] Golvani J, Roos L, Henricson M. Operating room nurses' experiences of limited access to daylight in the workplace - a qualitative interview study. BMC Nursing. 2021;**20**:227. DOI: 10.1186/s12912-021-00751-8

[12] Dornbusch J, Boston S, Colee J. Noise levels in veterinary operating rooms and factors that contribute to their variations. Veterinary Surgery: VS. 2018;**47**:678-682. DOI: 10.1111/vsu.12922

[13] Kempthorne P, Morriss WW, Mellin-Olsen J, Gore-Booth J. The WFSA global anesthesia workforce survey. Anesthesia and Analgesia. 2017;**125**:981-990. DOI: 10.1213/ane.0000000000002258

[14] Nurses Ico. Guidelines on advanced practice nursing nurse anesthetists

[Internet]. 2021. Available from: file:///D:/Book%20chapter%20221019/referenser/ICN_Nurse-Anaesthetist-Report_EN_WEB.pdf

[15] Jeon Y, Lahtinen P, Meretoja R, Leino-Kilpi H. Anaesthesia nursing education in the Nordic countries: Literature review. Nurse Education Today. 2015;**35**:680-688. DOI: 10.1016/j.nedt.2015.01.015

[16] Matsusaki T, Sakai T. The role of certified registered nurse anesthetists in the United States. Journal of Anesthesia. 2011;**25**:734-740. DOI: 10.1007/s00540-011-1193-5

[17] Association EORN. EORNA Common Core Curriculum For Perioperative Nursing [Internet]. 2019. Available from: https://eorna.eu/wp-content/uploads/2019/09/EORNA-core-curriculum_July2019.pdf

[18] Larsson J, Holmström IK. How excellent anaesthetists perform in the operating theatre: A qualitative study on non-technical skills. British Journal of Anaesthesia. 2013;**110**:115-121. DOI: 10.1093/bja/aes359

[19] Lodico DN, Darin Via RA. Mass casualty and the role of the anesthesiologist. Anesthesiology Clinics. 2021;**39**:309-319. DOI: 10.1016/j.anclin.2021.03.001

[20] Zacharowski K, Filipescu D, Pelosi P, Åkeson J, Bubenek S, Gregoretti C, et al. Intensive care medicine in Europe: Perspectives from the European Society of Anaesthesiology and Intensive Care. European Journal of Anaesthesiology. 2022;**39**:795-800. DOI: 10.1097/eja.0000000000001706

[21] Rama-Maceiras P, Parente S, Kranke P. Job satisfaction, stress and burnout in anaesthesia: Relevant topics for anaesthesiologists and healthcare managers? European Journal of Anaesthesiology. 2012;**29**:311-319. DOI: 10.1097/EJA.0b013e328352816d

[22] Larsson J. Monitoring the anaesthetist in the operating theatre - professional competence and patient safety. Anaesthesia. 2017;**72**(Suppl. 1):76-83. DOI: 10.1111/anae.13743

[23] Meeusen V, van Zundert A, Hoekman J, Kumar C, Rawal N, Knape H. Composition of the anaesthesia team: A European survey. European Journal of Anaesthesiology. 2010;**27**:773-779. DOI: 10.1097/EJA.0b013e32833d925b

[24] Lederer W, Paal P, von Langen D, Sanwald A, Traweger C, Kinzl JF. Consolidation of working hours and work-life balance in anaesthesiologists - a cross-sectional national survey. PLoS One. 2018;**13**:e0206050. DOI: 10.1371/journal.pone.0206050

[25] Vittori A, Marinangeli F, Bignami EG, Simonini A, Vergallo A, Fiore G, et al. Analysis on burnout, job conditions, alexithymia, and other psychological symptoms in a sample of Italian anesthesiologists and intensivists, assessed just before the COVID-19 pandemic: An AAROI-EMAC study. Healthcare (Basel, Switzerland). 2022;**10**:1370. DOI: 10.3390/healthcare10081370

[26] Adams PS, Gordon EKB, Berkeley A, Monroe B, Eckert JM, Maldonado Y, et al. Academic faculty demonstrate higher well-being than residents: Pennsylvania anesthesiology programs' results of the 2017-2018 ACGME well-being survey. Journal of Clinical Anesthesia. 2019;**56**:60-64. DOI: 10.1016/j.jclinane.2019.01.037

[27] Kluger MT, Townend K, Laidlaw T. Job satisfaction, stress and burnout

in Australian specialist anaesthetists. Anaesthesia. 2003;**58**:339-345. DOI: 10.1046/j.1365-2044.2003.03085.x

[28] Jackson SH. The role of stress in anaesthetists' health and well-being. Acta Anaesthesiologica Scandinavica. 1999;**43**:583-602. DOI: 10.1034/j.1399-6576.1999.430601.x

[29] Siddiqui S, Bartels K, Schaefer MS, Novack L, Sreedharan R, Ben-Jacob TK, et al. Critical care medicine practice: A pilot survey of US anesthesia critical care medicine-trained physicians. Anesthesia and Analgesia. 2021;**132**:761-769. DOI: 10.1213/ane.0000000000005030

[30] Augner C. Job satisfaction in the European union: The role of macroeconomic, personal, and job-related factors. Journal of Occupational and Environmental Medicine/ American College of Occupational and Environmental Medicine. 2015;**57**:241-245. DOI: 10.1097/ jom.0000000000000398

[31] Björn C, Lindberg M, Rissén D. Significant factors for work attractiveness and how these differ from the current work situation among operating department nurses. Journal of Clinical Nursing. 2016;**25**:109-116. DOI: 10.1111/jocn.13003

[32] Lee SE, MacPhee M, Dahinten VS. Factors related to perioperative nurses' job satisfaction and intention to leave. Japan Journal of Nursing Science: JJNS. 2020;**17**:e12263. DOI: 10.1111/jjns.12263

[33] Bigony L, Lipke TG, Lundberg A, McGraw CA, Pagac GL, Rogers A. Lateral violence in the perioperative setting. AORN Journal. 2009;**89**:688-696. quiz 97-700

[34] Higgins BL, MacIntosh J. Operating room nurses' perceptions of the effects of physician-perpetrated abuse. International Nursing Review. 2010;**57**:321-327. DOI: 10.1111/j.1466-7657.2009.00767.x

[35] Oh H, Uhm DC, Yoon YJ. Workplace bullying, job stress, intent to leave, and Nurses' perceptions of patient safety in south Korean hospitals. Nursing Research. 2016;**65**:380-388. DOI: 10.1097/ nnr.0000000000000175

[36] Clark CM, Kenski D. Promoting civility in the OR: An ethical imperative. AORN Journal. 2017;**105**:60-66. DOI: 10.1016/j.aorn.2016.10.019

[37] Villafranca A, Hiebert B, Hamlin C, Young A, Parveen D, Arora RC, et al. Prevalence and predictors of exposure to disruptive behaviour in the operating room. Canadian journal of anaesthesia. Journal Canadien d'anesthesie. 2019;**66**:781-794. DOI: 10.1007/ s12630-019-01333-8

[38] Clausen T, Burr H, Borg V. Does affective organizational commitment and experience of meaning at work predict long-term sickness absence? An analysis of register-based outcomes using pooled data on 61,302 observations in four occupational groups. Journal of Occupational and Environmental Medicine/American College of Occupational and Environmental Medicine. 2014;**56**:129-135. DOI: 10.1097/ jom.0000000000000078

[39] Geiger-Brown J, Trinkoff A, Rogers VE. The impact of work schedules, home, and work demands on self-reported sleep in registered nurses. Journal of Occupational and Environmental Medicine/ American College of Occupational and Environmental Medicine. 2011;**53**:303-307. DOI: 10.1097/JOM.0b013e31820c3f87

[40] Zhao I, Bogossian F, Turner C. The effects of shift work and interaction

between shift work and overweight/obesity on low back pain in nurses: Results from a longitudinal study. Journal of Occupational and Environmental Medicine/American College of Occupational and Environmental Medicine. 2012;**54**:820-825. DOI: 10.1097/JOM.0b013e3182572e6a

[41] Bjorn C, Josephson M, Wadensten B, Rissen D. Prominent attractive qualities of nurses' work in operating room departments: A questionnaire study. Work (Reading, Mass). 2015;**52**:877-889. DOI: 10.3233/wor-152135

[42] Dahlgren A, Tucker P, Gustavsson P, Rudman A. Quick returns and night work as predictors of sleep quality, fatigue, work-family balance and satisfaction with work hours. Chronobiology International. 2016;**33**:759-767. DOI: 10.3109/07420528.2016.1167725

