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# Occupational Safety Challenges for Operating Room Nurses: Contributing Factors, Health Impacts, and Coping Measures

Monograph

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*"The best way to predict the future is to create it"*

*Abraham Lincoln*

This monograph has been written by authors whose professional careers focus on research, academia, and nursing practice. The combination of these activities provides a deeper insight into healthcare professionals' issues and challenges. The activities of operating room nurses are crucial to ensuring patients' safety in the operating room and enabling the smooth cooperation of the operating room team. An interdisciplinary team of the authors of the monograph, using their scientific and professional experience, aims to contribute to improving the quality of operating room nursing, which is inextricably linked to the occupational safety of the staff and the mitigation or avoidance of occupational risks.

We thank the Lithuanian Society of Operating Room Nurses, particularly its President, Lina Marcinkevičienė, for allowing us to conduct research among Lithuanian operating room nurses. We express our sincere gratitude to all the Lithuanian operating room nurses and administrators who actively participated in the study and contributed to collecting necessary information.

We are also grateful to Nijolė Vasiliauskienė, senior specialist in occupational safety and health and lecturer at Kauno kolegija Higher Education Institution, for her valuable advice during the systematic analysis of the legislation on occupational safety and health and the insights, which were crucial to the quality of this monograph.

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Dr Viktorija Piščalkienė is an associate professor at the Department of Nursing, the Faculty of Medicine of Kauno kolegija Higher Education Institution, with a university education in Nursing and a PhD in Education. She has several years of practical experience as an operating room nurse. To continuously improve her competencies as a nurse, she has systematically updated her practical skills in operating room nursing practice, which is particularly important in the context of the rapid changes in healthcare services and medical technology. Since 2012, she has been training would-be operating room nurses in postgraduate studies. She closely cooperates with Lithuanian nurses' organisations, gives presentations at their events, and participates in expert activities of the Ministry of Health of the Republic of Lithuania, editorial boards of scientific journals, as well as international projects addressing the possibilities of improving health services for patients of different social groups (especially for people with autism spectrum disorders and intellectual disabilities).

Viktorija Piščalkienė has published more than 70 scientific publications. Most of them promote the results of nursing research at national and international levels. She is also the author or co-author of several methodological books. Her research focuses on ensuring the psychological safety of surgical patients and improving working conditions for nurses. Active participation in the Lithuanian Society of Operating Room Nurses allows her to share knowledge at seminars, give presentations, and expand a network of partnerships while contributing to the professional development of the nursing community. These activities help her retain her skills as a competent academic who is able to combine practical and theoretical aspects in the teaching of future nurses.

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The scholar is a participant in international projects and a co-author of scientific articles, study textbooks, and other publications. She is also an initiator and idea generator for social initiatives to improve the psycho-emotional experience of children in hospitals. Since 2024, she has been an active member of the ERN ERNICA Task Force for Operating Room Nurses. She has completed internships in the USA, Switzerland, Finland, Ireland, Portugal, and Spain and is constantly improving her knowledge and sharing it with colleagues, students, patients, and their relatives.

# Concepts

**Biological factors** refer to microorganisms, including genetically modified organisms, cell cultures, and human endoparasites, which may cause infection, allergy, or poisoning in workers.

**Chemical factor** refers to a chemical element or compound, whether pure or in a mixture, existing naturally or produced, used or released into the environment, including waste, in any work process, whether intentionally produced or not, and whether marketed or not.

**Ergonomic factor** is one based on the physical demands and strains of work and the adaptation of the workplace to the worker's capabilities.

**Hazard** is a potential threat to the employees' health and lives.

**Occupational risk factor** is a chemical, physical, biological, ergonomic, psychosocial, or physical factor that poses or may pose a risk to an employee's safety and health.

**Occupational risk** refers to the possibility of injury or other harm to employees' health due to exposure to harmful and/or dangerous factors in the working environment.

**Operating room manager** performs the day-to-day operational functions of the operating room, managing staff and resources (including surgical instruments, supplies, and equipment**)** to ensure smooth operation.

**Operating room nurse** is a person who has completed basic nursing studies and is qualified as such.

**Operating room nursing** is a special type of nursing practice that includes the activities of an operating room nurse in a sterile environment (sterile assisting) and the activities of an operating room nurse as a facilitator between the sterile environment and the operating department.

**Physical factors** refer to hazards caused by improper workplace design, the physical impact of work devices and their moving parts, lifting equipment and loads, vehicles, and falling objects, as well as the possibility of explosion, fire, and failure to ensure the stability and strength of structures.

**Physics-related factor** is one based on variations in physics-related substances in the environment.

**Prevention** includes all the measures taken or intended to be taken at all stages of an institution's performance to prevent or reduce occupational risks.

**Psychosocial factors** refer to factors that cause mental stress to staff due to working conditions, work requirements, the organisation and content of the work, and the relationships among employees or between the employer and the employee.

# Summary

The monograph is intended to identify occupational risk factors affecting operating room nurses, assess their impact on health complaints, and systematically search for measures to mitigate occupational risk factors affecting operating room nurses. The scientific study is characterised by various research methods, combining quantitative and qualitative research methods. In this way, the monograph is multidisciplinary, as it integrates the fields of nursing, public health, education, management, and psychology. The monograph on these issues is the first in Lithuania, as there has not yet been an open discussion of the challenges nurses face in their professional lives. Although the study involved the participation of Lithuanian operating room nurses, the research also discusses the experiences of other countries around the world related to the professional activities of operating room nurses and the risk factors, as well as their impact on health and the mitigation of occupational risk factors.

**Chapter 1** outlines the development of the profession of operating room nursing and its links with the development of surgical science. It presents the current view of operating room nursing and the existing practice of training nurses and operating room nurses, focusing on the Lithuanian context.

**Chapter 2** describes the concept of occupational risk and the factors such as biological, chemical, ergonomic, physical, and psychosocial. It also analyses the categories of the harm that occupational risks cause to health and provides recommendations for mitigating or preventing risks. This chapter offers statistical facts on occupational riskiness. It focuses on the WHO, the United Nations, the European Union, and the Lithuanian legislation regulating the prevention or mitigation of occupational risk.

**Chapter 3** highlights the occupational risks that operating room nurses are exposed to, identifies the occupational risk groups relevant to the profession, specifies the factors involved, and suggests universal measures to prevent or mitigate these factors. It provides a detailed analysis of the findings of the research conducted by various researchers from around the world, revealing the ergonomic, physical, biological, and chemical occupational risk factors affecting operating room nurses, their impact on health, and the practices of mitigating occupational risk factors operating room nurses are exposed to in different countries. The chapter also discusses the challenges of addressing the physiological needs of operating room nurses in relation to the specificity of the profession. It reviews the findings of a multi-country study that point to the possibilities for mitigating or even preventing occupational risks for nurses and their connection with responsible attitudes of operating room nurses themselves, managerial-organisational and cultural factors, as well as the importance of legislation and methodological guidelines.

**Chapter 4** presents the methodology of the quantitative study and the psychometric quality of the research instruments, and provides a detailed

review of the opinions of Lithuanian operating room nurses who participated in the survey of the expression of occupational risk factors and their impact on health. It also presents statistical calculations showing differences in occupational risk factors by sociodemographic groups and investigates the correlation between occupational risk factors and health complaints. **Chapter 4** also introduces the insights of the Lithuanian operating room nurses who participated in the study on the measures and methods to prevent or mitigate occupational risk factors in their work.

**Chapter 5** provides the findings of the qualitative study conducted with the participation of nursing management in operating rooms in Lithuanian hospitals. The thematic analysis carried out revealed their attitudes towards the occupational safety of operating room nurses and their assurance.

## Keywords

Operating room nurse, occupational risk factors, health, coping measures.

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# Introduction

Operating room nurses are professionals who remain unnoticed by patients and the public. By discussing their role more frequently in scientific and popular publications, the profile and prestige of the profession are enhanced.

In Lithuanian healthcare institutions, the attitude of operating room nurses towards their professional activities and the anticipation of opportunities for improvement is a poorly studied area. The shortage of nursing professionals in almost all European countries and many countries of the world is becoming a global problem. It has become more relevant since Lithuania joined the European Union. Then, much broader market prospects have opened up to nurses.

Operating room nurses are more often exposed to occupational risk factors than other professionals. To preserve and increase the occupational safety of the staff against these risk factors, the management of institutions and the administration of operating rooms should pay considerable attention to assessing and preventing risk factors [1].

The comprehensive nature of their activities distinguishes the specificity of operating room nurses' work. Operating room units differ from other departments in the hospital not only in terms of the different layout of the environment and strict rules for moving in and out of the operating room but also in terms of the stressful working environment and the heavy workload, which can adversely affect the health of operating room nurses [2]. The staff working in the operating room environment are exposed to more risk factors than professionals working in other departments. Their performance is usually characterised by unpredictable events during complex operations and working in environments with prevalent occupational hazards [3].

There are several groups of *hazards* to which operating room nurses are frequently exposed, i.e., biological, chemical, physical, and psychosocial. Chemicals include antiseptics, medications, etc.; physical factors involve working at higher temperatures and with hot sterilisers; biological cover contact with blood and other body fluids; ergonomic issues are interconnected with lifting heavy sets of instruments, standing for long periods, slips, and falls; and psychosocial are related to stress, job content, organisation of work, interpersonal relationships, etc. [4–13].

The various occupational risk factors that doctors and nurses face in their professional activities can affect their health, the quality of their performance, and patients' healing. Specifically, nurses in the operating room are exposed to stress, which may not only affect their personal, emotional, or physical health but also negatively impact the health of the patient undergoing surgery [14].

Patients' safety is a top priority in healthcare services worldwide. The World Health Organization [15] report provides highly relevant and thought-provoking facts showing that patients' safety is a serious global public health issue.

In a meta-analysis of a dozen studies, R. Mcmullan et al. [16] send the message that disruptions by the members of the operating room team and various distractions during surgery correlate not only with increased stress but also with patients' safety and complications during surgery. Nurses experience high stress levels at work that negatively impact their professional performance and the quality of their personal lives. The nurses experiencing high levels of occupational stress feel more energetically exhausted at work, are less productive, do not provide quality nursing care to patients, and, most importantly, have a negative impact on patient's healing [17].

The authors of the monograph put forward the motto "Safe Staff – Safe Patient". Therefore, the answer to the question of the extent to which operating room nurses, as major members of the operating room team, are safe today is highly relevant. The monograph sought to reveal how the 21st century operating room nurse is protected from various occupational risks, naturally, on her own as well, what the implications of these risks are for her health, and what measures are available to mitigate or avoid these risks.

An effort was made not to limit the presentation of occupational risks for operating room nurses to the examples of a single country, as healthcare systems are relatively different due to economic, social, and cultural factors. Therefore, the theoretical part reviews the scientific experience of various countries worldwide regarding occupational risk factors affecting operating room nurses or the operating room team.

In Lithuania, the dissemination of scientific publications on operating room nurses' work procedures and problems is very limited. Although it is very welcome that university and college students carry out such research, there is not enough research on the work of operating room nurses in Lithuania conducted by individual researchers or groups of researchers.

**The scientific problem** can be defined by the questions, the answers to which require specific scientific research. What are the characteristics of occupational risks among Lithuanian operating room nurses? How are occupational risk factors correlated with health complaints? What measures or approaches could be effective in mitigating or preventing occupational risks in the context of operating nursing?

**The research aims** to determine the occupational risks encountered by operating room nurses, their impact on health, and ways of coping with them.

**The objectives** include:

- to determine the manifestation of occupational risk factors from the point of view of operating room nurses;
- to determine the impact of occupational risk factors on health from the operating room nurses' perspective;
- to determine the correlation between occupational risk factors and health complaints among operating room nurses;
- to compare occupational risk factors and health complaints of operating room nurses according to sociodemographic data;

- to identify the opportunities for mitigating or preventing occupational risks from the point of view of operating room nurses;
- to reveal the attitudes of operating room management towards risk factors experienced by operating room nurses and ways of coping with them.

# Research methods

## Quantitative research

The study was conducted using a quantitative research strategy. Occupational risk factors affecting operating room nurses were assessed through 28 closed-ended questions related to occupational risk factors and the resulting health complaints (see **Section 4.2** for more details).

## Qualitative research

***Survey of operating room nurses***

The questionnaire for the quantitative study ended with an open-ended question: "*What suggestions do you have to improve the work of operating room nurses and ensure not only your safety but also the safety of patients?*". The qualitative study helped reveal the opinions of the nurses working in operating rooms in different healthcare settings on the possibility of ensuring occupational safety in their work (see **Section 4.3** for more details).

***Survey of operating room management***

A qualitative study was conducted using a semi-structured interview method to collect data, which allowed to reveal the experiences of operating room management regarding the occupational safety challenges encountered by operating room nurses and their opinions as nursing administrators on how to mitigate or avoid occupational risk factors to enable the perioperative team to carry out its functions safely and ensure the safety of the patients undergoing operations. The data obtained were analysed using V. Braun and V. Clarke's [18] inductive qualitative research analysis. Significant codes were extracted and combined into sub-themes, and similar sub-themes were combined into themes (see **Chapter 5** for more details).

The cross-sectional study provided valuable insights into occupational risks and their mitigation in operating room nursing. The quantitative research involved operating room nurses from Lithuania, including Kaunas, Vilnius, Klaipėda, Jonava, Kėdainiai, and other towns. The research participants work in various healthcare institutions, both public and private, that provide surgical services. The qualitative study involved operating room managers from three Lithuanian cities, Kaunas, Klaipėda, and Vilnius. They shared their experiences on the relevance of and opportunities for managing occupational risks affecting operating room nurses.

# The scientific, practice, education, and management novelty of the research

***Scientific novelty***

For the first time in Lithuania, occupational risk factors affecting operating room nurses have been systematically identified and analysed in relation to health complaints.

A research instrument has been developed and validated to provide a comprehensive assessment of occupational risk factors and health complaints of operating room nurses. This instrument can be used to study occupational risk factors and health complaints of operating room nurses or other health care professionals related to their occupational activities not only in Lithuania but also in other countries of the world.

The study has explored the constraints of meeting the physiological needs of operating room nurses, a phenomenon that has not been investigated in the world so far.

The preventive measures and recommendations for operating room nurses, developed based on the qualitative study's findings, complement the international practice of mitigating occupational risks for nurses.

The survey instrument can also be used and adapted, if necessary, to assess the occupational risk factors of healthcare professionals, particularly anaesthetists, anaesthesia nurses, surgeons, and operating room support staff, and the relevance of their mitigation or prevention.

***Practice novelty***

A holistic approach to revealing the correlation between ergonomic, physical, biological, chemical, and psychological factors has been applied, which is a new step in addressing the issues of operating room nurses' working conditions.

The monograph analyses the legal documents relevant to mitigating or even preventing occupational risks for healthcare professionals, including operating room nurses and operating room team members.

The monograph introduces possible measures to ensure the professional safety of operating room nurses and other operating room team members.

***Education novelty***

The non-formal education programme "Surgical nursing" in Lithuania will include new topics on occupational risk factors and the prevention of occupational hazards affecting nurses in the operating room.

Students of the General Practice Nursing study programme can choose specific occupational risk factors affecting operating room nurses and explore them in more depth in their final theses.

***Management novelty***

The research results create prerequisites for improving the work processes of operating room nurses and members of the operating room team in Lithuania.

The developed recommendations on occupational risk mitigation can be applied not only in Lithuania but also in the practice of healthcare institutions in other countries.

The quantitative and qualitative study involved operating room nurses and operating room management from different regions of Lithuania, reflecting a broader population of professionals in the field.

The study's findings will be important for healthcare institutions in developing occupational safety policies and improving the professional working environment of healthcare professionals (especially operating room nurses).

# Chapter 1
# The evolution of the profession of operating room nursing

## 1.1 Evolution of surgical science

Historical records indicate that the first surgeons worked without the help of specialised nurses. They date back to the Middle Ages and the Renaissance when surgery was primarily performed in outdoor environments or surgical guilds.

After the fall of the Roman Empire in the Middle Ages (around 500 BC–AD 1500), surgery was at a standstill, especially in Europe. Medical knowledge was transmitted through monasteries and Islamic medical schools. In the Middle Ages, monasteries became the most important centres of medical knowledge. There, ancient Greek and Roman medical books were preserved and transcribed, and new medical papers were written. In the Islamic world, however, surgery developed further and remained at a high level [19].

During the Renaissance period (around AD 1300–1600), surgery began to develop extremely rapidly. It was contributed by prominent personalities such as the Flemish anatomist, physician, and writer A. Vesalius, who wrote the book "*De humani corporis fabrica" (On the Structure of the Human Body)*, which provided a detailed description of the human anatomy and the basis for actual knowledge of the human body to be able to carry out surgeries topographically in the most accurate way. His predecessor, A. Pare, who was the first to apply the tools and surgical instruments that we know today (silk sutures, needles, scissors, knives, tweezers, trocars, haemostatic clamps, and pliers) should also be mentioned. He was the first in the world to use vascular clamping instead of burning the bleeding site with iron, thus reducing the risk of infections and complications in the surgical wound [20].

During the Middle Ages and the Renaissance, barber-surgeons performed various medical procedures to cure people in many European countries, including Lithuania. Due to advances in medical science and the shortage of doctors, barber-surgeons went beyond shaving and haircutting to perform various medical procedures such as bloodletting, tooth-pulling, suturing wounds, and even operating on various body parts. However, a large number of people died during or immediately after the operation. The leading causes of death were infection, pain, and blood loss [21].

The 19$^{th}$ century saw a breakthrough in the fight against infection. Until then, all operations were performed with unsterile instruments and other materials.

J. Lister, a notable British surgeon who lived in the 19$^{th}$ century, was famous for pioneering antisepsis. Using carbolic acid to disinfect wounds, he

reduced the incidence of postoperative infections from 50 to 15%. J.-E. Pean, the French surgeon who significantly impacted the development of surgery, lived in the 19th–20th centuries. He was well known for his innovative techniques and instruments, including Pean's haemostatic clamps for stopping blood, which are still used in operating rooms nowadays [22].

In the late 19th century, aseptic and antiseptic aids were introduced, and anaesthetic techniques were improved, leading to safer patient operating conditions and increased survival. The beginning of the 20th century can be seen as not only the beginning of safe surgery for the patient but also safer working conditions for the staff.

The rubber gloves were introduced at the beginning of the 20th century. It was J. Mikulicz who pioneered medical masks and gloves. However, they were reusable and had to be washed and steam sterilised after an operation before the next one. This way, they lost their effectivity and failed to ensure the safety of the staff [23].

Until the 19th century, all operations were performed without using anaesthesia. People were tied up and made drunk, which was thought to help them endure the terrible pain of surgery. The era of anaesthesia began in 1846 when the American dentist W. T. G. Morton performed the first publicly documented successful anaesthetic surgery using ether. Further evidence proved the successful use of ether in surgery. In Boston, America, the surgeon J. C. Warren removed a neck tumour, with the patient feeling no pain [24].

The origins of the science of medicine in Lithuania can be traced back to the Faculty of Medicine at Vilnius University, which was founded in 1781 and became an important centre of the science and practice of medicine. This Faculty trained future Lithuanian surgeons. However, training nurses was not mentioned [21].

## 1.2 Developments in operating room nursing, surgical care and professional training

The first nurses were often nuns who assisted patients in recovering from surgery. However, they did not participate in operations. As O. Riklikienė [25] claims, a significant shift in the history of nursing occurred in the early Christian period, having a significant impact on healthcare. The dogma was that serving a human being was equal to serving God. Organised nursing commenced with the spread of Christianity, which placed special emphasis on the sick and disabled, as well as the poor and the orphaned, who were cared for in special institutions.

As R. Dingwall et al. [26] describe in their book, looking back at healthcare a couple of hundred years ago might lead to the understanding that it did not exist at all. There was no universally accepted medical knowledge, so diverse and often competing theories and independent practices flourished. There was

no legal definition of a doctor and very little regulation on medical practice. The health of sick people was often cared for by family members, especially women or local individuals with a reputation as herbalists or midwives. At the beginning of the 19th century, nursing as a profession was not recognised. Anyone could introduce themselves as a nurse and call what they did nursing. Nor were data on practising nurses collected. The first such register was set up in the UK in 1923 (General Nursing Council Register). Other sources also confirm that nursing as a profession did not exist worldwide. Nursing became a topic of interest in 1899 when the International Council of Nurses (ICN) was founded in London, aiming to improve healthcare, the quality of nursing care, and the economic and working conditions of nurses [25].

However, the history of nursing begins with the Italian pioneer F. Nightingale (1820–1910), whose activities left a lasting historical legacy in the 19th century [27, 28]. F. Nightingale was educated and schooled in mathematics. However, she followed her vocation to stay with seriously ill and injured people. Her role was particularly evident during the Crimean War (1854), when she nursed the injured in accordance with hygienic requirements, thereby almost halving the rate of soldiers' mortality from wound infection and sepsis (from 40 to 2%). Her mathematical background enabled her to perform precise calculations on wound healing, and she well deserved to be called a pioneer in nursing science. She summarised her experience in her most significant works, "*Notes on Hospitals*" (1859) and "*Notes on Nursing*" (1860). Thanks to her, the first nurse training school was established at St Thomas's Hospital in London in 1860.

At the end of the 19th century – the beginning of the 20th century, the profession of operating room nurse was still in its "embryonic" phase. Historical evidence sheds just a little light on the functions of nurses in the operating room. Only fragmentary descriptions that mention the functions of operating room nurses can be found. Nurses in the operating room had to ensure that the surgical instruments and bandages were sterile, the patients were dressed in a specially designed lamb's wool gown and wore knee-length flannel stockings, and the bottles filled with warm water were placed at the patient's feet. It can be assumed that this work was carried out by women, as the pronoun *she* is found in English texts. The preparation process included a requirement for the nurse to take care of personal hygiene, and drastic measures such as bathing in a hot bath of carbolic acid and soaking clothes in carbolic acid were used [29].

The world's first nurse to be officially recognised as having worked in an operating room is C. Hampton Halsted (1861–1922), who lived in the United States and worked at Johns Hopkins Hospital in Baltimore. She is credited with being the first person to wear rubber gloves in the operating room. Due to her sensitive hand skin and the dermatitis and eczema that plagued her, the gloves were specially designed for her. W. S. Halsted, a prominent American surgeon of the time she worked with, ordered gloves for her, eager to keep her as an assistant surgeon for her excellent performance in the operating room, wear them during operations and protect the skin on her hands. Other surgeons and

operating room nurses followed C. Hampton's example. Evidence suggests that wearing gloves has several-fold reduced the risk of wound infections [30].

Worldwide, the training of nurses, including operating room nurses, started with special courses in hospitals. However, they did not include theoretical lectures and were based on observing practical situations. Every country in the world has its unique origins in the training of operating room nurses, and it would be challenging to provide a comprehensive historical overview of the universal experience in training operating room nurses.

Knowledge and skills related to the care of surgical patients, preparing instruments, and assisting the surgeon were acquired during traineeships in operating rooms, which were compulsory for all nursing students. It has been stated that each operating room in Australia at that time, as well as in the UK and the USA (the period referred to is the 1920s and 1930s), had to have at least one operating room nurse with two nursing students assigned. The trainees were required to practise in the operating room for at least 40 days during their entire period of nursing studies. It is worth noting that the first specialised six-month operating room nursing courses began to be organised in the mid-20$^{th}$ century in Australia, the USA, and the UK [29].

There is no historical evidence of the origins of the operating room nursing profession in Lithuania. The Red Cross Society, founded in 1876, is regarded as the pioneer of nursing in Lithuania. The Society was of great importance for the development of the nursing profession, and one of its most significant tasks was training Sisters of Mercy and orderlies, as well as developing their qualifications. The Sisters of Mercy Branch of the Red Cross Society, founded in Vilnius in 1888, was named after the Empress Mary in 1890.

The health crisis that followed World War I revealed a severe shortage of nurses, which hampered the proper care of the sick and injured. The high number of deaths, injuries, and casualties during the war put a huge strain on the healthcare system. Such a situation made nurse training courses extremely necessary in Lithuania as well as worldwide [31].

The history of nursing in Lithuania began after World War I. From the end of the 18$^{th}$ century until 1918, Lithuania was part of the Russian Empire. Russia's defeat of Germany in 1917 and later Germany's defeat of the Western Allies in 1918 enabled Lithuania to regain its former independence. The first medical school in Kaunas was founded in 1920 by obstetrician-gynaecologist P. Mažylis. It was called Kaunas Medical School and was one of the first institutions in Lithuania dedicated to training nurses and midwives.

The school was closely associated with the Lithuanian Red Cross, which helped to organise training and practice. The main traineeship base was the Red Cross Hospital, where students acquired practical skills. This school played a crucial role in training qualified healthcare specialists [25].

It is rewarding for us, as authors of this monograph, that we are graduates of this Medical School, which in 2001 joined Kauno kolegija, a higher education institution that we represent today as academics and researchers.

It was the Lithuanian Union of the Sisters of Mercy (LGSS), founded in 1921 with M. Aleksandravičiūtė as its President, that began to address essential nursing issues, including the training of nursing teachers and hospital nursing administrators. The organisation was under the patronage of President Smetona's wife, S. Smetonienė. K. Vitkauskaitė and V. Monkutė, who finished the Florence Nightingale Nursing Course in London, made an exceptional contribution to the development of nursing practice in Lithuania [25].

Nurses were trained at 6 medical schools in Lithuania: in Kaunas, Klaipėda, Panevėžys, Šiauliai, Utena, and Vilnius. The studies were highly medicalised, focusing only on treating diseases, prescribing medications and their functioning, performing doctors' orders, and assisting the doctor. There was no professional autonomy at all. The nurse was completely dependent on the doctor, merely assisting them, and could neither express her opinion on the patient's state of health nor have an opportunity to teach or advise the patient [32].

In 1957, the National Courses for Developing Qualification of Medical Staff started specialised training for operating room nurses in Lithuania [33]. At that time, they were called "instrumentalists' courses". Later on, this institution became a centre for developing the competencies of the nursing staff and, until the end of the 20$^{th}$ century, organised courses for operating room nurses.

Special training for operating room nurses (formerly known as *instrumentalists' specialisation*) was organised at the schools of further education, which later became part of the higher education institutions. Its duration was several months, encompassing both theoretical and practical training. Currently, operating room nurses are trained under the non-formal education programme "Operating Room Nursing" (480 hours) at Kaunas and other Lithuanian higher education institutions and Klaipėda University.

## 1.3 A review of non-governmental organisations of operating room nurses and the profile of the operating room nursing profession

At present, globally and in Lithuania, there are separate organisations that unite only operating room nurses with very similar aims, i.e., to bring together their members, represent and defend their professional interests, solve the issues of the science of operating room nursing, training and practice, take part in drafting legal documents, and cooperate at an international level.

The European Operating Room Nurses Association (EORNA) [34] was formally established in Copenhagen, Denmark, in 1980. It brings together 24 member associations from 23 European countries. In t he United States, the Association of Operating Room Nurses is now 75 years old. The American Association of PeriOperative Registered Nurses (AORN) [35] was founded in 1949 in Chicago, Illinois, USA.

The Lithuanian Society of Operating Room Nurses (LOSD) [36] is a voluntary, independent organisation that unites operating room nurses of the Republic of Lithuania. It was founded in 1999. The Society, now in its quarter-century, actively contributes to improving the professional qualifications of operating room nurses and defining medical norms that regulate their training. It promotes the dissemination of evidence-based scientific knowledge, which is specifically related to the performance of an operating room nurse.

Around the world, operating room nurses are referred to as "operating room nurses" or "operating theatre nurses" [37]. There is no difference between these terms; they only define specific functions. The term "operating room nurse" is more commonly used in America and Australia, and "operating theatre nurse" is more common in England. In the scientific literature, the term "operating room nurse" is more commonly used; therefore, it has been decided to use this term in the monograph. It is a common practice around the world for some operating room nurses to work in a sterile environment (scrub nurses), and others to assist them in a non-sterile environment (circulating nurses).

In Lithuania, the practice is different, with only very rare cases of two operating room nurses working in one operating room. This fact is supported by Lithuanian researchers who have conducted studies in the field of operating room nursing. In Lithuania, not all operating rooms have two surgical team nurses. In such cases, one operating room nurse carries all the workload that a nurse assistant cannot carry out.

The role of an operating room nurse is essential in the surgical process. From a surgical perspective, operating room nursing includes the activities of operating room nurses in a sterile environment (caring for the patient) and the mediation between sterile and non-sterile environments [38].

Nowadays, the operating room nurse is not only a "technical assistant" whose function is to "pass the instruments". She also ensures the patient's safety, prepares the patient for surgery (e.g., positioning on the operating table, preparing the operating area), and monitors for complications during the operation. The operating room nurse, working in a sterile environment, assists the surgeon or surgical team, prepares all surgical instruments for the operation following the requirements for sterility, places the sterile instruments on a sterile operating table, selects and passes the instruments necessary for the surgeon, handles the medical equipment following the requirements for sterility, monitors the complications, and stays with the patient until they leave for the post-operative ward. The operating room nurse working in a non-sterile environment collects and delivers the instruments needed for the operation in special containers and helps the operating room nurse working in a sterile environment prepare the instruments and medical equipment [39].

The operating room is one of the hospital's most important departments, where work is intense, stressful, fast-paced, and volatile. In the 21$^{st}$ century, with the rapid advances in medical science and technology, the range of activities of operating room nurses is very broad. Knowledge and skills in clinical

perioperative nursing, psychology, instrumentation, assisting, anaesthesia, and maintenance and handling of medical-surgical equipment are essential for these professionals [2].

In the 21st century, operating room nurses are assuming an increasingly diverse range of responsibilities. The introduction of medical technology and surgical innovations requires nurses to remain competent professionals and be able to utilise the latest tools and equipment. Specifically in Lithuania, at the end of the 20th century, operating room nurses, then known as instrumentalists (so far, it is known that only women held this job), were considered to be good, obedient, oriented, technically precise, and quick to identify which instruments the surgeon needed. Since 2000, debates within the Ministry of Health, among higher education institutions that train nurses, professional organisations, and medical institutions have raised numerous doubts and criticisms about the new job title. However, there was no sense in retaining the word "instrumentalist", as the nursing reform affected not only the educational institutions that train nurses but also the nursing practice itself. Nursing is viewed in a new light, and it has been gradually realised that it is not just a technical job, but a holistic activity that focuses on the patient's physical and psychosocial needs, requiring specific skills and knowledge. The holistic mission of nursing is clearly defined in the Lithuanian Medical Standard MN 28:2019 "General Practice Nurse" [40]. Here, it is established that "Nursing is a part of personal health care, which includes developing, promoting, and preserving health, preventing diseases and risk factors, and physical, mental, and social care of healthy and sick persons".

There is now a universal practice of training operating room nurses, whereby the first step is to qualify as a nurse and then complete a specific training programme in operating room nursing.

Specifically for Lithuania, a general practice nurse or a midwife with a specialisation in operating room nursing can become an operating room nurse (Medical Standard 93:2018 "Operating Room Nurse" [41]). According to the Medical Standard MN:93, in Lithuania, the competencies of an operating room nurse are wide-ranging and require the application of interdisciplinary knowledge, close communication, and teamwork. Operating room nurses must have a basic understanding of documenting, record-keeping, accounting, medical statistics, health law and insurance, organising health care, nursing science, information technology, and applying medical equipment. They must also be familiar with the processes that occur in the operating room, including surgical techniques and procedures, as well as the use and preparation of surgical instruments. They have to be able to prepare the patient for surgery and presume surgical complications and their management during surgery, ensuring the patient's physical and psychological safety in the operating room, complying with ethical requirements, providing safe and appropriate conditions for the performance of the surgical intervention, and, to the best of their competence, assisting the operating physician.

In Lithuania, there are only a few publications that introduce the profession of operating room nurse to the public. There is also a lack of scientific publications analysing aspects of the activities of an operating room nurse. It is worth mentioning a few thoughts on the profession of an operating room nurse as described in the Lithuanian sources:

*"The professional mission of an operating room nurse is specific and cannot be carried out by any other specialist who does not have the necessary professional qualifications. She must be able to make decisions on her own regarding the processes of organising work in the operating room"* [33].

*"Although our work is very interesting, it is invisible to the public. Few people know that the operating room nurse starts preparing for the operation much earlier than the patient arrives in the operating room. She resupplies instruments, prepares sets of instruments and coverings, additional instruments, bandages, and devices, checks how the operating room is prepared, discusses with the assistant what instruments might be needed and where they should be brought from, prepares documentation <...> We have to know the stages and process of the operation, the instruments, and special equipment. We prepare between 50 and 300, or even more, instruments for various purposes during a single operation. Sometimes the preparation for the operation takes even longer than the operation itself"* [42].

*"A successful surgery is the result of well-coordinated actions of operating room team, which is why Dalia Dirsienė, an operating room nurse-instrumentalist, stresses how important cooperation and instrumentalist's knowledge are in this work in a press release: «Following the sequence of the surgeon's actions, I know what instrument the surgeon will need. That is why it is very often the case that we understand each other without words»"* [43].

The latest social resources highlight the relevant shortage of nurses in the Lithuanian labour market (with the current lack of several thousand nurses in Lithuania). The highly challenging working conditions, such as very long working hours and specific demands that directly impact the health of nurses in the operating rooms, are openly discussed.

*"There is a lot to deal with: physical strain, continuous standing, being hot, sweating, wearing a mask and a heavy suit. Somewhere you might be in surgery for 10, 12, 7 hours, and you cannot take a break"* [44].

In today's fast-paced world of technology, training operating room nurses using innovative methods to improve patients' safety and the efficiency of surgical procedures is becoming routine.

However, not all countries can afford this practice. Germany, Switzerland, the Scandinavian countries, and the United Kingdom can boast technological advances in training operating room nurses. The scheme is also increasingly being deployed in other continents, such as North America and Asia. It is worth mentioning the NoscoTrainer System. It is one of the most advanced platforms used today for training healthcare professionals, particularly in the field of surgery. According to B. Glaser et al. [45], simulation-based training is based on allowing learners to acquire and improve their skills under realistic conditions.

The main advantages of this training system in the field of operation room nursing are the acquisition of technical skills and decision-making through simulation of different surgical scenarios, and most importantly, it is carried out in a way that does not put patients at risk. The NoscoTrainer System is extremely useful for improving teamwork skills. It presents a powerful motivational tool for future and current operation room nurses to link their professional future to the specific environment of surgery.

The integration of modern IT technologies into the planning of operating room environments and processes enables the operating room team to achieve high-quality performance results. This is illustrated in a study by J. Neuman et al. [46], which analysed the involvement of operating room staff in planning new operating rooms. The involvement of surgeons, nurses, anaesthetists, and other professionals in the 3D graphical design of the operating room simulation resulted in a safe working environment for the patient, ergonomics for the staff, and high-quality working environments from the organisational aspect.

