DDC Professional Journal
Vol. 6 No. 1, May 2025
ISSN 1908-3130

UNVEILING THE LIVED EXPERIENCES OF CARDIOVASCULAR SONOGRAPHERS WITH CHRONIC MUSCULOSKELETAL PAIN

Jo Krizza C. Estremos, RRT

Davao Doctors College

Abstract

This study examines the lived experiences of cardiovascular sonographers who suffer from chronic musculoskeletal pain, focusing on how chronic pain affects their professional performance, particularly in terms of scanning quality and productivity. Using a phenomenological approach, in-depth interviews were conducted with nine experienced cardiovascular sonographers who regularly experience work-related musculoskeletal pain. Participants had at least one year of experience to ensure relevant exposure to occupational musculoskeletal pain. The participants must be currently employed to ensure real-time working conditions and relevant coping mechanisms that participants use in current role. Data were analyzed using the Colaizzi method to emphasize the fundamental nature of specific lived experiences for cardiac sonographers. The study reveals that participants reported that pain frequently compromised image quality due to discomfort-induced changes in posture and technique, resulting in extended scanning durations and decreased diagnostic efficiency. Additionally, the study found that pain-related fatigue negatively affected productivity and contributed to emotional stress. Common coping strategies included stretching, deep breathing exercises, and taking regular breaks, aimed at reducing physical discomfort and mental fatigue. These findings underscore the significant impact of chronic musculoskeletal pain on the professional performance and well-being of cardiovascular sonographers. The study highlights the need for ergonomic interventions, better pain management strategies, and institutional support to improve sonographers' health, enhance productivity, and ultimately contribute to better patient care and job satisfaction.

Keywords: *Chronic Musculoskeletal Pain, Cardiovascular Sonographers, Descriptive-Phenomenology, Davao City*

Corresponding email: estremoskrizza@gmail.com
ORCID ID: https://orcid.org/0009-0003-5430-7403

Introduction

Cardiovascular sonographers frequently experience chronic musculoskeletal pain due to their work's repetitive and physically demanding nature that involves sustained pressure and awkward postures, particularly in the upper extremities, neck, and shoulders (Roll et al., 2022). According to Ezugwu et al. (2020), repetitive actions, immobile postures, poor ergonomic support, insufficient breaks, and pressure to maintain high productivity led to chronic discomfort, adversely affecting job performance and overall quality of life. Consequently, many sonographers suffer from chronic pain, which may increase absenteeism, reduce working hours, affect the quality of care given to the patients, the financial stability of the diagnostic sonography department, and workplace morale (Al Saikhan, 2023; McDonald, 2020; Murphy et al., 2021; Shaikh, 2021; Wooten, 2019).

In the study conducted in the USA, sonographers reported musculoskeletal pain as more severe compared to their peers in all specializations (Barros-Gomes et al., 2019; Hogan, 2022). In Switzerland, a study shows a significant incidence of chronic musculoskeletal pain among sonographers,

which is attributed to sonographers' failure to follow ergonomics guidelines (Bonutto et al., 2020). Additionally, sonographers' corresponding absence rate of 15.6% was reported mainly due to neck and lower back pain (Fernandez et al., 2022).

In Saudi Arabia, according to a systematic study by Alshuwaer et al. (2019), which included 100 studies, shoulder pain or injury is the most common among sonographers and can impact their performance. Furthermore, a study conducted in Saudi Arabia by Al Saikhan (2023) found that cardiac sonographers were more likely to experience work-related musculoskeletal disorders and that their pain was also more intense and prolonged.

This study aims to better understand the lived experiences of cardiovascular sonographers who suffer from work-related musculoskeletal pain, focusing on its impact on work performance. While previous research has highlighted the general prevalence of chronic musculoskeletal pain among sonographers, there is a specific gap in understanding how these issues affect cardiovascular sonographers in particular. Bonutto (2020) suggests that future studies should explore factors like body habitus and overwork as contributors to musculoskeletal disorders. Additionally, Hogan (2021) calls for research into the increased injury rates among cardiovascular sonographers.

This study addresses these gaps by evaluating the risk factors for musculoskeletal disorders among cardiovascular sonographers and examining how these conditions affect their professional performance. Additionally, this research can help cardiovascular sonographers understand the significance of preventive measures and ergonomic techniques in managing patients with increased body habitus, overwork, and poor echo window. The findings will provide valuable insights for administrators, human resource managers, sonographers, professional organizations, and future researchers, informing strategies for improving ergonomics, pain management, and overall workplace support.

Methods

This study employed a descriptive phenomenological research design based on Edmund Husserl's philosophical tradition. The descriptive phenomenological approach is particularly suitable for this study because it aimed to capture the essence of participants' lived experiences, free from the researcher's preconceived notions or biases. Husserl's phenomenology emphasizes bracketing prior assumptions to allow an unbiased analysis of participants' conscious experiences (Crotty, 1996).

The study was conducted in Davao del Sur, Davao del Norte, and Davao City, which allowed for geographic diversity while maintaining a focus on specific healthcare contexts. Participants were cardiovascular sonographers with at least one year of experience performing 2D-echocardiograms and vascular studies who also reported chronic musculoskeletal pain. The selection of participants was carried out using purposive sampling to ensure individuals who could provide in-depth, relevant insights into the experience of work-related musculoskeletal pain.

A total of nine cardiovascular sonographers participated in the study, all of whom met the following inclusion criteria: at least one year of experience as a cardiovascular sonographer, current employment in a healthcare facility, and self-reported experience with chronic musculoskeletal pain. This criterion was essential to ensure that participants had enough exposure to the physical demands of the profession and could speak meaningfully about the occurrence and management of pain in their professional lives. The sample size of nine participants was determined based on the principle of data saturation, a key element in qualitative research. Data saturation was reached when no new themes emerged during the interviews and the analysis, indicating that further interviews would likely provide redundant information. Despite reaching saturation, the researcher did not seek additional participants, as the data sufficiently captured the range of experiences and themes pertinent to the research objectives.

In-depth interviews (IDIs) were conducted with the participants, with each interview structured to explore their personal experiences with musculoskeletal pain and its impact on their work performance. The interviews were semi-structured, allowing for flexibility while ensuring that core

questions related to the research aims were addressed. After the interviews were conducted, the researcher transcribed the audio recordings, ensuring accuracy by returning transcripts to the participants for review and corrections, a process known as member checking. This helped ensure that the findings reflected the participants' true experiences.

The data were analyzed using Colaizzi's (1978) seven-step thematic analysis process, which is a well-established phenomenological method for identifying key patterns and themes within qualitative data. A qualitative analyst assisted in the interpretation of the data, ensuring a thorough analysis of the lived experiences of cardiovascular sonographers. To maintain privacy and confidentiality, all audio recordings and documents were securely stored and destroyed after the completion of the study.