[43] Dahlgren A, Tucker P, Epstein M, Gustavsson P, Söderström M. Randomised control trial of a proactive intervention supporting recovery in relation to stress and irregular work hours: Effects on sleep, burn-out, fatigue and somatic symptoms. Occupational and Environmental Medicine. 2022;**79**:460-468. DOI: 10.1136/oemed-2021-107789

[44] Moses XJ, Walters KM, Fisher GG. What factors are associated with occupational health office staffing, job stress, and job satisfaction? Journal of Occupational and Environmental Medicine/American College of Occupational and Environmental Medicine. 2016;**58**:567-574. DOI: 10.1097/jom.0000000000000741

[45] Arakelian E, Rudolfsson G, Rask-Andersen A, Runeson-Broberg R, Wålinder R. I stay-Swedish specialist nurses in the perioperative context and their reasons to stay at their workplace. Journal of Perianesthesia Nursing. 2019;**34**:633-644. DOI: 10.1016/j.jopan.2018.06.095

[46] Wong CA, Cummings GG, Ducharme L. The relationship between nursing leadership and patient outcomes: A systematic review update. Journal of Nursing Management. 2013;**21**:709-724. DOI: 10.1111/jonm.12116

[47] Arakelian E, Wålinder R, Rask-Andersen A, Rudolfsson G. Nurse managers in perioperative settings and their reasons for remaining in their jobs: A qualitative study. Journal of Nursing Management. 2020;**28**:1191-1198. DOI: 10.1111/jonm.13054

[48] Arakelian E, Rudolfsson G. Managerial challenges faced by Swedish nurse managers in perioperative settings- a qualitative study. BMC Nursing. 2021;**20**:117. DOI: 10.1186/s12912-021-00640-0

[49] Bondas TE. Caritative leadership. Ministering to the patients. Nursing Administration Quarterly. 2003;**27**:249-253

[50] Eriksson K. Nursing: The Caring Practice "Being there". In: Gaut A, editors. The presence of caring in nursing Delores. New York: National League for Nursing Press; 1992. pp. 201-210

[51] Fredriksson L, Eriksson K. The ethics of the caring conversation. Nursing Ethics. 2003;**10**:138-148. DOI: 10.1191/0969733003ne588oa

[52] Solbakken R, Bergdahl E, Rudolfsson G, Bondas T. International nursing: Caring in nursing leadership-a meta-ethnography from the nurse Leader's perspective. Nursing Administration Quarterly. 2018;**42**:E1-e19. DOI: 10.1097/naq.0000000000000314

[53] Karasek RA. Job demands, job Desicion latitude, and mental strain: Implications for job redesign. Administrative Science Quarterly. 1979;**24**:285-308

[54] Karasek R, Theorell T. Healthy Work. New York: Basic Books; 1990

[55] Elovainio M, Kivimäki M, Vahtera J, Keltikangas-Järvinen L, Virtanen M. Sleeping problems and health behaviors as mediators between organizational justice and health. Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association. 2003;**22**:287-293. DOI: 10.1037/0278-6133.22.3.287

[56] Linton SJ, Kecklund G, Franklin KA, Leissner LC, Sivertsen B, Lindberg E, et al. The effect of the work environment on future sleep disturbances: A systematic review. Sleep Medicine Reviews. 2015;**23**:10-19. DOI: 10.1016/j.smrv.2014.10.010

[57] Schnall PL, Pieper C, Schwartz JE, Karasek RA, Schlussel Y, Devereux RB, et al. The relationship between 'job strain,' workplace diastolic blood pressure, and left ventricular mass index. Results of a case-control study. JAMA. 1990;**263**:1929-1935

[58] Theorell T, Ahlberg-Hulten G, Jodko M, Sigala F, de la Torre B. Influence of job strain and emotion on blood pressure in female hospital personnel during workhours. Scandinavian Journal of Work, Environment & Health. 1993;**19**:313-318

[59] Hasselhorn HM, Tackenberg P, Peter R. Effort-reward imbalance among nurses in stable countries and in countries in transition. International Journal of Occupational and Environmental Health. 2004;**10**:401-408. DOI: 10.1179/oeh.2004.10.4.401

[60] Zhou H, Gong YH. Relationship between occupational stress and coping strategy among operating theatre nurses in China: A questionnaire survey. Journal of Nursing Management. 2015;**23**:96-106. DOI: 10.1111/jonm.12094

[61] Walinder R, Runeson-Broberg R, Arakelian E, Nordqvist T, Runeson A, Rask-Andersen A. A supportive climate and low strain promote well-being and sustainable working life in the operation theatre. Upsala Journal of Medical Sciences. 2018;**123**:183-190. DOI: 10.1080/03009734.2018.1483451

[62] Ndjaboué R, Brisson C, Vézina M. Organisational justice and mental health: A systematic review of prospective studies. Occupational and Environmental Medicine. 2012;**69**:694-700. DOI: 10.1136/oemed-2011-100595

[63] Elovainio M, Kivimäki M, Vahtera J. Organizational justice: Evidence of a new psychosocial predictor of health. American Journal of Public Health. 2002;**92**:105-108. DOI: 10.2105/ajph.92.1.105

[64] Stoetzer U, Bergman P, Aborg C, Johansson G, Ahlberg G, Parmsund M, et al. Organizational factors related to low levels of sickness absence in a representative set of Swedish companies. Work (Reading, Mass). 2014;**47**:193-205. DOI: 10.3233/wor-2012-1472

[65] Stoetzer U, Åborg C, Johansson G, Svartengren M. Organization, relational justice and absenteeism. Work (Reading, Mass). 2014;**47**:521-529. DOI: 10.3233/wor-131624

[66] Colquitt JA, Conlon DE, Wesson MJ, Porter CO, Ng KY. Justice at the millennium: A meta-analytic review of 25 years of organizational justice research. The Journal of Applied Psychology. 2001;**86**:425-445. DOI: 10.1037/0021-9010.86.3.425

[67] Greenberg J. Organizational injustice as an occupational health risk. The Academy of Management Annals. 2010;**4**:205-243. DOI: 10.1080/19416520.2010.481174

[68] McIntosh NJ. Leader support and responses to work in US nurses: A test of alternative theoretical perspectives. Work and Stress. 1990;**4**:139-154

[69] Luchman JNG-M, M.G. Demands, control, and support: A meta-analytic review of work characteristics interrelationships. Journal of Occupational Health Psychology. 2013;**18**:37-52

[70] Loponen M, Hublin C, Kalimo R, Mänttäri M, Tenkanen L. Joint effect of self-reported sleep problems and three components of the metabolic syndrome on risk of coronary heart disease. Journal of Psychosomatic Research. 2010;**68**:149-158. DOI: 10.1016/j.jpsychores.2009.07.022

[71] Arakelian E, Paulsson S, Molin F, Svartengren M. How human resources index, relational justice, and perceived productivity change after reorganization at a Hospital in Sweden that Uses a structured support model for systematic work environment management. International Journal of Environmental Research and Public Health. 2021;**18**:11611. DOI: 10.3390/ijerph182111611

[72] Rogers AE, Hwang WT, Scott LD. The effects of work breaks on staff nurse performance. The Journal of Nursing Administration. 2004;**34**:512-519

[73] Luger T, Maher CG, Rieger MA, Steinhilber B. Work-break schedules for preventing musculoskeletal symptoms and disorders in healthy workers. The Cochrane Database of Systematic Reviews. 2019;**7**:Cd012886. DOI: 10.1002/14651858.CD012886.pub2

[74] von Post I. Professionell naturlig vård ur anestesi- och operationssköterskors perspektiv. Åbo: Åbo Akademis förl; 1999

[75] Rudolfsson G, von Post I, Eriksson K. The perioperative dialogue: Holistic nursing in practice. Holistic Nursing Practice. 2007;**21**:292-298. DOI: 10.1097/01.HNP.0000298613.40469.6c

[76] Lindwall L, von Post I, Bergbom I. Patients' and nurses' experiences of perioperative dialogues. Journal of Advanced Nursing. 2003;**43**:246-253

[77] Lindwall L, von Post I, Eriksson K. Caring perioperative culture: Its ethos and ethic. Journal of Advanced Perioperative Care. 2007;**3**(27-34) 8p

[78] Lindwall L, von Post I. Continuity created by nurses in the perioperative dialogue--a literature review. Scandinavian Journal of Caring Sciences. 2009;**23**:395-401. DOI: 10.1111/j.1471-6712.2008.00609.x

[79] Ekman I. Personcentrering inom Hälso- och sjukvård- Från filosofi till praktik. Stockholm: Liber; 2014. pp. 1-261

[80] Arakelian E, Swenne CL, Lindberg S, Rudolfsson G, von Vogelsang AC. The meaning of person-centred care in the perioperative nursing context from the patient's perspective - an integrative review. Journal of Clinical Nursing. 2016;**26**:2527-2544. DOI: 10.1111/jocn.13639