## Summary of Chapter 1

The profession of operating room nurse is relatively new in the world, including Lithuania; it is just over 100 years old. Although surgery dates back to ancient times, it was unprofessional and hectic, as no painkillers were used, and aseptic-antiseptic requirements were not observed. History has shown that doctors' and nurses' work was dangerous because they were exposed to many risks of which they were unaware. They did not comply with hygienic requirements, which was dangerous for the patients and the people treating them. Doctors and nurses could have contracted dangerous infections through patients' blood and other body fluids. Surgical instruments were primitive, and there was a high risk of injury. It can also be assumed that the nurses were working in hazardous conditions, with excessive work and little rest, and that this had a negative impact on their health. However, doctors and nurses risked their health and lives for the noble mission of helping the sick or injured in war.

The profession of operating room nursing is relatively new. It is developing its vision and striving for autonomy and equality with other professions.

The role of the operation room nurse has evolved with advances in medical science and improvements in the healthcare system. However, the nurses' roles in the operating rooms were not mentioned in the early stages of surgical history. The first nurses were mostly nuns who cared for sick and injured patients. The first globally officially recognised operating room nurse was C. Hampton Halsted, who lived in America and whose sensitive hands were protected during operations by specially made gloves. She is considered the first operating room nurse and a pioneer in the worldwide use of surgical gloves.

Nowadays, operating room nurses possess a wide range of competencies, encompassing not only the use of surgical instruments and equipment but

also ensuring patient safety and collaborating closely with the operating room team. The role of operating room nurses has come to be seen as a holistic one, focusing on the patient's physical and psychosocial needs and their care.

The term "operating room nurse" reasonably emphasises the holistic approach to the profession. The clear and high standards of training these professionals, their participation in public life and the development of social partnerships through joining associations provide them with professional autonomy and increase their professional responsibility.

# Chapter 2
# Systematic mapping of occupational risks

## 2.1 Universally recognisable occupational risk factors, their classification, problematic issues

In Lithuania, as in any modern welfare state, working conditions are strictly regulated by legislation aimed at ensuring employees' safety and creating health-friendly working environments. A legally regulated concept of occupational risk facilitates a common understanding of its content, thereby preventing subjective opinions and interpretations.

The concept of occupational risk is defined in the Law on Safety and Health at Work of the Republic of Lithuania [47]: "*Occupational risk* means the probability of injury or other harm to employee's health due to exposure to a hazardous and (or) dangerous factor (factors) in the working environment".

Occupational risk factors are divided into biological, chemical, ergonomic, physical, and psychosocial. As further stated in the Law on Safety and Health at Work, considerable attention must be given to assessing *occupational risks*. The occupational risk assessment aims to identify and evaluate existing or potential risks at work, eliminate them, and, if they cannot be eliminated, introduce preventive measures to protect the staff from the dangers or minimise them. An occupational risk assessment must be carried out by a *competent person*, whether natural or legal, who possesses the necessary skills, knowledge, experience, and statutory and acquired qualifications to conduct the risk assessment.

The scope of occupational risks is wide, as employees may be exposed to a variety of harmful substances and agents. **Table 2.1** presents the occupational risk factors approved by the Seimas of the Republic of Lithuania, along with their descriptions [48]. The risk factors described in the document include microorganisms, chemical substances, physical workload, inadequate workplace design, and psychological stress. These factors pose a risk to the employees' safety and health in the working environment.

The purpose of determining the extent and acceptability of occupational risks is to help identify risks in the absence of quantitative studies of risk factors. Risks are identified by assessing the potential severity of the harm to health and the likelihood of its occurrence. As stated in the "General Regulations on Occupational Risk Assessment", "*While determining risk, it is useful to categorise the severity and likelihood of harm to health so that comparable events can be grouped and assessed together*". **Table 2.2** presents the three levels of harm categories (from low to high) and recommendations for risk elimination and/or mitigation actions.

**Table 2.1** Occupational risk factors

| Occupational risk factors | Description |
|---|---|
| Biological | Micro-organisms, including genetically modified ones, cell cultures, and human endoparasites that can cause infection, allergy or poisoning |
| Chemical | A chemical element or compound, whether pure or in a mixture, existing naturally or produced, used or released into the environment, including waste in any work process, whether intentionally produced or not, whether marketed or not |
| Ergonomic | The physical workload and stress, as well as adaptation of the workplace to employee's capabilities |
| Physics-related | Variations in physics-related substances in the environment |
| Physical | Hazards due to improper workplace design, physical effects of work equipment, moving parts, lifting equipment, loads being lifted, vehicles, falling objects, as well as possible explosion, fire, and failure to ensure the stability and robustness of structures |
| Psychosocial | Those arising from working conditions, work requirements and organisation, the content of the work, the relationships among employees or between the employer and the employee, which cause mental stress for the employee |

*Source: based on [48]*

**Table 2.2** Assessment of the severity of the harm to health

| Category of the harm | | |
|---|---|---|
| Small | Average | Great |
| Unpleasant sensations and irritations (e.g., headache, eye irritation, temporary discomfort), accidents that do not cause long-term discomfort (e.g., superficial wounds, minor cuts, minor contusions) | Accidents and diseases that cause minor but permanent or recurring disabilities (e.g., partial hearing loss, dermatitis, asthma, burns, traumatic brain injury, tendon strains, minor fractures or other minor injuries) | Accidents and diseases leading to severe and long-term disability and(or) death (e.g., multiple injuries, disability, incapacity for work) |
| Recommendations for the actions to eliminate and/or mitigate risk | | |
| No additional risk mitigation or elimination measures are required unless they are not costly (in terms of time, money, and effort). Ensure that the existing risk elimination and(or) mitigation measures are in place | It should be considered whether risks can be eliminated or mitigated to an acceptable level. Measures to eliminate and(or) mitigate the risk should be implemented within the timeframe set. Ensure that the existing risk elimination and(or) mitigation measures are in place | It should be ensured that measures to eliminate and(or) mitigate risks are determined. These measures must be implemented immediately within a specified timeframe. While implementing them, the suspension or restriction of the activity should be considered, or until the completion of the risk mitigation measures, temporary risk elimination and(or) mitigation measures should be applied |

*Source: based on [48]*

In cases of very low risk, no additional actions are required. However, in the cases of very high risks, substantial improvements in risk elimination and/or mitigation measures are needed to reduce the risk to a tolerable or acceptable level. The activity must be suspended until risk elimination and/or mitigation measures have been implemented to reduce the risk to a tolerable or acceptable level. If the risk cannot be reduced, work must be prohibited.

Based on the legislation, occupational risks are categorised into levels of harm. This categorisation provides a clear definition of the severity of the harm:

- *minor harm*, i.e., superficial scratches, minor injuries and temporary disabilities that do not lead to incapacity for work;
- *moderate harm*, i.e., fractures, mild poisoning, and temporary impairment due to a medical condition;
- *severe harm*, i.e., the consequences of serious injuries, such as limbs amputation, spinal injuries, occupational diseases such as pneumoconiosis, chronic chemical poisoning, severe burns, or loss of sight/hearing;
- *fatal harm*, i.e., fatal injuries resulting from a fall from a height, death due to poisoning by toxic substances, or radiation exposure).

This grouping also helps define the probability of the occurrence of such injuries and their impact on the employees' health as defined in the Law on Safety and Health at Work of the Republic of Lithuania, the legislation on occupational health and safety, and the methodologies of occupational risk assessment approved by the State Labour Inspectorate. The levels of harm caused by occupational risks allow employers and safety professionals to organise risk management appropriately, ensure the employees' safety and health, and take effective preventive measures.

According to the World Health Organisation [49], the known environmental hazards that could be prevented account for around a quarter of all deaths and diseases worldwide. At least 13 million deaths occur annually from environmental hazards. These figures suggest that a safe and healthy environment is crucial for human well-being.

More than one million deaths worldwide are caused by unsafe working conditions (fatalities). In the world population as a whole, occupation-related mortality accounts for 2.7% of all deaths, of which 70% are due to non-infectious diseases, 22% due to injuries, and 8% due to contagious diseases. The research shows that occupational mortality varies according to countries' economic and social development. The highest mortality rates have been found in underdeveloped countries [50].

A four-year study in Jordan has shown that workplace fatalities are a global problem. The study was conducted in three hospitals in Amman, where 88 individuals were involved in fatal accidents. The most dangerous occupation stated was construction workers, with falls from height and head trauma identified as the main causes of death [51].

However, the statistics on occupational accidents show that, from 2023 onwards, the incidence of deaths and serious injuries has decreased (**Table 2.3**).

**Table 2.3** Information on occupational accidents at work in Lithuania from 2021 to 2023

| Period (year) | Mortality (cases) | Serious injuries (cases) |
|---|---|---|
| 2021 | 37 | 97 |
| 2022 | 23 | 124 |
| 2023 | 17 | 106 |

*Source: based on [52]*

In 2023, the inspectors of the State Labour Inspectorate (SLI), investigating accidents at work that resulted in the employees' death or serious harm to their health, found the following:

- construction (6 fatal and 19 serious accidents at work);
- manufacturing (5 fatal and 25 serious);
- forestry (4 fatal and 6 serious);
- wholesale and retail trade, motor vehicle repair (15 severe and 1 fatal);
- agriculture (5 fatal and 6 serious);
- administrative and service activities (9 serious);
- water supply, sewage treatment, and waste management (1 fatal and 3 serious);
- electricity, gas, steam provision, and air conditioning (3 fatal);
- education (4 serious);
- human health care and social work (2 serious);
- real estate operations (2 serious);
- professional, scientific, and technical activities (2 serious);
- public administration and defence; compulsory social security (2 serious);
- maritime fishing (1 serious).

Construction, manufacturing, forestry, and wholesale and retail trade are the sectors with the highest number of fatal and non-fatal work-related accidents. These occupations have the highest number of deaths and accidents.

Pandemics also lead to differences in employees' mortality. The COVID-19 pandemic that struck the world a few years ago left its mark in terms of the increased death rates. Research shows that in specific occupations, mortality from COVID-19 was caused by working conditions characterised by interaction with customers at close distances.

In 2020, occupational differences in the COVID-19 disease were investigated in England. The highest mortality rates were found among taxi and public transport drivers and nursing and social care workers. The rate was 119.7 deaths per 100,000 population among drivers and 99.2 deaths among nursing and social care workers [53]. An American study also showed that the highest mortality rates during the pandemic period were among healthcare and transport workers [54].

## 2.2 Conceptualising occupational safety in the context of international and national policies

The occupational safety of employees across all professions is closely linked to ensuring their occupational health. Poor working conditions, lack of protective measures or inadequate use of protective equipment can impair employees' health.

According to the data presented in the European Commission's *Strategic Programme for Safety and Health at Work 2021–2027* [55], the number of fatal accidents at work in the EU decreased by around 70% between 1994 and 2018. Despite this progress, there were still more than 3,300 fatal accidents and 3.1 million non-fatal accidents in the 27 Member States of the European Union in 2018. More than 200,000 workers die every year from work-related diseases. Maintaining the standards of employees' protection and improving occupational safety is, therefore, a necessity.

The European Commission's *Strategic Framework on Health and Safety at Work 2021–2027* sets out key priorities and actions to improve workers' health. The document states that safe working conditions are a prerequisite for a healthy and productive workforce. No one should suffer from work-related illnesses or accidents. It is also a crucial aspect of the EU economy's sustainability and competitiveness. This document clearly emphasises that occupational safety is linked to economic and social issues. The *Strategic Framework* focuses on three main priorities:

- anticipating and managing change in the context of green, digital, and demographic transitions;
- improving the prevention of work-related accidents and diseases and striving towards a Vision Zero approach to work-related deaths;
- increasing preparedness to respond to current and future health crises.

The implementation of these three strategic priorities must be based on prevention, preparedness, and change. The success of the programme depends on its implementation in the European Union at national, sectoral, and company levels, focusing on social dialogue, financial resources, awareness-raising, data collection, and reinforcement (**Fig. 2.1**).

The European Commission's *Strategic Framework for Safety and Health at Work 2021–2027* pays considerable attention to psychosocial risks. The research findings provided show that even before the pandemic, mental health problems affected around 84 million people in the EU. Half of EU employees consider stress to be a common occurrence in their workplace, and stress contributes to around half of all missed workdays.

The *Framework* focuses on the conditions for changing working environments and the associated risks while striving to ensure a high level of safety and health at work.

This effort is particularly important in the context of health risks and occupational safety for operation room nurses.

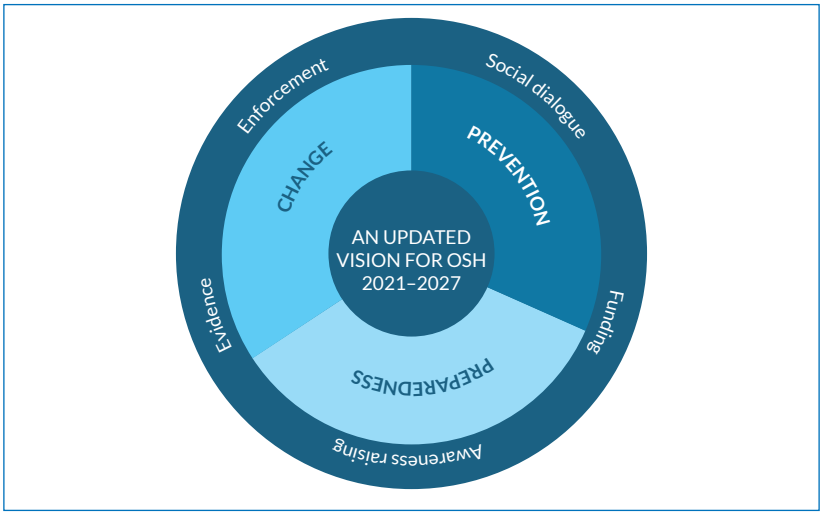



**Fig. 2.1** Components of the European Commission's Strategic Framework on Health and Safety at Work 2021–2027
*Source: [55]*

The *Framework* is directly linked to the assessment of occupational safety and health risks for operational nurses, which cover chemical, biological, physical, and psychosocial risks that are increasingly emerging on the market. The *Strategy* also envisages preventive measures, training, legal regulation, and health promotion initiatives to protect employees from evolving occupational challenges.

The European Union has several key instruments governing occupational safety and health. These laws and directives set the standards that all Member States must comply with to ensure a high level of protection of employees' safety and health (**Table 2.4**).

**Table 2.4** The European Union Directives on safety at work

| Directive | Purpose of the Directive |
|---|---|
| 1 | 2 |
| Directive 89/391/EEB [56] | **General Directive on the introduction of measures to encourage improvements in the workers' safety and health at work** It sets out the general principles related to prevention measures, risk assessment, and worker protection and obliges employers to provide safe working conditions and training for employees; it also covers the management of psychosocial risks in the workplace |
| Directive 2009/104/EB [57] | **On the safety and health requirements for the use of work equipmen**t It sets out the minimum safety requirements for the use of work equipment and devices in the workplace |

**Continuation of Table 2.4**

| 1 | 2 |
|---|---|
| Directive 2002/44/EB [58] | **On the health and safety requirements regarding the exposure to the risks arising from physical agents (vibration)** It sets out requirements for vibration and its prevention at work |
| Directive 2003/10/EB [59] | **On health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)** It sets out the processes and requirements for assessing the risks to workers from noise |
| Directive 2004/37/EB [60] | **On the protection of workers from the risks related to exposure to carcinogens or mutagens at work** It provides for the workers' protection from exposure to carcinogens, mutagens, or substances affecting the reproductive system at work and the requirements for risk assessment and preventive measures |
| Directive 1999/92/EB [61] | **On minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres** It sets out the measures employers must take to prevent the creation of explosive atmospheres by preventing ignition and explosion, thereby ensuring the health and safety of workers and patients |
| Directive 2003/88/EB [62] | **On certain aspects of the organisation of working time, including the periods of daily rest, breaks, and maximum weekly working time** It establishes that all workers have the right to rest, breaks, and annual leave and sets out the duration of work |
| Directive 90/270/EEB [63] | **On the minimum safety and health requirements for work with display screen equipment at work** It sets out the minimum requirements to ensure the safety and health of employees when working with equipment incorporating displays, including the design of workplaces, the maintenance of technical equipment, the organisation of work, and the working environment |
| Directive 2000/54/EB [64] | **On the protection of workers from risks related to exposure to biological agents at work** It sets out the requirements for employees' protection from exposure to biological agents at work, including measures for risk assessment and prevention to ensure the employees' health and safety |
| Directive 98/24/EB [65] | **On the protection of the health and safety of workers from the risks related to chemical agents at work** It sets out the requirements for employees' protection from exposure to chemical agents at work, including measures for risk assessment and prevention to ensure the employees' health and safety |

The documents in **Table 2.4** clearly state that every employee must be provided with safe and healthy working conditions.

As stated on the homepage of the Ministry of Social Security and Labour of the Republic of Lithuania, *"Safe working conditions must be provided irrespective of the type of activity of the enterprise, the type of employment contract, the number of employees, the profitability of the enterprise, the place of work, the working environment, the nature of the work, the length of the working day or shift, the employee's citizenship, race, nationality, gender, sexual orientation, age, social origin, and political or religious beliefs. It is the employer's responsibility to provide employees with safe and healthy working conditions in all aspects of their work"*.

The European Union's documents oblige the Member States to take responsibility at the national level and thus contribute to ensuring the employees' safety and health in the EU countries. These documents provide the legal basis for ensuring occupational safety and health in the European Union by setting out clear guidelines and requirements for the Member States of the Union.

The World Health Organisation (WHO) and the United Nations Organisation provide recommendations on protecting employees' health and mitigating risks. Although these documents are not legally binding on all countries in the world, they are valuable in contributing to national policy-making (**Table 2.5**).

**Table 2.5** WHO and United Nations documents on occupational safety

| Document | Purpose of the document |
|---|---|
| 1 | 2 |
| Global Strategy on Occupational Health for All: The Way to Health at Work, 2008 [66] | The strategy envisages access to health services for all working people and the importance of preventive measures to avoid occupational diseases and accidents at work |
| WHO Global Strategy on Health, Environment and Climate Change, 2020) [67] | The document emphasises that a healthy environment is essential for human health and well-being and that climate change and environmental challenges require urgent and coordinated actions worldwide |
| The 2030 Agenda for Sustainable Development, SDGs [68] | The Agenda consists of 17 Sustainable Development Goals (SDGs), several of which aim to improve working conditions for all workers, including preserving their health and ensuring safety at work. The Agenda promotes social protection and access to health care services |
| Occupational Health: Stress at Work, 2016 [69] | The document addresses the issue of occupational stress, stating that work-related stress can lead to physical and mental health problems. It also provides recommendations for managing stress in the workplace |

**Continuation of Table 2.5**

| 1 | 2 |
|---|---|
| Comprehensive Mental Health Action Plan 2013–2030 [70] | The document emphasises that the working environment must not have a negative impact on employees' health, and particular attention must be paid to preventive measures. Work-related mental health problems must be promptly identified and addressed |
| Working for Health 2022–2030 Action Plan [71] | The Action Plan encourages global efforts to improve employees' safety, reduce occupational risks and ensure better working conditions. It highlights three priority areas: planning and financing, education and employment, and protection and performance |
| Strategic Approach to International Chemicals Management – SAICM [72] | The document aims to ensure that chemicals are manufactured and used in a way that minimises their impact on workers' health and the environment |
| Occupational Noise: Assessing the Burden of Disease from Work-Related Hearing Impairment [73] | The document is intended for the assessment of noise exposure in the workplace and the prevention of hearing impairment and includes recommendations on how to reduce noise risks |
| The United Nations Sustainable Development Goals [74] | Goal 8 "Decent work and economic growth" calls for better working conditions, employees' protection and social well-being |
| C190 – Violence and Harassment Convention, 2019 (No. 190) [75] | Aims to prevent violence and harassment in the workplace and create a safe and respectful atmosphere |

Lithuania has approved legislation at the state level aiming to ensure the employees' safety, with a strong focus on prevention and appropriate criminal and administrative penalties for breaches.

The *Law on Safety and Health at Work* outlines the fundamental principles and requirements governing occupational safety and health. It regulates risk assessment, the rights and obligations of employers and employees, protective measures, and the adequacy of workplaces and working conditions.

The *Labour Code* is the main law in Lithuania (Law No IX-926) [76], which covers the broader regulation of labour relations. It provides provisions related to the employees' safety and health, including the employer's obligation to ensure the employees' safety and health at work.

The Occupational Safety and Health Commission of the Republic of Lithuania (OSHC) plays an essential role in ensuring employees' safety and health at work [77].

Its main functions include:

- participating in the development and review of the national occupational safety and health policy;
- monitoring compliance with occupational safety and health requirements and assessing and analysing workplaces;
- advising employers and employees on occupational safety and health;
- organising training to raise awareness of occupational safety and health among employees and employers;
- submitting recommendations to the government, labour inspectorate, and other authorities on the implementation of occupational safety and health measures;
- conducting investigations related to occupational safety and health.

Over the last 50 years, significant progress has been made in the European Union Member States in terms of occupational safety and health [78]. However, there are significant differences between eastern, southern, and central, as well as northern and western European countries. Physical and ergonomic risks (other than inactivity) are more frequently reported in eastern and southern European countries. Emotional difficulties such as difficult clients, poor communication, and long working hours are more common in northern and central European countries.

## Summary of Chapter 2

An occupational risk is a danger to an employee's health and safety arising from harmful or hazardous factors in the working environment. It includes biological, chemical, ergonomic, physical, and psychosocial aspects.

The assessment and management of these risks is an essential part of ensuring the employees' safety and health. According to the World Health Organisation (WHO), unsafe working environments are a significant risk factor in more than 1 million deaths worldwide each year.

The particularly hazardous occupations include construction, healthcare, and transport workers. Pandemics, such as COVID-19, have further highlighted the importance of safe working environments and the need for effective preventive measures.

The World Health Organisation (WHO) and the United Nations provide global recommendations on occupational health protection. Although these guidelines are not legally binding, they shape national policies to reduce occupational risks.

The global emphasis is on the importance of prevention and integration of occupational health into economic and social decisions.

The European Union's legal framework for safety and health at work includes Directives and policy documents that set standards that are binding on Member States.

The EU Strategic Framework for Safety and Health at Work 2021–2027 [55] envisages three priorities: anticipating and managing change in the context of green, digital, and demographic transitions; improving the prevention of work-related accidents and diseases and striving towards a Vision Zero approach to work-related deaths; and increasing preparedness to respond to current and future health crises. Directive 89/391/EEC [56] outlines basic prevention measures and requirements for risk assessment. These measures have contributed to reducing the number of fatal accidents in the EU by around 70% over the last three decades.

In Lithuania, occupational safety and health are regulated by the Law on Safety and Health at Work, which defines the basic principles and obligations related to risk assessment, protective measures, and the employees' health. The Labour Code obliges employers to ensure safe working conditions. The Occupational Safety and Health Commission (OSHC) shapes the national policy, monitors the implementation of legislation, and submits recommendations.

Occupational risk management is essential to ensure the safety and health of employees. The existing legislation at international, regional, and national levels stresses the importance of prevention, training, and risk management. The proper application of these measures not only reduces the number of accidents but also improves productivity and employee satisfaction with working conditions.

# Chapter 3
# Occupational risk factors affecting operating room nurses and their management

## 3.1 Identifying occupational risks affecting operating room nurses

Patient' safety is a top priority in healthcare service delivery worldwide. The World Health Organization report [15] provides highly relevant and thought-provoking evidence to show that patients' safety is a serious global public health issue. The chance of being harmed while travelling on an aeroplane is 1 in a million. By comparison, the chance of a patient being harmed during healthcare services is 1 in 300. Industries with higher risks, such as aviation and nuclear power, have a much better safety record than healthcare. These facts force healthcare professionals to take a responsible approach to preventing undesirable incidents while providing healthcare to patients and ensuring their safety when receiving its services.

Occupational risk is the ratio of the severity of the health harm potentially caused by hazards and risk factors to the likelihood of that harm occurring [78]. Operating room nurses worldwide are exposed to a wide range of health hazards in operating rooms and their associated facilities. They are among the group of professionals who are most exposed to risk factors in their professional activities [1, 79, 80].

Several groups of hazards are commonly encountered by operating room nurses, including biological, chemical, physical, and psychosocial hazards. Chemical risks include antiseptics, medications, etc.; physical factors include noise, lighting, vibration, temperature, etc.; biological cover blood and other body fluids; ergonomic include lifting heavy instruments in boxes, standing for a long time, etc.; psychosocial are related to stress, job content, organisation of work, interpersonal relationships, etc.; other hazards include working in higher temperatures, hot autoclaves, slips, falls, etc. [80].

Operating room nurses are more likely than other professionals to be exposed to occupational risk factors due to the nature of their work and close contact with patients suffering from various diseases. They are more susceptible to toxic chemicals and biological agents, as well as carcinogens, ionising and non-ionising radiation. To preserve and increase the safety of the staff from these hazards, the management of institutions and the administration of operating departments should pay considerable attention to assessing and preventing risk factors [1].

The specific nature of the performance of operating room nurses is characterised by a very broad range of activities, preconditioned by major medical breakthroughs and technological advances in surgery. Operating room departments differ from other departments in the hospital not only in terms of the different layout of the environment and strict rules for access to and from the operating room but also in terms of the stressful working environment and high workload, which can adversely affect the health of the operating room nurses [2].

The staff working in the operating room environment are exposed to several hazards compared to the specialists working in other departments. Unpredictable situations during complex surgeries usually characterize their performance, work in a confined environment, and occupational hazards that lead to burnout syndrome [3].

M. Saleh et al. [39] itemized the occupational risk factors affecting surgical nurses according to the occupational risk factor groups identified by the International Labour Organization [81] (**Table 3.1**).

**Table 3.1** Occupational risk factors affecting operating room nurses

| Risk factors | Causal factors |
|---|---|
| Physical | ■ sharp objects;<br>■ burns from contact with hot steriliser and hot air steam;<br>■ electrical trauma;<br>■ falling objects such as medical instruments, slips, stumbles, and falls on the wet floor;<br>■ exposure to X-ray radiation |
| Chemical | ■ chronic poisoning by anaesthetic gases and sterilisation fluids;<br>■ skin problems due to frequent use of disinfectants;<br>■ eye, nose, and throat irritation due to aerosols of cleaning fluids in the air;<br>■ latex allergy |
| Biological | ■ possibility of contracting hand and finger blisters (herpes virus);<br>■ increased risk of spontaneous miscarriages;<br>■ transmission of infection through blood, body fluids, or tissues;<br>■ risk of hospital-acquired disease due to needlestick |
| Ergonomic, psychosocial, organisational | ■ problems in interpersonal relationships with surgeons;<br>■ encounters with seriously ill and severely injured patients;<br>■ stress caused by the feeling of high responsibility towards patients;<br>■ strained family relationships and burnout due to shift work and overtime;<br>■ chronic musculoskeletal pain due to lifting patients;<br>■ acute muscle pain due to awkward body posture |

*Source: based on [39]*

As shown in **Table 3.1**, for each of the risk factors identified by the International Labour Organisation, there are a number of different and specific risk factors and potential health effects associated with the activities of operating room nurses. Some of these may also be observed in the activities of nurses working in other departments but not in such a large number of risk factors. Other members of the operating room team (surgeons, the anaesthetist, the anaesthetic nurse, and operating room support staff) may also be exposed to these risks.

M. Saleh et al. [39] include mechanical injuries (caused by sharp or falling objects), thermal agents (such as burns), and exposure to electricity and X-rays as physical agents. Chemical agents include poisoning by anaesthetic gases, sterilisation fluids, skin disinfection fluids, and skin allergy to gloves made of latex. Biological agents are associated with infection through blood and body fluids and also include negative effects on pregnancy due to an increased risk of miscarriage. Ergonomic, psychosocial, and organisational factors are presented in a single group and include situations related to psychological stress at work and musculoskeletal pain.

However, other authors suggest a slightly different classification of occupational risk factors. A. Danjuma et al. [2] refer to physical factors as accidents, which include mechanical and thermal hazards. Muscle pains also belong to the group of accidents. Physical risk factors in this classification, unlike M. Saleh et al. [39], include only exposure to X-ray and radioisotope radiation.

M. Saleh et al. [39] and A. Danjuma et al. [2] present the chemical and biological risk factors for operating room nurses in a very similar way. A. Danjuma et al. [2] elaborate on ergonomic, psychosocial, and organisational risk factors, which allows a deeper look into their causes. Some of these causes are related to ergonomic factors, such as lifting heavy objects, and organisational factors, such as working in a constrained position. This is particularly distressing for operating room nurses who work without breaks and stand for long hours. According to the group of psychosocial risk factors presented by A. Danjuma et al. [2], it is evident that stress and psychological health issues among operating room nurses (**Table 3.2**).

In 2012, the International Labour Organisation (ILO) issued practical recommendations to help reduce or avoid occupational risk factors for operating room nurses. They are universal and can be targeted to prevent risk factors regardless of their assignment to different risk groups. As mentioned earlier, the classification of occupational hazards encountered in the activities of operating room nurses is somewhat different in different sources.

**Table 3.2** presents the classification of risk factors according to A. Danjuma et al. [2]. The ways to mitigate or avoid these factors are related to the recommendations of the International Labour Organisation [81] and the Lithuanian Hygiene Institute [82].

Numbers indicate them next to the causal factors in the **Table**:

- wearing special closed footwear for medical personnel with a non-slip sole;

- disposing of needles in a special container after use and using disposable hypodermic needles;
- checking for grounding and cooperating with the technicians of the hospital's medical devices;
- being interested in and familiar with the safety requirements set for the devices in the operating room;
- wearing an X-ray radiation detector, using special aprons, being exposed to X-rays for only the minimum amount of time needed to perform the functions in the operating room, checking radiation levels regularly, and following safety protocols;
- checking that the operating room has a ventilation system that removes odours, harmful substances, and gases;
- using natural eyewash (e.g., eye spray);
- wearing latex-free and powder-free gloves (e.g., polymer-coated);
- following appropriate established infection control precautions;
- using protective equipment (gloves, face shields, goggles, medical gowns, and overshoes);
- performing proper hand hygiene and disinfection;
- following the technical-methodical requirements (descriptions) for performing procedures;
- using aids for lifting heavy objects and objects and consulting occupational therapists;
- being aware of the right to psychological support in the institution;
- using the manuals prepared for the use of medical equipment.

To sum up the recommendations of the International Labour Organisation [81], it could be stated that to ensure the occupational safety of operating room nurses and prevent or mitigate occupational risk factors, the attitude and responsibility towards occupational safety, adherence to the work instructions of the operating room nurses themselves, as well as the attention and support of the heads of the departments and hospitals, operating room administration, and provision of equipment are important. Wearing special footwear for operating room staff depends on both parties. Not all staff members are motivated or financially able to purchase safe footwear, so operating room management plays a crucial role in this respect. It is up to operating room nurses to develop safe working behaviour, which requires their responsibility. However, sometimes it is not enough for staff to be responsible, as medical equipment and devices continue to improve, and it is necessary to learn how to work with them safely. Therefore, the management's attention to enabling the operating room nurses and, of course, the other staff to acquire the necessary knowledge is no less critical. Ensuring the safety of operating room staff requires an understanding of protective measures. If an operating room nurse is allergic to latex, latex-free surgical gloves should be available. The availability and choice of preventive measures depend on the attitude and effort of the management and administration. However, it is up to the operating room nurses to use these measures correctly.

**Table 3.2** Occupational risk factors affecting operating room nurses and risk mitigating measures

| Risk factors | Causal factors and risk-mitigating measures (1-15) |
|---|---|
| Accidents | ■ falling surgical instruments, medical equipment (1);<br>■ slips and falls due to wet floors due to spillage of various liquids during surgery, especially in cases of haste (1);<br>■ injuries caused by sharp instruments and surgical needles (2);<br>■ burns due to contact with hot sterilisation equipment (4);<br>■ electric shock due to faulty or improperly earthed equipment or equipment with faulty insulation (3, 4);<br>■ muscle pain due to awkward body positioning during surgery or lifting heavy objects and transporting patients (13) |
| Physical | ■ source of exposure to X-rays and radioisotopes (5) |
| Chemical | ■ exposure to inhalation anaesthetics (gas) or antiseptic agents (6);<br>■ antiseptics, i.e., detergents and hand sanitisers (9, 10);<br>■ eye, nose, and throat irritation due to aerosols and contact with washing and cleaning fluids (6, 7);<br>■ chronic poisoning due to prolonged exposure to drugs and sterilising fluids, e.g., glutaraldehyde (10);<br>■ gloves and surgical instruments made of natural latex (8) |
| Biological | ■ blood, body fluids, and human tissue samples (9, 10, 12);<br>■ stabbing with sharp surgical instruments and infection with blood-borne diseases, e.g., HIV and hepatitis B and C (9, 10, 12);<br>■ the likelihood of contact and touching the palms and fingers of a person with herpes virus (9-12) |
| Ergonomic | ■ fatigue and chronic musculoskeletal pain due to lifting heavy objects and patients and long periods of standing in a confined position (13) |
| Psychosocial | ■ stress caused by high responsibility to the patient (14);<br>■ stress due to interpersonal relationships with the surgeon and other members of the operating room team (14);<br>■ violent and aggressive patients (14);<br>■ stress due to seriously ill and injured patients or patients' death during surgery (14) |
| Organisational | ■ long working hours, lack of rest breaks, and night and shift work (14, 15);<br>■ non-functioning equipment and lack of surgical supplies (15) |

*Source: based on [2, 81]*

The safety of patients and healthcare professionals is a topic of global debate. It is encouraging to note that research into the causes of occupational hazards is being carried out worldwide. The increase in the number of studies and the growing focus on them over the last couple of decades reflect the increasing interest in medical and nursing sciences. Swedish researchers highlight the relevance of research on identifying risk factors C. Wåhlin et al. [83], who state that learning from incident reporting is one of the key strategies for building a culture of safety among healthcare workers and patients.

Operating room nurses are one of the most vulnerable groups of professionals to be exposed to occupational risk factors due to the nature of their work. These risk factors include biological (contact with blood and body fluids), chemical (antiseptics and medications), physical (noise, lighting, and temperature), ergonomic (lifting heavy objects and standing for extended periods), psychosocial (stress and workload), and other hazards. The main measures to mitigate the occupational risks for operating room nurses are:

- using protective equipment, such as non-slip footwear, X-ray protective equipment, and gloves suitable for latex-allergic workers;
- adhering to infection control and hygiene protocols, disinfecting hands, and using appropriate protective equipment;
- adhering to the principles of ergonomics, including using lifting aids and organising breaks;
- ensuring the availability of psychosocial support and providing staff training on safe handling of medical equipment.

The assurance of occupational safety depends not only on the responsible attitude and behaviour of the operating room nurses but also on the management's endeavour to provide appropriate tools and training, as well as the effective performance of the operating room team.

## 3.2 Ergonomic occupational risk factors affecting operating room nurses

Ergonomic risk factors fall under the category of occupational risk factors. They are caused by exposure to force, complex posture, repetitive movements, hand and arm vibration, kneeling or squatting, and lifting and climbing [84].

40% of workers in the United States of America (USA) experience musculoskeletal pain. Even 15% of them experience pain every day. Health complaints related to musculoskeletal pain and incapacity for work account for $ 5.3 billion in lost annual earnings [85].