Results and Discussion

Table 1. Demographic Profile of the Respondents

Participant Alias	Sex	Age	Institution	Length of Service
Magnesium	25	F	A	2
Nitrogen	44	F	A	10
Calcium	25	F	A	2
Iodine	34	F	B	8
Gallium	32	F	B	7
Potassium	29	F	B	8
Carbon	34	F	C	3
Tungsten	33	F	E	7
Neon	30	F	E	7

Nine cardiovascular sonographers with diverse backgrounds and varying lengths of experience in the field participated in this study. The participants are adults ranging in age from 25 to 40 years old. The participants are all female. All of them are radiologic technologists who specialize as cardiovascular sonographers. They were assigned pseudonyms to ensure confidentiality.

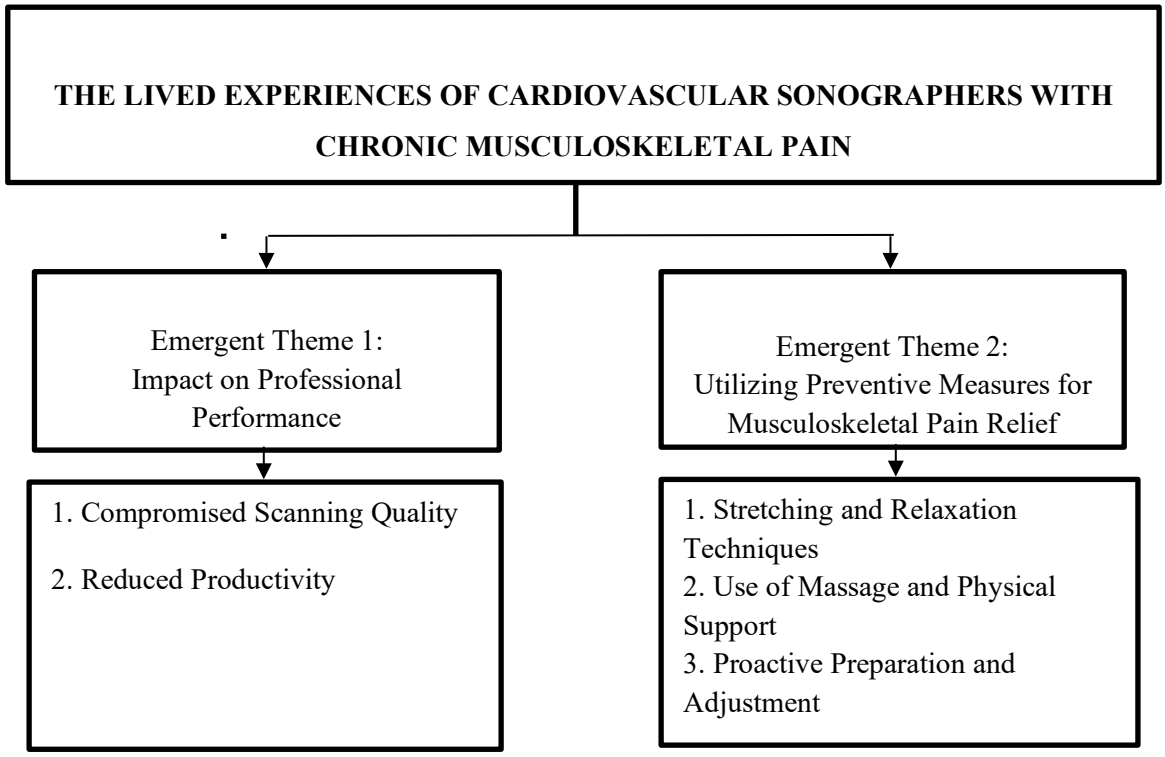

Figure 1. Thematic Map

Emergent Theme 1: Impact on Professional Performance

Chronic musculoskeletal pain is a significant concern among cardiovascular sonographers, directly affecting their professional performance (Al Saikhan et al., 2024). The nature of sonography, which involves repetitive, physically demanding tasks such as holding transducers for extended periods, repetitive movements, maintaining awkward postures, and performing prolonged scanning durations, makes sonographers particularly susceptible to musculoskeletal discomfort and injury (Zangiabadi et al., 2024). As highlighted by several participants in this study, chronic pain often leads to alterations in movement patterns, reduced scanning efficiency, and a decrease in the overall quality of diagnostic imaging.

Recent literature highlights that the repetitive and forceful motions required in sonography, such as sustained arm abduction, contribute to high rates of musculoskeletal pain among practitioners (Krukowski et al., 2021). Studies also emphasize that the prevalence of work-related musculoskeletal disorders is particularly pronounced in sonographers due to ergonomic challenges, including poor workstation design and the need to accommodate diverse patient sizes and conditions (Roll et al., 2022).

Moreover, prolonged exposure to such physical demands can lead to chronic pain and long-term disability, making musculoskeletal strain not only a health concern but also a significant professional issue that affects workforce retention and job satisfaction (Smith et al., 2023). Research also highlights that because of pain, sonographers more often sought medical evaluation, missed work, and had work restrictions (Gomes et al., 2019)

In this study, participants vividly described their struggles with physical strain, recounting incidents where long hours of scanning and handling non-portable, bulky machines exacerbated pain in their shoulders, backs, and

wrists. Henningsen et al. (2023) reiterate that a lack of proper equipment layout and fixed components results in excessive arm abduction and overreaching, which might impede blood circulation and induce muscular fatigue. The participant's narratives are consistent with findings from recent research, which underscores the need for targeted interventions, such as ergonomic training and improved equipment design, to mitigate physical strain and enhance the profession's sustainability (Brown & Taylor, 2021). These insights contribute to the growing understanding of the occupational challenges faced by cardiovascular sonographers and the urgent need for systemic improvements to support their health and well-being.

Cluster Theme 1: Decline in Scanning Quality

One of the most immediate effects of chronic musculoskeletal pain is the decrease in scanning quality. Persistent neck, shoulders, wrists, and lower back pain often inhibits sonographers' ability to achieve the proper hand and arm positions for precise imaging (Simonsen et al., 2020). According to Miller et al. (2020), sonographers with chronic musculoskeletal pain face difficulty maintaining the proper scanning postures, leading to shaky hands and inconsistent pressure on the transducer. Ultimately, all these factors reduce the clarity and specifics of diagnostic imaging, with the more alarming implications flying for cardiovascular sonographers as image quality is emphasized before accurately assessing cardiac and vascular conditions.

According to Collins and her collaborator's (2019) research, 42% of sonographers suffering from chronic pain claimed this condition directly affected the quality of the diagnostic imaging obtained, with many expressing the need to redo scans or modify procedures for comfort. Participants also reported increased pressure, such as being rushed to perform exams, handling more cases than usual, or feeling their scanning quality was compromised, leading to physical and mental errors that negatively affect worker health and patient outcomes (Roll et al., 2022).