[81] Abelsson A, Nygårdh A. The nurse anesthetist perioperative dialog. BMC Nursing. 2020;**19**:37. DOI: 10.1186/s12912-020-00429-7

[82] Abelsson A, Falk P, Sundberg B, Nygårdh A. Empowerment in the perioperative dialog. Nursing Open. 2021;**8**:96-103. DOI: 10.1002/nop2.607

[83] Pulkkinen M, Junttila K, Lindwall L. The perioperative dialogue--a model of caring for the patient undergoing a hip or a knee replacement surgery under spinal anaesthesia. Scandinavian Journal of Caring Sciences. 2016;**30**:145-153. DOI: 10.1111/scs.12233

[84] Wennstrom B, Tornhage CJ, Nasic S, Hedelin H, Bergh I. The perioperative dialogue reduces postoperative stress in children undergoing day surgery as confirmed by salivary cortisol. Paediatric Anaesthesia. 2011;**21**:1058-1065. DOI: 10.1111/j.1460-9592.2011.03656.x

[85] Rudolfsson G, Hallberg LRM, Ringsberg KC, von Post I. The nurse has time for me: The perioperative dialogue from the perspective of patients. Journal of Advanced Perioperative Care. 2003;**1**(77-84):8p

[86] Golay D, Salminen Karlsson M, Cajander Å. Negative emotions induced by work-related information technology use in hospital nursing. Computers, Informatics, Nursing : CIN. 2021;**40**:113-120. DOI: 10.1097/cin.0000000000000800

[87] Golay D, Salminen Karlsson M, Cajander Å. Effortlessness and security: Nurses' positive experiences with work-related information technology use. Computers, Informatics, Nursing: CIN. 2022;**40**:589-597. DOI: 10.1097/cin.0000000000000917

[88] Arakelian E, Hellman T, Svartengren M. Experiences of the initial phase implementation of the STAMINA-model in perioperative context addressing environmental issues systematically-a qualitative study. International Journal of Environmental Research and Public Health. 2020;**17**:3037. DOI: 10.3390/ijerph17093037

[89] Arakelian E, Molin F, Svartengren M. How anaesthesiologists and interns in anaesthesia care describe and categorise their work environment at a Swedish hospital. Journal of Biomedicine Research and Environmental Science. 2022;**3**:1065-1068. DOI: 10.37871/jbres1556

[90] Arakelian E, Molin F, Svartengren M. Success factors when implementing a structured support model for systematic work environment management in operating departments: A case study from Sweden. Journal of Nursing Management. 2022;**30**:3618-3627. DOI: 10.1111/jonm.13812

Chapter 6

Assessment of Employees' Group Behavior, Interpersonal Influence, and Stress Management Strategies

Nassir-Maru Yesuf

Abstract

This study was conducted in south Ethiopia, "Sidama" region, "Aleta Wendo" city administration, on employees working in infrastructure and cluster institutions directorate (ICID) and on members of the Solomon metal and wood-work micro-scale enterprise (SMWM-SE). The general objective of the study was to assess employees' group behavior, conflict resolution styles they practices, types of power they are applying, and stress management strategies they are practicing in one governmental office and in one private enterprise association. A cross-sectional design with a mixed approach was applied to the study. Purposive sampling techniques were used to select the sample. The study area was selected purposefully by the researcher for its convenience to conduct the study. Semi-structured interview guide questions developed by the researcher and a self-administered questionnaire adapted to collect the data. The result of the study was organized and presented based on the four categories: employee group behavior, conflict resolution styles, types of power, and stress management strategies.

Keywords: group behavior, conflict resolution styles, power, and stress

1. Introduction

Employees' behavior affects organizations directly or indirectly in positive or negative ways. Employees' behavior related to their group behavior, conflict resolution styles, types of power, and stress management strategies are topics among employees' behavior that can affect organizations which were also topics in this study conducted on one Micro Scale Enterprise (MSE) members and on one governmental office employees who are responsible for monitoring and supporting MSE. Studies have shown that employees' behavior affects their performance and organizational outcomes. A study conducted by [1] among public sector companies on employees in 12 cities, confirmed that good interpersonal relations at work are important [2]. Concluded about the important role that groups play in organizations if they are handled positively [3]. Stated that the quality of managing conflict impacts the performance of employee and the outcomes of organization. Another study conducted by [4] found that there was a significant effect of conflict on organizational performance. A study conducted by [5] on public sector organizations in Pakistan revealed that

organizational politics have a significant impact on employee performance. A study conducted by a study [6] on a private garment company in Ethiopia revealed that work-related stress measured in terms of work overload, role ambiguity, and lack of motivation have negative and significant effects on employees' performance.

Micro and small enterprise (MSE) development holds a strategic place within Ethiopia's Industrial Development Strategy. All the more so as MSEs are the key instruments of job creation in urban centers, whilst job creation is the centerpiece of the country's development plan. The role of MSEs as the principal job creators is not only promoted in low-income countries like Ethiopia, but also in high income countries including the United States of America. Accordingly, because MSEs play a pivotal role in employment creation, stimulating and strengthening MSE development should be one of Ethiopia's top development priorities [7].

The 2010/11 definition of MSE in Ethiopia was based on paid capital, sector, and human power (see **Table 1**). An enterprise is categorized as micro if its paid-up capital is less than or equal to 100,000 Ethiopian Birr (ETB) for Industry and less than or equal to 50,000 ETB for Service. Similarly, an enterprise is considered small when its paid-up capital is less than or equal to 1.5 million ETB for Industry and less than or equal to 500,000 ETB for Service.

It is inevitable that the micro and small enterprises (MSE) contribute for national development especially in developing countries, but most of the studies conducted on micro- and small-scale enterprises in Ethiopia focused on access to or challenges related to the finance, market place and the provision of support by the concerned bodies such as governmental offices ([9–12]. Though there are studies on work-related stress [13, 14] whereas there are few studies conducted related to employees Group behavior, interpersonal influence, and stress management strategies working in public offices and the MSE. Therefore, this study conducted on one MSE and on one governmental office which is responsible for monitoring the MSE in order to assess the employees' group and teamwork characteristics, styles they practice for conflict resolution, types of power they apply, and stress management strategies they practice.

1.1 Group

Group is two or more individuals interacting to accomplish a common goal [15]. The most common classification forms, used for the groups in the literature, are formal and informal groups [16]. As the name indicates, formal group is formed by management to accomplish the goals of the organization. On the other hand, informal groups is formed by individuals and developed around common interests and friendships rather than around an organizational goal [15]. Forming a group, it passes through different stages. One of the widely cited models is the five-stage model

Level of the enterprise	Sector	Human power	Total asset
Micro-enterprise	Industry	≤5	≤ 100,000 ETB ($6000 or E4500)
	Service	≤5	≤ 50,000 ETB ($3000 or E2200)
Small-enterprise	Industry	6–30	≤ birr 1.5 million ETB ($9000 or E70000)
	Service	6–30	≤ birr 500,000 ETB ($30,000 or E 23000)

(Source: Federal Micro and Small Enterprise Development Agency (FeMSEDA), cited in [8]).

Table 1.
The 2010/11 definition of MSE.

developed by Tuckman (1965) cited in [17], stated that there are five stages small groups go through:

- Forming: it is the beginning of the members of the group asking each other to know one another;
- Storming: here, members of the group argue with each other and start to work on the areas of conflict;
- Norming: in this stage, there is a sense of togetherness and the group becomes effective in working together;
- Performing: the group starts to perform and has shared norms and goals;
- Adjourning: the group disperses as it has achieved what it aimed to or there is a loss of interest and motivation [17].

Group formation has its importance for organizations. In a study conducted by Yee and Dyne as cited in [18], it is mentioned that helping behavior is higher in groups in which the cohesion between members is strong, task confusion is low, and strong institutional norms exist. Another study conducted by [19] investigated how the group formation method influences group dynamics as well as group outcomes.

1.2 Teamwork

Teams are specialized types of performance groups. Teams, like any group, promote interaction and interdependence among members, pursue goals, and are structured and unified, but teams exhibit these qualities with greater intensity than do groups in general [20]. A study conducted by [21] on employees from an entertainment company in Kuala Lumpur found that there was a significant and positive relationship between teamwork (effective communication, level of trust, interpersonal skills, leadership, accountability, and cohesiveness) and employee performance.

1.3 Conflict resolution styles

Conflict may have either positive or negative consequences for the organization, depending on how much exists and how it is managed. Depending upon the nature and conditions of the conflict, the following five approaches can be an effective approach to conflict-resolution management. These approaches are as follows:

1. *Dominating*: working to dominate and control,
2. *Accommodating*: allowing other groups to win,
3. *Collaborating/Problem Solving*: working together to solve problems,
4. *Avoiding*: ignoring or steering clear of other groups, and
5. *Compromising*: finding an acceptable solution so everyone feels good) [15].