Healthcare workers are more likely to suffer from musculoskeletal pain than representatives of other professions [86]. One of the leading causes is unfavourable ergonomic factors in the working environment.

The main ergonomic factors that have a negative impact on health among healthcare professionals are:

- sedentary work [87];
- lifting and transporting heavy objects, such as patients, medical equipment, and surgical instruments [39];
- standing and non-physiological postures [88];
- not using ergonomic aids [89];
- a lack of in ergonomic issues [86].

A study conducted in China between 2018 and 2020, involving 6099 Chinese healthcare workers, found a correlation between ergonomic factors

at work and musculoskeletal pain. The results revealed that 57.5% of healthcare professionals experience this type of problem. For doctors and nurses in sedentary jobs, the primary issues were neck pain (41.7%) and shoulder girdle pain (33.5%).

P. Soylar and A. Ozer [5] analysed 111 scientific publications from different countries worldwide and concluded that between 33% and 88% of nurses have musculoskeletal complaints. They pointed out that the incidence varies by country. Musculoskeletal problems are most prevalent among nurses in Taiwan, Brazil, Italy, and Turkey, with a particular focus on pain in the lower back, shoulders, neck, legs, and arms.

Another study conducted in Estonian hospitals showed that 56.1% of nurses complained of back pain and 51.5% of neck pain related to their occupational activities [90].

Surgeons and operating room nurses are the most vulnerable group due to the specific nature of their work. They are most affected by musculoskeletal problems. A survey in Latvia found that 82% of surgeons experience discomfort in the shoulder and neck area, arms, legs, and lower back. Of the 90% of operating room nurses who participated in the study, the most frequent complaints were pain in the arms, legs, and shoulders, with older nurses also mentioning discomfort in the lower back. The reason for these pains is that surgeons and nurses often work in an awkward posture, which can cause pain in the back, arms, neck, and shoulders [11].

E. Barrios et al. [86] present the results of a review of 99 scientific sources, stating that up to 80% of surgeons experience musculoskeletal pain. One of the primary causes is prolonged standing in a constrained position, without utilising additional ergonomic aids.

In a survey of 148 operating room nurses working in Italy, 45.9% were found to suffer from musculoskeletal pain [91]. A study in Egypt revealed that 63.5% of operating room nurses suffer from lumbar spine pain caused by heavy lifting [39]. A study in the Netherlands helped to shed light on neck and upper back pain among operation room nurses. Professionals in this field often work in an uncomfortable standing position. According to A. Gerbrands et al. [88] note that neck and back problems arise when operating room nurses strain, stoop, or find themselves in an awkward position to obtain an unobstructed view of the operating area. This position is necessary for them to know which instrument or tool is to be passed to the operating surgeon.

Ensuring ergonomically friendly work conditions for operating room nurses is one of the top priorities in preconditioning occupational safety and preventing the onset of health problems, particularly in the musculoskeletal system. There are few scientific publications worldwide and in Lithuania that suggest effective ergonomic measures for operating room nurses.

An article published a couple of decades ago offers valuable and universally applicable recommendations for ergonomics in operating room nursing, suitable for use in all countries around the world. These recommendations

focus on the use of standing supports, height-adjustable stools, height-adjustable operating room tables, and soft hand support pads placed on the operating table to mitigate muscle tension on the limbs and the back (of course, with the possibility to sterilise them). Attaching wheels to the tables and equipment would enable easier transportation, and using improved wound dilators could also reduce hand strain and muscle tension when holding surgical hooks [88].

65% of British surgeons with musculoskeletal pain neither consulted professionals nor did anything about it themselves. The majority of the rest self-medicated or talked informally with colleagues. Only a very small proportion (13.6%) consulted their GP [92].

A dozen years later, the same problems persist among operating room staff, suggesting that insufficient attention is being paid to addressing them. Z. Roja et al. [11] found that 31% of Latvian operation room staff (doctors, nurses) considered their workplace unsafe. Mobility within the room is limited, and the staff are not provided with aids for lifting and moving heavy patients. All participants confirmed that their working hours in the operating room could be as long as 10 hours, and the use of assistive devices would be very helpful for improving the musculoskeletal system.

Finland is one of the most advanced countries in the world, with a strong focus on ensuring the safety of both staff and patients. The Ergonomic patient handling card, which provides educational charts encouraging staff to follow safety and ergonomic principles, was introduced in 2009. However, the developers of the methodology and those responsible realised that the nature of operation room nurses' work is different from that of the staff working in other departments. Therefore, revisions and additions to these charts were made to ensure that operation room nurses work in an ergonomically safe environment [89].

The ergonomics of operating room nurses is also a topic of debate in the Asian research community. T. Abdollahi et al. [93] observe that the would-be nurses do not receive sufficient knowledge and skills in ergonomics during their studies, and this deficiency is not compensated for in practice due to a lack of on-the-job training. A lack of knowledge and skills in ergonomics can cause physical health issues and pose a risk to patients' safety.

In cooperation with occupational health professionals, a training programme in ergonomics was developed for nurses working in the operating room of an Iranian hospital. It focused on ergonomic risk factors in the activities of operating room nurses and their management. The training was delivered to 37 operating room nurses in three-day workshops, each attended by 12–13 nurses. After the training, the operating room nurses were monitored by video recordings, which were reviewed by the consultants in conjunction with the nurses, to analyse erroneous situations related to non-compliance with ergonomic rules and provide on-the-job advice. The researchers' findings clearly show that such practical training and individual counselling improved physical health, reduced musculoskeletal pain, and increased work motivation [93].

During surgery, nurses and surgeons are advised to adopt a neutral (ergoma) body position to reduce muscle tension. According to M. Dairywala et al. [93], the neutral body position is a position in which little or no pressure is exerted on body parts. This position can be maintained for an extended period and provides biomechanical stability to the body (**Fig. 3.1**).

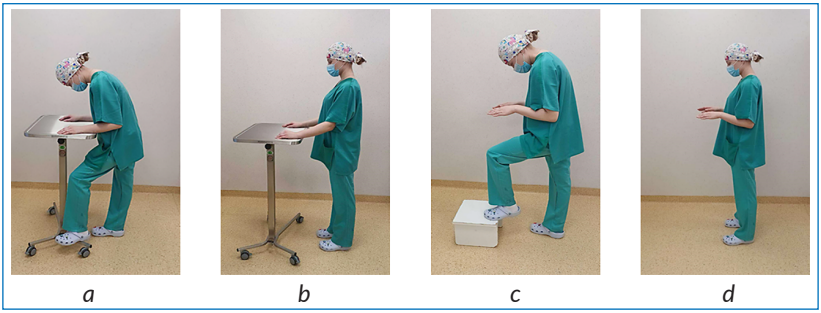



**Fig. 3.1.** Posture in the operating room: *a* – irregular during instrumentation; *b* – regular during instrumentation; *c* – irregular during assisting; *d* – regular during assisting
*Source: photographs by the authors, based on [94]*
*Note: in the photos, for a clearer view of the bending of the arms at the elbows and the position of the body, the operating room nurse is not wearing a sterile surgical gown and gloves; the instrumentation table is also not sterile*

It is recommended to maintain a neutral body posture for as long as possible during the operation. However, it goes without saying that it is not possible to remain in this position throughout the operation, as it is necessary to connect the equipment, collect additional surgical aids, and carry out other tasks specific to the course of the operation (**Table 3.3**).

To sum up, the neutral position of different parts of the body is the one in which there is little or no harmful pressure on them. Furthermore, a neutral posture is a comfortable position that can be maintained for an extended period. It supports the natural curvature of the spine, providing the body with a biomechanical advantage in performing work. It is important to follow the established ergonomic guidelines, as the positions that deviate significantly from them are considered a major ergonomic risk.

Modern robotic technology is also penetrating the healthcare system to help surgeons and operating room nurses work ergonomically and qualitatively. The results of a study by J. Cha et al. [95] showed that the upper body exoskeleton used by the operating team significantly reduced muscle tension and prevented musculoskeletal pain. It is one of the most effective ergonomic tools, allowing staff to work comfortably and safely in a physiological position, thereby preventing acute and chronic musculoskeletal problems.

Surgeons and nurses often have to work in elevated ambient temperatures when operating under intense lighting and wearing extra clothing.

A study examining the effects of heat stress on laparoscopic surgical tasks found that working at 26°C for even a short period (30 minutes) led to a greater sense of distraction and physical exertion. Increased temperature in the operating room may promote excessive sweating, which can contribute to contamination of the surgical field. Previous studies have found that surgeons and operating room nurses feel most comfortable at 19°C with 50% relative humidity, whereas anaesthesiologists and anaesthesia nurses prefer a temperature of 21.5°C [96].

**Table 3.3** Recommendations for adopting a neutral body posture

| Body part | Neutral body position | Recommendations for ergonomic positioning |
|---|---|---|
| Head and neck | The head is on the same level as the spine and is not turned to either side | The head must be upright and tilted no more than 15 degrees |
| Back | Neutral position in the S-curve without bending or stretching | Sit or stand upright without bending the joints to extreme positions; bending of the trunk must be limited to 6–10 degrees from vertical |
| Arms | Lowered straight to the sides of the body | Should hang normally at the side of the body without extending forward more than 40 cm; when extending the arms, they should be held vertically between the waist and the centre of the chest |
| Lower body | Bending in a neonatal posture | Stand upright, occasionally shifting weight from one leg to the other |

*Source: based on [94]*

Work in the operating room is characterised by unique working conditions and nature, long hours of strenuous work, and stressful surgical situations during operations [97]. However, very few studies have been conducted worldwide on the cases of falls among operating room nurses or other operating room staff. A paper published by S. Drebit et al. [98] states that falls are the leading cause of occupational injuries in the healthcare sector. However, the risk factors for falls in this sector have not been sufficiently investigated.

A study by Z. Uğurlu et al. [99] in Turkey, involving 74 operating room nurses, found that 20.3% of participants fell in the operating room at least once due to slippery floor ($n$ = 9), tripping over cables ($n$ = 2), losing their balance on stairs ($n$ = 1), or while running to an emergency patient ($n$ = 1).

***Examples***

**Fig. 3.2** illustrates situations where frayed wires and pump systems on the ground can lead to a fall among operating staff.

**Fig. 3.2** A potential cause of staff falls is scattered wires in an operating room
*Source: photos by the authors*

Physical activity should be considered in the search for efficient, cost-effective, and comprehensive measures that can benefit operating room nurses and other healthcare professionals working in high-risk settings, as physical activity, health, and quality of life are closely interlinked.

According to the World Health Organisation (WHO), physical activity is defined as movements induced by skeletal muscles that result in greater energy expenditure than in a state of rest [100].

Physical activity, exercise, and sports are attributed to personal human behaviour. Physical capability is the result of their practical application that can be characterised by the ability to achieve specific standards, norms, or levels of physical activeness. All adults should engage in regular physical activities for at least 150–300 minutes of moderate-intensity aerobic physical activity per week, or at least 75–150 minutes of vigorous-intensity aerobic activity per week, or an equivalent combination of the two (moderate- and vigorous-intensity). It is also advisable to build strength in all large muscle groups at least twice a week, or more, with a range of moderate- to high-intensity strength exercises [101].

A large-scale survey of emergency and operating room nurses in Greece ($N$ = 476) found that the level of physical activity was low in 44.5% of nurses, moderate in 33.4%, and high in 22.1%. Statistically significant correlations were observed between the quality of life, work, and physical activity. These findings suggest that nurses' participation in physical activities is beneficial to maintaining their health and the quality of their work and services. The most popular forms of physical activity among the nurses in the study were brisk walking, dancing, running, cycling, and swimming [102].

*Ergonomic risk factors trigger musculoskeletal disorders, which are particularly prevalent among healthcare workers. The main causes are heavy lifting, incorrect posture, repetitive movements, vibration, and a lack of ergonomic equipment. Healthcare professionals often experience pain in their neck, shoulders, back, and limbs, which can affect the quality of their lives and work. The treatment of musculoskeletal disorders entails high financial costs. The introduction of ergonomic devices such as*

*height-adjustable furniture and supports, as well as the use of modern technologies such as exoskeletons, significantly reduce muscle tension and pain. Practical training in ergonomics and following guidelines is an effective way for operating room staff to enhance musculoskeletal health and functionality. Physical activity is another effective preventive measure. Regular physical activities, such as brisk walking or swimming, improve health and quality of work. More physically active healthcare workers experience fewer health issues and tend to appreciate the quality of their lives better.*

## 3.3 Addressing the physiological needs of operating room nurses and the challenges they encounter

Operating room nurses often face limited opportunities to meet their physiological needs during the operation, such as drinking, eating, toileting, and sleeping. The intensive and prolonged activities in the operating room cause these problems. In practice, neither the operating room nurse nor the surgeon working in a sterile environment can withdraw from the operation to meet their physiological needs so that the patient's safety and sterility, which must be maintained throughout the operation, are ensured. There has been no research on this topic in Lithuania, and there is very limited research on this topic in other countries around the world.

**Drinking water and nutrition** are crucial for maintaining health, productivity, and overall well-being. The human body is very sensitive to hydration levels and water loss, which is between 1 and 2% of the total body weight. According to D. Parry et al. [103], this level of water loss can have a negative impact on physical and cognitive functions (memory, attention, and decision-making). Therefore, it is clear that water is a prerequisite for maintaining the biological functions of the human body.

However, research in the scientific community is mainly focused on the issues related to patients' dehydration and the impact of liquid deprivation on health and reducing complications. With knowledge of the physiological importance of drinking water and the negative effects of water deprivation, it is possible to imagine what happens to operating room staff working for several hours or more in a sterile operating room environment with no access to water.

A study in the United Kingdom revealed that medical errors are linked to patients' deaths (1 in 300 deaths per day). During Ramadan, there was a significant increase in the number of deaths of patients undergoing surgery as a result of medical errors, which suggests that for the staff working in the operating room, the consumption of liquids (especially water) and the provision of nutritional needs are not only very important for the health of the operating room team but are also a very important factor in patient's safety during surgery [103].

A study in the United States [104] found that 79% of surgeons experienced dehydration within 6 hours of surgery because they had not consumed liquids for 6 or more hours. 71% noted that not consuming liquids affected their

performance. Symptoms associated with inadequate drinking were dizziness, pain, and constipation. Starvation, prolonged sedentary behaviour for several hours or more, and dehydration are common problems that can negatively impact the quality of work and overall well-being during surgeries. In addition, dehydration affects women and men differently, with women developing dehydration more quickly and experiencing greater health problems than men.

According to the World Health Organisation (WHO), a healthy diet is the foundation of our well-being and health, while an unhealthy diet is one of the most significant risk factors for the global burden of diseases. Unhealthy diets contribute to obesity, cardiovascular disease, type 2 diabetes, cancer, and other chronic non-communicable diseases [49].

Nurses' jobs require them to work long hours and shifts, which is not only very tiring for the professionals but also potentially disruptive to their diet and habits.

Global scholars poorly study the dietary habits of operating room nurses. In Lithuania, there is no research of this kind at all. In the United States, a study suggests that nurses' dietary habits at work are detrimental to their health, as they often eat irregularly and infrequently due to stressful working conditions and frequently choose unhealthy foods that require minimal preparation time. Hospital managers do not do enough to improve the nutrition of their staff [105].

The global scientific literature does not yet provide data specifically on nurses' nutritional peculiarities in the operating room. However, it is evident that their dietary habits at work pose challenges to their health and quality of work. This is supported by a systematic review of 21 studies by R. Nicholls et al. [106], which found that the nature of nurses' work, the high workload, and the lack of dining facilities are all significant contributors to malnutrition.

**Hygienic requirements** for operating room nurses include strict requirements for room temperature of at least 22–25°C and humidity of 30–60% [107].

Maintaining this temperature is very important for patients, especially children and seniors undergoing surgery, as lower temperatures lead to hypothermia, impaired vital functions, and poorer postoperative wound healing [108].

Operating room nurses and surgeons have to work in sterile gowns and gloves. It should also be noted that the work of the operating room team requires considerable physical effort and movement. Thus, the patient-friendly temperature of the operating room often causes discomfort for the operating room nurses and surgeons, as they tend to sweat. The worst thing is that the sweat droplets can get into the patient's surgical wound.

**Sleep** plays a crucial role in human life, as quality rest is essential for various bodily functions, including work, learning, memory, attention, the immune system, the cardiovascular system, and liver and metabolic processes. It is recommended that an average adult should get 7 hours or more of sleep per night regularly [109]. A person with sleep problems is more likely to experience anxiety syndrome, depression, and fatigue, which increases the risk of accidents and unintentional errors at work and develops cardiovascular disease,

diabetes, and other health problems. Sleep problems are more common among women than men and have a negative impact on their health [110].

A study in Iran highlights that sleep problems among nurses not only affect their health but also their quality of life [111]. The results of a survey conducted in Turkey revealed that disrupted cognitive and sensory abilities of operating room nurses during operations can lead to serious errors, affecting the safety of both nurses and patients [112]. These findings suggest that identifying and mitigating the factors that cause sleep problems should not be the sole responsibility of nurses. As Y. Han et al. point out, there should be more discussion between the management of healthcare institutions and those who coordinate their performance, such as ministries and departments [113].

Nurses' job is hard and tiring, especially if they work long hours, such as 12 hours or more. This fact is confirmed by a study conducted in the USA, which found that only 60% of nurses had rest breaks during their shifts to sit down and rest. The established correlation between rest breaks and nurses' fatigue and exhaustion suggests that the provision of rest breaks and the satisfaction of physiological needs are a prerequisite for maintaining nurses' mental and physiological health and providing quality nursing care to patients [114].

Publications on the possibility of operating room nurses and surgeons to **use toilets**, which is essential to human nature, are not available worldwide. The scientific world is tight-lipped. It can only be predicted how this actually happens in practice. For instance, an operation can take a couple of hours or more, so what challenges do the staff, i.e., surgeons and operating room nurses, face while working in a sterile environment? Scientific publications that discuss the problems of operating room nurses in terms of access to the toilet often address broader issues, such as working conditions in healthcare settings, nurses' workload, shortages of healthcare staff, or even work-related stress. No separate studies have been conducted to analyse the needs of operating room nurses in terms of meeting physiological needs in the toilet. It is possible that researchers do not distinguish between operating room nurses and other nurses when conducting studies on nurses' occupational risk factors and favourable working conditions. However, operating room nurses must be distinguished from other nurses who work on wards because the specific requirements for operating room nurses in terms of sterility and the long working hours in the operating room (as operations last several hours or more) limit the conditions for meeting physiological needs from drinking and eating to using the toilet.

**Regular menstruation**, linked to physiological changes in women's bodies, is a key feature of reproductive health. However, women's menstrual cycle disorders can also be provoked by risk factors at work. In Lithuania, no scientific publications have been found that analyse work-related menstrual problems in nurses. Researchers from the Asian continent have done most of the research on these issues.

An extensive study in China involving 8304 nurses and 3977 other health professionals found that 41% of nurses experience menstrual cycle disorders. The main cause of these disorders is the frequent use of disinfectants during

work. Statistically significant differences were also obtained, suggesting that long periods of standing, lifting heavy objects, working long hours, and exposure to cytostatic drugs (for cancer treatment) also cause menstrual cycle disorders [115].

A study of 1,249 female nurses in Japan confirmed that night shifts are associated with an increased incidence of irregular periods or amenorrhoea (the absence of menstrual periods) among nurses. More than 30% of Japanese female nurses who worked night shifts complained of menstrual cycle disorders [116].

A study in South Korea involved almost 1,000 nurses and revealed that gynaecological problems, including menstrual cycle disorders, were more common among nurses who worked on shifts than among those who worked only during the day [117]. Shifts, which require working at night, also precondition women's participation in preventive programmes for cervical cancer caused by human papillomavirus. This suggests that nurses working shifts find it more challenging to manage their time and take care of their health.

Researchers in Taiwan [118] managed to prove that nurses experience troublesome menstrual symptoms at work that interfere with communication with colleagues, limit their professional performance, cause stress, and lead to uncertainty about taking medication. However, this is not considered or discussed at the institutional level, and the management does not create the conditions that help nurses perform well and feel better during their periods.

Further investigation of women's menstruation issues, which are particularly relevant to the reproductive-age nurses in the operating room, also highlights social issues. As H. Bhavya argues, the topic of menstruation remains taboo, and discussions on menstruation in the public sphere are considered shameful.

This is particularly the case in developing countries, as illustrated by the example of India, where menstruation is publicly considered "unclean", and menstruating girls are isolated and subject to restrictions within the family [119].

There is insufficient scientific evidence on the discomfort and other problems experienced by operating room nurses during menstruation in the global scientific literature. However, the above findings from the studies conducted in Asian countries suggest that these issues are of particular concern for operating room nurses. Given the nature of operating room nurses' work and the stringent requirements for sterility and patient safety, it is foreseeable that they will be even more uncomfortable with hygiene, the use of painkillers, rest, appropriate positioning, and other measures to help reduce menstrual pain and distress.

*The working conditions of operating room nurses pose many challenges to the patients' physiological and health needs, and there is a lack of research on this topic in Lithuania and globally, which means that to ensure the well-being of the staff and patient's safety, more attention needs to be paid to these issues in the future. Operating room nurses are often faced with limited opportunities to meet basic physiological needs such as drinking, eating, resting, or using the toilet. These problems are caused by long and intensive operations, during which sterility must be ensured and the patient's safety guaranteed. Studies show that dehydration and irregular dietary regimes have a negative impact on physical and cognitive health, reduce performance, and pose a threat to the*

*health of operating room staff and patients' safety. Nurses' dietary habits at work are often harmful to their health, as they eat irregularly due to the stressful working conditions and prefer fast food with low nutrient content. The scientific literature also highlights that sleep deprivation and sleep disturbances increase shift nurses' fatigue, the risk of making mistakes, and the development of various chronic diseases. Another important aspect is the discomfort caused by menstruation and the health issues that nurses of reproductive age face. Studies in Asian countries show that long working hours, standing, and the use of chemicals during operations can lead to menstrual cycle disorders. In addition, menstruation is often considered taboo, and the management does not take steps to address these issues despite the significant impact on the quality of women's work and health.*

## 3.4 Physical, biological, and chemical occupational risk factors affecting operating room nurses and their management

### 3.4.1 Physical risk factors

The operating room is a high-risk physical environment where a variety of undesirable events can occur, affecting not only the patient's health but also the health of the staff. Physical hazards in the operating room include exposure to fire, electric shock, radiation, lasers, and compressed gases.

Electrocoagulation is the process in which an electric current is applied to the skin and other tissues using a special device at the end of which a needle or a knife is attached to disrupt the skin and other tissues, aiming to stop bleeding from the surgical wound, separate the tissues, and cut them. Laser and electrosurgical operations release significant quantities of toxic substances, including carbon monoxide, acrylonitrile, hydrogen cyanide (hydrocyanic acid), and formaldehyde, into the operating room environment. Hazardous substances in surgical fumes can pose a health risk to operating room staff. Therefore, the use of preventive measures, such as a fume hood, is a very important step in preventing the release of hazardous fumes into the environment [120].

Although electrocoagulation has been used in global surgical practice for several decades, the health risks of electrocautery fumes for operating room nurses and other team members have only recently become more widely discussed. Consider what it is like to work one day in an operating room with exposure to electrocautery fumes from burnt human tissue. It may sound very frightening, as it is equivalent to smoking 30 cigarettes per day [121].

Depending on the amount of time spent working with the electrocautery device during surgery, specific symptoms may occur. Minor effects, which occur with less time spent in the operating room where electrocoagulation is performed, include headache, weakness, nausea, runny nose, watery eyes, and, in more severe cases, bronchial asthma [122]. The causal relationship between neurotoxins, carcinogens, and mutagens in surgical fumes and tumours is

discussed in case studies [6, 9]. In a review of 43 scientific articles from PubMed, researchers K. Bree et al. [123] from the United States of America concluded that surgical fume can cause a range of health issues, including headaches, skin, eye, nose, and throat irritation, coughing, nausea, allergies, asthma, bronchitis, anaemia, cancer, hypoxia, hepatitis, and anxiety. Any of these may contribute to increased morbidity and mortality among operating room staff.

Burns or even fire can be caused during surgery. There are no studies on this topic worldwide. However, the information accumulated by the authors of this monograph during their professional career suggests that there is a possibility of fire in the operating room, and patient's burns are also possible due to inappropriate use of electrosurgical devices, lasers, or heating devices (for the prophylaxis of hypothermia). Patient's skin burns can also be caused by chemicals such as antiseptics or an electrode from an electrocautery device that has been improperly applied to the patient's skin or has become wet.

Several studies related to burns among operating room staff have been conducted in Turkey. Only one (out of 148) operating room nurses suffered a fire during surgery in the course of professional activities. However, 46.3% of nurses reported burns on the patients' skin as a result of an electrocautery device being held against the skin and accidentally activated. According to the researchers, it is pretty rare for patients to suffer skin burns during surgery, as 86.4% of nurses defined this event as very rare. The findings presented by the researchers are somewhat alarming, as it was found that most of the operating room nurses take certain fire safety precautions, but these are not sufficient [124]. Operating room nurses are less likely to experience skin burns when working with electrocautery. Only 5.4% of them have experienced burns while working with electrocautery devices [99].

However, burns are only one of the physical hazards. Chinese researchers have found that nurses working in operating rooms and intensive care units are the most exposed to radiation [125]. As many as 71% of the Turkish operating room nurses in the study reported health problems caused by exposure to radiation, such as headaches, fatigue, weakness, anaemia, and anxiety. There were even some cases (a few per cent) in which operating room nurses attributed their infertility or miscarriage during pregnancy to possible radiation exposure at work [99].

In the medical field, ionising radiation has become an essential tool for diagnosing various diseases and has been used in surgical procedures. The most significant exposure in medical institutions is caused by fluoroscopic imaging, where X-rays are used to obtain dynamic and kinematic functional images [126].

The risk of exposure to radiation of the operating room staff is increasing due to the increased use of fluoroscopic imaging during surgery. Increased radiation risk has been linked to an increased risk of malignancy, vision problems, and thyroid problems.

Very high exposures have been found in spinal surgery and intramedullary nailing. With the increase in modern and percutaneous techniques, the use of intraoperative fluoroscopy has increased [127].

Depending on the physical hazards, operating room nurses experience headaches, visual and hearing impairment, fatigue, and feel weak [128].

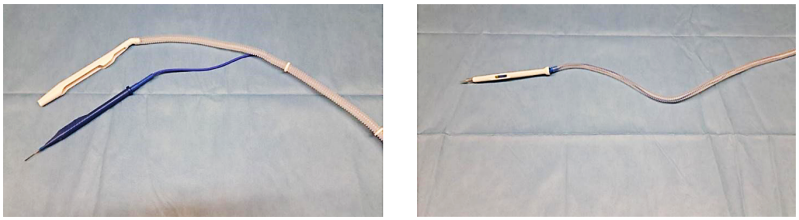
Causes of adverse events in the work of operating room nurses (occupational hazards) are attributed to increased workload and stress in the professional environment. A study conducted in Iran reveals that shift work and work overload are the leading causes of occupational accidents. Reducing the workload of operating room nurses, providing guidance, and effective training in preventive measures can help reduce adverse events at work [129].

Y. Hao and J. Shi [130], using PICOS criteria, selected 9 articles from PubMed and CINAHL databases and, based on their results, proposed effective methods to reduce physical factors in the operating room. To protect against surgical fumes, they suggest the use of smoke aspirators and smoke suction systems; training for operating room staff on the harm and preventive measures of these fumes; and the development of methodological tools (protocols) on work organisation and the roles of operating room staff. For protection from radiation, they also propose staff training and proper use of protective equipment.

***Examples***

A collector of the harmful fumes released during electrocoagulation.

In **Fig. 3.3**, the first picture provides the fume extraction and filtration system connected to the electrocautery device, and the second picture shows the fume extraction and filtration system integrated into the electrocautery device.



*a* *b*

**Fig. 3.3** Fume extraction and filtration systems for surgical procedures:
*a* – a surgical fume extraction and filtration system in combination with an electrocautery device (monopolar); *b* – a surgical fume extraction and filtration system installed in a surgical fume extraction and filtration system integrated into an electrocautery device (monopolar)
*Source: photos by the authors*

*The operating room environment is characterised by increased physical risks, ranging from surgical fumes, radiation, electrocution, and laser exposure to burns and fires. Electrocoagulation and surgical fumes cause health problems, including respiratory irritation, headaches, asthma, and long-term cancer risk. Exposure to radiation increases the risk of infertility, thyroid problems, and malignancy for operating room staff. Preventive measures such as fume aspirators, radiation protection measures,*

*and occupational safety protocols can significantly reduce the risk. Training of operating room staff and appropriate working conditions are essential to reduce the likelihood of adverse events.*

### 3.4.2 Biological risk factors

Healthcare workers' injuries with needles and other sharp objects are risky not only because of mechanical injury to tissue but also because of the increased risk of blood-borne infections from the patient. Needlestick pricks are the most common cause of occupational adverse events among healthcare workers (mainly nurses).

A study in Israel found that as many as 53% of healthcare professionals have been injured with needles. Needlestick injuries are most common among older workers, especially men, and among those who lack knowledge about preventing injuries caused by sharp medical instruments. When comparing by department, the incidence of needlestick injuries was highest among the staff in surgical wards and operating rooms [131].

V. Bevan et al. [12] conducted a systematic review of 16 selected research articles that published data on surgical instrument and needle injuries among operating room nurses. It was found that 22% ($N$ = 3460) of pricks were made by sharps and needle sticks during procedures where instruments were passed or received. The lowest recorded incidence was 14.2%, and the highest was 31.3%.

Egyptian researchers H. Asfour et al. [132] found that 25% of injuries to nurses are caused by instruments contaminated with blood or other human body fluids. One in three nurses' experiences stress related to possible sharps injuries. One in two nurses in the study had experienced high levels of stress following such an injury (Event Scale-Revised Scores). The stress of sharps injuries can predispose nurses to Post-Traumatic Stress Syndrome (PTSD).

In Lithuania, there is still a lack of research on the issue of sharps injuries among nurses in the operating room. A study conducted by N. Surgunt and D. Kriukelytė [133] almost a decade ago revealed that among the operating room nurses in Lithuania, there was not a single one who had not experienced a sharps injury at least once during their professional career. A needlestick caused the most frequent injury (40.6%), and most frequently (46.3%), the injury was caused by blood contamination of a medical instrument. In terms of injury severity, 48.6% of operating room nurses experienced superficial injuries.

The dangers of biological risk factors are not limited to sharp surgical instruments and needles. Israeli researchers have found that micro-organisms of bacterial origin can be found on protective lead vests, especially collars, which are designed to protect the staff working with X-rays from radiation. Staphylococcus epidermidis was detected on 87.8% of the lead collars used. Other cultures of microorganisms (*Micrococcus spp*., *Acinetobacter lwoffii*, *Bacillus species*, *Moraxella osloensis*, and *Pseudomonas stutzeri*) were also detected but less frequently [7].

Potential physical risks of electrocautery to operating room staff were presented above. However, potential biological hazards associated with the use of this device have also been observed. Viral diseases can be contracted through the fumes emitted by the electrocautery. In 2020, as coronavirus infection spread worldwide and became a pandemic, studies revealed that SARS-CoV-2 viruses were found in the fume of the burnt tissues of operated patients with Covid-19 disease [134, 135].

Human papillomavirus (HPV) can also be released into the environment via surgical fumes during laser and electrosurgical operations. The virus-damaged body cells are destroyed during surgery, but the aerosols released by these viruses are emitted into the environment. Although this mode of transmission is not very common, the use of prophylactic measures, such as surgical fume hoods and medical masks with filters, is an important measure to protect against HPV [136, 137].

Surgical fumes are composed of vapour (95%), and the remainder (5%) is composed of tissue cell debris containing viruses and bacteria. It has been determined that in addition to HPV, surgical fumes can expose operating room staff to organisms of bacterial origin, such as staphylococci [6]. A systematic literature review conducted by A. Merajikhah et al. [138] confirmed the above findings that surgical fumes and lasers pose a risk to operating room staff as they cause health disorders and the likelihood of contracting viral and bacterial diseases due to the presence of HPV, E. Coli bacteria, and even hepatitis B virus.

Splashing or spilling body fluids or blood and the content of exploded hollow organs do happen in practice. However, there is virtually no research on this topic in the scientific community. The results of a study conducted in Turkey with 74 (out of 88) operating room nurses in 6 private hospitals confirm the relevance of the issue of splashing with blood or body fluids, as the number of such cases is very high. As many as 90.5% of the operating room nurses stated that they had experienced situations in which they had been splashed with blood or body fluids [99].

The European Agency for Safety and Health at Work [78] sends a clear message that a comprehensive set of educational, managerial, and organisational measures can reduce occupational risk factors in the working environment by 80%.

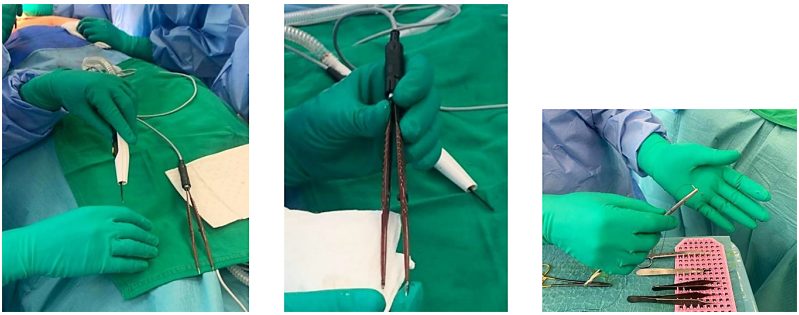
There must also be a strong focus on strengthening teamwork and broader implementation of training programmes for employees, the development of protocols, and strengthening the responsibility of the hospital as an institution and that of its employees [139].

Y. Hao and J. Shi [130] propose effective ways to reduce biological agents in the operating room. They suggest wearing double gloves to protect against injuries from sharp instruments, using blunt needles to suture organs and wounds, and wearing protective goggles to prevent the contents of an exploded hollow organ or drops of blood from getting into the eyes. Protection against infections during surgery includes observing proper practices and maintaining an effective ventilation system. Hospital management can improve safety

by establishing guidelines for the protection of nursing staff in the operating room, developing detailed protocols, allocating financial resources, organising on-the-job training programmes for staff, setting up audit teams to ensure compliance with them, and counselling the staff.

***Examples***

In **Fig. 3.4** and **3.5**, the photos show that an injury with an electrocautery device (when working with a monopolar electrocautery) or electrocautery tweezers (when working with a bipolar electrocautery) can be a bio-infection, as the injury can occur during the operation when the surgical instruments are contaminated with the patient's blood (as it is well-known, blood can spread various infections such as HIV, hepatitis B, C, etc.).