Similar findings have been reported by Lynch et al., 2020. Movement adjustments because of pain, for example, an adaptation in hand grip and body positioning, produced inconsistent results in imaging. It was similarly voiced by some participants of this study, who claimed that pain made it difficult to maintain steady transducer pressure or hold scanning angles over long periods, thus possibly impacting the accuracy of images for heart valve abnormalities, aneurysms, and vascular blockages.

Pain indeed affects everything related to scanning—it involves not just the technical aspects but also the mental aspects," Jones and Thomas stated (2020). It makes it hard for the sonographer to concentrate on details, for long periods of suffering from chronic pain usually leave one very fatigued.

Participants in the study shared various accounts of their experiences with chronic musculoskeletal pain.

> *It is sad to say that it affects the quality of the scanning. As cardiovascular sonographers, our job is to scan the heart and vessels. Many views and measurements are needed, so it takes time to finish. Although we can still get the videos and measurements, there are times when we could get better videos, but we can't because it already hurts.* – Potassium, Transcript 6, Lines 374-378

> *I've discovered that when I'm tired or experiencing pain, my scanning quality significantly suffers because I'm unable to push as hard. All I can think of is that this is the most I can do.* – Tungsten, Transcript 8, Lines 554-556

> *For the cardiologist's part, the image is acceptable. However, if I evaluate it, there should have been a better outcome for the image, but I feel like I can't get it because I'm rushing the procedure due to the pain.* – Neon, Transcript 9, 591-594

These utterances highlight how musculoskeletal pain negatively impacts the performance and quality of work, especially for cardiovascular sonographers. The person acknowledges the limitations caused by pain during the procedure, which affects their ability to achieve optimal imaging results.

The findings align with studies that state that pain is a barrier to the optimal performance of sonographers. According to Al Saikhan (2023), pain often forces sonographers to rush or alter their techniques, compromising image quality. Similarly, Murphy et al. (2021) note that the pain-induced rushing can lead to suboptimal scans and missed or inaccurate diagnoses, which not only affect patient care but also increase the need for repeat scans or follow-up procedures, adding to the burden of both the healthcare provider and the patient.

These findings highlight the importance of musculoskeletal pain, a physical challenge for sonographers, and create barriers that affect the quality and accuracy of their diagnostic work. The chronic nature of the pain, combined with the physical demands of the job, creates a cycle that reduces performance over time. Addressing musculoskeletal pain in this profession is essential to ensure the well-being of healthcare workers and the quality of patient care.

Cluster Theme 2: Reduced Productivity

Reduced productivity refers to a decline in the efficiency and effectiveness of cardiovascular sonographers in performing their duties, often resulting from chronic musculoskeletal pain. This reduction manifests in various forms, such as increased absenteeism, missed work shifts, and slower performance during examinations. Physical discomfort, work-related pressures, and disruptions in workflow influence these factors, all of which hinder the sonographers' ability to maintain optimal performance levels in their daily tasks.

Participants shared vivid accounts of how their performance was affected because of chronic musculoskeletal pain:

> *When the patient's window isn't good, or the patient is on the heavier side, the procedure takes longer because I must stop or pause due to the strain on my hands.* – Magnesium, Transcript 1, Lines 19-21

> *There was a sharp pain in my wrist, and instead of the usual 30-45 minutes for a procedure, it took longer because I had to pause several times because the pain became unbearable.* – Neon, Transcript 9, Lines 573-575

> *I occasionally notice my hand losing its hold on the probe as the discomfort begins, so I must pause for a few minutes and let the patient know. I must pause for a while because, in the end, I'm the one who will suffer.* – Neon, Transcript 9, Lines 587-589

This feedback indicates how musculoskeletal pain, especially in the hands, wrists, and back, can directly impact the productivity of cardiovascular sonographers. The frequent pauses to manage pain, the delay in procedure time, and the need to stop or slow down during scans reduce the number of patients that can be handled in a given shift.

This theme aligns with existing literature on how musculoskeletal pain among cardiovascular sonographers significantly impacts their productivity, leading to delays and reduced patient throughput. Pain in areas like the hands, wrists, and back forces sonographers to take frequent breaks, which extends the time required to complete each procedure. For example, instead of finishing a scan within the usual 30-45 minutes, sonographers often experience delays as they pause to manage pain, especially when dealing with more significant or more

challenging patients. These breaks disrupt the workflow, resulting in fewer patients seen per shift. Furthermore, the pain sometimes leads to temporary abandonment of the procedure, further slowing down the process and potentially compromising the quality of scans.

Research studies from recent years confirm that musculoskeletal disorders in sonographers reduce clinical productivity and affect the quality of care. Biyik et al. (2022) found that chronic musculoskeletal pain was directly linked to lower productivity and increased work-related injuries among diagnostic imaging professionals. Similarly, Johnson et al. (2020) highlighted that frequent pain interruptions led to more prolonged scan times and an inability to maintain a high level of efficiency in the workplace. These findings suggest that the physical strain caused by musculoskeletal pain significantly diminishes the quantity and quality of diagnostic services provided by cardiovascular sonographers.

These findings suggest that the physical strain caused by musculoskeletal pain in cardiovascular sonographers leads to frequent breaks and lengthier procedure times, reducing the number of patients they can see per shift. This strain also compromises the quality of scans, as pain can hinder focus, accuracy, and the ability to maintain proper technique. As a result, the quantity and quality of diagnostic services are diminished, potentially affecting patient care and overall workflow efficiency.

Emergent Theme 2: Utilizing Preventive Measures for Musculoskeletal Pain Relief

The emergent theme, Utilizing Preventive Measures for Musculoskeletal Pain Relief, refers to cardiovascular sonographers' conscious actions and strategies to prevent or alleviate musculoskeletal pain. These measures include a range of techniques designed to reduce physical strain, such as maintaining proper posture, engaging in regular stretching or strengthening exercises, and using ergonomic equipment. By implementing these strategies, sonographers aim to manage the physical demands of their work and avoid long-term injury or discomfort.

Recent literature supports the significance of preventive measures in managing musculoskeletal pain. A study by Dijkstra et al. (2023) highlights that healthcare professionals who engage in preventive practices, such as regular stretching and posture adjustments, report lower musculoskeletal pain levels than those who do not incorporate these strategies. Furthermore, the study of Albanesi et al. (2022) emphasizes preventive measures, such as ergonomic interventions and physical activity, to help mitigate the repetitive strain associated with long hours of scanning and improve overall comfort.

Kumar et al. (2022) found that healthcare workers who integrated breaks, ergonomic adjustments, and strengthening exercises into their daily routines experienced a reduction in the onset and severity of musculoskeletal pain. This proactive approach enables sonographers to manage physical strain effectively and maintain their productivity without exacerbating discomfort. In addition, research by Lee et al. (2024) emphasizes the role of ergonomic practices in preventing pain. Their study found that healthcare workers who received training on proper posture, equipment use, and physical activity experienced a significant reduction in chronic musculoskeletal pain. Such practices alleviate immediate discomfort and contribute to workers' long-term health and well-being.

