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The effect of arduous (microclimate, lighting) and harmful (noise) factors on the levels of occupational burnout in surgical nurses

Wpływ czynników uciążliwych (mikroklimat, oświetlenie) i szkodliwych (hałas) na poziom wypalenia zawodowego pielęgniarek

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Abstract

Introduction and Objective. Harmful factors may lead to a deterioration of health classified as occupational disease, while arduous factors may result in poor well-being or fatigue, but do not lead to permanent health damage. Occupational burnout syndrome poses a serious threat to the health of employees. The aim of the study is to evaluate the effect of arduous (microclimate, lighting) and harmful (noise) factors on the level of occupational burnout in a group of surgical nurses.

Materials and Method. Studies of burdensome and harmful health factors in operating theatres, including measurements of electric lighting intensity, moderate microclimate, and noise, were conducted by an accredited laboratory in selected operating theatres in hospitals in the Świętokrzyskie Province in southeast Poland. The study group consisted of 110 professionally active surgical nurses. The Link Burnout Questionnaire (LBQ) was used for the survey.

Results. Work environment measurements conducted in selected operating theatres by an accredited laboratory confirmed that factors such as microclimate, lighting, and noise meet the requirements for operating theatres. The average percentage of participants dissatisfied with the thermal conditions in the studied operating theatres was 8.33%. The highest light intensity in the central zone was found on the operating table, reaching 16,485.5 lux. The average daily noise exposure level was 56.2 dB.

Conclusions. A study of the impact of harmful and burdensome factors revealed their impact on psychophysical exhaustion and disillusionment among nursing staff. Increased temperature and uneven lighting contributed to increased psychophysical exhaustion and disillusionment in the study group.

Key words

noise, lighting, occupational burnout, microclimate, nurses operating

Streszczenie

Wprowadzenie i cel pracy. Czynniki szkodliwe mogą prowadzić do pogorszenia stanu zdrowia klasyfikowanego jako choroba zawodowa, a czynniki uciążliwe mogą powodować złe samopoczucie, zmęczenie, ale nie prowadzą do trwałego uszczerbku na zdrowiu. Syndrom wypalenia zawodowego stanowi poważne zagrożenie dla zdrowia pracownika. Celem pracy była ocena wpływu czynników uciążliwych (mikroklimat, oświetlenie) i szkodliwych (hałas) na poziom wypalenia zawodowego w badanej grupie pielęgniarek operacyjnych.

Materiał i metody. Badania czynników uciążliwych i szkodliwych dla zdrowia na salach operacyjnych, czyli pomiar natężenia oświetlenia elektrycznego, badanie mikroklimatu umiarkowanego oraz pomiar hałasu, zostały przeprowadzone przez akredytowane laboratorium na wybranych blokach operacyjnych świętokrzyskich szpitali. Grupę badaną stanowiło 110 czynnych zawodowo pielęgniarek operacyjnych. Do badań ankietowych wykorzystano Kwestionariusz Wypalenia Zawodowego LBQ (Link Burnout Questionnaire).

Wyniki. Przeprowadzone pomiary środowiska pracy w wybranych salach operacyjnych wykazały, że występujące tam czynniki takie jak mikroklimat, oświetlenie i hałas spełniają wymagania stawiane salom operacyjnym. Średni odsetek uczestników niezadowolonych z warunków termicznych na badanych salach operacyjnych wynosił 8,33%. Najwyższe natężenie światła w strefie środkowej charakteryzowało stół operacyjny i wynosiło 16485,5 lx. Średni poziom dziennej ekspozycji na hałas wyniósł 56,2 dB.

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Wnioski. Badanie oddziaływania czynników szkodliwych i uciążliwych uwidoczniło ich wpływ na wyczerpanie psychofizyczne oraz rozczarowanie personelu pielęgniarskiego. Wzrost temperatury i nierównomierność oświetlenia wpływały na zwiększenie wyczerpania psychofizycznego i poziom rozczarowania w badanej grupie.

Słowa kluczowe
wypalenie zawodowe, oświetlenie, hałas, mikroklimat, pielęgniarki operacyjne

INTRODUCTION

Occupational burnout syndrome is a problem warranting discussion due to the serious threat it poses to the health of employees. Awareness of this issue is an important factor in the employer's ability to make the right decisions when creating a positive work environment [1].

Christina Maslach defines burnout as a syndrome that includes emotional exhaustion, depersonalization, and a lowered assessment of one's professional achievements. The syndrome can occur in individuals working with others and burdened with excessive responsibilities. Emotional exhaustion refers to a sense of psychological overload and significantly contributes to the depletion of the body's energy resources. Depersonalization, on the other hand, is associated with a negative, callous, or at best, overly indifferent response to the needs of others dependent on the person affected by burnout. Lowered self-esteem refers to a radical decline in one's sense of competence and a loss of confidence in one's ability to succeed at work [2].

The factors most strongly associated with burnout among nurses include excessive workload, conflicting values, low control over the way work is performed, a limited range of possible decisions, little support and a bad climate in the workplace, and inadequate remuneration for the work performed. [3].