*a* *b* *c*

**Fig. 3.4** Potential electrocautery (*a*, *b*) and surgical needle (*c*) injuries as biological risk factors
*Source: photos by the authors*

**Fig. 3.5** Potential intestinal content exposure due to ruptured bowel as a biological risk factor
*Source: photos by the authors*

*Biological risk factors in the operating room environment occur not only due to exposure to sharp instruments but also to micro-organisms found on lead guards and in surgical fumes. Splashing operating room staff with patient's body fluids or blood is also a significant risk. However, there is still a lack of research on this topic. European and international organisations emphasise the importance of preventive measures, including the use of double gloves, blunt needles, wearing protective goggles, effective ventilation, and educational programmes. Hospital management needs to reinforce staff training, develop safety protocols, and carry out regular audits to mitigate occupational hazards and ensure staff safety.*

### 3.4.3 Chemical occupational risk factors affecting operating room nurses

Nearly 100,000 different chemicals are registered on the European Union market each year, and around 400 million tonnes of chemical products are produced. More than 600,000 chemicals are used in manufacturing and agriculture in Lithuania. The harm to human health caused by chemical agents can be evident immediately or develop later. Studies show that a large proportion of European employees are exposed to hazardous chemicals in their work environment; therefore, it is essential to consider their toxic properties, which can lead to acute or long-term health effects [140].

People of working age spend more than half of their lives at work. Naturally, the work environment is often filled with harmful substances and chemicals, which is particularly concerning for health professionals.

Disinfectants can be broadly defined as chemicals used on inanimate objects to neutralise the most known pathogenic microorganisms. Hundreds of chemicals are used in healthcare for aseptic and antiseptic purposes, which, when grouped, are known as Alcohol Sodium Hypochlorite, Sodium Dichloroisocyanurate, Chlorine Dioxide, Super-Oxidized Water, Formaldehyde, Glutaraldehyde, Hydrogen Peroxide, Iodophors, Peracetic Acid and Hydrogen Peroxide, Phenolics, and Quaternary Ammonium Compounds [141].

Chemical hazards include toxic, corrosive, irritant, carcinogenic, flammable, and mutagenic substance. According to their severity, they are classified into six classes (A, B, C, D, E, and F) (**Table 3.4**).

The study by P. Moradi Majd et al. [142] also analyses the data on hospitals' readiness or protocols for chemical incidents and threats found by searching six electronic databases (MEDLINE, PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar). Using PRISMA guidelines, the review identified 11 main thematic categories, including requirements for planning, decontamination, personal protective equipment, training, communication, and impediments to planning. The authors highlight that significant deficiencies still exist in the management of chemical hazards in healthcare settings.

**Table 3.4** Classification of chemical hazards by severity class

| Classes | Description |
|---|---|
| Class A | ■ compressed gas;<br>■ dissolved gas or liquefied gas |
| Class B | ■ flammable gases;<br>■ flammable and combustible liquids;<br>■ flammable solids;<br>■ flammable aerosols;<br>■ reactive flammable materials |
| Class C | Oxidizing materials, i.e., oxidizer and organic peroxide:<br>■ oxidizer: chlorates, nitric oxide, peroxides, permanganates, perchlorates, nitrites, nitrates, and easily oxidize metal powder;<br>■ organic peroxide: tetra hydro furan, diethyl ether, dioxane, and methyl isobutyl ether |
| Class D | Poisonous and infectious materials, e.g., cyanides, tea salts, and asbestos |
| Class E | Corrosive materials, e.g., inorganic acids and bases, hydrogen fluoride |
| Class F | Dangerous reactive materials, e.g., ethylene dioxide, organic azides, Na, Li, Ca |

*Source: based on [143]*

A. Danjuma et al. [2] identify the following main chemical risk factors:

- anaesthetic gases;
- soaps and disinfectants used for surgical handwashing (scrubbing);
- disinfectants used for instruments and surgical devices;
- airborne aerosol droplets of chemical solutions;
- sterilising fluid (e.g., glutaraldehyde);
- wearing latex gloves or exposure to latex-containing medical devices.

Hazards, especially chemicals, have been found to increase the risks of miscarriage and infertility in pregnant women working in operating rooms, endanger foetal health, and increase the incidence of foetal anomalies [8]. Occupational exposure to inhalational anaesthetics is associated with health problems, including women's reproductive health. L. Oliveira et al. [144] conducted a systematic review of 18 studies published in databases. Their findings highlight a significant correlation between exposure to inhalational anaesthetics in the work environment and the risk of spontaneous abortion. This risk was particularly pronounced among professionals working longer hours or in environments without effective gas removal or ventilation systems, which may increase the likelihood of spontaneous abortion in this group of women.

Dermatitis is a common problem in healthcare workers, especially nurses, due to their frequent exposure to various allergic and irritating substances [145]. Exposure of nursing staff to chemicals is primarily related to the use of disinfectants, medications, and metal instruments made from harmful substances, such as nickel, chromium, or their alloys with cobalt [146].

The staff working in the operating room are more exposed to chemicals, such as anaesthetic gases, and are at a higher risk of allergies to latex gloves than those working in other departments. A study in Egypt, involving 176 nurses working in the operating room at Benha University Hospital, found that scrub nurses working in a sterile environment are exposed to anaesthetic gases in a manner similar to anaesthetic nurses. Operating room nurses working in a non-sterile environment (circulating nurses) have significantly lower exposure to anaesthetic gases. However, when assessing latex glove allergy and skin problems due to disinfectant use, scrub nurses working in a sterile environment are more affected than nurses working in a non-sterile environment and anaesthesia nurses [39].

The results of a study conducted in the operating rooms of Polish public hospitals involving 625 operating room nurses confirm the above findings on the risk of chemical agents to the health of operating room nurses. 78.9% of operating room nurses reported that the use of disinfectants in their work has an adverse effect on their skin and causes various problems, such as dermatitis [146].

The results of a study in Spain, involving 157 operating room nurses and 157 ward nurses, confirm that operating room nurses are more likely to suffer from hand dermatitis (21.2%) than ward nurses (12.6%) [10].

A study in Portugal involving 214 operating room staff members, including doctors and nurses, revealed an important fact about chemical risk factors. 12% of accidents among operating room staff are related to chemicals. Only one in two workers in the study had received training in occupational risks. Statistically significant differences were obtained between the staff's knowledge of how to manage chemical occupational risk factors and accident rates [147].

The European Union has legislation regulating the use of hazardous substances in the work environment. In the Republic of Lithuania, the Law on Safety and Health at Work obliges employers or their representatives, such as occupational health specialists, to ensure that employees are provided with safe and health-protective working conditions.

EU Directive 98/24/EB [65] regulates the management of chemical agents in the workplace. The document places a strong emphasis on employers, who are first responsible for identifying whether any harmful chemical agents are present in the workplace. If they are present, the employer must assess the risks posed by these harmful agents to the safety and health of the staff.

Based on Order of the Minister of Health No. V-209 of 15 March 2012 "On the approval of the activities of the Institute of Hygiene for 2012", the specialists of the Lithuanian Institute of Hygiene prepared "Practical recommendations on the assessment of the exposure of workers to chemical substances". These recommendations are intended for occupational safety and health specialists and institutions that conduct research on chemical agents and assess occupational risks [148]. The guidelines provide information on how to identify chemical agents in the work environment, take air samples, conduct chemical

agent tests, assess their risks appropriately, and provide preventive measures to mitigate or eliminate these risks.

*To sum up, the mitigation of chemical risks in the operating room may depend on the staff member's responsibility to use personal protective measures when working with chemicals, undergo periodic health checks, and take a systematic interest in relevant legal documents and methodological recommendations. There is also a significant role for the employer, the institution, and the department management, who must systematically assess chemical risk factors, enable the correct use and disposal of chemicals, regularly check the health of the staff, and, as far as possible, opt for less toxic chemical products.*

## 3.5 Psychosocial occupational risk factors affecting operating room nurses and their management

### Occupational stress and fatigue in operating room nurses

Operating room nurses work in stressful conditions that require not only good technical skills but also psychological resilience. Psychological stability is needed to ensure patients' safety, cooperation, and a good distribution of roles among team members. A positive emotional atmosphere in the workplace increases motivation for work and professional development, reduces occupational risks, prevents burnout syndrome, and helps avoid medical errors that affect patients.

In the search for answers to the causes of stress in operating room nurses, it is worth mentioning the specific requirements of the operating room environment. The operating room is a unit that is isolated from other units, with strict hygiene and organisational requirements for access. This confined space may be a contributing factor to stress among operating room staff.

As mentioned in the previous chapters, there are more studies on occupational risks for operating room nurses in Eastern than in Western countries. Researchers in these countries have been courageous in their efforts to shed light on the prevailing problems.

The specific requirements, which include a confined and *isolated space*, are characterised by a lack of natural light, as many operating rooms are windowless, so there is no possibility of daylight entering the operating room. According to C. Meng et al. [149], natural light has a positive effect on a person's positive emotions. It reduces emotional problems, such as anxiety and depression, and has a positive impact on hormone production. Lack of natural light and working in an isolated environment can lead to anxiety and depression.

The Swedish researchers J. Golvani et al. [150] successfully determined the impact of natural light on the psychological well-being of operating room nurses. Daylight had a significant impact on nurses' well-being, improving their mood, energy, and work performance, compared to the artificial lighting used in

the operating room. The limited presence of daylight caused fatigue and stress. Daylight and the opportunity to look out of the window reduce the feeling of isolation and confinement in the operating room, thereby improving well-being. Therefore, daylight should be considered in future studies and while designing new operating rooms.

Studies show that there are more physical factors in the operating room that contribute to the stress of operating room nurses. The operating room is characterised by its high noise levels, which are exacerbated by the presence of various noise sources, including pumps, electrocautery devices, and other equipment used during surgery. The World Health Organisation (WHO) recommends that the level of continuous background noise in hospitals during the day should not exceed 35 dB to allow effective communication [151].

Turkish researchers A. Arabaci et al. [152] have also identified the impact of noise on the psychological health of operating room staff. They report that from the time of incision of the wound to its closure and dressing, operating room nurses were exposed to noise levels above 35 dB, which negatively affected the psychological health and stress of the staff, and conclude that the higher the noise level in the operating room, the more stressful the members of the team feel.

In Iran, a study conducted at Amadan University Hospital of Medical Sciences showed that 62.2% (out of 172 operating room nurses) experienced high occupational stress, with the most common cause being the fear of injury and being pierced by a scalpel [153]. A study conducted by Z. Uğurlu et al. [99] in Turkey revealed that as many as 91% of operating room nurses experience occupational stress.

A. Wheelock et al. [4] from the United Kingdom support the correlation between a *lack of surgical tools* and stress. They also provide evidence that acoustic distractions (when someone is discussing non-operative issues) also cause stress for operating room nurses.

The results of a study conducted by A. Sami et al. in Saudi Arabia indicate that when a surgeon experiences stress related to a specific trigger in the operating room, it naturally affects operating room nurses. However, the researchers limited themselves to examining these triggers through the surgeon's lens, without considering the operating room nurses. Of the 110 stressors potentially affecting surgeons, the most frequent were due to technical failures, such as problems with surgical instruments, work interruptions caused by sterilisation processes, and the accidental dropping of surgical instruments on the floor during surgery (16.4%). The most prevalent causes of stress (15.5% were non-functioning working tools (e.g., the equipment that stops bleeding, pumps that do not perform the suction function, etc.). Teamwork issues emerged as a factor causing stress during surgery for 15.5% of surgeons. The authors directly identified them as miscommunication with nurses, assisting and technical staff, and anaesthetists [154].

Having conducted a meta-analysis of a dozen studies, the Australian researchers R. Mcmullan et al. [16] send the message that *disruptions by members*

*of the operating room team*, as well as various distractions during surgery, are not only responsible for an increase in stress but also endanger patients' safety and cause complications during surgery.

The stress of operating room staff is directly related to the team's attitude towards them and, in particular, to the behaviour of the operating surgeon. If the surgeon lacks a culture of communication and behaves destructively, nurses and other staff in the operating room will experience stress and negative emotions that not only cause professional dissatisfaction with their work but also affect their personality [155].

In Turkey, a study by Z. Uğurlu et al. [99] showed that 91% of operating room nurses perceived their work as stressful. The reasons given are related to ineffective teamwork (42%), high workload and staff shortages (27%). A study in Japan showed that 40% of operating room nurses experienced psychological stress during surgery due to ineffective teamwork [156].

The causes of stress may also be related to increased *fatigue among staff.* Fatigue is a major problem for nurses in the operating room. It increases stress levels, as a study carried out in Turkey reveals. More than half of the operating room nurses (52.2%) reported feeling tired due to the hard, responsible, and stressful work, which is characterised by long working shifts of 12 or 24 hours a day. The most common causes of fatigue among nurses were demanding work, work-related stress, understaffing, unfavourable work environment factors, and excessive overtime. Research findings convey the message that to ensure patient safety and the health of operating room nurses, a significant amount of attention should be devoted to the management of the institution and its units. It is their responsibility to assess and control all processes that take place in the operating room and make efforts to ensure that their staff work in a safe and motivating environment [112].

Nurses' work is hard and tiring, especially if they *work long shifts*, such as 12 hours or more. This statement is confirmed by a study conducted in the United States, which found that only 60% of nurses had rest breaks during their shifts to sit down and rest. The correlation between rest breaks and nurses' fatigue and exhaustion suggests that providing rest breaks and satisfying physiological needs is a prerequisite for nurses to maintain their mental and physiological health and ensure quality nursing care for patients [114].

## Burnout syndrome – a consequence of occupational stress

The stress experienced by nurses in the operating room can have a negative impact on their health and quality of life, as evidenced by the results of the studies presented below. Nurses working in the operating room are under tremendous stress by the nature of their work. Occupational stress is a negative emotional and physical reaction to occupational activities when demands exceed an individual's abilities, knowledge, or resources [157].

Burnout, also known as burnout syndrome, is the result of prolonged exposure to intractable and complex situations that cause prolonged stress, leading to emotional, mental, and physical exhaustion. The term "burnout syndrome" was first used by the psychoanalyst Freudenberger in the early 1970s. Burnout can occur in any profession, but it is particularly common among healthcare professionals [158].

A study in Spain found that one in four nurses working in the operating room (25%) had experienced burnout syndrome [10]. S. De Hert [159] points out that staff working in operating rooms are at higher risk of burnout. This can have significant negative personal consequences (alcohol and drug abuse, broken relationships, and even suicide). Burnout syndrome also has professional consequences for medical staff, such as lower job satisfaction, reduced quality of work, and inappropriate and rude behaviour towards colleagues and patients.

A study conducted in Iran found that nurses experience high levels of stress at work, which has a negative impact on their professional performance, as well as personal physical and mental health and quality of life. Nurses experiencing high levels of occupational stress often feel more energetically exhausted at work, are less productive, and do not provide quality nursing care to patients. Furthermore, this stress has a negative impact on patients' health outcomes [17].

In Iran, the findings of a qualitative study on operating room nurses conducted by E. Teymoori et al. [160] highlight the negative impact of institutional factors and colleagues, especially surgeons, on the development of burnout syndrome. Poor competence of the unit manager, indifference, high and undefined work demands, and the aggressive and authoritarian behaviour of the surgeon are the main factors contributing to burnout syndrome in operating room nurses. Taking these factors into account, nursing management and nurses can consider appropriate strategies for preventing and managing burnout syndrome.

The Lithuanian researchers N. Mickiene et al. [13], in a systematic review of 31 articles, suggest that physical, chemical, biological, and psychosocial factors cause stress in operating room nurses. High workload, night work, underpayment, understaffing, and interpersonal conflicts with supervisors are also commonly identified as stressors for nurses. The authors define the negative health consequences of work-related stress as cardiovascular, respiratory, digestive, nervous, muscular, and reproductive health problems.

As stated in the recommendations for healthcare professionals adopted by the Lithuanian Institute of Hygiene [82], to reduce occupational fatigue, it is essential to ensure the health of healthcare professionals, the quality of their work, and the safety of patients. Physical and emotional exhaustion, often caused by an intense workload, increases the likelihood of errors, reduces efficiency, and adversely affects treatment outcomes. Constant stress and burnout at work can lead to serious mental health problems such as depression, anxiety,

and other psychological disorders. It is therefore essential to prioritise improving working conditions and offering psychological support to medical staff.

## Possibilities for improving stress management and teamwork among operating room nurses

Surgery is a high-risk area of science and practice where different specialists collaborate, performing various functions according to their competencies to achieve a common goal. C. McElroy et al. [161] refer to the operating room team as an 'action team' and compare nursing to the riskiest professions, such as those working in aerospace, car racing, or sports teams. Surgery is a stressful activity that requires skilled technical performance and non-technical skills, otherwise known as soft skills, such as communication, teamwork, quick decision-making, tolerance, and empathy [162].

For nurses, work stress is part of their daily lives as they are exposed to a huge amount of responsibility when providing care to patients. A special role is assigned to the profession of an operating room nurse because this profession requires the ability to work in a team and manage stressful situations, as the results of the team's performance, the success of the operation, and sometimes the patient's life, depend on it [163].

Quality teamwork among operating room staff is crucial to the efficient and safe performance of their responsibilities. In the monograph on nurses' teamwork competencies, V. Žydžiūnaitė [164] emphasises that teamwork competencies are essential for effective patient' care, as healthcare is a complex activity that requires cooperation, trust, and clear communication between different professionals. The author identifies communication, cooperation, leadership, and problem-solving skills as key and important teamwork competencies.

At the end of the 20$^{th}$ century, Western nursing researchers sought to answer questions related to effective teamwork in the operating room. A cross-cultural study involving operating room nurses in Finland, England, and the USA highlighted the professional and organisational limitations and opportunities of teamwork. In the USA, effective teamwork is negatively impacted by overtime and the frequent rotation of team members between different operating room profiles, which complicates nurses' work due to the diversity of activities and the rapid changes in surgical technology. A qualitative study highlighted a lack of attention to recording and analysing medical errors, as well as improving the psychological state of the team in response to unintentional errors, in Finland, the UK, and the USA. Twenty years ago, it was predicted that there would be a shortage of operating room nurses due to the ageing staff working there. One of the messages sent was to mix nurses of different ages when scheduling shifts so that the older generation of operating room nurses could share the invaluable professional experience they had accumulated over the years [165].

One of the messages sent was to mix nurses of different ages when scheduling shifts so that the older generation of operating room nurses could share the invaluable professional experience they had accumulated over the years [165].

However, there are still practices around the world that suggest that teamwork in the operating room is an area for improvement and needs to be made more efficient. Research analysing the challenges and success factors of teamwork in the operating room is scarce in both English and Lithuanian published sources.

Effective communication in the operating room is important for teamwork and patients' safety. However, the asymmetry in the status of team members, also known as a hierarchy, that still exists in some cultures, can lead to communication problems between staff, with lower-status staff feeling stressed and perceiving themselves as inferior team members.

There are several indications of hierarchical relationships within the operation team that are worth exploring in more detail. The traits of a colleague who perceives him/herself as "superior", reflecting hierarchical relationships, include not saying hello, not introducing him/herself, giving short answers to questions, not taking any advice from "inferior" colleagues, seeing him/herself as a "doctor" and other staff as a "nurse", and not favouring nurses who volunteer to initiate a conversation [166]. The origins of hierarchical relationships, as seen in authoritarianism, date back to earlier times when the professions of doctor and nurse were being established. Authoritarianism is a personal syndrome that manifests itself in a marked attitude of self-centredness and disregard for others [167].

Previously, society was dominated by males who healed people. History mentions male barbers. Even the first scientists, the inventors of medical science, were men. The history of nursing goes back only 100 years. Therefore, as K. Ballou et al. [167] argue, nursing does not have complete autonomy in all cultures. The exaltation of the gender role as a cult is the oldest and most deep-rooted problem in the field. A nurse is portrayed with traditional feminine traits such as altruism, sacrifice, and obedience. As a result, the profession is often symbolised and identified with women's social roles. The authority of the doctor is associated with patriarchal power, control, giving orders, and keeping "*power in his hands*".

There is a lack of research in the scientific literature discussing authoritarian relations in the operating room. However, studies on doctors' attitudes towards patients and decision-making have shown that doctors with an authoritarian attitude, who do not deal with their colleagues and do not involve patients or their relatives, tend to have a more neglectful attitude towards human life [168]. A study conducted in South Korea substantiated the correlation between authoritarian attitudes among physicians and medical errors, the primary cause of which is the lack of cooperation and information sharing between colleagues and the public [169].

The issues of teamwork among Lithuanian operating room staff have been studied by L. Pociūtė and D. Zagurskienė [170], N. Istomina, L. Šakienė, R. Bagdonas, and I. Bakanaitė [171], N. Jerdiakova, A. Mikaliūkštienė, and D. Kalibatienė [172], and A. Danilevičius, V. Kielė, and R. Urbanavičė [173].

A study in a Lithuanian hospital has shown that the problems related to the psychological experiences of operating room nurses and teamwork in the operating room do exist. According to L. Pociūtė and D. Zagurskienė [170], 40% of nurses were not satisfied with teamwork in the operating room, and only more than one-third (38.2%) were satisfied with the surgeon's attitude towards them and the relationships within the team (37.4%).

Lithuanian researchers N. Istomina et al. [171] raise the issue that surgeons and anaesthetists have different perceptions of teamwork practices compared to operating room nurses. Physicians believe that the operating room team coexists on a unitary basis, with all members working as a unified group, equally coordinated towards a common goal. However, operating room nurses tend to have a different view, seeing teamwork as sub-teamwork and often do not feel like full members of the team because they do not have the opportunity to be involved in important issues, such as discussing operation plans.

A. Danilevičius et al. [173] argue that the challenges of teamwork are not uncommon to teams performing eye surgery. The authors highlight the challenges of teamwork, including a heavy workload, severe medical conditions of patients, a lack of professional experience among team members, inadequate communication, and unforeseen situations during surgery.

Operating room team members face a variety of specific challenges, including long working hours, malfunctioning medical equipment, a lack of work aids, deterioration of patients' conditions during surgery, an isolated environment with no natural light, increased noise levels, and disruptions to teamwork. These factors have been discussed above as being correlated with an increase in occupational stress; therefore, being aware of them can help address them through specific organisational and managerial measures. It is possible that after applying all possible stress mitigation measures, the stress of operating room nurses or other operating room staff is mitigated upon their return home from work. These measures could definitely help to harmonise the emotional balance. However, the next day, when the staff go back to work and are exposed to the same irritants, stress would increase again. Thus, what measures can be effective in reducing stress for nurses and other staff working in the operating room? The answer is measures that involve the whole team, with all team members receiving or experiencing specific stress mitigation measures evenly.

Music therapy has its roots in ancient Egyptian, Chinese, Indian, Greek, and Roman civilisations. The first reference to music therapy is found in the article "Music Physically Considered", published in the Columbian Magazine in 1789. In the early 19$^{th}$ century, two medical theses by E. Attlee and S. Mathews investigated the therapeutic effects of music. After World War I, a new profession emerged, which can be called music therapy. Musicians visited hospitals and

played for soldiers and people suffering from war injuries. Doctors and nurses noticed the positive effects of music on patients' health and healing and continued to hire musicians to play in hospitals [174].

D. Campbell [175], an internationally renowned American composer, performer, educator, and music therapist, describes music as possessing a set of healing, educational, and spiritual attributes. Focusing directly on the power of Mozart's music, the author writes that music helps alleviate depression, anxiety, and stress, and the key to health and well-being is learning how to listen to the music properly and the sounds around you.

In Western countries, the effects of music therapy in terms of improving patients' health and mitigating staff stress are more widely studied than in Lithuania. Music therapy, like other non-medication methods in the perioperative period, helps not only reduce patients' pain but also achieve other goals, i.e., reduce stress and anxiety and increase self-esteem and the feeling of being able to control unpleasant states. Moreover, less medication is needed, resulting in improved economic indicators, as patients require fewer painkillers [176].

I. Kacem et al. [177] conducted a study in Tunisia to assess the effect of music therapy on stress levels and the risk of burnout in members of the operating team. After applying music therapy, the stress level scale scores decreased from 22 ± 8.9 to 16 ± 7.9, and scores for emotional exhaustion of the operating room staff also decreased. The results of these studies suggest that music therapy is an effective, non-invasive, and cost-effective method for reducing occupational stress among operating room staff.

Furthermore, studies worldwide aim to demonstrate the effectiveness of music in reducing stress among operating room staff during surgery [178–180]. Although music, as a stress-reducing tool, was used in an operating room of an Italian hospital, it did not demonstrate its effectiveness in mitigating stress. However, it did elicit positive emotions among the members of the operating team [178]. The results of these authors' study show that it is not enough to use music to improve the psychosocial climate. It is necessary to look for motivational measures to improve the working environment that enhance teamwork and employees' satisfaction.

In the 21$^{st}$ century, the approaches that focus on open and constructive identification and resolution of problems are becoming increasingly popular. The global and rapidly changing social environment poses new challenges in terms of critical thinking, decision-making, and lifelong learning. In the context of modern studies, all these skills cannot be acquired without reflection. Reflection, as a method used not only in education but also in professional life, helps make sense of the experience gained, develops new skills, and deepens knowledge. Reflection on personal experiences enables generalisation and assessment of colleagues' support and its importance for professional activity [181].

Reinforcement of reflection-based teamwork for healthcare professionals is a deliberate and constructive approach based on openness and trust. As a basis for this approach, the debriefing approach has been successfully

implemented in Western healthcare settings. A study in New Zealand demonstrated the benefits of this method in reducing stress among operating room staff, including operating room nurses. The use of this method in practice, where all team members have the opportunity to listen and express their experiences and doubts, improves psychosocial safety, contributes to team effectiveness, ensures patients' safety, and reduces the number of mistakes made during surgery, which could result in harm to patients' health or lives.

The application of effective teamwork-building methods in the operating room ensures not only the psychological safety of the staff but also the safety of patients [182]. In global practice, training focused on Crew Resource Management (CRM) is widely regarded as an effective tool. TeamSTEPPS (Team Strategies and Tools to Enhance Performance and Patients' Safety) is an equally popular approach to improving teamwork among healthcare professionals worldwide. The main aim of TeamSTEPPS is to promote effective teamwork, enhance communication between healthcare professionals, and reduce the likelihood of errors related to patient's safety. The key components of the TeamSTEPPS programme are:

- clear accountability and leadership;
- communication and dissemination of information among team members;
- assessment of the situation, identification of the problem, and selection of the action;
- peer assistance, support, and cooperation with team members [183].

Professional values must be developed during nursing studies. Therefore, with a strong focus on teamwork skills, higher education institutions must be interested in developing effective methods for incorporating these skills into their curricula. It is equally important to highlight the role of the institution's management, who must not only view the employee as a professional able to perform their functions to a high standard but also create conditions for their professional and personal development.

Researchers from Iran are openly talking about increasing access to cognitive-behavioural programmes for operating room nurses, as they can be useful in reducing stress for operating room staff, creating a healthier working environment, and achieving successful patients' outcomes [17]. In China, cognitive-behavioural training for operating room nurses helped them cope with post-traumatic stress disorder, effectively reduced stress levels, increased positive attitudes towards work, and improved the efficiency of their performance [184].

The use of simulation to enhance teamwork skills is one of the most recent educational innovations of the 21$^{st}$ century. However, learning by imitation (which is the basis of simulation) is one of the oldest teaching methods, dating back to the Middle Ages. As R. Riley [185] presents in his book, as early as ancient times, craftsmen and artisans taught their apprentices specific skills and craftsmanship. The first mannequins for healthcare of adults, children, and pregnant women, as well as imitation, appeared at the beginning of this century (SimMan, NOELE, PediaSim). The use of simulation in the training of

healthcare professionals and the development of their competencies enables them to acquire and improve professional skills without compromising patient health. Simulation is flexible in terms of time and organisation, as learners can work in a team and thus develop teamwork skills. The scientific literature offers numerous examples of the importance of debriefing and discussing teamwork when implementing the simulation approach. Authors identify this as a purposeful discussion between healthcare students, nurses, and doctors after a simulation experience, which allows participants to clearly understand the clinical actions they have taken, the opportunities for improvement, the contribution they have made to the teamwork, and the support they have received from team members [186, 187]. Physical simulations are being replaced by simulations of a much newer concept, known as virtual simulations, where teamwork skills are developed in a virtual environment, with no requirements for the environment, time, or number of participants [188].

*The work of operating room nurses is highly challenging and demanding, with the stress caused by a variety of physical, psychosocial, and organisational factors. Psychological stability is essential to ensure patient' safety, teamwork, and a good distribution of functions. Effective cooperation in the operating room not only improves the quality of work but also ensures patients' safety. However, in many parts of the world, teamwork in operating rooms faces challenges such as hierarchical staff relations, gaps in stress management, and a lack of reflective culture.*

## Summary of Chapter 3

Operating room nurses are exposed to a wide range of occupational risk factors when working in complex and intensive environments, including exposure to hazardous substances, radiation, heavy workloads, and emotional stress, which can lead to burnout syndrome. The specific nature of the work of operating room nurses is characterised by a complex layout of the environment, strict rules, and unpredictable events requiring rapid reaction and high competence. Nurses' work is demanding and tiring, primarily if they work long hours.

Ergonomic risk factors belong to the group of occupational risk factors and are preconditioned by the necessity to use strength, uncomfortable posture, repetitive movements, and hand and arm vibration. Due to the specific nature of their work, operating room nurses are the most vulnerable group and are primarily affected by musculoskeletal problems.

The use of ergonomic measures is crucial for operating room nurses to minimise muscular strain and ensure their safety. During their studies, the would-be nurses still do not receive sufficient training in ergonomics, and the lack of these skills is not compensated for in practice due to the lack of appropriate training in the workplace. Educational schemes that promote ergonomic and safety principles can significantly contribute to improving the health of operating room staff. One of the most effective ergonomic tools is the use of upper

body exoskeletons, which help reduce muscle strain, prevent musculoskeletal pain, and enable staff to maintain a physiologically correct body posture during surgery. Physical activity helps strengthen the musculoskeletal system, mitigate work-related strain, and prevent the onset of musculoskeletal pain.

Operating room nurses, as well as surgeons, work in special clothing, with the temperature strictly controlled to maintain a warmer environment; otherwise, patients may suffer from hypothermia. The staff often face limited access to water, food, toilet facilities, and sufficient sleep. This affects their physiological needs, which can be detrimental to their health.

Due to the specific requirements of working in a sterile environment, operating room nurses have more problems with hygiene during menstruation than nurses working in other departments. In addition, chemicals used in the operating room, such as anaesthetics, disinfectants, and sterilising agents, can have long-term adverse effects on fertility and smooth pregnancies. So far, almost nobody discusses or proposes any universal alternatives to address the physiological needs of operating room nurses that surgeons can implement. Regarding the harmful effects of chemicals on the health of operating room nurses, the use of protective equipment, staff training in preventive measures, and personal responsibility for the use of such equipment in their professional activities are increasingly valuable.

In the operating room, various dangerous situations can arise that affect the health of both patients and staff. Physical hazards in this environment include exposure to fire, electricity, radiation, lasers, and compressed gases. There is practically no operation that does not involve the use of electrocautery, without which it would be difficult to stop bleeding or remove tissue. The use of electrocautery produces fumes (toxic substances), which are particularly dangerous for operating room staff, including operating room nurses, who, together with the surgeons, are closest to the wound.

Operating room nurses are often exposed to the risk of sharps injuries, which can increase the risk of blood-borne infections. The most common cause is needlestick injuries. Operating room nurses, as well as all staff working in the operating room, can also be exposed to biohazards, such as bacteria and viruses present in surgical fumes, such as human papillomavirus and SARS-CoV-2. Preventive measures, such as the use of appropriate protective equipment, strengthening teamwork, and developing staff training programs, are necessary to reduce the risk of injuries and infections.

Operating room nurses work under stressful conditions that require not only good technical skills but also psychological resources. The nature of the work puts the nurses working in the operating room under considerable stress. The main causes of stress for them are poor teamwork and the destructive behaviour of surgeons, as well as distractions during surgery, which are not only stressful but may also compromise patient safety. The specific requirements of the operating room environment, such as the absence of natural light and high noise levels, also increase stress in the professional environment. The above

factors often lead to fatigue, burnout, and health problems for operating room nurses, which have a negative impact on the quality of their work and lives.

Various methods help improve psychological well-being. Music therapy, as a non-invasive tool, is effective in reducing stress and emotional exhaustion. Reflection and strengthening teamwork through debriefing also contribute to psychosocial safety and reduce errors during surgery. Additionally, the use of simulation to develop teamwork skills enables nurses to enhance their professional skills in a safe environment and reduce stress. Cognitive-behavioural programmes can help cope with post-traumatic stress and improve their performance in the operating room team.

# Chapter 4
# Occupational risk factors, health issues, and coping measures from the perspective of operating room nurses

## 4.1 Research methods

***Stages of the research***

The research was conducted in the following stages: searching for information in databases, scientific publications, textbooks, and methodological aids. The year of publication of the articles selected and used for the literature review varied from 2001 to 2024. The keywords used for the search were *operating room nurse*, *hazards and adverse events*, *occupational risk factors*, *risk mitigation*, *health*, *safety*, *and stress*.

The keyword search yielded the inclusion of 134 articles, 24 books, 22 legal documents, and information from 10 internet links, which contained data from Lithuanian and global associations, as well as social media.

The questionnaire developed by the authors of the monograph was posted on the website of the Lithuanian Society of Operating Room Nurses [36]. In this way, only the nurses working in the operating rooms of various Lithuanian hospitals were purposely invited to participate in the survey. The quantitative study was performed between March and June 2024. The open-ended questions in the questionnaire allowed identifying the measures proposed by operating room nurses to reduce occupational risks in their work:

1. The study used triangulation (a mixed-method research strategy) with semi-structured interviews of operating room managers (to obtain qualitative data).

2. Qualitative data collection was carried out between December 2024 and January 2025, using semi-structured interviews with nursing management (operating room managers in Lithuanian hospitals). More information on the qualitative research is provided in **Chapter 5**.

### Selection of the subjects for the quantitative study and sample characteristics

The selection method has been non-probability random sampling. The study was conducted through interviews with nurses working in secondary and tertiary healthcare settings. It was not possible to find the actual number of operating room nurses working in Lithuania, so a preliminary estimate of the

number of cases was based on $N = 700$. For the data to be representative, the sample was calculated according to the Pianotto formula, with 95% probability and 5% margin of error ($N = 254$)

$$n = 1 / (\Delta^2 + 1 / N),$$

where $n$ – number of respondents; $\Delta$ – the margin of error, with a margin of error of 5% (0.05); $N$ – the general set (average number of operating room nurses).

The inclusion criteria:

- operating room nurses;
- voluntary consent of operating room nurses to participate in the survey.

The study involved 254 operating room nurses from different regions of Lithuania, 98.4% of whom were women and 1.6% were men. 20.9% of the respondents were graduates of further education, 39.4% had higher non-university education, and 39.7% had university education.

19.7% have been working as nurses for up to 1 year, 24% for 1 to 5 years, 9.8% for 6 to 10 years, 15% for 11 to 20 years, and 31.5% for more than 20 years. The operating room nurses participating in the study represented operating rooms of different surgical profiles: general surgery, trauma-orthopaedics, obstetrics-gynaecology, ophthalmology, ear-nose-throat, neurosurgery, thoracic surgery, and plastic-anaesthetic surgery.