Utilizing preventive measures for pain relief is an essential theme in managing musculoskeletal pain among cardiovascular sonographers. Strategies like stretching, posture correction, and ergonomic tools have been shown to alleviate discomfort, prevent injury, and sustain long-term health. This proactive approach is crucial for ensuring the well-being of sonographers and maintaining their ability to perform their work efficiently and comfortably.

Cluster Theme 1: Stretching and Relaxation Techniques

The cluster theme, Stretching and Relaxation Techniques, refers to cardiovascular sonographers' practices to alleviate or prevent musculoskeletal pain by enhancing flexibility, reducing tension, and promoting muscle

recovery. These techniques often involve deliberate stretching exercises and relaxation methods that target muscle groups commonly affected by the physical demands of sonography, such as the back, shoulders, and wrists. Regular stretching and relaxation exercises can reduce muscle stiffness, prevent overexertion, and improve overall physical well-being.

The participants in the study expressed their use of stretching and relaxation techniques as a crucial part of managing the physical strain they experience during work. For instance, one participant noted:

> *After scanning, I usually do some stretches to relieve the tightness in my back and shoulders. It helps ease the discomfort from long hours of scanning.* – Magnesium, Transcript 1, Lines 46-48

> *I find it helpful to do some neck and wrist stretches during breaks. It reduces the tension from gripping the probe for long periods of time.* – Nitrogen, Transcript 2, Lines 92-94

> *I also do deep breathing exercises to relax after a heavy day. It's not just the body that hurts but my mind, too, so relaxing the muscles helps me calm down.* – Potassium, Transcript, Lines 360-362

Stretching and Relaxation Techniques play a significant role in managing the physical demands of cardiovascular sonography. These techniques help reduce muscle tension and improve overall well-being by providing mental relaxation. Research indicates that stretching and relaxation exercises can positively impact reducing musculoskeletal pain and stress among healthcare professionals. A study by Robinson et al. (2022) emphasizes that stretching routines designed for specific muscle groups can significantly alleviate pain in healthcare workers by improving flexibility and reducing muscle stiffness. Moreover, Kim et al. (2023) suggest that stretching can prevent musculoskeletal pain since it alleviates muscle tension, enhances blood circulation, and improves flexibility, enabling comfortable body movement.

A study by Vanbheim et al. (2021) suggests that engaging in relaxation techniques correlates with reduced blood pressure, oxygen consumption, respiratory rate, pulse rate, and muscle tension. Additionally, a review by Lee et al. (2023) suggests that incorporating relaxation techniques, such as deep breathing and mindfulness, can improve overall stress management and prevent chronic pain. These methods help workers regain energy and reduce the mental strain often accompanying physically demanding tasks, including cardiovascular sonography.

In conclusion, Stretching and Relaxation Techniques are vital for mitigating musculoskeletal pain in cardiovascular sonographers. These practices relieve physical discomfort and promote overall health, supporting sonographers' physical and mental well-being in their demanding roles. Regularly incorporating these techniques has been shown to effectively reduce pain, prevent injury, and improve the quality of life for healthcare professionals.

Cluster Theme 2: Use of Massage and Physical Support

The clustered theme, Use of Massage and Physical Support, refers to the strategies employed by cardiovascular sonographers to alleviate musculoskeletal pain and discomfort through external physical interventions. This theme encompasses professional massage therapy, self-administered massage techniques, and physical support mechanisms like ergonomic adjustments, supportive devices, or colleague assistance to reduce the strain on the body. These practices are employed as supplementary measures to relieve muscle tension, reduce soreness, and prevent injury resulting from the physical demands of sonography.

Participants in the study shared their reliance on massage and physical support to manage the pain associated with their work. One participant mentioned:

> *Sometimes, after a long day of scanning, I go for a massage. It helps release the tension in my back and shoulders, which are the areas I feel the most strain.* – Carbon, Transcript 7, Lines 436-437

> *I use a back support belt when I'm scanning. It helps take some pressure off my spine and reduces the strain on my lower back.* – Potassium, Transcript 6, Lines 354-356

> *When I feel too much tension, I ask a colleague for a quick massage on my shoulders or neck. It helps ease the discomfort and makes it easier to continue working.* Calcium, Transcript 3, Lines 168-169

Massage and physical support emerge as an important coping strategy for cardiovascular sonographers to manage the physical discomfort associated with their work. Both professional massage and self-administered techniques, along with the use of physical support devices, contribute to pain relief and muscle recovery. These interventions serve as valuable supplementary tools to address musculoskeletal pain in the workplace. Literature supports the effectiveness of these methods, as massage therapy has been shown to improve circulation, reduce muscle soreness, and alleviate stress among healthcare workers. A study by Hsieh et al. (2021) found that regular massage therapy sessions significantly reduced chronic musculoskeletal pain in workers exposed to repetitive movements and strenuous physical tasks, such as sonographers. Moreover, research supports using ergonomic tools and physical support, like back support belts. A study by Wang et al. (2023) found that ergonomic interventions, including posture supports and physical assistance, can significantly reduce the risk of lower back pain and enhance comfort for workers in physically demanding jobs. These strategies help manage the physical strain encountered during daily work routines and promote long-term health.

Massage and physical support are essential for mitigating musculoskeletal pain and discomfort in cardiovascular sonographers. These methods offer immediate relief and contribute to the long-term prevention of injuries, supporting sonographers' overall health and well-being in their demanding roles.

Cluster Theme 3: Proactive Preparation and Adjustment

The cluster theme of *Proactive Preparation and Adjustment* refers to the anticipatory measures taken by cardiovascular sonographers to prevent or minimize physical strain before or during their work. This includes proactive actions such as adjusting their posture, ergonomically preparing their work environment, and making physical adjustments to their routines to protect their bodies from the strain caused by repetitive movements or long working hours. By anticipating the potential for pain and discomfort, sonographers aim to reduce the severity of musculoskeletal issues before they arise.

Participants shared their proactive approaches to managing physical strain while working. Participants expressed:

> *Before I start my shift, I make sure to stretch and warm up significantly my back and shoulders. This lessens the pain.* – Gallium, Transcript 5, Lines 305-309

> *I constantly adjust the bed height and the chair before scanning to ensure my correct posture.* – Potassium, Transcript 6, Lines 368-370

> *I take short breaks whenever I can, even if it is just a minute to move around and stretch.* – Nitrogen, Transcript 2, Line 114

This theme highlights the importance of anticipating and preventing pain and discomfort before they manifest in the body. By taking measures such as stretching, adjusting posture, and taking regular breaks, cardiovascular sonographers can significantly reduce the physical strain they experience. These actions align with a proactive approach to health and well-being in high-demand work environments.

Recent literature emphasizes the effectiveness of these proactive strategies. Moser et al. (2020) found that stretching and warm-up exercises effectively reduced musculoskeletal discomfort and improved performance in healthcare workers engaged in repetitive tasks, such as sonographers. Similarly, ergonomic adjustments to workstations and patient positioning have been shown to reduce the risk of injury and strain in studies by Zhang et al. (2021). Additionally, incorporating short breaks into work routines has been identified as a key factor in preventing musculoskeletal pain in healthcare workers, with research by Smith et al. (2022) showing that regular breaks can help reduce fatigue and prevent long-term physical issues.