Noise is one of the most common harmful factors in the work environment. Long-term exposure to noise in the 80–85 dB range not only poses a threat to hearing, but also generates other health problems for workers. Lower noise levels are an arduous factor through causing stress and, as a result, lead to possible health complications [4]. An assessment of noise-induced discomfort was carried out on the basis of objective measurements of noise in the work environment in accordance with the norms set forth in the Regulations of a relevant Minister [5–12].

According to applicable regulations, noise is characterized by:

1) noise exposure level based on an 8-hour daily working time, LEX,8h, or noise exposure level based on an average weekly working time, as defined in the Labor Code;
2) time exposure, LEX,w (exceptionally, in the case of noise affecting the human body unevenly across individual days of the week);
3) maximum A-weighted sound pressure level, LAmax;
4) C-weighted peak sound pressure level, LCpeak [10].

Visual strain caused by improper lighting may result in the feeling of fatigue, headaches, dizziness, straining of the eye (tearing, burning, conjunctiva redness), deterioration of visual acuity, reduced well-being, lower productivity, and a possible increase in accidents in the workplace. Basic information regarding the lighting requirements of health care facilities is contained in the Polish PN-EN-12464–1 Norm. The lighting of operating theatres plays a particularly important role due to the nature of the activities carried out in them. Among those activities, those performed directly in the operating field require a very high intensity of lighting, while those performed in other areas of the theatre require a level suitable for moderately strenuous visual work. Meanwhile it is necessary to provide adequate electric lighting which would meet the requirements of the applicable lighting norms [12–15].

In the case of operating theatres in particular, efforts should be implemented to eliminate or reduce the phenomenon of light glare, which can distract staff and even prevent their perception. Whether or not glare is present is the subject of visual scrutiny in practice through checking whether there are unshielded light sources in the field of vision of employees, or reflections of light from working planes towards the eyes of personnel. Operating theatres should be equipped with modern, shadow-less surgical lamps. The required parameters of surgical lamps are contained in the PN-EN 60601–2–41:2010 norm [12, 15, 16].

According to the Decree of the Minister of Health of 29 March 2019 on the detailed requirements to be met by the premises and equipment of a facility performing medical activities, operating theatres should use supply and exhaust ventilation or air conditioning which would ensure air quality within the parameters suited to the functions of those theatres [16, 17]. Working conditions in operating theatres, surgery offices and medical diagnostic laboratories should meet the moderate environment microclimate norms. The impact of this type of thermal environment on the human health, well-being, and effective work results in low levels of strain imposed on the body [18].

Breaking the standards of harmful and arduous factors in the workplace, in tandem with chronic stress in surgical nurses, can undoubtedly have an impact on the occurrence of occupational burnout syndrome.

The aim of this study is to evaluate the impact of arduous (microclimate, lighting) and harmful (noise) factors on the level of occupational burnout in the participating group of surgical nurses.

MATERIALS AND METHOD

The research was carried out between Januar 2020 – August 2022 in hospitals in the Świętokrzyskie Province in southeast Poland whose directors gave written consent for participation. However, the spread of the SARS-CoV-2 pandemic significantly reduced the number of facilities surveyed.

The research method involved the evaluation of arduous (microclimate, light intensity level) and harmful (noise) factors present in operating theatres. The measurements were carried out by the Expert Bureau of Occupational Safety Management [EBOSM] in Ostrowiec Świętokrzyski, which is an accredited laboratory, and by questionnaire surveys carried out among surgical nurses. The study was approved by the

Bioethics Committee of the Jan Kochanowski University in Kielce (Resolution No. 7/2019 of 22.01.2019.

The study included operating theatres located in 6 medical facilities:
- St. Luke's Specialist Hospital in Końskie;
- John Paul II Healthcare Complex in Włoszczowa;
- Świętokrzyskie Oncology Centre in Kielce;
- Independent Public Healthcare Centre in Staszów;
- Świętokrzyskie Mother and Newborn Centre of the Specialist Hospital in Kielce;
- Paediatrics Centre of the Provincial Combined Hospital, in Kielce.

The population sample consisted of 323 active surgical nurses. Due to the inclusion and exclusion criteria of the study, as well as the spread of the SARS-CoV-2 pandemic (quarantine, isolation, morbidity), the participating sample of surgical nurses finally consisted of 110 women. The inclusion criteria were as follows: being an operating theatre nurse, work experience of at least 5 years, aged at least 30. Exclusion criteria included being a nurse working on a ward, work experience of less than 5 years, under 30 years of age, anaesthesia nurse.

The Link Burnout Questionnaire (LBQ), published by the Psychological Testing Laboratory of the Polish Psychological Association, was used as the questionnaire in the survey part of the study. This is the official Polish adaptation of an Italian questionnaire by Massimo Santinellon which consists of 24 items describing a respondent's feelings about their professional work involving caring for others. All items are answered on the basis of according to a 6-point scale which assesses the frequency at which the feelings occur, where 1 means they 'never' occurring, and 6 means they occurring every day'. This enables the assessment of 4 aspects of professional burnout: psycho-physical exhaustion (energy – exhaustion), relational deterioration (commitment – lack of commitment), professional inefficacy (effectiveness – lack of effectiveness) and disillusionment (satisfaction – disappointment) [19].