The distribution of nurses working in operating rooms is also proportional, with 42.1% working daytime and 57.9% working on a mixed schedule.

Almost half of operating room nurses (43.5%) work in multiprofile operating rooms, which means that general, trauma-orthopaedic, gynaecological, etc. surgeries are performed. 14.6% work in general surgery operating rooms. A very high proportion, ranging from 6 to almost 10%, work in the operating rooms for trauma-orthopaedic, plastic-aesthetic, neurosurgical, thoracic, obstetric-gynaecological, ophthalmic, and ear, nose, and throat surgeries (**Table 4.1**).

**Table 4.1** Sociodemographic data of operating room nurses in the quantitative study, $N = 254$

| Characteristics | Groups | Number | Percentage |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| Gender | Female | 250 | 98.4 |
| | Male | 4 | 1.6 |
| Education | Further (medical school) | 53 | 20.9 |
| | Higher non-university | 100 | 39.4 |
| | University (Bachelor Degree) | 61 | 24.0 |
| Education | University (at least Master Degree) | 40 | 15.7 |

**Continuation of Table 4.1**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Length of service in an operating room | Up to 1 year | 50 | 19.7 |
| | 1 to 5 years | 61 | 24.0 |
| | 6–10 years | 25 | 9.8 |
| | 11–20 years | 38 | 15.0 |
| | 21 or more years | 80 | 31.5 |
| Work schedule | Daytime | 107 | 42.1 |
| | Mixed (days and nights) | 147 | 57.9 |
| Profile of the operating room | Multiprofile | 110 | 43.5 |
| | General Surgery | 37 | 14,6 |
| | Trauma-Orthopaedics | 25 | 9.9 |
| | Plastic-Aesthetic surgery | 22 | 8.7 |
| | Obstetric-Gynaecological | 18 | 7.1 |
| | Thoracic and angiosurgery | 16 | 6.3 |
| | Ophthalmology | 12 | 4.7 |
| | Neurosurgery | 8 | 3.2 |
| | Ear, Nose, and Throat (ENT) | 5 | 2 |

## Straightforwardness of data collection and participation of the respondents

The researchers received feedback via email that the questionnaire was interesting and that the survey focused on the problems of operating room nurses. Operating room managers proactively contacted the researchers to express their gratitude for the study, which addressed their needs related to occupational risks and their mitigation. Further cooperation with the Lithuanian Society of Operating Room Nurses includes presentations based on the findings of the monograph, which are discussed at conferences organised by the Society.

## Research material

The research was conducted using a quantitative research strategy. A questionnaire developed by the authors of the monograph was posted on the Internet.

The authors used social networks (Facebook platform and the website of the Lithuanian Society of Operating Room Nurses, whose homepage contained a link to the survey). In this way, only operating room nurses were targeted and invited to participate in the study.

The occupational risk factors of operating room nurses were assessed using 28 indicators, which were grouped into 7 scales for analysis. Health changes and complaints related to the profession of operating room nursing were assessed by 31 indicators divided into 6 scales (**Table 4.2**).

**Table 4.2** Scales and indicators of the questionnaire on occupational risk factors and health complaints of operating room nurses

| Scale | Number of indicators | Indicators |
|---|---|---|
| 1 | 2 | 3 |
| Occupational risk factors affecting operating room nurses | | |
| Lifting heavy objects | 3 | ■ lifting heavy objects (sterilisers with instruments);<br>■ lifting patients;<br>■ transporting, carrying, and pushing heavy equipment |
| Slips and falls | 4 | ■ slips and falls caused by wet floor;<br>■ slips and falls caused by the equipment wires on the floor;<br>■ slips and falls due to instability of furniture in the operating room;<br>■ slips and falls caused by uncomfortable footwear |
| Contact with body fluids and punctures | 8 | ■ poking with a scalpel;<br>■ puncture with a surgical needle;<br>■ puncture with an injection needle;<br>■ injury with sharp surgical instruments;<br>■ injury with an electrocautery device;<br>■ burns with an electrocautery device;<br>■ splashing with body fluids (e.g., body fat);<br>■ splashing with blood |
| Limitations in meeting physiological needs | 3 | ■ irregular eating;<br>■ irregular liquid intake (especially drinking water);<br>■ not being able to use the toilet when needed |
| Stress related to the psychological climate in the operating room | 3 | ■ stress due to the surgeon(s)' personality, unpredictable behaviour and tone of voice;<br>■ stress due to the psychological climate in the team;<br>■ stress due to poor teamwork |
| Stress related to the course of operation and supplies | 4 | ■ stress due to complex situations during surgery;<br>■ stress due to the unpredictable course of the operation and the instruments and devices needed for it;<br>■ stress due to malfunctioning equipment;<br>■ stress due to lack of instruments |
| Stress related to heavy workload | 3 | ■ stress due to heavy workload;<br>■ stress due to training new colleagues and students;<br>■ stress due to lack of staff |

**Continuation of Table 4.2**

| 1 | 2 | 3 |
|---|---|---|
| Health complaints of operating room nurses | | |
| Emotional distress | 5 | ■ depression;<br>■ anxiety;<br>■ apathy;<br>■ increased feelings of guilt;<br>■ desire to be alone |
| Sleep problems | 4 | ■ difficulty in falling asleep;<br>■ waking up at night;<br>■ waking up early in the morning;<br>■ feeling sleep deprived |
| Pain | 8 | ■ headache;<br>■ stomach pain;<br>■ intestinal pains;<br>■ back pain;<br>■ pain in legs;<br>■ pain in arms/hands;<br>■ chest pains;<br>■ eye pain |
| Allergic reactions and skin problems | 5 | ■ local allergic reactions to disinfectants, medications (skin problems);<br>■ general allergic reactions to disinfectants, medications;<br>■ allergic reactions from medical masks;<br>■ skin problems due to wearing gloves;<br>■ dry skin |
| Nausea and discomfort | 4 | ■ nausea from the electrocautery used;<br>■ nausea and other unpleasant sensations from the content of human organs (e.g., open bowel);<br>■ nausea and other unpleasant sensations from the solutions used for surgery;<br>■ nausea and other unpleasant sensations from inhalational anaesthetic agents |
| Complaints related to clothing and standing work | 5 | ■ swelling/heaviness in legs;<br>■ fatigue due to standing in a forced position;<br>■ lack of air due to prolonged wearing of medical masks;<br>■ sweating;<br>■ weakness due to high temperature in the operating room |

The occupational risk factors affecting operating room nurses were assessed based on 28 indicators, which were divided into 7 scales (**Table 4.2**):

- lifting heavy objects (3 indicators);
- slips and falls (4 indicators);

- contact with body fluids and punctures (8 indicators);
- limitations in meeting physiological needs (3 indicators);
- stress related to the psychological climate in the operating room (3 indicators);
- stress related to the course of operation and supplies (4 indicators);
- stress related to heavy workload (3 indicators).

Health changes and complaints related to the profession of operating room nurse were assessed based on 31 indicators, divided into 6 scales:

- emotional distress (5 indicators);
- sleep problems (4 indicators);
- pain (8 indicators);
- allergic reactions and skin problems (5 indicators);
- nausea and discomfort (4 indicators);
- complaints related to clothing and standing work (5 indicators).

There was also an open-ended question to gauge the opinions of nurses in operating rooms regarding the availability of assurance of professional security. 100 operating room nurses expressed their views on this question. The research method was a written survey.

The data were analysed using qualitative content analysis, which involved distinguishing between themes and subthemes related to the phenomenon under study.

## Research ethics

The research was approved by the Committee for Assessing the Compliance of Applied Research with Research Ethics at Kauno kolegija Higher Education Institution (No. 13-35). All principles of ethics and integrity were observed during the research.

The preamble of the electronic questionnaire for operating room nurses provided information on the purpose of the research and its procedures. It stated where the data collected would be used and how confidentiality would be ensured. The participants were informed that by answering the questions, they confirmed their consent to participate in the survey. The first filter question was whether they agreed to participate in the survey. Those who disagreed did not complete the questionnaire.

## Statistical analysis of the data

**Statistical analysis of the quantitative data** was performed using the IBM SPSS Version 22.0 software package. Methods of quantitative data analysis included descriptive statistics, Anova test for group comparison, Student's *t*-test, and correlation analysis.

## Questionnaire design and psychometric quality of the quantitative study

The occupational risk factors affecting operating room nurses and their physical and emotional health (due to the work environment) were assessed based on 59 indicators that, while analysing the research findings, were divided into two domains:

- occupational risk factors;
- health changes and complaints related to the profession of operating room nursing.

To validate the reliability of the questionnaire scales assessing occupational risk factors and health among operating room nurses, and to determine how accurately the questionnaire captured occupational risk factors and health complaints, Cronbach's *α* coefficient was calculated (**Table 4.3**).

**Table 4.3** Psychometric quality characteristics of the scales of the questionnaire for assessing occupational risk factors and health complaints of operating room nurses

| Scale | Cronbach's Alpha *α* | Number of indicators |
|---|---|---|
| The occupational risk factors affecting operating room nurses | | |
| Lifting heavy objects | 0.786 | 3 |
| Slips and falls | 0.879 | 4 |
| Contact with body fluids and punctures | 0.902 | 8 |
| Limitations in meeting physiological needs | 0.888 | 3 |
| Stress related to the psychological climate in the operating room | 0.751 | 3 |
| Stress related to the course of operation and supplies | 0.801 | 4 |
| Stress related to heavy workload | 0.762 | 3 |
| Health complaints of operating room nurses | | |
| Emotional distress | 0.890 | 5 |
| Sleep problems | 0.800 | 4 |
| Pain | 0.808 | 8 |
| Allergic reactions and skin problems | 0.839 | 5 |
| Nausea and discomfort | 0.847 | 4 |
| Complaints related to clothing and standing work | 0.747 | 5 |

*Note: α – (Cronbach α) – a coefficient of internal consistency of the test*

The psychometric quality of the scales, *the Occupational Risk Factor* and *Health Assessment Questionnaire for Operating Room Nurses*, is acceptable from the point of view of operating room nurses. The internal validity and internal

consistency of the scales were sufficiently high, as evidenced by an acceptable Cronbach's $\alpha$ of 0.82. On one scale, Cronbach's $\alpha$ was 0.9; on eight scales, it was 0.8; and on four scales, it was 0.7. None of the scales had a Cronbach's $\alpha$ of 0.6 or less (**Table 4.3**).

This diagnostic instrument was administered using group rather than individual scores, so the psychometric quality of the subtests is relatively high.

**Table 4.4** presents the results of the Skewness and Kurtosis tests. Skewness refers to the asymmetry of the distribution of the data around its mean. It allows for assessing whether the data are evenly distributed or whether there is a "skewness" in one direction. Kurtosis describes the concentration of the "tail" and the centre of the distribution. It measures the "tailedness" of the probability distribution of a dataset and quantifies the amount of data that lies in the tails, as well as how sharply or flatly the data are distributed around the mean [189].

**Table 4.4** Normality of data distribution using Skewness and Kurtosis

| Scale | Statistics | Results |
|---|---|---|
| 1 | 2 | 3 |
| Occupational risk factors affecting operating room nurses | | |
| Lifting heavy objects | Skewness | −0.053 |
| | Kurtosis | −0.698 |
| Slips and falls | Skewness | 0.767 |
| | Kurtosis | 0.919 |
| Contact with body fluids and punctures | Skewness | 0.794 |
| | Kurtosis | 0.927 |
| Limitations in meeting physiological needs | Skewness | −0.818 |
| | Kurtosis | 0.089 |
| Stress related to the psychological climate in the operating room | Skewness | 0.178 |
| | Kurtosis | −0.645 |
| Stress related to the course of operation and supplies | Skewness | 0.197 |
| | Kurtosis | −0.234 |
| Stress related to heavy workload | Skewness | 0.148 |
| | Kurtosis | −0.460 |
| Health complaints of operating room nurses | | |
| Emotional distress | Skewness | 0.383 |
| | Kurtosis | −0.333 |
| Sleep problems | Skewness | 0.174 |
| | Kurtosis | −0.179 |

**Continuation of Table 4.4**

| 1 | 2 | 3 |
|---|---|---|
| Pain | Skewness | 0.301 |
| | Kurtosis | −0.009 |
| Allergic reactions and skin problems | Skewness | 0.262 |
| | Kurtosis | −0.511 |
| Nausea and discomfort | Skewness | 0.780 |
| | Kurtosis | 0.517 |
| Complaints related to clothing and standing work | Skewness | −0.089 |
| | Kurtosis | −0.074 |

Using the normality tests Skewness and Kurtosis, the distribution has been found to be normal (coefficients ranging from (−) 1 to (+) in all of the 13 scales). To compare group means across scales, parametric calculations such as ANOVA and Student's *t*-test could be applied. Spearman's correlation coefficient ($R^2$) has been used for correlation analysis.

## 4.2 Identification of occupational risk factors, health, and health complaints of operating room nurses

### 4.2.1 Manifestation of the occupational risk factors affecting operating room nurses

The survey data show that a variety of occupational risk factors characterise the work of operating room nurses. Operating room nurses were asked to rate the occurrence of occupational risk factors by selecting one of the following response options: 1 – never, 2 – seldom, 3 – frequently, 4 – very often. For all scales, the minimum value of indicators was 1, and the maximum was 4.

All the scales consisted of at least three indicators assessing the occupational risk for operating room nurses. In some cases, the scale consisted of 7 or 8 indicators.

The data in **Table 4.5** reveal that "limitations in meeting physiological needs" is the most common occupational risk factor affecting operating room nurses (mean 3.3, standard deviation 0.706), followed by the physical occupational risk factor, "lifting heavy objects" (mean 2.7, standard deviation 0.768). Stress is common in the activities of operating room nurses. They experience stress related to the psychological climate in the operating room (mean 2.6, standard deviation 0.695), stress related to the course of the operation and supplies (mean 2.6, standard deviation 0.637), and stress related to heavy workload (mean 2.4, standard deviation 0.694). The mean for the biological

risk factor "contact with body fluids and punctures" was 2.0 (standard deviation 0.547), and the mean for the physical risk factor "slips and falls" was 1.8 (standard deviation 0.641).

**Table 4.5** Prevalence of the occupational risk factors affecting operating room nurses (from most to least frequent)

| Scales | Mean | Standard deviation |
|---|---|---|
| Limitations in meeting physiological needs | 3.3 | 0.706 |
| Lifting heavy objects | 2.7 | 0.768 |
| Stress related to the psychological climate in the operating room | 2.6 | 0.695 |
| Stress related to the course of operation and supplies | 2.6 | 0.637 |
| Stress related to heavy workload | 2.4 | 0.694 |
| Contact with body fluids and punctures | 2.0 | 0.547 |
| Slips and falls | 1.8 | 0.641 |

The professional activities of operating room nurses require the use of physical resources and strength. One in two operating room nurses participating in the study need to lift heavy objects. 56% of Lithuanian operating room nurses in the survey reported having to lift patients frequently or very often. In their work, a significant proportion of operating room nurses (65.3%) lift sterilisers with instruments that are quite heavy. *It should be noted that the survey did not ask how much sterilisers weigh. However, based on our professional experience, their weight varies from 3 to 10 kilograms or more.* Operating rooms nowadays are modern and equipped with a variety of medical equipment, so it is natural that when relocating a patient's operating table or transferring medical appliances from one operating room to another, operating room nurses must use their strength to move or push them. One in two operating room nurses (49.4%) is involved in transporting heavy medical equipment (**Table 4.6**). The research findings suggest that operating room nurses are frequently exposed to lifting heavy objects during their professional activities, which can have a detrimental impact on their physical health.

**Table 4.6** Lifting heavy objects in operating room nurses' professional activities, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Lifting patients | 10.3 | 33.7 | 30.6 | 25.4 |
| Lifting heavy objects (sterilisers with instruments) | 5.2 | 29.5 | 38.6 | 26.7 |
| Transporting, carrying, and pushing heavy equipment | 11.1 | 39.5 | 30.8 | 18.6 |

Slips and falls can be closely related to the specific nature of operating room nurses' activities. It is common for liquids to be used to wash wounds during surgery; they can leak onto the floor, as operating room activities are characterised by extreme responsiveness and urgency. The floor is smooth to allow for good cleaning during and after surgery. Another reason why slips and falls occur is the special operating room clothing, which is not always the correct size. If the sterile gown is longer and reaches the floor, there is a risk of tripping and falling when making brisk movements. It is essential to wear footwear with non-slip soles; otherwise, slips and falls can occur (**Table 4.7**).

**Table 4.7** Slips and falls in operating room nurses' professional activities, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Slips and falls caused by wet floor | 30.6 | 53.2 | 12.5 | 3.6 |
| Slips and falls caused by the equipment wires on the floor | 25.5 | 54.6 | 15.1 | 4.8 |
| Slips and falls due to instability of furniture in the operating room | 41.3 | 49 | 8.1 | 1.6 |
| Slips and falls caused by uncomfortable footwear | 40.2 | 46.7 | 8.6 | 4.5 |

Although slips and falls affect a small proportion of nurses in operating rooms, it is impossible to assume that this problem does not exist and ignore preventive measures that should be taken to mitigate the risk of falls. Slips and falls caused by wet floors have been experienced by 16.1% of operating room nurses in the study. For nearly 20% of operating room nurses, slips and falls were caused by the equipment wires on the floor. Uncomfortable footwear caused slips and falls in 13.1% of operating room nurses, and unstable furniture in the operating room affected 9.7% of the same group (**Table 4.7**).

The data in **Table 4.8** are particularly notable as they show the relevance of occupational risk factors due to their hazardous nature. Stabbings and injuries caused by sharp surgical instruments pose a significant biohazard, as operating room staff, including operating room nurses, may be exposed to blood-borne diseases.

The data in **Table 4.8** show that almost 15 out of 100 operating room nurses in the study have had a scalpel injury during surgery, with an even higher proportion (20.6%) having a surgical needle injury, 14% having a needle stick injury, and 16.4% having a sharps injury. The lowest risk of injury is from electrocautery, with 6.1% of operating room nurses being injured by electrocautery and 4.8% suffering burns. Splashing with body fluids (body fat or blood) is a very common occupational risk factor. For example, 45.3% of operating room nurses in the study have been exposed to body fat, and 58.5% to blood.

**Table 4.8** Exposure to body fluids and injuries in the professional activities of operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Poking with a scalpel | 21.9 | 63.3 | 10 | 4.8 |
| Puncture with a surgical needle | 18.3 | 61.1 | 14.3 | 6.3 |
| Puncture with an injection needle | 22.8 | 63.2 | 9.6 | 4.4 |
| Injury with sharp surgical instruments | 18.1 | 65.5 | 12 | 4.4 |
| Injury with an electrocautery device | 48.0 | 45.9 | 4.5 | 1.6 |
| Burns with an electrocautery device | 53.7 | 41.8 | 3.7 | 0.8 |
| Splashing with body fluids (e.g., body fat) | 12.2 | 42.5 | 31.9 | 13.4 |
| Splashing with blood | 6.7 | 34.8 | 35.2 | 23.3 |

The data in **Table 4.9** show the limitations of meeting physiological needs in the professional activities of operating room nurses.

**Table 4.9** Limitations of physiological needs in professional activities of operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Irregular eating | 2 | 11.8 | 38.6 | 47.6 |
| Irregular liquid intake (especially drinking water) | 1.6 | 8.3 | 34 | 56.1 |
| Not being able to use the toilet when needed | 4 | 21.7 | 37.9 | 36.4 |

The data presented in **Table 4.9** show that meeting the physiological needs of operating room nurses is a pressing issue. As many as 86.2% of the operating room nurses in the study reported eating irregularly, frequently, or very often. A more significant concern is the excessive consumption of liquids, which can lead to dehydration and pose a serious health risk. As many as 90.1% of operating room nurses frequently or very often consume liquids irregularly, specifically drinking water. Additionally, a relatively high proportion of operating room nurses (74.3%) reported that they cannot use the toilet when needed.

**Tables 4.10–4.12** reveal the expression of stress that affects Lithuanian operating room nurses in the study in relation to three factors. One of them is the stress related to the psychological climate in the operating room. Others include stress associated with the surgical process, supplies, and the heavy workload.

It can be confidently stated that every second operating room nurse in the study frequently or very often (59%) experiences stress due to the surgeon(s)' personality, unpredictable behaviour, and tone of voice in the operating room (**Table 4.10**). The prevailing psychological climate in the operating

room is no less of a problem, with a very similar proportion of nurses (50.8%) experiencing stress frequently or very often. Teamwork in the operating room is an area for improvement, and its lack is frequently or very often the cause of stress for almost half of the operating room nurses (40%).

**Table 4.10** Operating room nurses' stress related to the psychological climate in the operating room, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Stress due to the surgeon(s)' personality, unpredictable behaviour, and tone of voice | 2.4 | 38.6 | 36.6 | 22.4 |
| Stress due to the psychological climate in the team | 8.3 | 40.9 | 32.3 | 18.5 |
| Stress due to poor teamwork | 13 | 47 | 28.5 | 11.5 |

Operating room nurses are subject to unpredictable procedures and sudden complications during surgeries. The use of a large number and variety of medical devices during surgery is also involved. Therefore, it was relevant to investigate how the technological working environment and its distractions impact the psychological state of operating room nurses (**Table 4.11**).

**Table 4.11** Operating room nurses' stress related to the course of operation and supplies, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Stress due to complex situations during surgery | 2 | 36.2 | 44.9 | 16.9 |
| Stress due to the unpredictable course of the operation and the instruments and devices needed for it | 7.1 | 45.8 | 35.6 | 11.5 |
| Stress due to malfunctioning equipment | 6.3 | 40.9 | 38.2 | 14.6 |
| Stress due to lack of instruments | 14.2 | 42.7 | 32 | 11.1 |

The research revealed that at least half of the operating room nurses in the study experienced stress related to the course of operation and the use of instruments and devices. Two-thirds of operating room nurses (61.8%) frequently or very often experienced stress related to difficult situations during surgery. Almost half of the operating room nurses (47.1%) have experienced stress due to the unpredictable course of the operation and the frequent need for supplies and devices (47.1%). Naturally, to perform their functions professionally, the staff strive for smoothly running equipment and a full supply of working instruments. In practice, however, the situation is somewhat different, as one in two operating room nurses in the study (52.8%) very often or fre-

quently feel stressed by malfunctioning equipment during surgery. Slightly less than half of the operating room nurses (43.1%) very often or frequently feel stressed due to a lack of supplies (**Table 4.11**).

**Table 4.12** Stress related to heavy workload among operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Stress due to heavy workload | 10.2 | 38.2 | 31.5 | 20.1 |
| Stress due to training new colleagues and students | 26.7 | 52.2 | 19.1 | 2.0 |
| Stress due to lack of staff | 9.4 | 40.2 | 34.3 | 16.1 |

Heavy workloads can cause stress to operating room nurses (**Table 4.12**). One in two operating room nurses (51.6%) in the study reported being stressed by a heavy workload. Also, every second operating room nurse in the study (51.6%) agrees that staff shortages cause them stress. The least stressful for operating room nurses is the training of new colleagues and students (21.1%).

**Fig. 4.1** illustrates the stress levels of the operating room nurses who participated in the study, ranked according to their scores (1 being the lowest and 5 being the highest stress level).

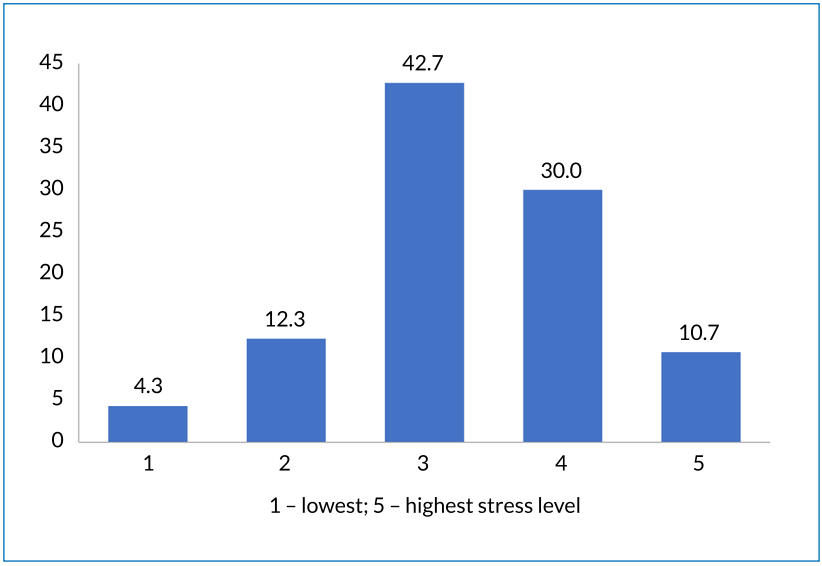



**Fig. 4.1** Stress experienced by operating room nurses at work, *N* = 254 (%)

When asked to rate the level of stress, none of the operating room nurses in the study indicated that they did not experience stress. 16.6% of them reported having experienced minor stress (1 or 2 points). Moderate stress was reported by 42.7% and high or very high stress by 40.7% of the operating room nurses in the study (**Table. 4.13**). The research calculation revealed that the mean job stress level of operating room nurses was 3.3 (on a 5-point scale), with a standard deviation of 0.967.

The correlation matrix provided in **Table 4.13** shows systematic and, in all cases, statistically reliable relationships. The correlation between the scales ranged from 0.2 to 0.7, indicating a weak to strong relationship between health complaints. This suggests that nurses in operating rooms are exposed to a range of adverse occupational risk factors, and if some risks are present, others are likely to emerge as well.

The physical occupational risk factors, *lifting heavy objects*, *slips and falls*, *contact with body fluids and punctures*, and *limitations in meeting physiological needs*, correlate with each other as well as with the psychosocial risk factors, *stress related to the psychological climate in the operating theatre*, *stress associated with the course of operation and supplies*, and *stress related to heavy workload*.

A strong correlation was found between slips and falls and exposure to body fluids ($r = 0.645$).

A strong correlation exists between all stress scales. The stress related to the psychological climate in the operating room correlates with stress related to the course of surgery and supplies ($r = 0.600$) and stress related to a heavy workload ($r = 0.624$).

Stress in the activities of operating room nurses deserves special mention. Spearman's correlation analysis revealed that the stress related to the psychological climate in the operating room, the course of the operation and supplies, or heavy workload was weakly or moderately correlated with all the physical occupational risk factors, such as lifting heavy objects, slips and falls, contact with body fluids and punctures, and limitations in meeting physiological needs ($p \leq 0.01$).

A moderate correlation was found between lifting heavy objects and slips and falls ($r = 0.448$), exposure to body fluids and punctures ($r = 0.443$), and limitations in meeting physiological needs ($r = 0.452$). There was a significant correlation between slips, falls, lifting heavy objects ($r = 0.448$), limitations in meeting physiological needs ($r = 0.415$), and stress related to the course of operation and supplies ($r = 0.432$).

A moderate correlation was also found between exposure to body fluids, punctures, and lifting heavy objects ($r = 0.443$), as well as limitations in meeting physiological needs ($r = 0.481$). Limitations in meeting physiological needs correlate with the stress associated with heavy workload ($r = 0.462$), as well as lifting heavy objects ($r = 0.452$), slips, falls ($r = 0.415$), and contact with body fluids and punctures ($r = 0.481$).

**Table 4.13** Correlation between occupational risk factors affecting operating room nurses (Spearman's correlation coefficient applied), *N* = 254

| Scales | Indicators | Lifting heavy objects | Slips and falls | Contact with body fluids and punctures | Limitations in meeting physiological needs | Stress related to the psychological climate in the operating room | Stress related to the course of operation and supplies | Stress related to heavy workload |
|---|---|---|---|---|---|---|---|---|
| Lifting heavy objects | *r* | | 0.448** | 0.443** | 0.452** | 0.265** | 0.301** | 0.291** |
| | *p* | | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ |
| Slips and falls | *r* | 0.448** | | 0.645** | 0.415** | 0.364** | 0.432** | 0.331** |
| | *p* | $p \leq 0.01$ | | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ |
| Contact with body fluids and punctures | *r* | 0.443** | 0.645** | | 0.481** | 0.384** | 0.363** | 0.325** |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ |
| Limitations in meeting physiological needs | *r* | 0.452** | 0.415** | 0.481** | | 0.385** | 0.368** | 0.462** |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ |
| Stress related to the psychological climate in the operating room | *r* | 0.265** | 0.364** | 0.384** | 0.385** | | 0.600** | 0.624** |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | | $p \leq 0.01$ | $p \leq 0.01$ |
| Stress related to the course of operation and supplies | *r* | 0.301** | 0.432** | 0.363** | 0.368** | 0.600** | | 0.565** |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | | $p \leq 0.01$ |
| Stress related to heavy workload | *r* | 0.291** | 0.331** | 0.325** | 0.462** | 0.624** | 0.565** | |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | |

*Note: ** when $p \leq 0.01$; r-correlation coefficient; p-statistical significance.*
*Weak correlation (r = 0.20–0.39). Moderate correlation (r = 0.40–0.59). Strong correlation (r = 0.60–0.79)*

### 4.2.2 The impact of occupational risk factors on health from the point of view of operating room nurses

Occupational activities often cause changes in the health of operating room nurses and their health complaints. Operating room nurses who participated in the study attributed the existing health complaints to occupational risk factors. The respondents were asked to rate the prevalence of health complaints by selecting one of the following response options: 1 – never, 2 – sometimes, 3 – frequently, 4 – very often. For all scales, the minimum value of the indicator was 1; the maximum was 4.

All scales consisted of at least 4 indicators assessing operating room nurses' health complaints. In some cases, the scale consisted of 6 or 8 indicators.

The most prevalent health complaints among the nurses in the study were related to the specificity of the work and clothing of operating room nurses (mean 2.7, standard deviation 0.614). The identical mean scores (2.4) were found for the scales of allergic reactions and skin problems (standard deviation, 0.741) and sleep problems (standard deviation, 0.704). Operating room nurses had a slightly lower level of occupation-related pain, with a mean of 2.2 (standard deviation 0.510). For the indicator of emotional distress, the mean was 2.1, with a standard deviation of 0.702. The least frequently reported health complaint was nausea, with a mean of 1.8 and a standard deviation of 0.604 (**Table 4.14**).

**Table 4.14** Prevalence of health complaints of operating room nurses (from most to least often)

| Scales | *N* | Mean | Standard deviation |
|---|---|---|---|
| Complaints related to the specificity of the work and clothing of operating room nurses | 248 | 2.7 | 0.614 |
| Allergic reactions and skin problems | 243 | 2.4 | 0.741 |
| Sleep problems | 245 | 2.4 | 0.704 |
| Pain | 244 | 2.2 | 0.510 |
| Emotional distress | 245 | 2.1 | 0.702 |
| Nausea | 239 | 1.8 | 0.604 |

Anxiety was the most common emotional state problem among the operating room nurses who took part in the survey, with more than a third of respondents (36.5%) attributing it to themselves frequently or very often. A third of the nurses in the operating rooms reported that they frequently or very often feel depressed (30.1%). The desire to be alone was also very often or frequently noted by just over a third of operating room nurses who participated in the survey (31.9%). Apathy is frequently and very often experienced

by 20.5%, and an increased feeling of guilt and worries are experienced by 17.2% of operating room nurses (**Table 4.15**).

**Table 4.15** Signs of emotional distress among operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Depression | 19 | 50.8 | 22.6 | 7.5 |
| Anxiety | 17.5 | 46 | 26.2 | 10.3 |
| Apathy | 31.3 | 48.2 | 16.9 | 3.6 |
| Increased feelings of guilt | 34 | 48.8 | 14 | 3.2 |
| Desire to be alone | 28.3 | 39.8 | 22.7 | 92 |

Operating room nurses have a high and varied prevalence of sleep problems (**Table 4.16**). As many as two-thirds of respondents (60.7%) are frequently or very often bothered by a feeling of sleep deprivation. Other types of sleep problems affect more than a third: 44.2% wake up at night, 44.2% have difficulty falling asleep, and 32.8% wake up early in the morning.

**Table 4.16** Signs of sleep problems among operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Difficulty in falling asleep | 18.2 | 49 | 21.7 | 11.1 |
| Waking up at night | 13.9 | 41.8 | 29.9 | 14.3 |
| Waking up early in the morning | 19.8 | 47.4 | 21.1 | 11.7 |
| Feeling sleep deprived | 7.1 | 32.1 | 37.3 | 23.4 |

Operating room nurses experience pain in various parts of their bodies, which they attribute to their work in the operating room. **Table 4.17** provides the localisation of pain.

**Table 4.17** Expression of pain among operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Headache | 79.0 | 56.7 | 28.3 | 7.1 |
| Stomach pain | 25.0 | 54.8 | 15.9 | 4.4 |
| Intestinal pains | 45.8 | 44.3 | 7.9 | 2.0 |
| Back pain | 4.8 | 28.6 | 43.3 | 23.3 |
| Pain in legs | 4.8 | 20.6 | 50.8 | 23.8 |
| Pain in arms/hands | 22.5 | 50.2 | 18.6 | 8.7 |
| Chest pains | 50.2 | 45.0 | 4.0 | 0.8 |
| Eye pain | 23.7 | 39.8 | 27.3 | 9.2 |

Legs are the most common location of pain among nurses in operating rooms (74.6%). Spinal pain is the next most frequent problem, felt very often (66.6%). Eye pain (36.5%) and headaches (35.4%) are frequent or very frequent problems for more than one-third of operating room nurses in the study. Almost one-third of operating room nurses have frequent or very frequent hand pain (27.3%), and 20.3% of operating room nurses have stomach pain (**Table 4.17**).

**Table 4.18** presents the prevalence of allergic reactions and skin problems among operating room nurses, which varies by cause, ranging from 20 to more than 60%.

**Table 4.18** Allergic reactions and skin problems affecting operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Local allergic reactions to disinfectants, medications (skin problems) | 20.2 | 36.0 | 26.5 | 17.4 |
| General allergic reactions to disinfectants, medications | 28.4 | 42.0 | 18.0 | 11.6 |
| Allergic reactions from medical masks | 31.0 | 38.3 | 23.8 | 6.9 |
| Skin problems due to wearing gloves | 21.2 | 37.2 | 28 | 13.6 |
| Dry skin | 9.5 | 25.3 | 35.2 | 30 |

Local allergic skin reactions to disinfectants and medications are frequent and very frequent in 43.9% of operating room nurses in the study. Almost one-third of operating room nurses (29.6%) experienced general allergic reactions to disinfectants and medications frequently and very often. A very similar proportion of operating room nurses (30.7%) experience allergic reactions to medical masks. Skin problems in operating room nurses' work can be caused by wearing gloves, which is frequently and very often experienced by almost every second operating room nurse in the study (41.6%).

Dry skin is the most common problem for operating room nurses, due to their direct exposure to chemicals and the frequent use of gloves. Even more than two-thirds (65.2%) indicated that they frequently or very often experience dry skin (**Table 4.18**).

Operating room environments are dominated by a variety of irritants that cause unpleasant odour sensations. Chemicals can get into the respiratory tract, and staff may feel nausea and other unpleasant sensations.