Therefore, proactive preparation and adjustment play a crucial role in preventing and managing the physical strain experienced by cardiovascular sonographers. Through simple actions like stretching, adjusting ergonomics, and taking breaks, sonographers can protect themselves from injury and improve their overall physical well-being. Extensive research supports these preventive measures and is key to promoting long-term health in the workplace.

Conclusion and Recommendations

The results of this study provide valuable insights into the experiences of cardiovascular sonographers dealing with chronic musculoskeletal pain, uncovering key findings that have significant implications for the medical imaging field, particularly within ultrasound departments. The study revealed that poor posture and improper patient positioning were major contributors to musculoskeletal discomfort, with participants frequently suffering from pain due to repetitive motions and the need to bend or reach at awkward angles during scanning. These challenges were compounded by the lack of ergonomic equipment and insufficient training on body mechanics, leading to physical strain and diminished work performance.

One of the primary recommendations arising from the study is the need for healthcare facilities to invest in ergonomic equipment, such as adjustable beds, chairs, and scanning tables, which could help minimize physical strain and support neutral body postures. In addition, designing workstations that reduce unnecessary movements and encourage proper posture is crucial. Providing accessible, ongoing training for sonographers on how to optimally set up their work environment and position patients in an ergonomically sound way is also essential to preventing musculoskeletal pain.

The study also underscored the importance of preventive actions in managing musculoskeletal pain. Participants shared that stretching and physical preparation were key strategies they used to alleviate discomfort. Therefore, it is recommended that healthcare institutions use these proactive measures by incorporating regular physical therapy and stretching routines into sonographers' daily workflows. This approach could play a critical role in preventing physical strain and managing pain more effectively.

Despite these important findings, the study is not without limitations. The sample size was only nine cardiovascular sonographers, which may limit the generalizability of the findings to other specializations. Future research should explore larger, more diverse samples and longitudinal studies to track the long-term effects of chronic musculoskeletal pain on sonographers' career longevity and job satisfaction. Additionally, investigating the effectiveness of specific ergonomic interventions and evaluating the role of work environment design could provide valuable

insights into practical, cost-effective solutions for reducing pain and improving sonographer well-being.

In conclusion, the findings of this study contribute valuable knowledge to the field of medical imaging, highlighting the critical need for better ergonomic practices, preventive measures, and workplace support. By addressing these challenges, healthcare institutions can improve the health and job satisfaction of sonographers, leading to better patient care and more efficient work environments.

REFERENCES

Abu-El-Noor, N. I., Abu-El-Noor, M. K., Abuowda, Y. Z., Alfaqawi, M., & Bottcher, B. (2019). Patient safety culture among nurses working in Palestinian governmental hospital: A pathway to a new policy. BMC Health Services Research, 19, 550 (2019). doi: 10.1186/s12913-019-4374-9

Aiken. L. H., Sloane, D. M., Barnes, H., Cimiotti, J. P., Jarrin, O. F., & McHugh, M. D. (2018). Nurses' and patients' appraisals show patient safety in hospitals remains a concern. Health Affairs, 37(11). doi: 10.1377/hlthaff.2018.0711

Alao, M. A., Durodola, A. O., Ibrahim, O. R., & Asinobi, O. A. (2020). Assessment of health workers' knowledge, beliefs, attitudes, and use of personal protective equipment for prevention of COVID-19 infection in low-resource settings. Advances in Public Health, 2020. doi: 10.1155/2020/4619214

Aldawood, F., Kazzaz, Y., AlShehri, A., Alali, H., & Al-Surimi, K. (2020). Enhancing teamwork communication and patient safety responsiveness in a pediatric intensive care unit using the daily safety huddle tool. BMJ Open Quality, 2020(9). doi: 10.1136/bmjoq-2019-000753

AlJhani, S., AlHarbi, H., AlJameli, S., Hameed, L., AlAql, K., & Alsulaimi, M. (2021). Burnout and coping among healthcare providers working in Saudi Arabia during the COVID-19 pandemic. Middle East Current Psychiatry. doi: 10.1186/s43045-021-00108-6

Alsabri, M., Castillo, F. B., Wiredu, S., Soliman, A., Dowlat, T., Kusum, V., & Kupferman, F., E. (2021). Assessment of patient safety culture in a pediatric department. Cureus, 13(4). doi:10.7759/cureus.14646

Alsalem, G., Bowie, P., & Morrison, J. (2018). Assessing safety climate in acute hospital settings: a systematic review of the adequacy of the psychometric properties of survey measurement tools. BMC Health Services Research, 18. doi: 10.1186/s12913-018-3167-x

Alshuwaer T. et al., (2019). Prevention of Shoulder Injuries in Sonographers: A Systematic Review. Journal of Diagnostic Medical Sonography 2019, Vol. 35(5) 392–399. doi.org/10.1177/8756479319850140

Amaliyah, E., & Sansuwito, T. (2022). Relationship between burnout and quality of care in nurses in Banten, Indonesia: A cross-sectional study. The International Virtual Conference on Nursing, 2022, 185 - 193. doi: 10.18502/kls.v7i2.10301

Avramchuk, A. S. & McGuire, S. J. (2018). Patient Safety Climate: A Study of Southern California Healthcare Organizations. Journal of Healthcare Management, 63(3), 175–192. doi: 10.1097/JHM-D-16-00004

Bisbey, T. M., Kilcullen, M. P., Thomas, E. J., Ottosen, M. J., Tsao, K., & Salas, E. (2019). Safety culture: An integration of existing models and a framework for understanding its development. Sage Journals, 63(1), 88-110. doi: 10.1177/0018720819868878

Butera, K. et al., (2024). Through the Lens of Movement-Evoked Pain: A Theoretical Framework of the "Pain-Movement Interface" to Guide Research and Clinical Care for Musculoskeletal Pain Conditions. The Journal of Pain, Volume 25, Issue 7, 104486. doi.org/10.1016/j.jpain.2024.01.351

Carlin, D. (2019). Democratic, authoritarian, laissez-faire: What type of leader are you? Forbes. Retrieved from https://www.forbes.com/sites/davidcarlin/2019/10/18/democratic-authoritarian-laissez-faire-what-type-of-leader-are-you/?sh=330bf18a2a6b

Castilho, D. E. C., Silva, A. E. B. C., Gimenes, F. R. E., Nunes, R. L. S., Pires, A. C. A. C., & Bernardes, C. A. (2020). Factors related to the patient safety climate in an emergency hospital. Revista Latino-Americana de Enfermagem, 28. doi: 10.1590/1518-8345.3353.3273

Cohen, J., & Rodgers, Y. V. M. (2020). Contributing factors to personal protective equipment shortages during the COVID-19 pandemic. Preventive Medicine, 141, 106263. doi: 10.1016/j.ypmed.2020.106263