A study conducted by [22] suggested that the self-managed project team (SMPTs) transforms into an avoidance approach during the conflict as time goes by. In any event, conflict and its management strategies are fostered or hindered by factors such as the approaching deadline as well as individual reputation.

1.4 Types of power

The study of power and its effects is important to understand how organizations operate. How organizational subunits and individuals are controlled is related to the issue of power and influence. Power is the capability to get someone to do something; influence is the exercise of that capability [15]. Power is obtained in a variety of ways in an organization. Two important categories of power in an organization are interpersonal and structural. French and Raven cited in [8] suggested five interpersonal sources, or bases, of power: they are (1) Legitimate, (2) Reward, (3) Coercive, (4) Expert, and (5) Referent. Members of a group who controlled the bases of power are more influential than those who did not. *Legitimate* power is a person's ability to influence others because of the position within the organization that person holds. *Reward* power is based on a person's ability to reward a follower for compliance. *Coercive* power is the power to punish. *Referent* power is a power based on a subordinate's identification with a charismatic superior. Expert power is a power based on the capacity of influence related to some expertise, special skill, or knowledge [20a] [8]. Structural power is frequently prescribed by structure within the organization. Organizational structure creates formal power and authority by specifying certain individuals to perform specific tasks and make certain decisions [15].

1.5 Stress management strategies

Stress is an adaptive response, moderated by the individual difference that is a consequence of any action, situation, or event that places special demands on a person. Stress is seen partially as a response to some stimulus, called a stressor. A stressor is a potentially harmful or threatening external event or situation. However, stress is more than simply a response to a stressor. It is the consequence of the interaction between an environmental stimulus (a stressor) and the individual's response. Stress prevention and management strategies include (1) maximizing person-environment fit, (2) organizational programs such as employee assistance and wellness, and (3) individual approaches such as cognitive techniques, relaxation training, meditation, and biofeedback [15].

2. Objectives of the study

- To assess group behavior of employees in the infrastructure and cluster institutions directorate (ICID) and members of the Solomon metal and woodwork micro-scale enterprise (SMWM-SE).

- To assess conflict resolution styles of employees in the ICID and members of the SMWM-SE.

- To assess the types of power used by employees in the ICID and members of the SMWM-SE.

- To assess the stress management strategies used by an employee of the ICID and by members of the SMWM-SE.

3. Methods

3.1 Area of the assessment

The assessment was conducted in "Aleta Wondo" which is one of 19 "woredas" of "Sidama" the newly established region, which was previously under Southern nation nationalities and people's regional state (SNNPRS), city administration.

The data about population of "Aleta Wondo" city administration according to [23] census results and the latest official projections is: population census of 1994 is 11,321; population census of 2007 is 22,093; population projection in 2015 would be 42,200 (**Figure 1**).

There are 23 offices available in "Aleta Wondo" city administration. Enterprises and industry development is one of the public service offices among them. In the office, there are 13 directorates. From these directorates, the infrastructure and cluster institutions directorate (ICID) is responsible for monitoring and supporting micro- and small-scale enterprises. Solomon metal and woodwork micro-scale Enterprise (SMWM-SE) is a self-initiated enterprise working on metalwork and woodwork. Two females and three males total of five individuals established it. Its members saved as a group 20,000 Ethiopian birr after they established the enterprise; they got 100,000 Ethiopian birr loan from "Omo" microfinance. Currently, they are in a good condition and they are paying their loan. The Enterprise is producing metal works and wood works such as buildings doors, windows, drawers, tables, chairs, sofa, bed, and other home and bureau furnitures.

3.2 Method applied for the study

A mixed approach was applied to the study.

Figure 1.
Map of Ethiopia, SNNPR, Sidama region and Aleta Wondo Woreda.

3.3 Selection of the organizations and sample size

A purposive sampling technique was applied to select the sample for the study. "Aleta Wondo" city administration was selected for its convenience to conduct the study. From the enterprises and industry development office, the infrastructure and cluster institutions directorate (ICID) was also selected by the researcher through purposive sampling method as it monitor and supports micro- and small-scale enterprises. All the employees (nine male and six female) working in ICID including their head manager of the office were included in the study. From the private organization, Solomon metal and woodwork micro-scale enterprise (SMWM-SE) was purposively selected as the study was on small- and micro-scale enterprises and for its convenience, because the enterprise was working in the small industry shade and all members of the association (three male and two female) were available at the time of the assessment and all members of the enterprise was included in the study.

3.4 The development of data gathering tools

Interview questions and the self-administered questionnaires were developed by the researcher from [15], the self-administered questionnaire for the conflict resolution styles was adapted from shell as cited in [15], developed in order to collect the data, self-administered questionnaire for the assessment of team effectiveness also adapted from "mind tools" at [24].

The qualitative data was gathered through interviews and the quantitative data through a self-administered questionnaire. To make the interview an appointment was arranged with each participant. After that, the interview was conducted with each participant of the study. And the self-administered questionnaire was also filled out by the participants.

3.5 Data gathering procedures

First, the researcher got a letter from the university provided for the Enterprises and Industry Development office in "Sidama' region "Aleta Wondo Woreda" and explained the objective of the study to the office head, discussed and agreed on the date for starting data collection. Then, the researcher interviewed employees who were working in the infrastructure and cluster institutions directorate (ICID) which is one of the directorates under the enterprises and industry development office. The interview was audiotaped and the researcher took note of what has been said by the interviewees.

3.6 Methods of data analysis

The data was analyzed by following the six steps described by [25].

Step 1. Organize and prepare the data for analysis.

Step 2. Read or look at all the data.

Step 3. Start coding all of the data.

Step 4. Use the coding process to generate a description of the setting or people as well as categories or themes for analysis.

Step 5. Advance how the description and themes will be represented in the qualitative narrative.

Step 6. A final step in data analysis involves making an interpretation in qualitative research of the findings or results.

The quantitative data collected through a self-administered structured questionnaire was also described and presented by number and percent on tables along with the qualitative data according to its categories.

3.7 Validity and reliability

The issue of validity in this study was substantiated through member checking. Member checking was held during data collection by asking the interviewees for further clarification whenever there were vague statements and by repeating their idea for themselves to get their comments. Additionally, the validity was also held at the end of the process of the study by sharing the result with the participants of the study to get feedback. This technique of insuring validity in the qualitative study is stated by Gray (2018) and Beuving and de Vries (2015) as cited in [26]. Member checking determines the accuracy of the qualitative findings by taking the final report or specific descriptions or themes back to participants and determining whether these participants feel that they are accurate [25].

The technique applied in this study to ensure reliability is the triangulation technique. Triangulation compares results from two or more different methods of data collection and/or two or more data sources since consistent findings from different data sources or collection methods are also likely to better evidence the integrity of the research conclusions [26]. In this study, the data was collected through both qualitative and quantitative methods, and the data were also collected from two sources (ICID and SMWM-SE).

4. Results

4.1 Result of the ICID

4.1.1 Socio-demographic characteristics of participants of the ICID

As indicated on **Table 2** fifteen participants were included in the study and all of them were interviewed and filled self-administered questionnaire. Their response to

No	Socio-demographic characteristics		Frequency	Percent
1	Gender	Male	9	60%
		Female	6	40%
2	Age	21–29	5	33.3%
		30–39	7	46.7%
		40–49	3	20%
3	Educational status	Diploma	4	26.7%
		Degree	11	73.3%
4	Work Experience	1–5 years	5	33.3%
		6–10 years	7	46.7%
		11–15 years	3	20%
Total			15	100%

Table 2.
Socio-demographic characteristics of the participants from ICID.

the interview question is classified into four themes which are group formation and teamwork and spirit, conflict resolution styles, types of power, and employee stress management.

4.1.2 Group behavior

4.1.2.1 Criteria that differentiate groups and teams

The researcher adapted seven criteria which are the distinct characteristics and differences of groups and teams explained by [15], to differentiate whether the employees working in the ICID are group or team.

As indicated in **Table 3**, from the total 15 participants, all of them chose six criteria listed under the group column and they only chose one response listed under the team column.

4.1.2.2 Team effectiveness assessment

To crosscheck the above seven criteria, the self-administered questionnaire for the assessment of team effectiveness also adapted from "mind tools", also applied. There are 15 questions with five scale which are: 1 = Not at all, 2 = Rarely, 3 = Sometimes, 4 = Often, and 5 = Very often. The maximum sum score is 75 and the minimum sum score is 15. The sum of the scores classified into three levels: First, 15–30 is considered as worrying, which needs work to improve the effectiveness as a team member, and the effectiveness of the team; Second, 31–45 is considered as the effectiveness as a team player and team's effectiveness are patchy which is good at some things, but there's room for improvement elsewhere; third, 46–75 is considered as a solid team member working well as part of an effective team. Lower scores in this range show that there is room for improvement, though.