**Table 4.19** presents the cases of nausea and discomfort experienced by operating room nurses due to chemicals and visual images in the operating room.

The manifestation of nausea and discomfort among operating room nurses is one of the rarest health complaints. Frequent and very frequent complaints of nausea and discomfort are reported by less than a few to a few dozen per cent of respondents.

**Table 4.19** Nausea and discomfort of operating room nurses, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Nausea from the electrocautery used | 41.3 | 44.5 | 10.9 | 3.2 |
| Nausea and other unpleasant sensations from the content of human organs (e.g., open bowel) | 30.1 | 54.6 | 11.2 | 4.0 |
| Nausea and other unpleasant sensations from the solutions used for surgery | 42.7 | 48.0 | 6.5 | 2.8 |
| Nausea and other unpleasant sensations from inhalational anaesthetic agents | 43.8 | 47.5 | 7.9 | 0.8 |

Nausea from the content of the patient's organs during surgery is a frequent or very frequent complaint for 15.2%, and nausea from the use of electrocautery is a frequent or very frequent complaint for 14.1% of operating room nurses. Less than 10% of operating room nurses complain of nausea from solutions used for surgery and inhalational anaesthesia (**Table 4.19**).

The work of operating room nurses is characterised by standing work and specific requirements for clothing and environment. A high proportion of operating room nurses in the study had various complaints related to particular clothing requirements and standing work (**Table 4.20**).

**Table 4.20** Complaints of operating room nurses related to special clothing requirements and standing work, *N* = 254 (in %)

| Indicators | Never | Seldom | Frequently | Very often |
|---|---|---|---|---|
| Swelling/heaviness in legs | 8.3 | 27.7 | 41.9 | 22.1 |
| Fatigue due to standing in a forced position | 3.9 | 20.1 | 46.5 | 29.5 |
| Lack of air due to prolonged wearing of medical masks | 22.3 | 31.1 | 36.7 | 10.0 |
| Sweating | 8.3 | 32 | 39.5 | 20.2 |
| Weakness due to high temperature in the operating room | 12.4 | 38.2 | 36.7 | 12.7 |

Leg swelling/heaviness and fatigue due to standing in a forced position are the most common health complaints among nurses in operating rooms. 64% of operating room nurses are bothered by leg swelling/heaviness, and more than two-thirds (76%) of them experience fatigue due to forced standing. The operating room nurses participating in the study reported experiencing discomfort due to the lack of air and high temperature in the operating room. Almost two-thirds (59.7%) of the respondents sweat frequently or very often. Nearly half (49.4%) frequently or very often experience weakness due to the

high temperature in the operating room, and 46.7% feel a lack of air due to prolonged wearing of medical masks (**Table 4.20**).

**Table 4.21** shows the correlation of health complaints of operating room nurses.

The correlation matrix in **Table 4.21** reveals a systematic and statistically reliable relationship in all cases ($p \leq 0.01$). The correlation between the scales ranged from 0.3 to 0.7, indicating a weak, moderate, and strong correlation between health complaints.

A strong correlation has been found between complaints about the specificity of operating room nurses' work and clothing and pain ($r = 0.621$), as well as allergic reactions and skin problems ($r = 0.617$).

A moderate correlation has been found between pain and sleep problems ($r = 0.530$), emotional distress ($r = 0.551$), nausea ($r = 0.447$), and allergic reactions and skin problems ($r = 0.567$).

A weak correlation prevails between nausea and sleep problems ($r = 0.398$) and emotional distress ($r = 0.380$).

### 4.2.3 Correlation between occupational risk factors and health complaints of operating room nurses and comparison of occupational risk factors and health complaints by sociodemographic characteristics

### Correlation between occupational risk factors and health complaints among operating room nurses

**Table 4.22** presents the statistical correlation between occupational risk factors (7 scales) and health complaints (6 scales) of operating room nurses.

The correlation matrix in **Table 4.22** presents systematic and, in all cases, statistically reliable correlations. The correlation coefficients found are theoretically meaningful. In all cases, the *p*-value obtained was 0.01. Therefore, it can be stated the correlation is statistically significant, which means that the relationship between the variables is not due to coincidence. The correlation between the scales ranged from 0.5 to 0.7, indicating a moderate to strong correlation between occupational risk factors and health complaints among operating room nurses. In **Table 4.22**, the correlation coefficient (*R*) is marked with asterisks (**) and more detailed information (*r*, *p*-values) is provided in **Annex 1**.

The correlation analysis used helped identify the relationships between various occupational risk factors affecting operating room nurses and their complaints of physiological and psychological health issues. The research findings suggest that all of the operating room nurses' health complaints are statistically significantly related ($p \leq 0.01$) not only to each other but also to the occupational risk factors affecting operating room nurses, which are complex and negative in nature.

**Table 4.21** Correlation between operating room nurses' health complaints (based on Spearman's correlation coefficient applied), *N* = 254

| Scales | Indicators | Pain | Sleep problems | Emotional distress | Nausea | Complaints related to the specificity of operating room nurses' clothing and work | Allergic reactions and skin problems |
|---|---|---|---|---|---|---|---|
| Pain | *r* | | 0.530** | 0.551** | 0.447** | 0.621** | 0.567** |
| | *p* | | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ |
| Sleep problems | *r* | 0.530** | | 0.467** | 0.398** | 0.486** | 0.444** |
| | *p* | $p \leq 0.01$ | | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ |
| Emotional distress | *r* | 0.551** | 0.467** | | 0.380** | 0.552** | 0.427** |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ |
| Nausea | *r* | 0.447** | 0.398** | 0.380** | | 0.537** | 0.531** |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | | $p \leq 0.01$ | $p \leq 0.01$ |
| Complaints related to the specificity of operating room nurses' clothing and work | *r* | 0.621** | 0.486** | 0.552** | 0.537** | | 0.617** |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | | $p \leq 0.01$ |
| Allergic reactions and skin problems | *r* | 0.567** | 0.444** | 0.427** | 0.531** | 0.617** | |
| | *p* | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | $p \leq 0.01$ | |

*Note: ** when p ≤ 0.01; r-correlation coefficient; p-statistical significance.*
*Weak correlation (r = 0.20–0.39).*
*Moderate correlation (r = 0.40–0.59).*
*Strong correlation (r = 0.60–0.79)*

**Table 4.22** Correlation between occupational risk factors of operating room nurses and health complaints (Spearman), *N* = 254

| Scales | Statistical indicators | Limitations in meeting physiological needs | Lifting heavy objects | Stress related to the psychological climate in the operating room | Stress related to the course of operation and supplies | Stress related to heavy workload | Contact with body fluids and punctures | Slips and falls | Complaints related to clothing and standing work | Allergic reactions and skin problems | Sleep problems | Pain | Emotional distress | Nausea |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Limitations in meeting physiological needs | Correlation | 1.000 | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| | Sig. (2-tailed) | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Lifting heavy objects | Correlation | ** | 1.000 | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Stress related to the psychological climate in the operating room | Correlation | ** | ** | 1.000 | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Stress related to the course of operation and supplies | Correlation | ** | ** | ** | 1.000 | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Stress related to heavy workload | Correlation | ** | ** | ** | ** | 1.000 | ** | ** | ** | ** | ** | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Contact with body fluids and punctures | Correlation | ** | ** | ** | ** | ** | 1.000 | ** | ** | ** | ** | ** | ** | ** |

**Continuation of Table 4.22**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contact with body fluids and punctures | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Slips and falls | Correlation | ** | ** | ** | ** | ** | ** | 1.000 | ** | ** | ** | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Complaints related to clothing and standing work | Correlation | ** | ** | ** | ** | ** | ** | ** | 1.000 | ** | ** | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Allergic reactions and skin problems | Correlation | ** | ** | ** | ** | ** | ** | ** | ** | 1.000 | ** | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Sleep problems | Correlation | ** | ** | ** | ** | ** | ** | ** | ** | ** | 1.000 | ** | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Pain | Correlation | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | 1.000 | ** | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 |
| Emotional distress | Correlation | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | 1.000 | ** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 |
| Nausea | Correlation | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | 1.000 |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | |

*Note: ** Correlation is significant at 0.01 level (2-tailed)*

For instance, "limitations in meeting physiological needs" is strongly correlated with other stressors in the work environment, such as "stress due to the psychological climate in the operating room", "heavy workload", and "sleep problems" ($p \leq 0.01$). This correlation shows that the presence of one stressor often amplifies the effects of other factors.

The correlation between "exposure to body fluids and punctures" and "allergic reactions and skin problems" ($p \leq 0.01$) highlights the biological and chemical hazards in operating room nurses' work, which not only causes physical discomfort but also affects nurses' psychological well-being through persistent anxiety about health.

A statistically significant correlation has been found between "emotional distress" and the occupational risk factors of physical and biological origin, such as "lifting heavy objects", "slips and falls", "exposure to body fluids and punctures", and "limitations in meeting physiological needs" ($p \leq 0.01$). It can be argued that emotional distress, pain, and nausea are often due to the difficult working conditions of operating room nurses, such as long operations, specific limitations of movement due to clothing, or stress due to the course of the operation, lack of supplies, the surgeon's disrespectful behaviour, or poor teamwork. The findings show that working conditions have a direct impact on the physical and emotional well-being of operating room nurses.

## Comparison of occupational risk factors and health complaints of operating room nurses by operating room profile

The Skewness and Kurtosis coefficients of all subscale distributions fall within the range from -1 to 1, suggesting that all of them satisfy the conditions of normality. The normality of the scaled distributions is intact; therefore, parametric statistical criteria for the statistical analysis can be applied.

Due to a relatively small sample of operating room nurses working in the ear, nose, and throat and ophthalmology operating rooms, the two groups have been combined to obtain an equal number of nurses working in different operating rooms. Operating room nurses working in neurosurgical and thoracic operating rooms have also been grouped together.

Based on the Post Hoc Tamhane criterion of analysis of variance, when comparing the means of the scale "lifting heavy objects", statistically significant differences have been found between nurses working in general surgery and the joint ophthalmology and ear, nose, and throat (ENT) profiles (**Table 4.23**). Statistically significant differences were also found between the combined group of nurses working in the ear, nose, and throat and ophthalmology operating rooms and the nurses working in the multiprofile operating rooms, where different surgeries are performed ($p \leq 0.05$). More detailed information regarding the Post Hoc Tamhane criterion is provided in **Annex 2**.

**Table 4.23** Comparison of occupational risk factors affecting operating room nurses across different operating room profiles, *N* = 254

| Scale | Profiles of operating rooms | *N* | Mean | Standard deviation | *P*-value |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Lifting heavy objects | Trauma-Orthopaedics | 24 | 2.6 | 0.65 | 0.020 |
| | General Surgery | 36 | 2.8 | 0.69 | |
| | Obstetric-Gynaecological | 17 | 2.9 | 0.88 | |
| | Ophthalmology and Ear, Nose, and Throat | 16 | 2.1 | 0.53 | |
| | Plastic-Aesthetic surgery | 22 | 2.5 | 0.55 | |
| | Neurosurgical and thoracic | 23 | 2.6 | 0.83 | |
| | Multiprofile | 110 | 2.8 | 0.81 | |
| Slips and falls | Trauma-Orthopaedics | 23 | 1.9 | 0.69 | 0.078 |
| | General Surgery | 35 | 1.7 | 0.64 | |
| | Obstetric-Gynaecological | 17 | 2.1 | 0.78 | |
| | Ophthalmology and Ear, Nose, and Throat | 17 | 1.5 | 0.45 | |
| | Plastic-Aesthetic surgery | 22 | 1.9 | 0.50 | |
| | Neurosurgical and thoracic | 22 | 1.8 | 0.57 | |
| | Multiprofile | 103 | 1.9 | 0.66 | |
| Contact with body fluids and punctures | Trauma-Orthopaedics | 22 | 2.2 | 0.52 | 0.014 |
| | General Surgery | 36 | 1.9 | 0.54 | |
| | Obstetric-Gynaecological | 17 | 2.2 | 0.50 | |
| Contact with body fluids and punctures | Ophthalmology and Ear, Nose, and Throat | 17 | 1.7 | 0.31 | 0.014 |
| | Plastic-Aesthetic surgery | 22 | 2.2 | 0.60 | |
| | Neurosurgical and thoracic | 20 | 1.9 | 0.46 | |
| | Multiprofile | 104 | 2.0 | 0.56 | |
| Limitations in meeting physiological needs | Trauma-Orthopaedics | 25 | 3.2 | 0.76 | 0.018 |
| | General Surgery | 37 | 3.1 | 0.76 | |
| | Obstetric-Gynaecological | 18 | 3.0 | 0.84 | |
| | Ophthalmology and Ear, Nose, and Throat | 16 | 3.4 | 0.63 | |
| | Plastic-Aesthetic surgery | 22 | 3.7 | 0.48 | |
| | Neurosurgical and thoracic | 23 | 3.1 | 0.72 | |
| | Multiprofile | 110 | 3.3 | 0.67 | |

**Continuation of Table 4.23**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Stress related to the psychological climate in the operating room | Trauma-Orthopaedics | 25 | 2.6 | 0.79 | 0.486 |
| | General Surgery | 37 | 2.6 | 0.61 | |
| | Obstetric-Gynaecological | 18 | 2.4 | 0.55 | |
| | Ophthalmology and Ear, Nose, and Throat | 16 | 2.4 | 0.74 | |
| | Plastic-Aesthetic surgery | 22 | 2.6 | 0.78 | |
| | Neurosurgical and thoracic | 24 | 2.5 | 0.80 | |
| | Multiprofile | 110 | 2.7 | 0.68 | |
| Stress related to the course of operation and supplies | Trauma-Orthopaedics | 25 | 2.6 | 0.66 | 0.344 |
| | General Surgery | 36 | 2.6 | 0.63 | |
| | Obstetric-Gynaecological | 18 | 2.4 | 0.50 | |
| | Ophthalmology and Ear, Nose, and Throat | 17 | 2.7 | 0.62 | |
| | Plastic-Aesthetic surgery | 22 | 2.5 | 0.46 | |
| | Neurosurgical and thoracic | 23 | 2.3 | 0.75 | |
| | Multiprofile | 110 | 2.6 | 0.66 | |
| Stress related to heavy workload | Trauma-Orthopaedics | 24 | 2.3 | 0.80 | 0.052 |
| | General Surgery | 37 | 2.4 | 0.59 | |
| | Obstetric-Gynaecological | 18 | 2.1 | 0.49 | |
| | Ophthalmology and Ear, Nose, and Throat | 16 | 2.5 | 0.67 | |
| | Plastic-Aesthetic surgery | 22 | 2.5 | 0.62 | |
| | Neurosurgical and thoracic | 23 | 2.1 | 0.83 | |
| | Multiprofile | 110 | 2.5 | 0.69 | |

When comparing the means of the scale "contact with body fluids and punctures", statistically significant differences were found between nurses working in trauma-orthopaedic, obstetric-gynaecology, plastic-aesthetics, and multiprofile operating rooms, and ophthalmology and ear, nose, and throat operating rooms ($p \leq 0.05$). Further details regarding the Post Hoc Tamhane criterion are provided in **Annex 3**.

When comparing the scale "limitations in meeting physiological needs", statistically significant differences have been found between nurses working in the obstetrics-gynaecology and plastic-aesthetic surgery operating rooms ($p \leq 0.05$). Post Hoc analysis was performed based on the LSD criterion. More detailed information regarding the Post Hoc Tamhane criterion is provided in **Annex 3**.

No statistically significant differences have been observed in the assessment of health complaints by operating room profiles, which suggests that operating room nurses may experience the same health complaints regardless of the operating room profile ($p \geq 0.05$).

## Comparison of the occupational risk factors affecting operating room nurses by work schedule

**Table 4.24** reveals statistically significant differences in occupational risk factors between the groups of nurses working in the operating rooms on daytime and mixed (day and night) schedules. Student's *t*-test has been used to compare the means of the two groups. The mean score for the scale *lifting heavy* objects is higher in the group of nurses working on mixed schedules ($p \leq 0.05$). Operating room nurses with mixed schedules also have a higher incidence of *exposure to body fluids and punctures* than those working daytime ($p \leq 0.05$).

In a comparative analysis of health complaints between the two groups, a statistically significant difference was found in the severity of *sleep problems*. Nurses working on a mixed schedule experience more sleep-related difficulties than nurses working on the daytime schedule ($p \leq 0.05$).

**Table 4.24** Comparison of the occupational risk factors affecting operating room nurses by work schedule, $N = 254$

| Scale | Work schedule | *N* | Mean | Standard deviation | *P*-value |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Lifting heavy objects | Daytime | 105 | 2.6 | 0.73 | 0.005 |
| | Mixed | 144 | 2.8 | 0.77 | |
| Slips and falls | Daytime | 102 | 1.8 | 0.61 | $p \geq 0.05$ |
| | Mixed | 138 | 1.9 | 0.66 | |
| Contact with body fluids and punctures | Daytime | 100 | 2.0 | 0.53 | 0.030 |
| | Mixed | 134 | 2.1 | 0.55 | |
| Limitations in meeting physiological needs | Daytime | 106 | 3.2 | 0.76 | $p \geq 0.05$ |
| | Mixed | 146 | 3.3 | 0.67 | |
| Stress related to the psychological climate in the operating room | Daytime | 107 | 2.6 | 0.73 | $p \geq 0.05$ |
| | Mixed | 146 | 2.6 | 0.67 | |
| Stress related to the course of operation and supplies | Daytime | 106 | 2.6 | 0.68 | $p \geq 0.05$ |
| | Mixed | 146 | 2.5 | 0.60 | |
| Stress related to heavy workload | Daytime | 105 | 2.4 | 0.69 | $p \geq 0.05$ |
| | Mixed | 146 | 2.3 | 0.69 | |

## Comparison of the occupational risk factors and health complaints of operating room nurses by length of work experience

Using the ANOVA test to compare the means of several groups, it was found that the length of work experience is related to the scale "lifting heavy objects" (**Table 4.25**).

**Table 4.25** Comparison of the occupational risk factors affecting operating room nurses based on the length of work experience, *N* = 254

| Scale | Length of work experience | *N* | Mean | Standard deviation | *P*-value |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Lifting heavy objects | Up to 1 year | 50 | 2.5 | 0.73 | 0.001 |
| | 1–5 years | 58 | 2.5 | 0.60 | |
| | 6–10 years | 25 | 2.7 | 0.72 | |
| | 11–20 years | 37 | 3.1 | 0.73 | |
| | 21 years and more | 79 | 2.8 | 0.86 | |
| Slips and falls | Up to 1 year | 48 | 1.8 | 0.61 | $p \geq 0.05$ |
| | 1–5 years | 58 | 1.7 | 0.60 | |
| | 6–10 years | 24 | 1.8 | 0.52 | |
| | 11–20 years | 37 | 2.0 | 0.66 | |
| Slips and falls | 21 years and more | 73 | 1.9 | 0.71 | $p \geq 0.05$ |
| Contact with body fluids and punctures | Up to 1 year | 47 | 1.9 | 0.45 | $p \geq 0.05$ |
| | 1–5 years | 53 | 2.1 | 0.57 | |
| | 6–10 years | 24 | 2.1 | 0.59 | |
| | 11–20 years | 35 | 2.1 | 0.61 | |
| | 21 years and more | 75 | 2.1 | 0.54 | |
| Limitations in meeting physiological needs | Up to 1 year | 50 | 3.2 | 0.75 | $p \geq 0.05$ |
| | 1–5 years | 61 | 3.4 | 0.66 | |
| | 6–10 years | 25 | 3.3 | 0.79 | |
| | 11–20 years | 37 | 3.4 | 0.56 | |
| | 21 years and more | 79 | 3.2 | 0.74 | |

**Continuation of Table 4.25**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Stress related to the psychological climate in the operating room | Up to 1 year | 50 | 2.7 | 0.77 | $p \geq 0.05$ |
| | 1–5 years | 61 | 2.7 | 0.66 | |
| | 6–10 years | 25 | 2.6 | 0.63 | |
| | 11–20 years | 38 | 2.6 | 0.78 | |
| | 21 years and more | 79 | 2.5 | 0.65 | |
| Stress related to the course of operation and supplies | Up to 1 year | 48 | 2.7 | 0.65 | 0.009 |
| | 1–5 years | 61 | 2.7 | 0.58 | |
| | 6–10 years | 25 | 2.4 | 0.67 | |
| | 11–20 years | 38 | 2.6 | 0.61 | |
| | 21 years and more | 80 | 2.4 | 0.63 | |
| Stress related to heavy workload | Up to 1 year | 49 | 2.3 | 0.73 | $p \geq 0.05$ |
| | 1–5 years | 60 | 2.5 | 0.63 | |
| | 6–10 years | 25 | 2.4 | 0.80 | |
| | 11–20 years | 38 | 2.4 | 0.64 | |
| | 21 years and more | 79 | 2.3 | 0.71 | |

The Post Hoc Tamhane criterion revealed statistically significant differences in the means between the groups of nurses with up to 1 year and 11–20 years of service, as well as between the groups of nurses with 1–5 years and 11–20 years of service ($p \leq 0.05$).

Operating room nurses with the least experience in the operating room tend to feel more stress related to the course of the *operation and supplies* than their more experienced colleagues. The least significant difference (LSD) criterion helped determine that operating room nurses with 21 or more years of professional experience were least likely to feel stress related to the course of operation and supplies. However, operating room nurses with up to five years of service in the operating room experience the most stress of this type ($p \leq 0.05$).

There were also no statistically significant differences in the assessment of health complaints among operating room nurses based on the length of their service in the operating room. This indicates that operating room nurses experience the same health complaints regardless of their service length as operating room nurses ($p \leq 0.05$).

The research revealed that there are basically no differences between the occupational stress experienced by operating room nurses and sociodemographic characteristics (**Table 4.26**). Therefore, it can be concluded that there is no statistical correlation between stress scores and sociodemographics.

**Table 4.26** Comparison of the stress experienced by operating room nurses by sociodemographic data, *N* = 254

| Anova test | | | | |
|---|---|---|---|---|
| Intergroup comparison | Amount of squares | Squares of means | Fisher's criterion | Statistical significance (*p*) |
| Operating room profile | 41.049 | 10.262 | 2.040 | 0.089 |
| Work schedule | 0.437 | 0.109 | 0.443 | 0.777 |
| Education | 2.591 | 0.648 | 0.674 | 0.610 |
| Work experience | 13.410 | 3.352 | 1.393 | 0.237 |

## 4.3 Possibilities of ensuring occupational safety from the point of view of operating room nurses

The qualitative research conducted helped reveal the opinions of nurses working in operating rooms across various healthcare institutions regarding the possibility of ensuring occupational safety in their professional activities. The same operating room nurses who participated in the quantitative study and answered the questions also took part in this study. 100 out of 245 participants gave their opinions on the open-ended question at the end of the questionnaire, i.e., *What suggestions do you have to improve the work of operating room nurses and ensure not only your but also patients' safety?*

The majority of operating room nurses are women (99%), with a small number of male nurses (1%). This reflects the general trend in nursing towards a profession dominated by females. The majority of nurses have non-university higher education (37%), and the smallest number of them have completed further education (20%). 43% of the respondents have a Bachelor's Degree, and 19% have at least a Master's Degree.

The most experienced group (with 21+ years of professional experience) make up the most significant proportion (35%), while newcomers (up to 1 year of experience) make up 16%. 24% of nurses have 1–5 years of experience, indicating that a significant number have joined the profession recently. 58% of operating room nurses work on a mixed schedule (days and nights), with the smaller remainder working on a daytime schedule. The majority of respondents work in multiprofile operating rooms (35%), followed by general surgery (17%) and trauma-orthopaedic (12%) operating rooms. Other

specialised profiles (e.g., plastic-aesthetic surgery or neurosurgery) account for smaller proportions of 7% or less (**Table 4.27**).

The data obtained have been analysed using thematic analysis, which is a social science research method used to analyse and interpret textual, visual, or audio material.

**Table 4.27** Sociodemographic data of the operating room nurses in the qualitative study (*N* = 100)

| Characteristics | Grouping | *n* | % |
|---|---|---|---|
| Gender | Female | 99 | 99 |
| | Male | 1 | 1 |
| Education | Further (medical school) | 20 | 20 |
| | Higher non-university | 37 | 37 |
| | University (Bachelor Degree) | 24 | 24 |
| | University (at least Master Degree) | 19 | 19 |
| Length of service in an operating room | Up to 1 year | 16 | 16 |
| | 1–5 years | 24 | 24 |
| | 6–10 years | 10 | 10 |
| | 11–20 years | 15 | 15 |
| | 21 and more years | 35 | 35 |
| Work schedule | Daytime | 42 | 42 |
| | Mixed (days and nights) | 58 | 58 |
| Profile of the operating room | Multiprofile | 35 | 35 |
| | General Surgery | 17 | 17 |
| | Trauma-Orthopaedics | 12 | 12 |
| | Plastic-Aesthetic surgery | 7 | 7 |
| | Obstetric-Gynaecological | 9 | 9 |
| | Thoracic and angiosurgery | 5 | 5 |
| | Ophthalmology | 6 | 6 |
| | Neurosurgery | 4 | 4 |
| | Ear, Nose, and Throat (ENT) | 5 | 5 |

Three main themes emerged from the analysis of occupational safety of operating room nurses, i.e., *Improving working conditions from an organisational standpoint*, *Improving the psychosocial climate in the operating room*, and *Measures to motivate operating room nurses*. Each theme consisted of a number of sub-themes, ranging in number from two to six (**Table 4.28**).

**Table 4.28** Opportunities for improving the working conditions of operating room nurses, *N* = 100

| Themes | Subthemes |
|---|---|
| Improving working conditions from an organisational standpoint | ■ sufficient staffing and reduction of the workload;<br>■ reduction of instrumentation volumes during operations;<br>■ optimisation of work functions;<br>■ longer intervals between operations;<br>■ adequate provision of supplies;<br>■ improving ergonomic conditions |
| Improving the psychosocial climate in the operating room | ■ changing attitudes towards the operating room nurse and enhancing respect;<br>■ improving teamwork;<br>■ professional psychological support |
| Measures to motivate operating room nurses | ■ increased salary;<br>■ competence development |

## Improving working conditions from an organisational standpoint

The participants in the study highlight the systematic application of organisational measures to improve the working conditions of operating room nurses in a targeted manner. The content analysis has revealed that the following measures can improve nurses' working conditions from an organisational standpoint:

- sufficient staffing and reduction of the workload;
- reduction of instrumentation volumes during operations;
- optimisation of work functions;
- longer intervals between operations;
- adequate provision of supplies;
- improving ergonomic conditions.

Nurses believe that there is currently a shortage of operating room nurses during surgeries, which is associated with heavy workload and overwork that lead to mistakes being made:

*"Barely managing or even failing to do all the operations, even without taking breaks" (Nurse 53).*

*"The number of operating room nurses should be increased so that there are two nurses in the operating room, and they can rotate so that when one operation is completed, another nurse assists with the next operation" (Nurse 57).*

*"Two operating room nurses per operating room is mandatory. Possibility to rotate during long operations lasting 7 hours should be provided" (Nurse 30).*

*"The workload is severe; we work for several hours and get overworked; naturally, there occur more careless mistakes" (Nurse 7).*

The actual practice of operating room nurses reveals that the duration of operations varies widely, ranging from 30 minutes to 7 hours or more. The participants' suggestion in the study **to reduce the volume of instrumentation during surgery** is very rational. It contributes to improving the organisation of the activities of operating room nurses and ensuring the safety of the patients undergoing surgery:

*"Wherever possible, the volumes of surgeries should be reduced; the duration of the operation should be shortened, thus reducing the risk of postoperative complications for the patients. The operating room nurses would not feel overworked and would have minimal breaks to rest, both physically and psychologically" (Nurse 26).*

**While optimising the work of operating room nurses** and searching for new measures, less qualified staff could be involved in the activities currently carried out by operating room nurses. The operating room nurses who participated in the study suggested practical alternatives, such as recruiting a stronger workforce (men in particular) to help with patients' transportation, lifting heavy instrument boxes and other equipment, and employing a sufficient number of ancillary staff to help prepare for the next operation and prepare sterile instruments:

*"Recruiting men to help lift patients, push equipment, etc., would reduce the workload for operating room nurses" (Nurse 13).*

*"It would help a lot if there were enough staff, assistants, and nurses to help with the clean-up after the operation and prepare for the next operation. This would reduce the great stress we get from the doctors because they want to operate as soon as possible and with less time between surgeries" (Nurse 40).*

*"The number of staff in the autoclave should be sufficient so that they don't have to both instrument kits and then take care of the supplies between operations" (Nurse 50).*

The respondents suggest limiting the work of operating room nurses in different units, as a lot of time is spent on changeovers, which they refer to as "running around":

*"<...> to work in one operating room and avoid having to go to different operating rooms. For example, like now in some places, there is the main operating theatre, you work in it, and you are told to run to a separate maternity department or reception" (Nurse 47).*

*"There should be an even distribution of the workload. For example, one operating room performs only one operation a day, while others have five or more, and this happens all the time. There should be rotation among those who work daytime and night shifts" (Nurse 73).*

The work of operating room nurses is characterised by the specificity of long-standing in the operating room. Therefore, the operating room nurses who participated in the study made reasonable suggestions regarding longer intervals between operations. Breaks between operations would allow for rest and basic physiological needs:

*"<...> breaks to rest both physically and psychologically" (Nurse 15).*

*"We need to have a lunch break so that we can eat" (Nurse 8).*

The respondents associate **longer intervals between operations** with patients' safety, as well as the need for time to properly prepare for surgery and pay particular attention to infection prevention:

*"It is necessary to have enough time to prepare the instruments, enough time to wash and dry the hands, and good teamwork without negative emotions" (Nurse 66).*

*"It is necessary to have longer breaks between operations so that you can prepare more carefully for the next operation, and there are no unexpected situations during the operation when something is missing, and we can't pass it quickly, or we don't even have it" (Nurse 50).*

The study showed that there is still a shortage of basic supplies for surgery, which hinders the quality performance of operating room nurses and emphasises the importance of **adequate provision of supplies**. Nurses point to the lack of modern and safe facilities for getting instruments ready for surgery:

*"Still, we do not automatically decontaminate and process surgical instruments in the decontamination and washing facilities after surgery. We just wash them under running water by hand" (Nurse 12).*

It can be assumed that in some Lithuanian hospitals, nurses' smooth service is hampered by the outdated environment of operating rooms and the ineffective functioning of ventilation systems:

*"Effective ventilation and cleaning systems are needed in operating rooms" (Nurse 37).*

The research findings suggest that operating room nurses and the entire operating room team are working under hazardous conditions. This is demonstrated not only by the lack of ventilation systems in some operating rooms but also by the disuse of protective devices, such as an electrocautery fume collector:

*"<...> we don't have a fume collector during bipolar electrosurgery" (Nurse 99).*

Nurses are concerned about the lack of medical supplies needed for surgery. This shortage can technically disrupt the work of the operating room nurses, which in itself is closely linked to the smooth running of the surgery, to say nothing about the psychological tension caused by the surgeon:

*"It is least up to us to ensure that the medical supplies are always fully sufficient for the operation and that the surgeon does not express his dissatisfaction directly to us" (Nurse 63).*

*"Disposable scalpels must be provided, and there must be a sufficient amount of supplies to mitigate stress at work" (Nurse 31).*

*"There is a need to be provided with all the necessary supplies, and disposable instruments should be used just once" (Nurse 48).*

Operating room nurses not only face the problem of a lack of supplies but also the lengthy repair of malfunctioning equipment. Nurses see this problem as a social challenge, where the competent professionals responsible for the technical maintenance of the appliances do not fulfil their duties adequately:

*"A faster reaction is needed to malfunctions, loss of vacuum during surgery, and fixing the equipment. We have to wait for help for a very long time, or we do not get it at all because the staff are either unprofessional or indifferent, and the better ones run away to where they are paid more" (Nurse 96).*

A survey of operating room nurses has revealed that some operating rooms lack the facilities and environment to meet ergonomic requirements.

**Improving the ergonomic conditions** of operating room nurses is an important area. Operating room nurses note that the furniture in operating rooms and its layout are uncomfortable, and various wires are scattered, which can cause falls. There is a lack of means for patients' transfer, especially when it comes to repositioning patients who are overweight. Operating room nurses suggest increasing the use of assistive devices to ensure patients' safety and the quality of the service of the operating room team:

*"Comfortable and stable chairs with neatly running wheels are needed to make work easier and reduce the strain on the legs" (Nurse 40).*

*"It is necessary to be able to sit during instrumentation. This is especially important for pregnant nurses in operating theatres to avoid fainting and falls" (Nurse 54).*

*"New operating room tables with height adjustment are needed" (Nurse 16).*

*"Aids for lifting patients are needed <...>" (Nurse 69).*

## Improving the psychosocial climate in the operating room

The operating room nurses who participated in the survey shared their views on the need to improve the psychosocial climate. The analysis of these data has highlighted three areas:

- changing attitudes towards the operating room nurse and enhancing respect;
- improving teamwork;
- professional psychological support.

The participants in the study believe that it is important to change **attitudes towards the operating room nurse and enhance respect**.

Disrespectful attitudes towards the operating room nurse by some surgeons still exist.

Operating room nurses openly remark that there should be a change in the way they are treated, as they are equal members of the team, and there should be no division based on levels of prestige. This highlights the stereotypes some surgeons have of the operating room nurses, who, in their opinion, despite their professional experience, are supposed to know everything:

*"It is necessary to respect those who work for us. For example, the surgeon's behaviour, unpleasant remarks, insults, raising the tone of voice at us are offensive" (Nurse 20).*

*"<...> as much mutual understanding and respect as possible, especially from the operating doctor" (Nurse 70).*

*"Changing the surgeons' attitude towards us as "inferior" staff is extremely important" (Nurse 95).*

*"More understanding of the newly recruited staff is needed, not just demanding to know everything from the very beginning. Often, a new person is required to know everything as if they have been working for a long time. This is also a problem with older workers. If you have been working for a long time, you have to know everything. Some surgeons are surprised "How come you don't know? You have been working for us for 2 years?!" (Nurse 52).*

The psychosocial climate is closely linked to teamwork, with effective communication and sharing of tasks. The research findings have revealed untapped opportunities for **improving teamwork**. Operating room nurses report a lack of effective communication, which is related to smooth preparation for surgery. Regrettably, cooperation is not shared with all team members:

*"There is a need for good cooperation between colleagues and information about what additional instruments will be needed for the surgery, the severity of the operation" (Nurse 36).*

*"Discussion of the activities at the beginning of the day is needed between nurses, surgeons, and anaesthetists, and the same discussion at the end of the day to improve performance" (Nurse 50).*

*"<...> promoting better cooperation with all members of the team" (Nurse 46).*

*"The ability of the operating room manager to bring together the nurses of the operating rooms as a team working towards a common goal and resolve problematic issues in the meetings" (Nurse 23).*

*"Joint pre-operative patient's rounds involving the whole operating room team" (Nurse 24).*

There were several cases where operating room nurses identified mobbing at work. As it was their choice how extensively to answer the open-ended question, none of them commented further and simply included phrases such as "to prevent mobbing" (Nurse 23) and "to reduce mobbing at work" (Nurse 28), among others. One of the rational solutions is **professional psychological support**:

*"A counsellor psychologist who can be addressed on a daily basis is needed to share the reasons that cause stress. Such an impartial person would inform the management about the microclimate in the team and the necessary changes" (Nurse 64).*

## Motivational opportunities for operating room nurses

Operating room nurses shared their views on measures that would contribute to motivation:

- increased salary;
- competence development.