Chapman, S. (2020). Personal protective equipment (PPE) for healthcare workers: New Cochrane evidence. Evidently Cochrane. Retrieved from https://www.evidentlycochrane.net/personal-protective-equipment/

Chen, H. Y., Lu, L., Ko, Y. M., Chueh, J. W., Hsiao, S. Y., Wang, P. C., & Cooper, C. L. (2021). Post-pandemic patient safety culture: A case from a large metropolitan hospital group in Taiwan. International Journal of Environmental Research and Public Health, 18. doi: 10.3390/ijerph18094537

Chin, R. W. A., Chua, Y. Y., Chu, M. N., Mahadi, N. F., Wong, M. S., Yusoff, M. S. B., & Lee, Y. Y. (2018). Investigating validity evidence of the Malay translation of the Copenhagen Burnout Inventory. Journal of Taibah University Medical Sciences, 13(1). doi: 10.1016/j.jtumed.2017.06.003

Churruca, K., Ellis, L. A., Pomare, C., Hogden, A., Bierbaum, M., Long, J. C., Olekalns, A., & Braithwaite, J. (2021). Dimensions of safety culture: A systematic review of quantitative, qualitative and mixed methods for assessing safety culture in hospitals. BMJ Open 2021(11). doi: 10.1136/bmjopen-2020-043982

Clark, T. R. (2019). The 4 stages of psychological safety. The Horizons Tracker. Retrieved from http://adigaskell.org/2019/11/17/the-4-stages-of-psychological-safety/

Custo, P. T., Custo, R. T., & Buttigieg, S. (2019). The relationship between safety climate and performance in Intensive Care Units: The mediating role of managerial safety practices and priority of safety. Frontiers in Public Health, 23. doi: 10.3389/fpubh.2019.00302

Dall'Ora, C., Ball, J., Reinius, M., & Griffiths, P. (2020). Burnout in nursing: A theoretical review. Human Resouces for Health, 18, 41(2020). doi: 10.1186/s12960-020-00469-9

De Bienassis, K., Kristensen, S., Burtscher, M., Brownwood, I., & Klazinga, N. (2020). Culture as a cure: Assessments of patient safety culture in OECD countries. OECD Health Working Papers, 119. doi: 10.1787/6ee1aeae-en

Deng, Z. H., Zhu, W. J., Quan, L. J., & Xu, M. M. (2018). Zhonghua lao dong wei sheng zhi ye bing za zhi = Zhonghua laodong weisheng zhiyebing zazhi = Chinese journal of industrial hygiene and occupational diseases, 36(4), 277–280.

https://doi.org/10.3760/cma.j.issn.1001-9391.2018.04.011

De Lima Silva Nunes, R., de Camargo Silva, A. E. B., de Lima, J. C., Carvalho, D. E., Bernardes, C. A., Sousa, T. P., Gimenes, F. R. E., & Pires, A. C. A. C. Factors influencing the patient safety climate in intensive care units: Cross-sectional study. BMC Nursing, 20(2021). doi: 10.1186/s12912-021-00643-x

Derahim, N., Arifin, K., Wan Isa, W. M. Z., Khairil, M., Mahfudz, M., Ciyo, M. B., Ali, M. N., Lampe, I., & Samad, M. A. (2021). Organizational safety climate factor model in the urban rail transport industry through CFA analysis. Sustainability, 13. doi: 10.3390/su13052939

Dong, H., Zhang, Q., Liu, G., Shao, T., & Xu, Y. (2020). Prevalence and associated factors of musculoskeletal disorders among Chinese healthcare professionals working in tertiary hospitals: a cross-sectional study. BMC musculoskeletal disorders, 20(1), 175. https://doi.org/10.1186/s12891-019-2557-5

Dyrbye, L. N., Shanafelt, T. D., Johnson, P. O., Johnson, L. A., Satele, D., & West, C. P. (2019). A cross-sectional study exploring the relationship between burnout, absenteeism, and job performance among American nurses. BMC Nursing, 18(57). doi: 10.1186/s12912-019-0382-7

Elguea, J. O., Orkaizagirre-Gomara, A., De Miguel, M. S., Urcola-Pardo, F., German-Bes, C., & Lizaso-Elgarresta, I. (2019). Adapting and validating the Hospital Survey on Patient Safety Culture (HSOPS) for nursing students (HSOPS-NS): A new measure of Patient Safety Climate. Nurse Education Today, 75(2019). 95-103. doi: 10.1016/j.nedt.2019.01.008

Elmonstri, M., Banarsee, R., & Majeed, A. (2018). Improving patient safety in developing countries – moving towards an integrated approach. Journal of the Royal Society of Medicine, 9(11). doi: 10.1177/2054270418786112

Eltaybani, S., Yamamoto-Mitani, N., Ninomiya, A., & Igarashi, A. (2021). The association between nurses' burnout and objective care quality indicators: A cross-sectional survey in long-term care wards. BMC Nursing, 20(34). doi: 10.1186/s12912-021-00552-z

Farokhzadian, J., Nayeri, N. D., & Borhani, F. (2018). The long way ahead to achieve an effective patient safety culture: Challenges perceived by nurses. BMC Health Services Research, 18, 654 (2018). doi: 10.1186/s12913-018-3467-1

Felton, J. et al., (2022). Knowledge and use of work-related musculoskeletal disorder (WRMSD) prevention techniques in the daily practice of final-year Australian sonography students: A cross-sectional study. School of Health, Medical and Applied Science, Medical Sonography. doi: 10.10.1002/sono.12334

Fentiman-Hall, S. (2018). Autocratic, democratic or laissez-faire - what's your leadership style? Virgin. Retrieved from https://www.virgin.com/about-virgin/latest/autocratic-democratic-or-laissez-faire-whats-your-leadership-style

Garcia, C. L., Abreu, L. C., Ramos, J., Castro, C., Smiderle, F., Santos, J., & Bezerra, I. (2019). Influence of burnout on patient safety: Systematic review and meta-analysis. Medicina (Kaunas, Lithuania), 55(9), 553. doi: 10.3390/medicina55090553

Gaille, B. (2018). 16 advantages and disadvantages of transactional leadership. Brandon Gaille. Retrieved from https://brandongaille.com/16-advantages-and-disadvantages-of-transactional-leadership/

Granel, N., Manresa-Dominguez, J. M., Watson, C. E., Gomez-Ibanez, R., Bernabeu-Tamayo, D. (2020). Nurses' perceptions of patient safety culture: a mixed-methods study. BMC Health Services Research, 20. doi: 10.1186/s12913-020-05441-w

Gribben, L. & Semple, C. J. (2021). Prevalence and predictors of burnout and work-life balance within the haematology cancer nursing workforce. European Journal of Oncology Nursing, 52. doi: 10.1016/j.ejon.2021.101973