The result of the evaluative assessment is shown as the following:

As shown in **Table 4**, the total participants had a score of 19 to 30 which lay in the first classification level, so they were considered worrying according to the "mind tools".

Number of criteria statements	Number of options that reflect group chosen by the participants	Number of options that reflect team chosen by the participants
7	6	1

Table 3.
Result of the criteria that differentiate groups and teams.

No of participants filled out the assessment	Total score
3	30
5	27
6	26
2	19

Table 4.
Result of team effectiveness assessment.

Therefore, based on the above two types of assessment results the participants of the infrastructure and cluster institutions directorate members were considered as a group than a team.

All of the participants in the interview explained they consider their directorate as a group. The following was expressed by participants regarding the group formation process, purpose, members' roles, and whether the group has norms like standards of behaviors shared by members:

Participant 1.

"*I think I am member of a group as we members of the infrastructure and cluster institutions directorate working together and shared a single office, and the group or the directorate is established by the structure of the office employees of the directorate hired based on the fulfilling formalities and criteria's of the structure of the office, such as education preparation and experience*".

Regarding whether the group has norms like standards of behaviors shared by members their roles and the purpose of the group, Participant 12 said:

"All of the group members know their roles and responsibilities, because all of the employees hired according to their application, there is no different norms in our directorate or group, we all adhere to the office rule like doing work as planned at office level, and the purpose of the directorate or group is to accomplish the plan as a directorate".

Participant 9 explained the criteria for selection of the group head, about working with a group, group composition, cohesiveness in the group, the desire to remain or continue as a member in the group, and commitment to the group.

"Our group leader who is head of the directorate is selected according to the criteria of the office related to educational preparation and experience, our group members has different cultures, slightly different in income and age, two females and two males, all of us have the same educational status and different in work experience, I have desire to remain in the group and committed to the group, but if I got better opportunity like better salary or allowance I will leave this group".

Related to the group members' ability and skill and the group's resources to accomplish the group's objectives, the decision-making process in the group, and understanding individual roles and other members roles: Participant 14 said:

"*I think I have ability and skill but there is lack of resources to accomplish the planned objectives, in the group we decide through meeting as a directorate, and as we are experienced workers, I understand what is expected from me, I think other members also know what expected from them*".

Regarding group members openly discuss on their weak and strong sides and the feedback system, acceptance of creative thinking and new ideas by the office, and training, education, entertainment, and field trips that can stimulate new thinking, taking responsibility for the group's failure or success and about rewards for successful, participant 11 and participant 3 explained as follows:

Participant 11 said:

"*There is weekly and monthly programmed meeting in our group, at that time openly discuss our strong and weak side related accomplishing planned objectives, for the weekly one, the feedback is given by the head of our directorate and for the monthly one, the feedback is given by the manager of the office, new creative or new ideas are accepted as long as it is related to the office plan and budget*".

Participant 3 said:

"*Training and experience sharing with other city administration is sometimes delivered by previously Zonal departments now by regional bureaus, but there is no educational opportunity, if the achievement is lag as a group, the head of the directorate take the*

responsibility and displace it to our group members individually according to expectation of the individual, if the group succeed the first head of the directorate got recognition as a reward from the manager of the office, secondly, the recognition comes to the group members according to their contribution".

4.1.3 Conflict resolution styles

The participants of the study explained their experience related to the conflict in the following ways:

Participant 7: "S*ometimes there are conflicts that occur between our group members and other times between our group members and customers, the conflicts harm the group members work motivation, it also lags the accomplishment of the groups planned achievement, when the conflict was not handled on the time*".

Participant 14:

"*If conflict occurs between members of the group, we do not make it personal rather we consider it as differences of viewpoint, the individuals who make the difference talk each other and try to reach on consensus, most of the time it is solved by themselves. But if they cannot agree by themselves, the issue passes to the head of the directorate, and then the if the issue did not solved by the directorate, we took it to manager of the office, most of the time our manager listen both parties and try to negotiate first, if the agreement is not settled, he command what he believe as a right thing*".

4.1.3.1 Self-assessment questions related to conflict resolution styles used in the ICID

As indicated in **Table 5** using Shell as cited in [15] conflict resolution styles assessment tool, the assessment participants either preferred compromising or collaborating as a backup conflict-handling style.

Compromising indicates that the conflict resolution style is to try to "close the gap" in two parties' desires by using some type of fair criteria that appear reasonable to both sides. Compromisers tend to want to preserve the relationship between parties. On the other hand, participants who preferred *collaborating* tend to enjoy the negotiation process because it gives them an opportunity to probe deeply into difficult problems and help produce solutions that are acceptable to multiple parties.

Scoring and Interpretation	**Number of participants and their score**				
	Participant: 4	**Participant: 3**	**Participant: 2**	**Participant: 5**	**Participant: 1**
Competing	5	6	5	4	4
Collaborating	9	8	7	8	7
Avoiding	6	6	5	6	6
Accommodating	5	6	6	6	8
Compromising	8	9	8	7	6
Preferred conflict-handling style	Collaborate	Compromise	Compromise	Collaborate	Compromise
Backup conflict-handling style	Compromise	Collaborate	Collaborate	Compromise	Accommodate

Table 5.
Self-assessment questions related to conflict resolution styles used in the ICID.

4.1.4 Types of power used in the ICID

The participants explained about the basis of a person's or manager's ability to influence others or subordinates is related to the position one holds, and there was sharing of power or delegation of authority to some extent, and the subunit's sources of power in their office were related with on the sub-unit's level of work contributed to the office's final output. One participant explained in the following ways:

Participant 2:

"In my office, sources of power is because of the position one holds in the office, and there is delegation of authority in our office in a limited way, for instance our directorate head or our office manager temporarily appoint and give their authority to someone when they are out of the city for meeting, training or other reasons, regarding sub-units sources of power, mainly it is based on the sub-unit's level of work contribution to the offices final output".

The following statements explain some of their views related to managers or sub-units power starts and stops/ends and whether they are acting accordingly, and about resistance to authority by the employees in the office.

Participant 10:

"In our office, everyone's power is known, but sometimes there is some individuals try to use above their power, and sometimes there is also resistance of authority by some employees in the time of disagreement".

Regarding political tactics and impression management, all of the participants explained about claiming friendship, and self-promoting by claiming accomplishment, one participant explained it as follows:

Participant 15:

"One of the political influence tactics used by managers or workers to persuade others or getting support is through claiming friendship, and the impression management used by many of us is self-promoting by claiming accomplishment".

4.1.5 Employee stress management

Participants of the study explained about their stress experience in the following ways:

Participant 5: *"I have experiences of stress in my office especially in the time work overload, and the factors that make an event or situation stressful is the importance of the event or situation for me".*

Participant 13: "*One of the things that make me always being in a stressful situation is the reason of inadequate career development opportunity or lack of educational opportunity in my office".*

Participant 1: "*When I experience stress, I try to alleviate stressful feelings and emotions like stop working and go to a place that can make me feel better".*

Participant 6: *"From my experience the consequences of stress related to myself is inability to concentrate on the work so my work performance becomes less and my directorate achievement also decreased, but there is no anything done by my office related to stress".*

4.2 Result of the SMWM-SE

4.2.1 Socio-demographic characteristics of the participants from SMWM-SE

Table 6 shows the socio-demographic characteristics of the participants from SMWM-SE members.

	Age	Sex	Role in the association
Participant: 16	28	Male	Chairman
Participant: 17	31	Male	Secretary
Participant: 18	29	Female	Deputy chairman
Participant: 19	24	Female	Cashier
Participant: 20	23	Male	Store man

Table 6.
Socio-demographic characteristics of the participants from SMWM-SE.

4.2.2 Group behaviors

4.2.2.1 Criteria's that differentiate groups and teams

The criteria's that differentiate groups and teams also applied to SMWM-SE members as indicated in **Table 7**, from the total of five participants, all of them chose five criteria listed under the group column and they chose two responses listed under the team column.

4.2.2.2 Team effectiveness assessment

The self-administered questionnaire for the assessment of team effectiveness also adapted from "mind tools", also applied, in addition to the above seven criteria.

The result of the evaluative assessment is shown as the following:

As indicated in **Table 8**, the total participants had a score of 18 to 30 which lay in the first classification level, so they were considered worrying according to the "mind tools". Therefore, based on the above two types of assessment results, the SMWM-SE members are considered as a group than a team.