Higher remuneration was a very frequently mentioned measure:

*"The salaries should be more generous because we are forced to work overtime, which is paid by the so-called actual hours so that not to pay more" (Nurse 12).*

Nurses usually very briefly and clearly identify the need for a *"higher salary"*, *"pay rise"*, *etc.*

Operating room nurses recognise opportunities for competence development to enhance their services, improve their professional safety, and contribute to patient safety in the operating room. Operating room nurses express the need for targeted training for operating room nurses only, and they would like information to be available online:

*"There is a lack of conferences and courses for operating room nurses. No updates on developments in the Lithuanian language" (Nurse 91).*

*"We would like to receive training on correct and safe lifting of patients in the operating room" (Nurse 13).*

*"More conferences for operating room nurses" (Nurse 38).*

*"There should be more frequent training (recollecting, refreshing) on the operation of medical equipment and the procedure of less frequent operations" (Nurse 62).*

*"More updated information on the internet specifically for operating room nurses to be available at their leisure" (Nurse 25).*

## Summary of Chapter 4

Lithuanian operating room nurses are exposed to several occupational risk factors, including limitations in meeting physiological needs (e.g., irregular meals and limited access to liquids). Ergonomic risk factors, such as lifting heavy objects and transporting medical equipment, are frequent, as many nurses must lift patients and heavy surgical instruments. Significant psychological stress is caused by the stressful work in the operating room, the unpredictable behaviour of the surgeon, and the poor team atmosphere. There are also biological risks associated with contact with body fluids and punctures from sharp instruments, which can pose a threat to health. Although slips and falls are not particularly common, they remain a significant problem related to wet floors, uncomfortable footwear, and messy wires in the operating room.

Health complaints from operating theatre nurses were mostly related to the nature of the work and the discomfort caused by clothing. They included fatigue, leg swelling, sweating, and shortness of breath due to wearing medical masks. Local allergic reactions and skin problems came second. Sleep disturbances came third. Frequent pain in various parts of the body may also be related to the professional activities of operating room nurses. Emotional distress, including anxiety, depressed mood and apathy, was also common. Nausea and discomfort due to electrocautery fumes or unpleasant odours were the least common complaints.

Nurses working in operating rooms of different profiles are exposed to various occupational risk factors. Nurses in general surgery and multiprofile operating rooms are more likely to lift heavy objects. In contrast, nurses in obstetrics-gynaecology, trauma-orthopaedics, and plastic surgery operating

rooms are more likely to be exposed to body fluids and punctures. Operating room nurses with a mixed schedule are more likely to experience ergonomic and biological factors, as well as more sleep problems, than operating room nurses with a full-time schedule. Operating room nurses with less professional experience are more stressed by the process and the surgical tools. Despite these differences, health complaints remain similar across operating rooms, suggesting that the working environment poses common challenges to nurses' health.

Organisational factors for improving working conditions, such as sufficient staffing, an ergonomic working environment, and an improved psychosocial climate, are essential to ensure the quality of nurses' work in operating rooms, which is linked to patients' safety. To ensure the efficiency of operating room nurses' services, it is necessary to increase the number of staff and reduce the workload, which might help avoid overwork and mistakes. At least two nurses should work in the operating room, and long operations should be planned with the possibility of rotation or breaks. Efficient distribution of work functions and the use of lower-skilled staff for ancillary tasks can mitigate the physical and emotional strain on nurses. In addition, the scope of instrumentation and the division of functions should be reviewed and optimised.

Longer intervals between operations, allowing nurses to rest and prepare for the next operation, are essential not only for the quality performance of operating room nurses but also for patients' safety. It is relevant to ensure a sufficient and high-quality provision of medical supplies and the use of modern equipment. Improving ergonomic conditions, from comfortable furniture to patients' lifting aids, is a key aspect of reducing the risk of injury and improving work efficiency. It is vital to change the attitude towards operating room nurses as equal members of the team, strengthen mutual respect, and promote effective communication between all members of the operating room team. It is also crucial to prevent mobbing and ensure the availability of professional psychological support. Nursing and unit managers should organise regular meetings and clearly allocate assignments to improve the time management of the operating room team.

# Chapter 5
# Opportunities to ensure occupational safety of operating room nurses as perceived by operating room managers

## 5.1. Methods of qualitative research

The qualitative research aimed to reveal the attitudes of operating room managers towards the risk factors affecting operating room nurses and the measures they use to cope with them. The study was conducted from December 2024 to January 2025, with the participation of operating room managers from Lithuanian healthcare institutions.

### Data collection methods

Individual semi-structured interviews were conducted with operating room managers to reveal their attitudes towards the risk factors affecting operating room nurses and their methods of coping with them.

Eleven interviews were conducted with operating room managers using a question guide developed by the authors of the monograph. Each interview lasted 20–25 minutes. The operating room managers were asked about teamwork, the challenges of working as an operating room nurse and occupational safety.

### Research sample and selection of subjects

The sample for the qualitative part of the study differed from that of the quantitative part, and it was significantly smaller. To gain a deeper understanding, the data were compared, searching for similarities and differences, additional information, and contradictions.

The study included operating room managers working in different Lithuanian healthcare institutions who met the following criteria:

- had at least 3-year experience in operating room management;
- agreed to participate in the study.

A purposive sampling method was used for the qualitative study of operating room managers. The informativeness of the data obtained determined the size of this sample; as the sample size decreased, it was decided not to include any additional sample units.

## The procedure of the interview

A convenient time for an individual interview was arranged with the operating room managers who decided to participate in the study. The interviews were conducted remotely using Google Meet software. The researcher attached notes and observation protocols to the audio recording as supplementary research materials. The interviews were conducted following a pre-arranged plan. The guiding questions have been formulated after analysing the survey data and reflecting on which topics required more in-depth information than was obtained during the first stage of the study. Each interview was recorded on a dictaphone. At the beginning of the interview, questions about cooperation and teamwork were asked. This allowed the interviewers to get to know the participants and establish contact. Then, other interview questions gradually followed (e.g., about the challenges encountered in the work of nurses and nursing administrators), moving on to more relevant questions about the occupational safety of operating room nurses and occupational risk factors in their work:

*1. Please share your experience on how cooperation and teamwork are going in the operating room where you work.*

*2. What should be improved to ensure better cooperation and teamwork in the operating room?*

*3. Please describe the situations that are most challenging for nurses in the operating room.*

*4. What are the most difficult functions related to managing the activities of operating room nurses? What makes them difficult?*

*5. How have you tried to cope with the difficulties that arise in your work?*

*6. What mainly prevents the assurance of the occupational safety of operating room nurses and the mitigation of occupational risk factors?*

*7. How do you think the occupational safety of operating room nurses is linked to patients' safety?*

*8. What could you suggest to make operating room nurses feel safe at work?*

At the end of the interviews, the participants were asked whether they would like to add something about the issues discussed during the interviews. In the end, the participating operating room managers were thanked and provided with contact information in case they had any questions about the interview or the study later.

While transcribing the discussion materials, participants' emotions were indicated, as well as pauses. Signs and symbols were used for this purpose:

- (.4) a dot and a number in brackets indicate how long the pause lasted;
- (.) a dot in brackets indicates a pause that lasted no longer than one second;
- ( ) empty brackets indicate a part of the text that could not be heard to be transcribed;
- (( )) double brackets were used for the researcher's observations;
- - a dash at the end of a word indicates an unfinished word;
- ↓ or ↑ arrows indicate a marked change in the participant's intonation;

- *text* the researcher's questions are written in italics.

Two researchers interviewed operating room managers. They had met twice before the survey and interview to discuss the aims, procedure, and potential challenges of the study. The investigators met several times a month during the study to discuss emerging issues and challenges.

## Research ethics

The research was approved by the Committee for Assessing the Compliance of Applied Research with Research Ethics at Kauno kolegija Higher Education Institution (No. 13-35). The informed consent forms were signed by operating room managers and sent to the researcher in an encrypted format, with no third party having access to them.

Transcription of the material was performed by the principal researcher using Express Scribe Transcription Software. All audio recordings were destroyed after they were transcribed. The transcribed interviews were coded based on a specially created identification number. Names, surnames, and other personal data that could identify the respondents were excluded from the data file. All transcripts were stored in a secure institution cloud server. The login password is known only to the primary researcher and is updated monthly. The subjects were guaranteed the right to withdraw from the study at any time without any consequences.

## Methods of data analysis

The research materials obtained during the interviews with the operating room managers who participated in the qualitative part of the study have been analysed using thematic analysis [18]. When transcribing the interview materials, the participants' emotions observed, as well as pauses, were indicated and included in the analysis [190]. Codes and themes were derived from the data, which helped reveal the uniqueness and meaning of the information available and avoid preconceptions. This method is also described as a method of identifying, analysing, and highlighting the structure of the data [191].

Following the recommendations of V. Braun and V. Clarke [192], the data analysis involved 6 stages:

- transcribing, i.e., transcribing the interview materials, helped study the data;
- coding, i.e., the text was broken down to identify meaningful units;
- initial codes were generated for the analysis of the research materials;
- identifying themes; during this stage, the research materials were read again, the appropriateness of the selected codes was examined, the codes were grouped into subthemes and then into potential themes;

- reviewing the themes at two levels; at the first level, the wording of the themes, subthemes, the coherence of the code structure, and consistency were checked; at the second level, the codes were regrouped, and a "thematic map" was created;
- defining and describing themes, i.e., further analysis of the data was carried out, and the titles of the themes were developed and refined;
- at the final stage of the analysis, the findings were described and illustrated with the most vivid quotations from the participants that were most appropriate to the theme revealed.

It should be noted that the data analysis process involved a continuous back-and-forth motion throughout all stages.

Often, new insights and ideas emerge at the end of one stage of the research, leading to revisions of the research materials and modifications to the established structure.

## Researchers' links to the research topic

The researchers are experienced nurses with extensive backgrounds in perioperative nursing and nursing administration. It can be stated that the area chosen for the research is familiar and relevant to them. Despite the small number of nurses in this field in Lithuania, the researchers are very confident that the chosen topic is important and applicable not only for them. The fact that the researchers have "matured" in the field through their professional experience has undoubtedly impacted the way they assessed and interpreted the data. The authors of the monograph hope that their connections to the field and the research subject have been beneficial, as they allowed them to understand better and appreciate the issues that emerged during the interviews. The research findings are partly informed by the insights of other researchers, which can be seen as evidence of the study's objectivity.

## 5.2 Findings of the qualitative research

To explore the attitudes of operating room managers towards the risk factors affecting operating room nurses and strategies for coping with them, a qualitative study was conducted involving 11 operating room managers, aged between 33 and 64. All of the participants were women, with a higher proportion having a Master's degree (**Table 5.1**).

**Table 5.2** provides the themes and subthemes identified during the interviews. The five themes characterise the occupational safety experience and the environment of operating room nurses from the perspective of operating room managers. They reflect the multifaceted nature of occupational safety and its impact within the operating room context.

**Table 5.1** Socio-demographic characteristics of the participants in the qualitative study

| Participant's code | Age (in years) | Gender | Education | Experience in operating room management (in years) |
|---|---|---|---|---|
| V1 | 45 | Female | University (Master's degree) | 4 |
| V2 | 50 | Female | University (Master's degree) | 5 |
| V3 | 33 | Female | University (Master's degree) | 7 |
| V4 | 51 | Female | Higher non-university | 9 |
| V5 | 46 | Female | University (Master's degree) | 12 |
| V6 | 39 | Female | University (Master's degree) | 9 |
| V7 | 54 | Female | University (Master's degree) | 31 |
| V8 | 64 | Female | University (Bachelor's degree) | 41 |
| V9 | 59 | Female | Higher non-university | 32 |
| V10 | 53 | Female | University (Master's degree) | 17 |
| V11 | 55 | Female | Higher non-university | 29 |

**Table 5.2** The risky areas affecting operating room nurses from the perspective of operating room managers

| Themes | Subthemes |
|---|---|
| Cooperation and communication | ■ the role of an operating room nurse;<br>■ intercommunication |
| Challenges in operating room nursing | ■ lack of supplies;<br>■ human resources;<br>■ management of operating room nursing |
| Occupational risk factors | ■ work environment;<br>■ psychological strain |
| Safe Nurse – Safe Patient | ■ the importance of teamwork;<br>■ job satisfaction |
| Occupational safety of operating room nurses | ■ psychosocial safety;<br>■ delegation of functions;<br>■ organisational culture and management |

Five main themes have been identified:
1. Cooperation and communication.
2. Challenges in operating room nursing.
3. Occupational risk factors.
4. Safe Nurse – Safe Patient.
5. Occupational safety of operating room nurses.

Each theme consists of two or three subthemes. The descriptions of the main themes and subthemes identified are provided below, accompanied by extracts from the interviews. The language of the participants' quotations has not been corrected. The identification code created is indicated in brackets at the end of the quotation. The contractual sign <...> indicates that the text contains an incomplete quotation, i.e., only part of the statement is taken, and the part of the text that the researchers consider irrelevant is omitted.

## Cooperation and communication

Two subthemes dominated this theme: ***the role of an operating room nurse and intercommunication***.

***The role of an operating room nurse***

Operating room nurses have a very important role in the team:

*"I think the operating room nurse is the most important person in the operating room. The pivot around whom everything revolves, the one who keeps an eye on everything" (V7).*

*"The operating room nurse is the queen of the operating room. In the good sense" (V5).*

*"The person who takes care of everything and everyone" (V6).*

The operating room managers stated that sometimes the activities of the operating room nurse are very important but remain "behind the scenes". Such an autonomous profession is not even widely known in society:

*"<...> very often, the job remains invisible" (V5).*

*"All the laurels go to the surgeons. And anaesthesiologists. But there are so many people working in the operating room..." (V4).*

*"In mass media, only the surgeons' achievements are reported. And how about the whole operating team?" (V8).*

***Intercommunication***

Operating room managers emphasised that teamwork is the foundation for smooth, efficient, and safe work in the operating room. The goal of smooth cooperation between all team members is the patient's well-being:

*"Cooperation works best when all team members (the operating room nurse, the anaesthesia and intensive care nurse, anaesthetist, intensive care physician, surgeon, assistant, and nursing assistant) are equally interested in doing the job – the surgery – well" (V3).*

*"Sufficiently respectful communication, in most cases, cooperation for the welfare of the patient" (V1).*

*"Communication and mutual support between all members of the team is of utmost importance" (V9).*

*"We talk; we discuss <...>. In certain cases, misunderstandings are more likely to arise when certain people confront" (V11).*

Communication may be difficult due to language barriers:

*"It is fine if the nurse's assistant speaks Lithuanian because, in many cases, we have to speak a different language every day: Russian or English. Fewer problems if*

*the operations are simple, but in major abdominal surgeries, it is difficult to work with foreigners, and the work becomes stressful for all staff" (V3).*

*"We have two nurses from Ukraine, so, in the beginning, it was really challenging for young surgeons to communicate with them. Some were even angry about why they had to speak Russian" (V7).*

The operating room managers with more experience noted that communication between them changed over time:

*"Before, the team was like a family. We used to have babies together and celebrate holidays together. Now that's long gone..." (V8).*

*"Things have changed; everything has changed a lot. A different generation. A different attitude towards work and colleagues. Communication is completely different. A nurse used to be worthy of attention and respect" (V9).*

*"Then we would have a friendly conversation, and everything would work out. There were no complaints about each other" (V11).*

## Challenges in operating room nursing

Three subthemes were identified under this theme: ***lack of supplies, human resources, and management of operating room nursing***.

***Lack of supplies***

Even modern, well-established healthcare institutions still face a lack of supplies:

*"A severe shortage of disposable instruments leads to reusing them, and they are difficult to wash and sterilise" (V3).*

*"Lack of certain medical supplies, equipment, and premises in the institution. Lack of operating room facilities" (V2).*

*"Protective X-ray aprons are already morally obsolete. It is difficult to stay in them for the whole shift. Newer, lighter ones are now available. Still, nobody buys them, as they are expensive..." (V8).*

However, operating room managers believe that proper planning of operations and optimising the accounting of the existing resources could partly help ensure the availability and accessibility of the supplies:

*"Automation and digitalisation, i.e., shared platforms where doctors and nurses can see the residues of disposable instruments such as meshes, staplers, staples and other supplies" (V3).*

*"If surgeons planned and informed in advance about what instruments would be needed, it would be easier for everyone to organise activities" (V8).*

Staff shortages, attracting and retaining new staff were a topic of particular interest to all the operating room managers:

*"Lack of supporting staff and no circulating nurse" (V3).*

*"Staff shortage causes tension in the operating room every day" (V6).*

*"Every day, the assistant nurse changes in the operating room, resulting in daily explanations or reminders about where to move the operating room equipment, from which shelf to take the necessary sterile instruments, telling to close the window blinds for laparoscopic operations, and so on" (V3).*

*"Adequate staffing and time between operations would reduce tension and rush, and we would pay more attention to wearing personal protective measures" (V4).*

*"I don't even know how to persuade the staff to stay" (V8).*

Staff shortages even lead to health problems:

*"I have been in situations where I had to work in the heat, with no food and no drinks for a long shift, not even being able to go to the toilet. As I was pouring sterile saline into a bowl to wash a patient's stomach, I almost fainted because I just wanted to drink. And this is not something that happened long ago, just a simple staff shortage. I came back to work with my antibiotics after a kidney infection without recovering because it was summer, COVID, and a complete lack of staff" (V1).*

***Management of operating room nursing***

Management of operating room nursing is a challenging task that requires knowledge and expertise. Human resource management is the most demanding task for operating room managers:

*"When I started administrating the operating room, I managed to attract a number of new staff (operating room nurses), both post-graduates and those wishing to change their specialisation by moving from other departments to the operating room. Unfortunately, due to the heavy workload and emotional strain, only one of the 5 recruits stayed" (V3).*

*"The permanent adjustment of work schedules, changes, and search for staff are time-consuming and demanding" (V9).*

*"I find it difficult to remain impartial... After all, I know all the staff very well over the years. I know their weaknesses and strengths" (V5).*

*"Staff shortage and the organisation of public procurement. Sometimes I feel as if I work as a manager, not as a nursing administrator" (V11).*

Despite the challenges at work, the operating room managers stated that they feel fulfilled in their daily work:

*"Where some people see difficulties and obligations, I see opportunities to challenge and improve myself" (V5).*

*"No matter how difficult it is, I see meaning in this work, especially thanks to the people I work with" (V6).*

## Occupational risk factors

Two subthemes were identified under this theme: ***work environment and psychological strain***.

***Work environment***

According to the operating room managers, operating room nurses are constantly exposed to occupational risk factors in their daily work due to the nature of their work, the very close contact with patients, and the exposure to various chemicals and ionising radiation:

*"Humidity, heat, and lack of ventilation increase the risk of contracting airborne infectious diseases from the patient" (V10).*

*"The majority of orthopaedic trauma-type operations are performed under X-ray control. Exposure to X-rays is increasing year by year. The orthopaedic traumatologists change, and the operating room nurse is the same with them" (V5).*

*"We are constantly "soaking" in patients' blood, pus, bowel content... This certainly increases the risk of contracting various diseases" (V8).*

*"All those disinfectants and chemicals in cleaning products. Then there are the evaporating anaesthetics. After all, the operating room staff breathe all that in" (V9).*

From the point of view of operating room managers, improving ergonomic conditions is an essential aspect of protecting operating room nurses from injury or harm at work:

*"I don't know for how many years we have been asking for new instrumentation tables. We work with the ones that barely move; not all of them are even height-adjustable" (V5).*

*"Not everything is adapted to make it comfortable for shorter and taller staff. Some people have sore backs after a shift, others have strained necks" (V6).*

***Psychological strain***

Psychological strain and stress in the activities of operating room nurses have often been pointed out as crucial occupational risk factors. Feelings of uncertainty and urgency are common among nurses working in the operating room:

*"There is a lot of rush, tension, and stress in the work of operating room nurses. These often become occupational risk factors" (V9).*

*"You never know what will happen in a minute. What's coming... That constant being on standby is really tiring" (V7).*

*"It's not pleasurable to work with a patient who is brought from prison or temporary detention. You don't know what to expect from them..." (V8).*

Some of the interviewed felt that the psychological strain experienced at work affected the health of the operating room nurses:

*"Stress leads to reduced resistance to diseases" (V4).*

*"I don't even measure my blood pressure after a complicated operation or a "complicated" surgeon.... It's scary to see the numbers" (V11).*

However, some operating room managers observe that by following work instructions and protocols, occupational risks can be minimised:

*"Physical, chemical, and biological occupational risks are minimal if work safety instructions are followed" (V2).*

*"<...> the completion of a "Safe Surgery Checklist" should be introduced in all medical institutions. It would certainly reduce the risks" (V3).*

## Safe Nurse – Safe Patient

Two subthemes were identified under this theme: ***the importance of teamwork and job satisfaction***.

***The importance of teamwork***

The participants in the study observed a direct link between the occupational safety of operating room nurses and the safety of patients. According to

them, *"you can only take care of others when you are absolutely sure that you are already taken care of"*:

*"If an operating room nurse feels safe in her job, she will pay more attention to patient's safety" (V3).*

*"Occupational safety and patient's safety are closely interlinked" (V10).*

*"Errors due to overwork, rude communication with patients, poor communication, emotional impact on the patient. As a result, the patient's safety suffers" (V1).*

*"Frequent teamwork failure – "it's my responsibility / it's not my responsibility" (V4).*

A cohesive operating room team and the feeling of being "part of something important" are also important:

*"A good emotional environment in the team means that each team member contributes to good performance and job satisfaction" (V6).*

***Job satisfaction***

Good team relationships lead to higher job satisfaction among operating room nurses. Operating room managers felt that there was a direct link between the relationships between operating room nurses and job satisfaction:

*"The more cohesive the team, the higher the job satisfaction of the operating room nurses and their willingness to perform better with the help of other team members" (V2).*

*"The better the psychological climate at work, the greater the satisfaction with what you do" (V10).*

*"I always say that when the employee is satisfied, the client is also satisfied" (V11).*

*"A happy employee is a productive and loyal employee" (V5).*

## Occupational safety of operating room nurses

Three subthemes were identified under this theme: ***psychosocial safety, delegation of functions, and organisational culture and management.***

***Psychosocial safety***

The operating room managers stated that to ensure the occupational safety of operating room nurses, their psychosocial safety must be addressed first. They argue that psychological safety is an individual factor that depends on the ability not only to "take" but also to "give":

*"Anonymous help from psychologists and psychotherapists around the clock, training in crisis and stress management, and enhancing a team culture are needed" (V3).*

*"When employees feel safe, they are not afraid to express their observations and suggestions. Discussions give rise to different ideas" (V10).*

*"It is important to allow employees to speak their minds, express their opinions and expectations freely, and feel like equal members of the team" (V8).*

Reducing background noise in the operating room and listening to favourite music during operations contribute to nurses' psychological safety:

*"We have replaced the operating room pumps with modern ones, and the environment has become much quieter. Previously, after long operations, you could still hear the hum of the operating pumps in your head for a long time" (V9).*

*"We listen to music during surgery. It helps to calm down" (V7).*

Improving social conditions and ensuring social security are important for the well-being of operating room nurses:

*"Sometimes they come to work sick because they are unwilling to take sick leave due to reduced income. Sometimes they see that there will be no one to work" (V7).*

*"Heavy workload causes fatigue, but they lack money and are inadequately paid, especially given the shortage of professionals in this speciality. This makes people reluctant to have one-and-a-half tenure" (V1).*

It has also been mentioned that nurses' occupational safety can be affected by personal factors as well as work-related ones:

*"Nurses' occupational safety can also be affected by non-work-related factors; personal, family and similar factors can also trigger occupational risk factors, so it is very individual" (V3).*

*"All of them know the work instructions and the procedures for using protective measures. But the human factor is always there..." (V6).*

***Delegation of functions***

Reviewing and redistributing job functions could reduce the workload of operating room nurses and increase their job satisfaction:

*"You don't need to be qualified as an operating room nurse to wash surgical instruments, pack and sterilise instrument kits. This could be done by operating room supporting staff" (V5).*

*"Some functions that do not require a nursing qualification, such as washing instruments, could be taken over from nurses" (V2).*

*"Medical technicians refuse to transport medical equipment because their training is too high for such unskilled work. However, an operating room nurse with a Master's degree does not have this option (to refuse to move medical equipment). This demotivates the staff" (V5).*

Reviewing and redistributing job functions would also allow considering more competent assignments for operating room nurses:

*"I have communicated with operating room nurses in foreign countries. In some of them, the operating room nurse is not only an instrumentalist. She also assists the anaesthetist. In some places, nurses are also involved in the post-operative care of patients. This could be considered in Lithuania as well" (V5).*

***Organisational culture and management***

The operating room managers noted that the occupational safety of operating room nurses and other staff should be a priority for any healthcare institution. They stated that "management support, an appropriate and ergonomic working environment, and psychological support" are essential. However, the focus should be on enhancing organisational culture, without which "no good results can be achieved":

*"The employees and their well-being should be the hospital's matter of honour. Our people are very loyal; they do not wander from place to place. They must be valued" (V8).*

*"I think that the management of the institution should be interested in how their employees work and what their working conditions are and try to improve them, not just save money. Sometimes, this happens at the expense of the staff's health.*

*After all, occasionally, the nurses don't use protective measures just because they are the cheapest, low-quality, and uncomfortable" (V5).*

*"Disrespectful behaviour, mobbing, and belittling the staff should not be tolerated. Regardless of your position" (V4).*

At the end of the interviews, the operating room managers gave their insights and suggestions on what should be done to improve the occupational safety of operating room nurses:

*"<...> a suitable and ergonomic working environment, constant psychological support, enhancement of occupational safety, support from management, enhancing organisational culture, and introducing technology and innovation" (V3).*

*"Ensuring adequate provision starting with nursing supplies, instruments, and other working facilities" (V10).*

*"The hard-to-understand rationality of purchasing supplies when the cheapest rather than the most cost-effective ones are purchased" (V1).*

*"Ensuring sufficient staffing to allow for unrushed performance of duties, lunch, toilet facilities, as well as adequate hygienic workplace temperatures during the summer period" (V1).*

*"Cooperation should be seen as a common goal and not as the operating physician giving orders" (V2).*

## Summary of Chapter 5

Operating room nurses play a very important role in the operating room team but often remain invisible. Operating room managers stated that teamwork is the basis for smooth, efficient, and safe work in the operating room. However, administrators with more experience in operating room management have noticed that intercommunication has changed over time and lost the "one family" sense. Operating rooms nowadays are still faced with a shortage of supplies and reuse disposables. However, operating room managers believe that proper planning of operations and optimising the accounting of existing resources would partially ensure the availability and accessibility of supplies. The management of operating room nursing is a challenge that requires knowledge and expertise. Human resource management is the most demanding area for operating room managers. Staff shortages can even lead to health problems. Psychological strain and stress in the activities of operating room nurses have often been mentioned as important occupational risk factors. From the perspective of operating room managers, improving ergonomic conditions is a crucial aspect of protecting operating room nurses from work-related injuries and health issues. However, some operating room managers noted that following work instructions and protocols minimises occupational risks.

The participants in the study saw a direct link between the occupational safety of operating room nurses and patients' safety. From the perspective of operating room managers, good relationships among operating room nurses

lead to higher job satisfaction. The operating room managers stated that to ensure the occupational safety of the operating room nurses, their psychological well-being and social conditions should be prioritised first. Reviewing and redistributing job functions could reduce the workload of operating room nurses and increase their job satisfaction. To ensure the effective performance of operating room nurses and increase their job satisfaction, healthcare institutions must foster an organisational culture and create a safe working environment, considering physical, chemical, biological, ergonomic, and psychosocial occupational risk factors.

# Discussion

The quantitative and qualitative studies aimed to systematically review the occupational risk factors affecting operating room nurses and their impact on health complaints of operating room nurses in the Lithuanian context. A strong focus was placed on uncovering the opinions of operating room nurses and nursing management on the possibilities of mitigating or even preventing occupational risk factors affecting operating room nurses.

The research findings are very closely related to the results of the investigations conducted in other countries. It is worth noting that the issues addressed in this monograph have been studied quite extensively, from Asia to the Americas, including Europe. However, this monograph reflects a broader approach to occupational risk factors. The studies presented by some global scholars are mostly limited to identifying the expression of occupational risk factors, while other researchers explore the health complaints of operating room nurses. No studies have been found to link occupational risks to health complaints. This monograph focuses on answering two key questions: how closely occupational risk factors correlate with socio-demographic characteristics, and how occupational risk factors correlate with the health complaints reported by operating room nurses themselves.

The findings of the quantitative study, which included 254 Lithuanian operating room nurses, are similar to those of research conducted in other countries worldwide, suggesting that the problem is universal and relevant not only in Lithuania but also globally. The analysis of the investigations dealing with the professional activities of operating room nurses implies that the sample of research subjects depends on the country in which the study is conducted. In a country with hundreds of millions of inhabitants, such as Brazil (with 216.4 million inhabitants), the number of respondents in a study addressing a specific issue related to nurses' professional activities (insomnia) was 3,013. However, the population of Lithuania, where the research for this monograph was carried out, is 2.872 million, so naturally the number of nurses is significantly smaller as well.

The results of the study reveal that the most common occupational risk factor is *limited possibilities to meet physiological needs* such as eating, drinking, and using the toilet. This study is distinguished by its focus on the specific and understudied worldwide identification of problems in meeting the physiological needs of operating room nurses. It has revealed major issues in meeting physiological needs, such as inadequate nutrition, insufficient fluid intake, and limited access to toileting facilities. The results show that as many as 90.1% of operating room nurses do not drink liquids regularly, which increases the risk of dehydration and related health complications. The participants in the qualitative research, operating room managers, admitted that there were situations

when an operating room nurse fainted because she had to work in the heat without eating or drinking, and even without being able to use the toilet. 86.2% of the participants report irregular nutrition, which can negatively affect their energy levels and ability to concentrate. The results of a study conducted by D. Parry et al. [103] showed a significant increase in patients' deaths related to medical errors during Ramadan, when fasting leads to a reduction in liquid and food intake. Thus, in the near future, more attention needs to be paid to finding solutions to efficiently meet the needs of the liquid and food consumption of the operating room team. Worldwide, there are no publications on the use of toilets (which is essential to human nature) by operating room nurses and surgeons. In this study, 74.3% of operating room nurses reported difficulties using the toilet, which could potentially impact their health and work quality.

*Ergonomic risk factors* are a significant group of occupational risks. They have a major impact on the physical health and occupational safety of healthcare staff, especially operating room nurses. Scientific literature review and research findings reveal that these factors often cause musculoskeletal pain and fatigue due to forced standing [5, 85, 88]. According to the operating room managers who participated in the qualitative study, improving ergonomic conditions is a crucial aspect of protecting operating room nurses from job-related injuries and health disorders.

P. Soylar and A. Ozer [5] report that between 33 and 88% of nurses worldwide experience musculoskeletal complaints, with prevalence varying by country. The most common area for these problems is the back. This study found that back pain is the most acute musculoskeletal problem, with 66.6% of Lithuanian operating room nurses complaining of back pain. The comparison of the results of the three Baltic countries reveals similar trends with Estonian nurses, where 56.1% of operating room nurses complain of back pain [90]. However, a study in Latvia found that as many as 90% of operating room nurses experience discomfort due to back pain, mostly related to standing in an awkward posture [11]. The results of this study are similar to those of a study of operating room nurses in Latvia. 76% of the Lithuanian operating room nurses in the study reported experiencing fatigue due to standing in a forced position.

The occupational environment of operating room nurses is characterised by a variety of ergonomic risk factors, including lifting and moving heavy equipment and working in a static position for extended periods. Compared to anaesthesia nurses, operating room nurses are more likely to be exposed to lifting heavy objects [80]. The results of the quantitative study showed that the occupational activities of operating room nurses require the use of physical resources and strength. Every second operating room nurse in the study is involved in lifting heavy objects (e.g., equipment), patients, or heavy sterilisers with surgical instruments.

The results of the study, as presented in the monograph, revealed that the psychological climate in Lithuanian operating rooms requires more attention and improvement. According to the study, every second operating room nurse

experiences stress due to the surgeon's personality, unpredictable behaviour, or tone of voice (59%), and an unfavourable psychological climate (50.8%). From the perspective of the operating room managers who participated in the qualitative study, teamwork is the foundation for smooth, efficient, and safe work in the operating room. Moreover, a good emotional climate within the team demonstrates the contribution of each team member to overall performance and job satisfaction. Poor teamwork, identified as an area for improvement, causes stress for nearly 40% of nurses. The findings support the fact that team members need to change their attitudes towards the operating room nurse so that every second of them in Lithuania does not feel humiliated by surgeons who cause stress due to their unpredictable behaviour or raised tone. Most of the research in Eastern and Asian countries suggests that operating room nurses are psychologically insecure because of the staff around them. A study in Japan found that 40% of operating room nurses experience psychological distress during surgery due to poor teamwork [156]. In Turkey, a study by Z. Uğurlu et al. [99] showed that 91% of operating room nurses perceived their work as stressful. The results of a qualitative study of operating room nurses in Iran highlight a negative impact on the organisation and colleagues, especially surgeons [160].

In this study, the authors have identified additional factors that contribute to stress in operating room nurses. The results obtained suggest that complex situations during surgery, *an unpredictable course of surgery, malfunctioning medical equipment, and a lack of supplies are also significant factors in generating stress, ranging from 41.1% to 61.8%.* Psychological strain and stress in the workplace of operating room nurses were also frequently mentioned as important occupational risk factors in the qualitative study. As operating room managers have stated, adequate planning of operations and optimising the accounting of existing resources can partially help ensure the availability and accessibility of supplies, reducing the likelihood of reusing disposable instruments and mitigating the resulting stress experienced by operating room nurses. No other studies by other authors that address the causes of stress mentioned by operating room nurses have been found. However, based on a study conducted in Saudi Arabia several years ago, it can be stated that during surgeries, technical causes of stress, such as work disruptions due to sterilisation processes or accidental drops of surgical instruments, were less common (16.4%). However, a significant cause of stress (15.5%) was malfunctioning supplies, including medical equipment.

This research, along with other studies, suggests that the causes of stress may also be related to increased staff fatigue. 51.6% of employees experience stress due to both increased workload and staff insufficiency. Very similar research results were obtained in Turkey, showing that 52.2% of operating room nurses experience fatigue due to hard, responsible, and stressful work [112]. The fact is supported by the findings of the qualitative research, which show that operating room managers consistently argue that staff shortages cause tension in the operating room daily. They acknowledge that there is a shortage

of supporting staff in operating rooms, and as a result, they cannot guarantee that a circulating nurse is part of the team every day.