Guspianto, Ibnu, I. N., & Solida, A. (2021). Predictors of hospital patient safety culture outcomes in Jambi Province. Enfermeria Clinica, 31(5), 722-729. doi: 10.1016/j.enfcli.2021.07.024

Hamed, M. M. M., & Konstantinidis, S. (2021). Barriers to incident reporting among nurses: A qualitative systematic review. Western Journal of Nursing Research, 44(33). doi: 10.1177/0193945921999449

Hao, H. S., Gao, H., Li, T., & Zhang, D. (2020). Assessment and comparison of patient safety culture among healthcare providers in Shenzhen hospitals. Risk Management and Healthcare Policy, 13, 1543–1552. doi: 10.2147/RMHP.S266813

Henningsen, C., Sayeed, Y., & Fields, C. (2023). AIUM Practice Principles for Work-Related Musculoskeletal Disorder. Journal of Ultrasound in Medicine, Volume 42, Issue 5. doi.org/10.1002/jum.16124

Hobfoll, S. E. (1989). Conservation of resources: A new attempt at conceptualizing stress. American Psychologist, 44(3), 513–524. doi: 10.1037/0003-066X.44.3.513

Huang, C. H., Wu, H. H., & Lee, Y. C. (2018). The perceptions of patient safety culture: A difference between physicians and nurses in Taiwan. Applied Nursing Research, 40(2018), 39–44. doi: 10.1016/j.apnr.2017.12.010

Hwang, J., Sung, W. K., & Chin, H. J. (2019). Patient participation in patient safety and its relationships with nurses' patient-centered care competency, teamwork, and safety climate. Asian Nursing Research, 13(2), 130-136. doi: 10.1016/j.anr.2019.03.001

Institute of Medicine. (2000). To err is human: Building a safer health system. Washington, DC: National Academies Press

Janes, G., Mills, T., Budworth, L., Johnson, J., & Lawton, R. (2021). The association between health care staff engagement and patient safety outcomes: A systematic review and meta-analysis. Journal of Patient Safety, 17(3). doi: 10.1097/PTS.0000000000000807

Jun, J., Ojemeni, M. M., Kalamani, R., Tong, J., & Crecelius, M. L. (2021). Relationship between nurse burnout, patient and organizational outcomes: Systematic review. International Journal of Nursing Studies, 119(2021). doi: 10.1016/j.ijnurstu.2021.10393

Kabunga, A. & Okalo, P. (2021). Prevalence and predictors of burnout among nurses during COVID-19: a cross-sectional study in hospitals in central Uganda. BMJ Open, 2021(11). doi: 10.1136/bmjopen-2021-054284

Kakemam, E., Gharaee, H., Rajabi, M. R., Nadernejad, M., Khakdel, Z., Raeissi, P., & Kalhor, R. (2021). Nurses' perception of patient safety culture and its relationship with adverse events: A national questionnaire survey in Iran. BMC Nursing, 60(2021). doi: 10.1186/s12912-021-00571-w

Kang, S., Ho, T. T. T., & Lee, N. (2021). Comparative studies on patient safety culture to strengthen health systems among Southeast Asian countries. Frontiers in

Public Health 12(2021). doi: 10.3389/fpubh.2020.600216

Kaushik, V., & Walsh, C. A. (2019). Pragmatism as a research paradigm and its implications for social work research. Social Sciences, 8(9), 255. doi:10.3390/socsci8090255

Kampstra, N. A., Zipfel, N., Van Der Nat, P. B., Westert, G. P., Van Der Wees, P. J., & Groenewoud, A. S. (2018). Health outcomes measurement and organizational readiness support quality improvement: A systematic review. BMC Health Services Research, 18(2018). doi: 10.1186/s12913-018-3828-9

Khasne, R. W., Dhakulkar, B. S., Mahajan, H. C., & Kulkarni, A. P. (2020). Burnout among healthcare workers during COVID-19 pandemic in India: Results of a questionnaire-based survey. Indian Journal of Critical Care Medicine, 24(8), 664–671. doi: 10.5005/jp-journals-10071-23518

Kim, E.S., Jo, E.D., & Han, G.S. (2023). Effects of Stretching Intervention on Musculoskeletal Pain in Dental Professionals. Journal of Occupation Health, Vol. 65, Issue 1. https://doi.org/10.1002/1348-9585.12413

Kim, S. H., & Weng, S. J. (2018). Incorporating work experience of medical staff into patient safety climate management: a multi-group analysis, BMC Health Services Research, 18. doi: 10.1186/s12913-018-3747-9

Leo, C. G., Sabina, S., Tumolo, M. R., Bodini, A., Ponzini, G., Sabato, E., & Mincarone, P. (2021). Burnout among healthcare workers in the COVID 19 era: A review of the existing literature. Frontiers in Public Health. doi: 10.3389/fpubh.2021.750529

Leonard, J. (2018). How to recognize and cope with emotional exhaustion. Medical News Today. Retrieved from https://www.medicalnewstoday.com/articles/323441

Liu, X., Zheng, J., Liu, K., Baggs, J. G., Liu, J., Wu, Y., & You, L. (2018). Hospital nursing organizational factors, nursing care left undone, and nurse burnout as predictors of patient safety: A structural equation modeling analysis. International Journal of Nursing Studies, 86, 82-89. doi: 10.1016/j.ijnurstu.2018.05.005

Luan, H. D., Hai, N. T., Xanh, P. T., Giang, H. T., Van Thuc, P., Hong, N. M., & Khue, P. M. (2018). Musculoskeletal Disorders: Prevalence and Associated Factors among District Hospital Nurses in Haiphong, Vietnam. BioMed research international, 2018, 3162564. https://doi.org/10.1155/2018/3162564

Luo, T. (2020). Safety climate: Current status of the research and future prospects. Journal of Safety Science and Resilience, 1(2), 106–119. doi: 10.1016/j.jnlssr.2020.09.001

Mahmoudi, S., Barkhordari-Sharifabad, M., Pishgooie, A., & Atashzadeh-Shoorideh, F. (2020). Burnout among Iranian nurses: A national survey. BMC Nursing, 19(1). doi: 10.1186/s12912-020-00461-7

Miles, S. (2019). Addressing shame: What role does shame play in forming a modern medical professional identity? BJ PSych Bulletin, 44(1). 1–5. doi: 10.1192/bjb.2019.49

Moda, H. M., Dama, F. M., Nwadike, C., Alatni, B. S., Adewoye, S. O., Sawyerr, H., Doka, P. J. S., & Danjin, M. (2021). Assessment of workplace safety climate among healthcare workers during the COVID-19 pandemic in low and middle-income countries: A case study of Nigeria. Healthcare, 9. doi: 10.3390/healthcare9060661

Mueller, B. U., Neuspiel, D. R., & Fisher, E. R. (2019). Principles of pediatric patient safety: Reducing harm due to medical care. Pediatrics, 127(6). doi: 10.1542/peds.2018-3649