Of the five participants of the interview, all of them reported they consider their enterprise members as a group. The following was expressed by participants regarding

Number of criteria statements	Number of options that reflect the group chosen by the participants	Number of options that reflect team chosen by the participants
7	5	2

Table 7.
Result of the criteria that differentiate groups and teams.

Participants in the assessment	Total score
Participant 16	22
Participant 17	29
Participant 18	23
Participant 19	18
Participant 20	30

Table 8.
Results of team effectiveness assessment.

the group formation process, purpose, members' roles, and whether the group has norms like standards of behaviors shared by members:

Participant 17.

"*All members of the enterprise have their own expertise specially on metal work and wood work, so we established this enterprise based on our profession to work together and to get financial support from the government so that we got this workshop in addition to the loan, so all members of the enterprise work together and equally share the outcome of our effort as a group, and we also have rules that every members should comply*".

Related to the roles in the SMWM-SE and purpose of the group,

Participant 16 said:

"In addition to our skill we have, we got training from the office about how we can function as an enterprise, so every group members know their roles and responsibilities, and the purpose of the our enterprise is to return our loan we got from "Omo" micro finance and to be successful on the business".

Participant 8 explained the criteria for a selection of the group head, about working with a group, group composition, cohesiveness in the group, the desire to remain or continue as a member in the group, and commitment to the group.

"We members of the group selected when we establish the association based on his sociable behavior by considering he might lead as in attractive way and better negotiate and create a link between our association and the government offices to get any support, our group members has almost the same cultures, slightly different in age, two females and three males, I think not only me, but all of the group members want to continue as members of the group and committed to the group because currently we are in a better condition in income than before when we work individually".

The participants of the assessment also explained their ideas about the group members' ability and skills and the group's resources to accomplish the group's objectives, the decision-making process in the group, and understanding individual roles and other members' roles:

Participant 20 said:

"In our enterprise all of us have skills related to metal and wood work, because of we have been working individually before establishing the enterprise. After we established the enterprise we overcome our financial and working place problems,, but still there is one problem we have facing, which is our work place is at the corner of the city which make customers do not look our products like other private organizations who are working in the middle of the city, so it lags achieving our planned objectives. As a group we decide through meeting, all members of the group work according to his/her skill. Additionally, all members of the enterprise has additional roles like being chairman, secretary, store man, so I think all members know their responsibility".

Participants from the SMWM-SE also explained that group members openly discuss their weak and strong sides and the feedback system, acceptance of creative thinking and new ideas in the enterprise, and training, entertainment, and field trips that can stimulate new thinking, taking of responsibility for the group failure or success and about rewards for successful, participant 19 and participant 17 explained as follows:

Participant 19 said:

"In the SMWM-SE there is monthly scheduled meeting, in the meeting we discuss openly about everything related to our enterprise, feedback is given by every members during the meeting as well as in day to day activities, the feedback is also given by the supervisors and experts who came from ICID, new creative or new ideas related to our products are accepted as long as it is profitable and attract customers".

Participant 17 said:

"Most of the time trainings like entrepreneurship and business management, experience sharing with other city administration enterprises and bazaars are provided and facilitated as a support by the city administration ICID; if the group succeeds the recognition comes to the group members according to their contribution".

4.2.3 Conflict resolution styles

Participants from SMWM-SE also explained their experience related to the conflict in the following ways:

Participant 18:

"Whenever there is overlapping orders by our customers, there is conflict between our group members and customers, because of some members fleeing of work overload, and other times because of not all members come to work on-time, some members come to work being late and others become absent, the conflicts harm the association, because production time do not go in line with the agreement reached with the customers, and in time of conflict members lateness and absenteeism also increase, so it also create additional conflict".

Participant 16:

"In the time of conflict, first, if the conflicting parties do not speak each other individual try to negotiate them reached in agreement, unless the issue goes to the chairman of SMWM-SE and try to establish peace. But if both the conflicting individuals speak to each other, they discuss on the issue and solve the problem in a short period of time, if the conflict is not solved by these means, the way we solve conflicts is through making meeting that participate all members".

4.2.3.1 Self-assessment questions related to conflict resolution styles used in SMWM-SE

As indicated in **Table 9** using Shell as cited in [15] conflict resolution styles assessment tool, the assessment participants of the SMWM-SE preferred collaborating and accommodating as a backup conflict-handling style.

Participants who preferred *collaborating* tend to enjoy the negotiation process because it gives them an opportunity to probe deeply into difficult problems and help produce solutions that are acceptable to multiple parties.

Scoring and Interpretation	**Participant: 16**	**Participant: 17**	**Participant: 18**	**Participant: 19**	**Participant: 20**
Competing	5	4	4	4	6
Collaborating	9	7	6	7	10
Avoiding	4	3	7	4	5
Accommodating	8	8	6	8	9
Compromising	6	6	9	6	6
Preferred conflict-handling style	Collaborate	Accommodate	Compromise	Accommodate	Collaborate
Backup conflict-handling style	Accommodate	Collaborate	Avoid	Collaborate	Accommodate

Table 9.
Self-assessment questions related to conflict resolution styles used in the SMWM-SE.

On the other hand, participants who preferred *accommodating* minimize their own concerns by maximizing the concerns of others trying to solve the problems.

4.2.4 Types of power used in the SMWM-SE

In this evaluative assessment, participants of the SMWM-SE explained the bases of power that enable them to influence each other's, and delegation of authority and responsibility in the following ways:

Participant 18:

"There are two sources of bases of power that serve to influence one another, the first one is the power that emanate from expertise and the other one is the power that bases the position that individual assigned for, and there is delegation of authority in our enterprise, for instance whenever any members of the enterprise is out of the work place because of personal cases or problems or for the reason of our enterprise like meeting he/she appoint other member of the enterprise".

The following statements explain some of their views related to authorities assigned to members of the SMWM-SE, whether it is known by the boundary of the power when it starts and ends, and about the resistance of authority by the employees in the enterprise.

Participant 20:

"As there is already prepared rules and regulation which explained every members roles and responsibilities by ICID and we signed on it when our enterprise was established, we are familiar with every one's authority, but sometimes there is some individuals tries to use above their authority, in that case there is resistance to authority and it leads to conflict".

About political tactics and impression management, one participant explained as follows:

Participant 19:

"In our enterprise many times our chairman tries to get others support by participating them in the planning process, and other times he tries to get support by claiming that such support is consistent with the enterprise rules. Other members also try to persuade others or getting support through claiming friendship and the impression management used by many of us is claiming previous success".

4.2.5 Employee stress management strategies

Participants of the SMWM-SE also explained their stress experience in the following ways:

Participant 16:

"As to me, there is a lot if things or situations that make me stressful in the work place, the importance of the event with its costs and the degree of uncertainty surrounds the event makes me more or less stressful".

Participant 18:

"Balancing the demands of work and family roles are the major stressor that I experience not only in my work place but also in the home".

Participant 20:

"In the time of stress, I try to get help from family or friend, and I got less motivation for everything in time of stress and try to be alone till I become better, in our enterprise if I told to other members about my situation they take my responsibility, gave me a rest".

5. Discussion

5.1 Group behavior in the ICID and in the SMWM-SE

Based on the result, participants from both ICID and SMWM-SE members were considered as a group than a team. The ICID group was established by the structural hierarchy of the office, but the group formation is self-initiated and established based on profession to get financial and a place for workshop from the government for the case of SMWM-SE. As the study participants of ICID explained employees of the group are committed to and continue their working in the group until they got a better opportunity, this is contrary to the result of SMWM-SE members as currently, they are in a better condition in income than before, members of the group are committed to and continue working in the group. Participants from both ICID and SMWM-SE feel that they have enough skills and ability to meet their group's objectives, whereas they differ what they lack, in the case of ICID explaining their resources, SMWM-SE members explained they lack showroom in the city to sell their products.

5.2 Conflict resolution styles used in the ICID and SMWM-SE

All of the participants from ICID and SMWM-SE explained dysfunctional conflict occurs among them which harms their work motivation and lags accomplishment of the group's planned achievement. This result agreed with the study of [4] which found that there was a significant effect of conflict on organizational performance and with the study of [27] employee performance is affected by conflicts.

Participants of the ICID selected compromising, and collaboration and participants from the SMWM-SE selected collaborating and accommodating as conflict-handling style. This result agreed somehow with the following results. The study [27] found that one of the commonly used conflict management style among the doctors, nurses and clinical officers was compromising style. Another study conducted by [4] found that the dominating factors employees use as techniques to solve organizational conflicts are compromising, and accommodating techniques.

5.3 Types of power used in the ICID and SMWM-SE

Sources of power are based on the position one holds in the office for ICID, in the case of SMWM-SE sources of power are based on the position one holds and expertise in the enterprise. There is delegation of authority in a limited way in both ICID and SMWM-SE. It is known by the employees where the head of the directorate power starts and ends for ICID, and the authority figures' power, where it starts and ends are also known by members of the SMWM-SE. Political tactics used in ICID are personal appeals and impression management used is self-promotion. For MSWM-SE the political tactics used in the enterprise are consultation and personal appeals, and self-promotion as impression management.