Injuries caused by surgical sharps pose a serious biological risk, as operating room staff, including nurses, can contract blood-borne diseases. The quantitative study showed that 16.4% of Lithuanian operating room nurses are injured by surgical sharps and 20.6% by surgical needles. The comparison of the data in this study with those of other researchers reveals that in different countries, the incidence of injuries to operating room nurses from sharp instruments and surgical needles is higher. V. Bevan et al. [12] conducted a systematic review of scientific sources and concluded that the lowest reported incidence of injuries was 14.2%, and the highest was 31.3%.

Other biological occupational risk factors are more prevalent among operating room nurses, such as *exposure to body fluids* and blood of the operated patient. This is also confirmed by the operating room managers who participated in the qualitative study. They note that operating room nurses have very close contact with patients' blood, pus, and bowel content, which, in their view, increases the risk of contracting various diseases. The quantitative study has shown that 45.3% of operating room nurses are exposed to body fat and 58.5% to blood. In the global scientific literature, only one study from Turkey has been found, which states that operating room nurses in that country are almost twice as likely (90.5%) to be exposed to situations where they splash themselves with blood or body fluids [99].

S. Drebit et al. [98] state that falls are the leading cause of occupational injuries in the healthcare sector. However, the risk factors for falls in this sector are understudied. In Lithuania, no studies have been conducted on slips and falls among nurses in the workplace, even though they are very closely linked to patients' safety. A study by Z. Uğurlu et al. [99] in Turkey showed that 20.3% of respondents had fallen at least once in the operating room due to slippery floors. The current study revealed that a very similar number of Lithuanian operating room nurses (16.1%) had experienced slips and falls due to wet floors. It also examined other causes of slips and falls among operating room nurses that are specific and relevant to this profession, such as slips and falls due to wires scattered on the floor, unstable furniture in the operating room, and uncomfortable footwear. The most common cause of slips and falls is wires on the floor. The staff in a hurry or wearing a long medical gown may not see them. One in five operating room nurses participating in the study (20%) had experienced slips and falls due to messy wires on the floor.

The current quantitative study shows that complaints about the *specificity of operating room nurses' work and clothing* rank first among all health complaints. Based on the hygiene regulations in force worldwide, including in Lithuania, operating room facilities are subject to strict requirements on room temperature and humidity. However, according to the operating room managers in the study, this is not always the case, especially during the summer. Humidity, heat, and lack of ventilation increase the risk of contracting infectious diseases through airborne

droplets. Higher temperatures and higher humidity levels cause discomfort for operating room nurses and surgeons; they sweat. Operating room nurses and surgeons have to wear aprons, sterile gowns, gloves, medical caps, and masks. The findings of the quantitative study revealed that due to the lack of air and the high temperature in the operating room, operating room nurses often experience discomfort in the form of sweating (59.7%), weakness (49.4%), and heavy breathing due to wearing masks for a long time (46.7%). There is very little research worldwide on the assessment of physiological discomfort issues among operating room staff. However, during the COVID-19 pandemic, medical staff wore personal protective equipment (PPE) in various situations, which is essentially equivalent to the clothing worn by operating room nurses and surgeons. The results of a study conducted in South Korea confirm the relevance of the findings of this research, as their study showed that as many as 81.1% sweated, and 61.4% due to wearing this special protective equipment [193]. A qualitative study conducted in Iran also confirms the fact that operating room nurses are bothered by sweating and weakness due to special clothing and specific requirements in the operating room.

According to the current study, allergic reactions are the second most common health concern. Studies in Poland and Spain confirm that chemicals pose a significant health risk to operating room nurses. In Poland, 78.9% of operating room nurses report that disinfectants adversely affect their skin and cause dermatitis [146], while in Spain, 21.2% of operating room nurses experience hand dermatitis [10].

*Sleep problems* are the third most common health complaint. The statement is substantiated by the findings of the current quantitative study and the results of other researchers who have conducted similar studies in other parts of the world. As many as 60.7% of the operating room nurses in this study reported being bothered by sleep deprivation; 44.2% woke up at night, and 32.8% had difficulty falling asleep and woke up early in the morning. As there are no data on sleep problems experienced by operating room nurses in Lithuania, it is sensible to review the sleep problems experienced by operating room nurses in other countries. In Poland, operating room nursing staff suffer from very similar sleep problems, with 65.6% of respondents experiencing sleep problems manifested by frequent awakenings at night. 45.6% of operating room nurses do not have enough time to sleep, and 60% of respondents experience sleepiness [194]. The South Korean researchers who studied nurses' sleep problems found that the overall prevalence of sleep problems in their study was 46.5% [195]. There are many more articles in the global scientific literature on the sleep problems of doctors and nursing staff, including operating room nurses, during the COVID-19 pandemic. However, the results of these studies are not worth being considered in this context, as the pandemic period was characterised by a lack of personal protective equipment, fear of infection with an unknown virus, and constant tension and fear in society.

The findings of the quantitative study being discussed also reveal that operating room nurses experience pain in various parts of the body, with a

prevalence ranging from a few per cent to 74.6%. The most frequent locations of pain are the chest and the abdomen, specifically the intestines. However, it is worth noting that leg pain is reported by 74.6% and spinal pain by 66.6% of Lithuanian operating room nurses who participated in the study. The comparison of these results with those of other countries indicates that the percentage of Lithuanian nurses is slightly higher than that of Estonian nurses, of whom only 56.1% suffer from back pain [90]. Results from various studies worldwide indicate that between 33% and 88% of nurses experience musculoskeletal complaints [5].

Considering that operating room nurses' work is characterised by a variety of stressors, which include relationships with colleagues, stressful situations during surgery, high fatigue, and specific demands in the operating room [17, 149, 153, 155, 156], it is obvious why the operating room nurses in this study were experiencing a deterioration of their *emotional state*. One-third of Lithuanian operating room nurses attribute their depressed mood, feelings of anxiety, and the desire to be alone to their professional activities.

*Nausea and discomfort* are among the least frequent health complaints among operating room nurses, with fewer than 12% of respondents experiencing them. The most common complaints of nausea are 15.2% due to the contents of the patient's organs and 14.1% due to the use of electrocautery; less than 10% of nurses experience nausea due to solutions or inhaled anaesthetic agents.

The quantitative research approach used by the authors of this monograph allowed them to find associations between occupational risk factors and health complaints. The scientific literature usually reports the expression of occupational risk factors or health complaints of operating room nurses separately. This study provided a comprehensive examination of the relationship between occupational risk factors and health complaints among operating room nurses. The correlation between various health problems and risk factors, such as work environmental stress, body fluid contact, and allergic reactions, shows that these factors have a complex and negative impact on the health and well-being of nurses. It should also be highlighted that changes in emotional state, pain and nausea are often caused by difficult working conditions in the operating room, such as lengthy operations, clothing restrictions, and stress due to poor teamwork or surgeon's behaviour. However, some operating room managers have observed that, by following work instructions and protocols, the occupational risks for operating room nurses are essentially minimised.

The Lithuanian operating room nurses surveyed believe that several actions could improve their working conditions, mitigate occupational risk factors, and contribute to the safe operation of patients.

Improving operating room nurses' working conditions from an organisational standpoint is essential for their well-being. It is vital to ensure adequate staffing levels, reduce workload and instrumentation during surgery, and optimise work functions. Longer intervals between operations and sufficient provision of supplies also contribute to better working conditions. Improving

ergonomic conditions and the psychosocial climate in the operating room, including attitudes towards operating room nurses and enhancing respect, also has a direct impact on staff well-being. In addition, enhancing teamwork, professional psychological support, and motivational measures such as higher salaries and competence development are essential to mitigate stress and ensure job satisfaction among nurses.

These ideas were supported by the operating room managers, who stated that to ensure the effective work of operating room nurses and increase their job satisfaction, healthcare institutions must foster an organisational culture, create a safe working environment, and pay greater attention to physical, chemical, biological, ergonomic, and psychosocial occupational risk factors. To ensure the occupational safety of operating room nurses, the first thing that needs to be addressed is their psychosocial safety. Reviewing and redistributing job functions could reduce the workload of operating room nurses and increase their job satisfaction.

## Research limitations

1. Only Lithuanian operating room nurses participated in the study; thus, the research results do not reveal the occupational risk factors to which other staff are exposed when working in an operating room team. The results of the study may only be relevant for operating room nurses, so it would be beneficial to survey other members of the operating room team.

2. The opinions of the operating room nurses who participated in the study represent only their personal interests, and it is unclear how much effort operating room nurses should make to contribute to their personal development to mitigate or eliminate these occupational risk factors. Therefore, the involvement of other members of the operating room team, including surgeons, anaesthetists, anaesthesia nurses, and nursing assistants, is important for future research.

3. The peculiarities of organising the activities and the culture of teamwork vary in healthcare institutions. Therefore, for research of such a nature, it is preferable to select different hospitals and conduct a comparative study considering different institutions.

4. The quantitative study involved only Lithuanian operating room nurses; the survey instrument has not been tested in other countries, and it is therefore relevant to include operating room nurses from other countries in future studies.

## Research benefits

1. Scientific advantages. The developed and validated research instrument can be applied not only in Lithuania but also internationally to assess occupational risk factors affecting operating room nurses and other members

of the operating room team (surgeons, surgical assistants, anaesthetists, and anaesthetic nurses). For the first time in Lithuania, occupational risk factors affecting operating room nurses and their links to health disorders have been systematically analysed, and a qualitative study has provided meaningful suggestions on how to mitigate or even avoid occupational risk factors affecting operating room nurses.

2. Educational advantages. The authors of the monograph propose to expand the topics on the management of the occupational risks affecting operating room nurses and the surgery team in postgraduate non-formal education programmes "Operative Nursing". Students in the General Practice Nursing study programme can choose specific occupational risk factors affecting operating room nurses and analyse them in more depth in their final theses. The study provides opportunities for colleges and universities to complement the content of nursing study programs by teaching operating room nursing.

3. Practical advantages. A holistic approach has been adopted, revealing the interrelationship between ergonomic, physical, biological, chemical, and psychological factors, marking a new step in improving the working conditions of operating room nurses. The monograph presents and analyses legal documents relevant to mitigating or even preventing occupational risks for healthcare professionals, including operating room nurses and surgery team members. Possible measures to ensure the occupational safety of operating room nurses and other team members have been outlined.

4. Operating room management advantages. The results of the quantitative and qualitative research provide a basis for improving the work processes of operating room nurses and surgery teams in Lithuania. The research has involved operating room nurses and operating room managers from different regions of Lithuania; therefore, the findings of the study reflect the wider cultural context of Lithuania. The research results are important for healthcare institutions in developing occupational safety policies and improving the working environment of healthcare professionals, especially operating room nurses.

# Conclusions

Multiple occupational risks characterised the work of the Lithuanian operating room nurses who participated in the study. Operating room nurses were most often affected by limitations in meeting physiological needs. Almost three-thirds of the operating room nurses in the study had to deal with irregular meals during their shifts. Liquid consumption was a more serious problem, with virtually all operating room nurses reporting irregular intake of liquids, especially water. Additionally, more than two-thirds of operating room nurses reported being unable to use the toilet when needed during operations.

Ergonomic occupational risk factors, such as lifting heavy objects, were the second most common. One in two operating room nurses in the study had been exposed to lifting heavy objects, as well as transporting heavy medical equipment/devices. Half of the operating room nurses had to lift patients, and an even larger number, two-thirds, had to lift heavy surgical instrument sets.

Stress is widespread among operating room nurses. Operating room nurses experienced stress related to the psychological climate in the operating room, the surgical process, the instruments, and the heavy workload. Every second operating room nurse in the study experienced stress due to the surgeons' personalities, unpredictable behaviour, and tone of voice in the operating room. The prevailing psychological climate in the operating room is also a significant issue, with half of the operating room nurses in the study reporting stress. Poor teamwork was the cause of stress for almost half of the operating room nurses.

At least half of the operating room nurses experience stress related to the procedure of the operation and the use of instruments and devices. Two-thirds of operating room nurses reported feeling stressed due to the complexity of situations during surgery. Almost half of them were nervous due to the unpredictable nature of the operation and the specialised instruments and tools required for it. Also, half of the operating room nurses reported stress due to malfunctioning equipment during surgery. Slightly less than half of the operating room nurses experienced stress due to a lack of supplies.

Heavy workload is a pressing and challenging issue among operating room nurses. One in two operating room nurses in the study experienced stress due to increased workload and staff shortages. The least stressful issue for operating room nurses was the training of new colleagues and students, as indicated by only a quarter of respondents.

In terms of occupational risk factors affecting operating room nurses, the biological risk factor 'contact with body fluids and punctures' also remains a problem. Nearly half of the operating room nurses surveyed were splashed with the patient's body fat and more than half with blood. Injuries caused by sharp surgical instruments are more dangerous because of the risk of contracting various blood-borne diseases than because of the nature of the injury. Just

under a quarter of operating room nurses have been exposed to a surgical needle, sharps, scalpel, or needle stick in surgery. The incidence of injuries while using electrocautery was not high.

A small part of operating room nurses experienced slips and falls. However, it does not mean that such a problem does not exist. Slips and falls caused by wet floors and uncomfortable footwear were experienced by a dozen of the 100 operating room nurses in the study. Less than a quarter of the slips and falls were caused by wires scattered on the floor. Unstable furniture in the operating room caused a fall among a small number of operating room nurses.

The most prevalent health complaints among the operating room nurses in the study were related to the specific nature of the work and the clothing worn in an operating room. Almost three-thirds were bothered by fatigue due to standing in a forced position, and two-thirds by swelling and heaviness in the legs. More than two-thirds complained of sweating, half of weakness due to the high temperature in the operating room, and almost half of the respondents complained of a lack of air due to the prolonged wearing of medical masks.

Local allergic reactions and skin problems came second. Allergic skin reactions to disinfectants and medications were experienced by almost half of the operating room nurses in the study. General allergic reactions to disinfectants and medications were reported by one-third of operating room nurses. The same proportion experienced allergic reactions to medical masks. Almost half of the operating room nurses had skin problems due to wearing gloves. More than two-thirds reported experiencing dry skin.

Sleep problems were the third most prevalent problem among operating room nurses. More than two-thirds were distressed by the feeling of not getting enough sleep. Almost half were troubled by night waking, one-third had difficulty falling asleep, and the same number complained of waking early in the morning.

Operating room nurses experienced pain in various parts of their bodies, possibly related to their professional activities in the operating room. The most common location of pain was the legs, experienced by almost three-thirds of operating room nurses. More than two-thirds of the participants complained of back pain. More than one-third suffered from pain in the eyes and headache, almost one-third from pain in the arms, and less than one-quarter from stomachache.

Anxiety was the most common emotional problem among operating room nurses, with more than a third of respondents indicating it. A third of operating room nurses reported experiencing depression. The desire to be alone very often or frequently was noted by just over a third of operating room nurses in the survey. Apathy and increased guilt were experienced by less than a quarter of the operating room nurses in the study.

Nausea and discomfort are the least common health complaints among operating room nurses. A small number of respondents (between a few and a dozen per cent) complained of nausea and discomfort due to the smell of electrocautery fumes and the content of the patient's organs during surgery.

The research results revealed a statistically significant correlation ($p \leq 0.01$) between the occupational risk factors affecting operating room nurses and their health complaints. The operating room nurses' health problems are caused not by chance but by the complex effects of occupational risk factors. Limitations in meeting physiological needs, stressors in the working environment, and biological and chemical hazards affect both the physical and psychological well-being of operating room nurses.

Occupational risk factors such as lifting heavy objects, exposure to body fluids and punctures, and limitations in meeting physiological needs were statistically significantly correlated with the operating room profile. Differences were found between groups of nurses working in different operating room profiles, which suggests that the specificity of work in different operating room profiles may influence the manifestation of occupational risk factors. Operating room nurses working in general surgery and multiprofile operating rooms were more likely to lift heavy objects than nurses working in ophthalmology and ear, nose, and throat profiles ($p \leq 0.05$). The nurses working in trauma-orthopaedics, obstetrics-gynaecology, plastic-aesthetics, and multiprofile operating rooms had a higher risk of exposure to body fluids and punctures compared with nurses working in the ophthalmology and ear-nose-throat (ENT) operating rooms ($p \leq 0.05$). The limitations in meeting physiological needs were statistically significantly different only among nurses working in obstetrics-gynaecology and plastic-aesthetic surgery operating rooms; the nurses working in plastic-aesthetic operating rooms had less access to meeting physiological needs, such as having a drink, a snack or going to the toilet ($p \leq 0.05$). However, health complaints were similar in all groups of operating room nurses regardless of the operating room profile ($p \geq 0.05$). The data suggest that the operating room environment poses identical challenges and risks to nurses' health.

Occupational risk factors and health complaints are statistically significantly different between operating room nurses working daytime shifts and those with mixed schedules. Nurses working on a mixed schedule are more likely to be exposed to lifting heavy objects, contact with body fluids, and punctures ($p \leq 0.05$). In addition, these nurses experience more sleep problems compared to their daytime colleagues ($p \leq 0.05$).

The stress experienced by operating room nurses regarding surgery procedures and supplies closely correlates with their level of work experience. Nurses with less experience tend to experience more stress, while those with longer service terms report feeling less stress ($p \leq 0.05$). However, health complaints are not correlated with the length of service ($p \geq 0.05$).

The surveyed Lithuanian operating room nurses suggested measures that could significantly contribute to the well-being of operating room nurses and improve the quality of their work. The proposed organisational measures, such as optimal staffing levels and a balanced workload, would help reduce overwork and increase efficiency. Reducing the amount of instrumentation required during operations and optimising work functions could make daily

tasks easier, and longer intervals between operations would allow nurses to prepare physically and emotionally better.

Ensuring the provision of supplies and improving ergonomic conditions would contribute to occupational safety. Operating room nurses pointed out the uncomfortable furniture and its layout, the scattered wires that could cause falls, and the deficiency in patient transfer means, especially when it came to repositioning patients who were very overweight. Operating room nurses suggest a wider use of assistive devices to ensure patients' safety and the quality of the operating room team's performance.

Improving the psychosocial climate, respect for nurses, and enhancing teamwork would increase staff's motivation. Professional psychological support and motivational measures, such as higher salaries, would contribute to their loyalty to the organisation. Competence development is also important to ensure the safety of operating room nurses and patients, as well as to adapt to the continuous modernisation of healthcare services.

From the point of view of operating room managers, operating room nurses are constantly exposed to occupational risk factors in their daily work due to the nature of their work, including close contact with patients and exposure to a variety of chemicals and ionising radiation. The psychological strain and the inability to meet physiological needs at work have an impact on the health of operating room nurses. Human resources management and procurement are the most demanding tasks for operating room managers. Operating room managers argue that to ensure the occupational safety of operating room nurses and their psychosocial safety, the availability of quality work equipment and the improvement of the working environment should be a priority. A review and redistribution of job functions could reduce the workload of operating room nurses and increase their job satisfaction.

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**Correlation between occupational risk factors of operating room nurses and health complaints (Spearman correlation)**

| Scales | Statistical indicators | Limitations in meeting physiological needs | Lifting heavy objects | Stress related to the psychological climate in the operating room | Stress related to the course of operation and supplies | Stress related to heavy workload | Contact with body fluids and punctures | Slips and falls | Complaints related to clothing and standing work | Allergic reactions and skin problems | Sleep problems | Pain | Emotional distress | Nausea |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Limitations in meeting physiological needs | Correlation Coefficient | 1.000 | 0.452** | 0.385** | 0.368** | 0.462** | 0.481** | 0.415** | 0.485** | 0.363** | 0.303** | 0.408** | 0.412** | 0.325** |
| | Sig. (2-tailed) | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Lifting heavy objects | Correlation Coefficient | 0.452** | 1.000 | 0.265** | 0.301** | 0.291** | 0.443** | 0.448** | 0.461** | 0.370** | 0.244** | 0.383** | 0.284** | 0.467** |
| | Sig. (2-tailed) | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Stress related to the psychological climate in the operating room | Correlation Coefficient | 0.385** | 0.265** | 1.000 | 0.600** | 0.624** | 0.384** | 0.364** | 0.423** | 0.389** | 0.395** | 0.401** | 0.568** | 0.273** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Stress related to the course of operation and supplies | Correlation Coefficient | 0.368** | 0.301** | 0.600** | 1.000 | 0.565** | 0.363** | 0.432** | 0.485** | 0.419** | 0.305** | 0.400** | 0.525** | 0.393** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Stress related to heavy workload | Correlation Coefficient | 0.462** | 0.291** | 0.624** | 0.565** | 1.000 | 0.325** | 0.331** | 0.440** | 0.397** | 0.386** | 0.495** | 0.547** | 0.297** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |

**Continuation of Table**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contact with body fluids and punctures | Correlation Coefficient | 0.481** | 0.443** | 0.384** | 0.363** | 0.325** | 1.000 | 0.645** | 0.507** | 0.473** | 0.283** | 0.409** | 0.402** | 0.609** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Slips and falls | Correlation Coefficient | 0.415** | 0.448** | 0.364** | 0.432** | 0.331** | 0.645** | 1.000 | 0.553** | 0.551** | 0.415** | 0.519** | 0.450** | 0.600** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Complaints related to clothing and standing work | Correlation Coefficient | 0.485** | 0.461** | 0.423** | 0.485** | 0.440** | 0.507** | 0.553** | 1.000 | 0.617** | 0.486** | 0.621** | 0.552** | 0.537** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Allergic reactions and skin problems | Correlation Coefficient | 0.363** | 0.370** | 0.389** | 0.419** | 0.397** | 0.473** | 0.551** | 0.617** | 1.000 | 0.444** | 0.567** | 0.427** | 0.531** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Sleep problems | Correlation Coefficient | 0.303** | 0.244** | 0.395** | 0.305** | 0.386** | 0.283** | 0.415** | 0.486** | 0.444** | 1.000 | 0.530** | 0.467** | 0.398** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 |
| Pain | Correlation Coefficient | 0.408** | 0.383** | 0.401** | 0.400** | 0.495** | 0.409** | 0.519** | 0.621** | .0567** | 0.530** | 1.000 | 0.551** | 0.447** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 | ≤ 0.01 |
| Emotional distress | Correlation Coefficient | 0.412** | 0.284** | 0.568** | 0.525** | 0.547** | 0.402** | 0.450** | 0.552** | 0.427** | 0.467** | 0.551** | 1.000 | 0.380** |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | | ≤ 0.01 |
| Nausea | Correlation Coefficient | 0.325** | 0.467** | 0.273** | 0.393** | 0.297** | 0.609** | 0.600** | 0.537** | 0.531** | 0.398** | 0.447** | 0.380** | 1.000 |
| | Sig. (2-tailed) | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | |

*Note: ** Correlation is significant at the 0.01 level (2-tailed)*

**Multiple Comparisons**
**Tamhane's Criterion: the scale "lifting heavy objects"**

| Profile of the operating room | Profile of the operating room | Mean Difference | Std. Error | Sig. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Trauma-Orthopaedics | General Surgery | −0.13889 | 0.17631 | 1.000 |
| | Obstetric-Gynaecological | −0.22386 | 0.25195 | 1.000 |
| | Ophthalmology and Ear, Nose, and Throat | 0.51389 | 0.18750 | 0.181 |
| | Plastic-Aesthetic surgery | 0.09343 | 0.17723 | 1.000 |
| | Neurosurgery and Thoracic | 0.03019 | 0.21870 | 1.000 |
| | Multiprofile | −0.19747 | 0.15400 | 0.992 |
| General Surgery | Trauma-Orthopaedics | 0.13889 | 0.17631 | 1.000 |
| | Obstetric-Gynaecological | −0.08497 | 0.24332 | 1.000 |
| | Ophthalmology and Ear, Nose, and Throat | 0.65278* | 0.17573 | 0.014 |
| | Plastic-Aesthetic surgery | 0.23232 | 0.16472 | 0.977 |
| | Neurosurgery and Thoracic | 0.16908 | 0.20870 | 1.000 |
| | Multiprofile | −0.05859 | 0.13943 | 1.000 |
| Obstetric-Gynaecological | Trauma-Orthopaedics | 0.22386 | 0.25195 | 1.000 |
| | General Surgery | 0.08497 | 0.24332 | 1.000 |
| | Ophthalmology and Ear, Nose, and Throat | 0.73775 | 0.25155 | 0.135 |
| | Plastic-Aesthetic surgery | 0.31729 | 0.24399 | 0.992 |
| | Neurosurgery and Thoracic | 0.25405 | 0.27559 | 1.000 |
| | Multiprofile | 0.02638 | 0.22768 | 1.000 |
| Ophthalmology and Ear, Nose, and Throat | Trauma-Orthopaedics | −0.51389 | 0.18750 | 0.181 |
| | General Surgery | −0.65278* | 0.17573 | 0.014 |
| | Obstetric-Gynaecological | −0.73775 | 0.25155 | 0.135 |
| | Plastic-Aesthetic surgery | −0.42045 | 0.17666 | 0.389 |
| | Neurosurgery and Thoracic | −0.48370 | 0.21824 | 0.505 |
| | Multiprofile | −0.71136* | 0.15334 | 0.002 |
| Plastic-Aesthetic surgery | Trauma-Orthopaedics | −0.09343 | 0.17723 | 1.000 |
| | General Surgery | −0.23232 | 0.16472 | 0.977 |
| | Obstetric-Gynaecological | −0.31729 | 0.24399 | 0.992 |
| | Ophthalmology and Ear, Nose, and Throat | 0.42045 | 0.17666 | 0.389 |
| | Neurosurgery and Thoracic | −0.06324 | 0.20948 | 1.000 |
| | Multiprofile | −0.29091 | 0.14060 | 0.618 |

**Continuation of Table**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Neurosurgery and Thoracic | Trauma-Orthopaedics | −0.03019 | 0.21870 | 1.000 |
| | General Surgery | −0.16908 | 0.20870 | 1.000 |
| | Obstetric-Gynaecological | −0.25405 | 0.27559 | 1.000 |
| | Ophthalmology and Ear, Nose, and Throat | 0.48370 | 0.21824 | 0.505 |
| | Plastic-Aesthetic surgery | 0.06324 | 0.20948 | 1.000 |
| | Multiprofile | −0.22767 | 0.19023 | 0.997 |
| Multiprofile | Trauma-Orthopaedics | 0.19747 | 0.15400 | 0.992 |
| | General Surgery | 0.05859 | 0.13943 | 1.000 |
| | Obstetric-Gynaecological | −0.02638 | 0.22768 | 1.000 |
| | Ophthalmology and Ear, Nose, and Throat | 0.71136* | 0.15334 | 0.002 |
| | Plastic-Aesthetic surgery | 0.29091 | 0.14060 | 0.618 |
| | Neurosurgery and Thoracic | 0.22767 | 0.19023 | 0.997 |

**Multiple Comparisons**
**Tamhane's Criterion: the scale "contact with body fluids and punctures", "limitations in meeting physiological needs"**

| Occupational risk factors | Profile of the operating room | Profile of the operating room | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Contact with body fluids and punctures | Trauma-Orthopaedics | General Surgery | 0.27331 | 0.14787 | 0.066 |
| | | Obstetric-Gynaecological | 0.00840 | 0.17570 | 0.962 |
| | | Ophthalmology and Ear, Nose, and Throat | 0.49370* | 0.17570 | 0.005 |
| | | Plastic-Aesthetic surgery | −0.01190 | 0.16619 | 0.943 |
| | | Neurosurgery and Thoracic | 0.29981 | 0.17051 | 0.080 |
| | | Multiprofile | 0.15914 | 0.12905 | 0.219 |
| | General Surgery | Trauma-Orthopaedics | −0.27331 | 0.14787 | 0.066 |
| | | Obstetric-Gynaecological | −0.26491 | 0.15848 | 0.096 |
| | | Ophthalmology and Ear, Nose, and Throat | 0.22038 | 0.15848 | 0.166 |
| | | Plastic-Aesthetic surgery | −0.28522 | 0.14787 | 0.055 |
| | | Neurosurgery and Thoracic | 0.02650 | 0.15271 | 0.862 |
| | | Multiprofile | −0.11417 | 0.10440 | 0.275 |
| | Obstetric-Gynaecological | Trauma-Orthopaedics | −0.00840 | 0.17570 | 0.962 |
| | | General Surgery | 0.26491 | 0.15848 | 0.096 |
| | | Ophthalmology and Ear, Nose, and Throat | 0.48529* | 0.18471 | 0.009 |
| | | Plastic-Aesthetic surgery | −0.02031 | 0.17570 | 0.908 |
| | | Neurosurgery and Thoracic | 0.29141 | 0.17979 | 0.106 |
| | | Multiprofile | 0.15074 | 0.14108 | 0.286 |

**Continuation of Table**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Contact with body fluids and punctures | Ophthalmology and Ear, Nose, and Throat | Trauma-Orthopaedics | −0.49370* | 0.17570 | 0.005 |
| | | General Surgery | −0.22038 | 0.15848 | 0.166 |
| | | Obstetric-Gynaecological | −0.48529* | 0.18471 | 0.009 |
| | | Plastic-Aesthetic surgery | −0.50560* | 0.17570 | 0.004 |
| | | Neurosurgery and Thoracic | −0.19389 | 0.17979 | 0.282 |
| | | Multiprofile | −0.33456* | 0.14108 | 0.019 |
| | Plastic-Aesthetic surgery | Trauma-Orthopaedics | 0.01190 | 0.16619 | 0.943 |
| | | General Surgery | 0.28522 | 0.14787 | 0.055 |
| | | Obstetric-Gynaecological | 0.02031 | 0.17570 | 0.908 |
| | | Ophthalmology and Ear, Nose, and Throat | 0.50560* | 0.17570 | 0.004 |
| | | Neurosurgery and Thoracic | 0.31172 | 0.17051 | 0.069 |
| | | Multiprofile | 0.17104 | 0.12905 | 0.186 |
| | Neurosurgery and Thoracic | Trauma-Orthopaedics | −0.29981 | 0.17051 | 0.080 |
| | | General Surgery | −0.02650 | 0.15271 | 0.862 |
| | | Obstetric-Gynaecological | −0.29141 | 0.17979 | 0.106 |
| | | Ophthalmology and Ear, Nose, and Throat | 0.19389 | 0.17979 | 0.282 |
| | | Plastic-Aesthetic surgery | −0.31172 | 0.17051 | 0.069 |
| | | Multiprofile | −0.14067 | 0.13456 | 0.297 |
| | Multiprofile | Trauma-Orthopaedics | −0.15914 | 0.12905 | 0.219 |
| | | General Surgery | 0.11417 | 0.10440 | 0.275 |
| | | Obstetric-Gynaecological | −0.15074 | 0.14108 | 0.286 |

**Continuation of Table**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Contact with body fluids and punctures | Multiprofile | Ophthalmology and Ear, Nose, and Throat | 0.33456* | 0.14108 | 0.019 |
| | | Plastic-Aesthetic surgery | −0.17104 | 0.12905 | 0.186 |
| | | Neurosurgery and Thoracic | 0.14067 | 0.13456 | 0.297 |
| Limitations in meeting physiological needs | Trauma-Orthopaedics | General Surgery | 0.06486 | 0.17959 | 0.718 |
| | | Obstetric-Gynaecological | 0.20000 | 0.21443 | 0.352 |
| | | Ophthalmology and Ear, Nose, and Throat | −0.23750 | 0.22208 | 0.286 |
| | | Plastic-Aesthetic surgery | −0.46667* | 0.20278 | 0.022 |
| | | Neurosurgery and Thoracic | 0.14203 | 0.20042 | 0.479 |
| | | Multiprofile | −0.13636 | 0.15369 | 0.376 |
| | General Surgery | Trauma-Orthopaedics | −0.06486 | 0.17959 | 0.718 |
| | | Obstetric-Gynaecological | 0.13514 | 0.19934 | 0.498 |
| | | Ophthalmology and Ear, Nose, and Throat | −0.30236 | 0.20755 | 0.146 |
| | | Plastic-Aesthetic surgery | −0.53153* | 0.18675 | 0.005 |
| | | Neurosurgery and Thoracic | 0.07716 | 0.18419 | 0.676 |
| | | Multiprofile | −0.20123 | 0.13183 | 0.128 |
| | Obstetric-Gynaecological | Trauma-Orthopaedics | −0.20000 | 0.21443 | 0.352 |
| | | General Surgery | −0.13514 | 0.19934 | 0.498 |
| | | Ophthalmology and Ear, Nose, and Throat | −0.43750 | 0.23834 | 0.068 |
| | | Plastic-Aesthetic surgery | −0.66667* | 0.22046 | 0.003 |

**Continuation of Table**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Limitations in meeting physiological needs | Obstetric-Gynaecological | Neurosurgery and Thoracic | −0.05797 | 0.21829 | 0.791 |
| | | Multiprofile | −0.33636 | 0.17637 | 0.058 |
| | Ophthalmology and Ear, Nose, and Throat | Trauma-Orthopaedics | 0.23750 | 0.22208 | 0.286 |
| | | General Surgery | 0.30236 | 0.20755 | 0.146 |
| | | Obstetric-Gynaecological | 0.43750 | 0.23834 | 0.068 |
| | | Plastic-Aesthetic surgery | −0.22917 | 0.22791 | 0.316 |
| | | Neurosurgery and Thoracic | 0.37953 | 0.22582 | 0.094 |
| | | Multiprofile | 0.10114 | 0.18560 | 0.586 |
| | Plastic-Aesthetic surgery | Trauma-Orthopaedics | 0.46667* | 0.20278 | 0.022 |
| | | General Surgery | 0.53153* | 0.18675 | 0.005 |
| | | Obstetric-Gynaecological | 0.66667* | 0.22046 | 0.003 |
| | | Ophthalmology and Ear, Nose, and Throat | 0.22917 | 0.22791 | 0.316 |
| | | Neurosurgery and Thoracic | 0.60870* | 0.20686 | 0.004 |
| | | Multiprofile | 0.33030* | 0.16201 | 0.043 |
| | Neurosurgery and Thoracic | Trauma-Orthopaedics | −0.14203 | 0.20042 | 0.479 |
| | | General Surgery | −0.07716 | 0.18419 | 0.676 |
| | | Obstetric-Gynaecological | 0.05797 | 0.21829 | 0.791 |
| | | Ophthalmology and Ear, Nose, and Throat | −0.37953 | 0.22582 | 0.094 |
| | | Plastic-Aesthetic surgery | −0.60870* | 0.20686 | 0.004 |
| | | Multiprofile | −0.27839 | 0.15904 | 0.081 |
| | Multiprofile | Trauma-Orthopaedics | 0.13636 | 0.15369 | 0.376 |

**Continuation of Table**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Limitations in meeting physiological needs | Multiprofile | General Surgery | 0.20123 | 0.13183 | 0.128 |
| | | Obstetric-Gynaecological | 0.33636 | 0.17637 | 0.058 |
| | | Ophthalmology and Ear, Nose, and Throat | −0.10114 | 0.18560 | 0.586 |
| | | Plastic-Aesthetic surgery | −0.33030* | 0.16201 | 0.043 |
| | | Neurosurgery and Thoracic | 0.27839 | 0.15904 | 0.081 |