Nobre, D. F. R., Rabiais, I. C. M., Ribeiro, P. C. P. S. V., & Seabra P. R. C. (2019). Burnout assessment in nurses from a general emergency service. Revista Brasileira de Enfermagem, 72(6), 1457-1463. doi: 10.1590/0034-7167-2017-0870

O'Donovan, R., & McAuliffe, E. (2020). Exploring psychological safety in healthcare teams to inform the development of interventions: Combining observational, survey and interview data. BMC Health Services, 20(2020). doi: 10.1186/s12913-020-05646-z

Okuyama, J. H. H., Galvao, T. F., Silva, M. T. (2018). Healthcare professional's perception of patient safety measured by the Hospital Survey on Patient Safety Culture: A systematic review and meta-analysis. Scientific World Journal. doi: 10.1155/2018/9156301

Patton, M. (2002). Qualitative research and evaluation methods (3rd ed.). Thousand Oaks, CA: Sage Publications

Pantaleon, L. (2019). Why measuring outcomes is important in health care. Journal of Veterinary Internal Medicine, 33(2), 356-362. doi: 10.1111/jvim.15458

Pelzang, R., & Hutchinson, A. M. (2018). Patient safety issues and concerns in Bhutan's healthcare system: A qualitative exploratory descriptive study. BMJ Open, 2018. doi: 10.1136/bmjopen-2018-022788

Profit, J., Sharek, P. J., Cui, X., Nisbet, C. C., Thomas, E. J., Tawfik, D. S., Lee, H. C., Draper, D., & Sexton, J. B. (2020). The correlation between Neonatal Intensive Care Unit safety culture and quality of care. Journal of Patient Safety, 16(4). doi: 10.1097/PTS.0000000000000546

Rajalatchumi, A., Ravikumar, T. S., Muruganandham, K., Thulasingam, M., Selvaraj, K., Reddy, M. M., & Jayaraman, B. (2018). Perception of Patient Safety Culture among Healthcare Providers in a Tertiary Care Hospital, South India. Journal of natural science, biology, and medicine, 9(1), 14–18. https://doi.org/10.4103/jnsbm.JNSBM_86_17

Renecle, M., Curcuruto, M., Lerin, F. J. G., & Marco, I. T. (2021). Enhancing safety in high-risk operations: A multilevel analysis of the role of mindful organising in translating safety climate into individual safety behaviours. Safety Science, 138. doi: 10.1016/j.ssci.2021.105197

Robertson, J. J., & Long, B. (2018). Suffering in silence: Medical error and its impact on health care providers. The Journal of Emergency Medicine, 54(4), 402–409. doi: 10.1016/j.jemermed.2017.12.001

Sadler, F., & Vaughn, N. (2020). Nursing leadership: what is it and why is it important? Relias. Retrieved from https://www.relias.com/blog/nursing-leadership

Sarfraz, A., Sarfraz, Z., Anwer, A., Sarfraz, M, & Siddiq, J. (2020). Availability, use, and satisfaction of personal protective equipment among healthcare workers: A cross-sectional assessment of low- and middle-income countries. Journal of Occupational and Environmental Medicine, 62(11). doi: 10.1097/JOM.0000000000002028

Schuklenk, U. (2020). What healthcare professionals owe us: Why their duty to treat during a pandemic is contingent on personal protective equipment (PPE). Journal of Medical Ethics, 2020(46), 432-435. doi: 10.1136/medethics-2020-106278

Schwendimann, R., Blatter, C., Dhaini, S., Simon, M., & Ausserhofer, D. (2018). The occurrence, types, consequences and preventability of in-hospital adverse events – A scoping review. BMC Health Services

Research, 521(2018). doi: 10.1186/s12913-018-3335-z

Scott, E. (2020). Burnout symptoms and treatment. Very Well Mind. Retrieved from https://www.verywellmind.com/stress-and-burnout-symptoms-and-causes-3144516#citation-5

Shahabinejad, M., Khoshab, H., Najafr, K., & Haghshenas, A. (2020). The relationship between patient safety climate and medical error reporting rate among Iranian hospitals using a structural equation modeling. Ethiopian Journal of Health Science, 30(3). doi: 10.4314/ejhs.v30i3.2

Sherf, E. N., Parke, M. R., & Isaakyan S. (2020). Distinguishing voice and silence at work: Unique relationships with perceived impact, psychological safety, and burnout. Academy of Management Journal, 64(1). doi: 10.5465/amj.2018.1428

Singh, S. (2019). The nexus between nurse burnout, missed care and patient outcomes (Doctoral

dissertation, University of Pennsylvania). Retrieved from https://repository.upenn.edu/edissertations/3580

Solomon, A. (2019). The relationship of nurse manager's leadership styles in maintaining a just culture. Walden University. Retrieved from https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=9024&context=dissertations

Sommerich et al., (2019). Collaborating With Sonographers and Vascular Technologists to Develop Ergonomics Interventions to Address Work-Related Musculoskeletal Disorders. Journal of Diagnostic Medical Sonography 2019, Vol. 35(1) 23–37. doi: 10.1177/8756479318810710

Strudwick, R. (2018). The Management of Wicked Problems in Health and Social Care, 1st Ed. Routledge. Retrieved from https://www.taylorfrancis.com/chapters/edit/10.4324/9781315102597-12/blame-culture-national-health-service-nhs-uk-ruth-strudwick

Surbhi, S. (2019). Difference between transactional and transformational leadership. Key Difference. Retrieved from https://keydifferences.com/difference-between-transactional-and-transformational-leadership.html

Syed, J. (2021). What are 'adverse events,' and why is it necessary to record and report them? Students 4 Best Evidence. Retrieved from https://s4be.cochrane.org/blog/2021/03/26/what-are-adverse-events-and-why-is-it-necessary-to-record-and-report-them/?preview_id=16365

Tang, N. H., Tsai, S. H., Liou, J. H., Lai, Y. H., Liu, S. A., Sheu, W. H. H., & Wu, C. L. (2020). The association between the participation of quality control circle and patient safety culture. International Journal of Environmental Research and Public Health, 17. doi: 10.3390/ijerph17238872

Vambheim, S.M., Kyllo T.M., & Hegland, S. (2021). Relaxation techniques as an intervention for chronic pain: A systematic review of randomized controlled trials. Department of Psychology, The Arctic University of Norway, Norway, Volume 7, Issue 8. doi.org/10.1016/j.heliyon.2021.e07837

Xie, Y., Coombes, B. K., Thomas, L., & Johnston, V. (2020). Musculoskeletal Pain and Disability in Sonographers: More Than an Ergonomic Issue. Journal of the American Society of Echocardiography: Official publication of the American Society of Echocardiography. doi.org/10.1016/j.echo.2020.07.005

Zangiabadi, Z & Makki, F. (2024). Musculoskeletal Disorders Among Sonographers: A

Systematic Review and Meta-Analysis. *BMC Health Serv Res* **24**, 1233 (2024). https://doi.org/10.1186/s12913-024-11666-w