5.4 Employee stress management strategies used in the ICID and SMWM-SE

Factors that make an event or situation stressful for the employees are the importance of the event or situation for ICID, the importance of the event and its costs, and the degree of uncertainty surrounding the event or situation for SMWM-SE.

The major stressor for employees working in the ICID is the reason for inadequate career development and lack of educational opportunities. This result is also somehow agreed with thy study by [14] stated that factors of occupational stress are lack of career development, and dealing with difficult clients. The major stressor for the participants is balancing the demands of work roles and family roles.

Employees of ICID and members of SMWM-SE use emotion-focused coping strategies in dealing with stress. This result is different from the result of [13] which stated that to cope up with stressful situations, employees use different coping mechanisms including taking responsibility, learn better communication, learn task management skills, and the organization uses job redesign/restructuring, improve communication, coaching, counseling, and medication.

The outcome of stress at the individual level is cognitive consequences such as poor concentration at work for ICID. And the individual outcome of stress is psychological consequences, such as frustration, and lack of motivation for their work for SMWM-SE. This result is a little bit closer to the study result of [13] among the symptoms of stress that staffs face because of stress factors such as worry, restlessness, anger, inability to concentrate, and loss of energy.

In the ICID and SMWM-SE, there was no designed program to deal with employee stress.

6. Conclusion

From the study result, the following points are concluded:

6.1 Infrastructure and cluster institutions directorate (ICID)

6.1.1 Group behavior

Group behavior in the ICID

- Based on the result, participants from ICID were considered as a group than a team.
- The group was established by the structural hierarchy of the ICID.
- As the study participants explained employees of the group are committed to and continue their working in the group until they got better opportunities.
- Participants feel that group members have enough skills and ability to meet the group's objectives but they lack resources.
- Participants explained they know their roles and responsibilities.
- Feedback is given by the head of the directorate at the end of every week, and by the manager of the office at the end of every month.
- Creative ideas that come from group members are accepted in line with the office plan and budget.
- Based on the groups' achievement, the recognition comes from the office to the directorate head and then to the group members according to their contribution.

Group behavior in the SMWM-SE

- Based on the result, SMWM-SE members are considered as a group than a team.
- The group formation is self-initiated and established based on the profession to get financial and a place for workshop from the government.
- As currently, they are in a better condition in income than before when they work individually, members of the group are committed to and continue working in the group.
- Group members think that they have enough skills and ability to meet the group's objectives but they lack a showroom in the city to sell their products.
- Feedback is delivered in day-to-day activities by every member of the SMWM-SE for each other, and monthly feedback by supervisors and experts of the ICID.
- Acceptance of creative ideas which come from group members is received by the group as long as it maximizes profit and customer satisfaction.
- Based on the groups' achievement, the recognition comes from ICID to the chairman of the SMWM-SE and then to the rest members of the group.

6.2 Conflict resolution styles used

Conflict Resolution Styles Used in the ICID

- Dysfunctional conflict occurs between employees which harms their work motivation and lags accomplishment of the group's planned achievement.
- Participants preferred compromising, and collaboration as a backup conflict-handling style.
- The group also used arbitration as a third-party negotiation style.

Conflict Resolution Styles Used in the SMWM-SE

- Members of the group experience dysfunctional conflict which hinders their achievement of the planned objectives of the enterprise.
- Participants from the SMWM-SE preferred collaborating for conflict-handling, and accommodating as a backup.
- The group also used third-party negotiation to resolve conflicts, such as mediation.

6.3 Types of power used

Types of Power used in the ICID

- Sources of power are based on the position one holds in the office.

- There is delegation of authority in a limited way.
- It is known by the employees where the manager or head of the directorate power start and ends.
- Political tactics used are fir personal appeals and the impression management used is self-promotion.

Types of Power used in the SMWM-SE

- The Sources of power in the enterprise are based on expertise and the position one holds in the enterprise.
- There is sharing of authority in the group in some cases.
- As the enterprise has rules and regulation, the authority figures power, where it starts and ends are known by members of the SMWM-SE.
- Political tactics used in the enterprise are consultation and personal appeals, and self-promotion as impression management.

6.4 Stress management strategies used

Employee Stress Management Strategies used in the ICID

- Factors that make an event or situation stressful for the employees are the importance of the event or situation for them.
- The major stressor for employees working in the directorate is the reason of inadequate career development and lack of educational opportunities.
- Employees use emotion-focused coping strategies in dealing with stress.
- The outcome of stress at the individual level is cognitive consequences such as poor concentration at work.
- In the ICID there was no designed program to deal with employee's stress.

Stress Management Strategies used in the SMWM-SE

- Factors that make an event or situation stressful are the importance of the event and with its costs, and the degree of uncertainty surrounding the event or situation.
- The major stressor for the participants is balancing the demands of work roles and family roles.
- Emotion-focused coping is the strategy used by members of the enterprise to deal with stress.

- Individual outcome of stress is psychological consequences, such as frustration, and lack of motivation for their work.

- Even though there is no planned program to deal with stress, members of the SMWM-SE help each other by allowing rest for the stressed member.

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Annex A: Interview Guide

Part 1: Interview questions about group formation and teamwork and spirit

These questions are prepared for the purpose of gathering information through interviews. The information will be used only for the research on investigating group formation and teamwork and spirit. And I will not mention anyone's name in the research to keep confidentiality.

Address; Regional state _____ City _____ Organization name _____.

Number of the group/team members' _____ Date of establishment of the team_____.

1. Is there a group/team that you are a member in your organization? If, yes …

2. Who organized the group/team, are there membership criteria? What are they?

3. What is the purpose of the group/team organized?

4. What it looks like the steps/processes in establishing the group/team?

5. Is there a different status hierarchy or roles in the group/team?

6. Are there norms like standards of behaviors shared by members of the group/team? What are they?

7. Is there a difference in work performance between working alone and with a group/team? Which one is better? And why?

8. The group/team has a leader? By what criteria is the leader selected in the group/team?

9. What is the composition of the group/team? Characteristics of members such as; culture, gender, socio-economic background, education, age, skills, work experience, etc.

10. Is there cohesiveness in the group/team, such as closeness or common attitude, behavior performance? What it looks like the relationship between group/team members?

11. Do you have the desire to remain or continue as a member in the group/team?

12. Do you have commitment to the group/team? Such as attending all the group meeting on time, accomplishing the objectives and expectation of the group/team?

13. Do the group/team members think that the members have the ability and skill and the group/team have enough resources, strategies and support to accomplish the groups/team's objectives?

14. What looks like the decision-making process in the group/team?

15. Do all group/team members understand the roles and responsibilities of the group/team leader, and other members of the team?

16. Has the group/team established norms or rules of conduct in areas such as conflict resolution?

17. Do group/team members openly discuss their weak and strong side and what is the feedback system?

18. Is there acceptance of creative thinking and new ideas by the office/organization? And does it provide training, education, entertainment, and field trips that can stimulate new thinking?

19. Who took responsibility for the group/team's failure or success? And are rewards supplied by the office/organization when the group/team is successful?

Part 2: Interview questions related to conflict resolution styles used in the office/organization

20. Have you experienced conflict in your organization? If yes, by whom?

21. Is the conflict functional which enhances and benefits the organizations' performance? Or harms the achievement of organizational goals?

22. What are the consequences of the conflict?

23. What did managers do to deal with the time of conflict?

24. What do you do in time of conflict or when you experience it?

Part 3: Interview questions related to types of power used in the office/ organization

25. What do you think that the base of a person's or manager's ability to influence others or subordinates within your office/organization?

26. Is there sharing of power or delegation of authority in your office/ organization?

27. What are the subunit's sources of power?

28. In your office/organization, is it known where an individual, manager or sub-unit's power starts and stops/ends, and are they act accordingly?

29. Is there resistance to authority by the employees in the organization? Or are there any political competitions, game, or power struggles in your office/organization?

30. What are the political influence tactics used by managers/workers persuading in your office/organization?

31. What kind of impression management is applied in your office/organization?

Part 4: Interview questions about employee stress management

32. Do you have an experience with stress-related with job in your office/ organization?

33. What are factors that make an event or situation stressful in your workplace/time?

34. What are the stressors you experience in your workplace/organization?

35. What are you doing in time of stress?

36. What are the outcomes or consequences of stress related to you and your work performance?

37. Is there a thing that your office/organization tries to assess the workers stress experience? If yes, what are they?

Annex B: Self-administered questionnaire

Part 1: Criteria that differentiate groups and teams

Instruction: Below is a list of the ways you experienced in the group/team, please make ✓ mark in the box for each of the statement choice under column A or column B which can best explain about your group or team.

	Criteria Statement	A		B	
1	Goals of the group	Works on common goals	☐	Total commitment to common goals	☐
2	Accountability	To manager	☐	To team members and team leader	☐
3	Skill levels	Random	☐	Complementary	☐
4	Performance evaluation	By manager	☐	By team members and team leader	☐
5	Culture	Marked by change & conflict	☐	Based on collaboration & goal attainment	☐
6	Performance outcomes	Positive, neutral, or negative	☐	Synergistic or greater than sum of members' contributions	☐
7	Definition of success	By manager's aspirations	☐	By members' & team leader's aspirations	☐

Part 2: About team effectiveness assessment

Instructions: For each statement, circle one choice for each of the items in the column that best describes you. Please answer questions as you actually are (rather than how you think you should be), and do not worry if some questions seem to score in the 'wrong direction'.

1 = Not at all 2 = Rarely 3 = Sometimes 4 = Often 5 = Very often.

No	Statement	Circle one
1	My group/team is knowledgeable about the stages of development teams can be expected to go through.	1 2 3 4 5
2	Group/Team members are provided with a great deal of feedback regarding their performance.	1 2 3 4 5
3	Group/Team members are encouraged to work for the common good of the organization.	1 2 3 4 5
4	There are many complaints, and morale is low on my group/team.	1 2 3 4 5
5	Group/Team members do not understand the decisions that are made, or do not agree with them.	1 2 3 4 5
6	People are encouraged to be good group/team members, and build good relationships.	1 2 3 4 5
7	Group/Team members are provided with development opportunities.	1 2 3 4 5
8	Meetings are inefficient and there is a lot of role overlap.	1 2 3 4 5
9	Group/Team members are encouraged to commit to the team vision, and leaders help them understand how their role fits into the big picture.	1 2 3 4 5
10	Group/Team members are often given a chance to work on interesting tasks and stretch their knowledge and capabilities.	1 2 3 4 5
11	The Group/team understands what it needs to accomplish and has the resources needed to be successful.	1 2 3 4 5
12	Conflict and hostility between members are pervasive issue that does not seem to get better.	1 2 3 4 5

No	Statement	Circle one
13	People feel that good work is not rewarded and they are not sure what is expected of them.	1 2 3 4 5
14	Group/Team members balance their individual needs for autonomy with the benefits of mutual interdependence.	1 2 3 4 5
15	Working relationships across units or functions is poor, and there is a lack of coordination.	1 2 3 4 5

Part 3: Self-assessment questions related to conflict resolution styles used in the office/organization

Instructions: For each statement, circle one choice for each of the items in the column that best describes your experience in your office/organization.

1 = Never 2 = Rarely 3 = Sometimes 4 = Often 5 = Very often.

	Statement	*Circle one*				
1	**I work to come out victorious, no matter what.**	**1**	**2**	**3**	**4**	**5**
2	I try to put the needs of others above my own.	1	2	3	4	5
3	I look for mutually satisfactory solution.	1	2	3	4	5
4	I try not to get involved in conflicts.	1	2	3	4	5
5	I strive to investigate issues thoroughly and jointly.	1	2	3	4	5
6	I never back away from a good argument.	1	2	3	4	5
7	I strive to foster harmony.	1	2	3	4	5
8	I negotiate to get a portion of what I propose.	1	2	3	4	5
9	I avoid open discussions of controversial subjects.	1	2	3	4	5
10	I openly share information with others in resolving disagreements.	1	2	3	4	5

Author details

Nassir-Maru Yesuf
Werabe University, Werabe, Ethiopia

*Address all correspondence to: yesufnm@gmail.com

References

[1] Saxena T, Sinha R. Role of interpersonal behavior in enhancing employee performance among public sector companies in Uttar Pradesh and National Capital Region. International Journal of Creative Research Thoughts (IJCRT). 2021;**9**:104

[2] Gupta A. To analysis the role of group dynamics in organization. International Journal of Multidisciplinary Approach and Studies. 2015;**2**(3):170-174

[3] Nino P, Teona M, Badri G, Lidija W, Viktor K. Conflict management impact on the employee productivity. SHS Web of Conferences. 2021;**111**:01010. DOI: 10.1051/shsconf/202111101010

[4] Awan AG, Saeed S. Conflict management and organizational performance: A case study of Askari Bank ltd. Research Journal of Finance and Accounting. 2015;**6**(11):88-103

[5] Abbas Q, Awan SH. Impact of organizational politics on employee performance in public sector organizations. Pakistan Administrative Review. 2017;**1**(1):19-31

[6] Yadiel A. The Effect of Work Related Stress on Employees' Performance: A Case in Shints Ethiopia Garment Private Limited Company [Thesis]. London: School of Graduate Studies, Mary's University; 2020

[7] Ministry of Urban Development and Housing (MoUDH), Micro and Small Enterprise Development Policy and Strategy. Ethiopia: MoUDH; 2016. Available from: https://www.cmethiopia.org

[8] Assefa B, Zerfu A, Tekle B. Identifying Key Success Factors and Constraints of Ethiopia's MSE Development: An Exploratory Research. EDRI Research Report 18. Addis Ababa: Ethiopian Development Research Institute; 2014

[9] Wolday A. Growth of youth-owned MSEs in Ethiopia: Characteristics, determinants and challenges. Ethiopian Journal of Economics. 2015;**XXIV**(2): 93-128

[10] Tibebe S. Constraints and Challenges of Small-Scale Enterprises: The Case of Gulele Textile Product [Thesis]. Ethiopia: St Mary's University; 2015. Available from: https://hdl.handle.net/123456789/6456

[11] Mohammed G. The challenge and prospects of small scale Enterprise in Ethiopia: A survey of some selected small scale Enterprise in Addis Ababa City. International Journal of Scientific and Research Publications. 2016;**6**(5): 617-626

[12] Mehari W-A. Factors Affecting the Performance of Micro and Small Enterprises in Kirkos Sub-City, Addis Ababa, Ethiopia [Thesis]. Ethiopia: St Mary's University; 2016. Available from: https://hdl.handle.net/123456789/1286

[13] Selamawit GA. Workplace Stress and its Management. Journal of Business and Administrative Studies (JBAS). St Mary's University, Ethiopia. 2013;**5**(1):89-120. Available from: https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413.8837

[14] Tedbabe A. Assessing the Effect of Organizational Stress Management on Job Performance: A Case of Health Counseling and Information Center (952 Health Hotline) [Thesis]. Ethiopia: Addis Ababa University; 2018

[15] Ivancevich J, Konopaske R, Matteson M. Organizational Behavior

and Management. 10th ed. New York: McGraw-Hill; 2014

[16] Saim M, Cemberci M, Civelec M, Gunel D. Groups and their effects in organizations. European Scientific Journal. 2015;**11**(32):12-34

[17] Brown C. Social Psychology. London: SAGE Publications; 2006

[18] Gençer H. Group dynamics and behavior. Universal Journal of Educational Research. 2019;**7**(1):223-229

[19] Hassaskhah J, Mozaffari H. The impact of group formation method on group dynamics and group outcome in EFL creative writing. Journal of Language Teaching and Research. 2015; **6**(1):147-166 Research Gate

[20] Forsyth D. Group Dynamics. 5th ed. USA: Wadsworth; 2010

[21] Hassan Z. Impact of effective teamwork on employee performance. International Journal of Accounting & Business Management. 2016;**4**(1):76-85

[22] Yazid Z. Exploring conflict management. Gadjah Mada International Journal of Business. 2015;**17**(1):65-82 National University of Malaysia

[23] Central Statistical Agency of Ethiopia (CSA). Available from: https:// www.citypopulation.de/Ethiopia.html

[24] Available from: https://www.mind tools.com/pages/article/newTMM_84. htm

[25] Creswell JW. Research Design: Qualitative, Quantitative, and Mixed Methods Approach. 4th ed. USA: SAGE Publications Inc.; 2014

[26] Phil C. Validity and reliability within qualitative research in the caring sciences. International Journal of Caring Sciences. 2021;**14**(3):2041

[27] Francis, JS. Conflict Management Styles and Employee Performance in Public Hospitals in Nyeri County, Kenya [Unpublished Thesis]. Nairobi, Kenya: Kenyatta University; 2015. Available from: https://ir-library.ku.ke/handle/ 123456789/18709

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Occupational stress is a global phenomenon and this book aims to identify the various factors associated with occupational stress in industrial and healthcare workers while also suggesting some potential coping strategies that have been found to help in overcoming such occupational stress. After reading this book, I trust that readers will be able to appreciate the importance of coping strategies for mental wellbeing in the workplace.

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