In order to test the existence of a monotonic relationship between variables, the Spearman's correlation coefficient was used. The significance level was set at $p = 0.05$, while statistically significant results for levels of $p = 0.01$ and $p = 0.001$ were also indicated.

RESULTS

Measurements conducted in select operating theatres by the EBOSM accredited laboratory confirmed that factors such as microclimate, lighting and noise met the stipulated requirements of operating theatres.

Through an examination of the microclimate in operating theatres, data was obtained on the thermal insulation of the operating teams' clothing, which ranged from 0.54 – 0.58 clo, with an average value of 0.57 clo. The metabolic rate was equal to 100 units in each facility. The mean percentage of participants dissatisfied with thermal conditions in the investigated operating theatres was about 8.33%.

The highest median illumintion was characteristic of operating tables – 16485.5 lux. Next in order of medial light intensity were the operating room and the desk (medical documentation table) – medians 1497.5 lx and 1035 lx, respectively. The lowest illumination values were found in the circulation area, median – 540.5 lx. The highest uniformity of illumination was recorded at the operating table and the desk. The lowest uniformity of illumination among the 4 sites studied was found in the circulation path, median uniformity – 0.92.

As the measurements were being recoded, the level of daily noise exposure and the maximum values of A and C-weighted frequencies were also determined. The mean level of daily noise exposure was about 56.2 dB. The maximum level of A-weighted frequencies averaged at 82.5 dB, while the peak C-weighted measurement averaged at about 97.4 dB. The maximum level of A or C-weighted frequencies did not exceed the expected norms in any of the establishments examined.

Occupational burnout subscales and microclimate in the workplace. When investigating the relationship between occupational burnout and the microclimate in the workplace, Spearman correlation coefficients were calculated between both raw and sten scores of the LBQ scales and hospital microclimate scores. Psycho-physical exhaustion showed significant positive correlations with the black globe temperature, air humidity and the predicted mean vote of thermal comfort. These correlations were weak (Tab. 1). The predicted percentage of those dissatisfied with thermal conditions showed a weak negative correlation with psycho-physical exhaustion. This would suggest that an increase in the percentage of dissatisfied persons is associated with a decrease in psycho-physical exhaustion.

Disillusion on the LBQ scale correlated significantly with air temperature and black globe temperature. Both of these correlations were positive. The results also indicated a positive correlation between air velocity and the predicted mean vote of the thermal comfort and disillusion, and a negative correlation between disillusion and the predicted percentage of those dissatisfied with thermal conditions. An increase in the temperature of the environment surrounding the surgeon's assistant's workstation resulted in a higher number of responses suggesting disillusion in the LBQ questionnaire. The same relationship was also noted in the case of the results of the disillusion subscale of the LBQ questionnaire being correlated with air velocity and the predicted mean vote of thermal comfort. In the case of the questions which aimed to determine the percentage of people dissatisfied with thermal conditions, a decrease in declared disillusion was observed as the predicted percentage of people dissatisfied with temperature increased. Declaring dissatisfaction with thermal conditions creates an environment of decreased disillusion-related stress on the LBQ scale (Tab. 1).

Occupational burnout subscales and electric light in the workplace. Through the analysis of the relationship between the results of the LBQ questionnaire and the measurements of workplace lighting, it emerged that psycho-physical exhaustion was significantly positively correlated with the mean illuminance of the circulation area, as well as with the mean illumination of the operating table. This would suggest that an increase in light intensity increases the psycho-physical exhaustion of the participants. A significant correlation was also found between the uniformity of the illuminance of the circulation area and psycho-physical exhaustion. The correlation, however, was weak and positive. An increase in the uniformity of light in the circulation area was associated with an increase in the exhaustion of the studied group (Tab. 2).

Table 1. Correlation table regarding the results of psycho-physical exhaustion and disillusion (LBQ scales) and the microclimate factor measurements

Psycho-physical exhaustion (LBQ scale) and microclimate				
Variable	Spearman (r) Coefficient	*p*-value	Spearman (r) Coefficient	*p*-value
	Raw scores		Sten scores	
Head				
t_a (°C)	0.15	0.108	0.19	0.052
t_g (°C)	0.21	0.028	0.24	0.011
RH (%)	0.26	0.007	0.26	0.006
v_a (m/s)	0.11	0.265	0.15	0.117
PMV	0.22	0.022	0.24	0.012
PPD (%)	–0.19	0.048	–0.23	0.017
Abdomen				
t_a (°C)	0.15	0.108	0.19	0.052
t_g (°C)	0.21	0.028	0.24	0.011
RH (%)	0.26	0.007	0.26	0.006
v_a (m/s)	0.21	0.032	0.25	0.009
PMV	0.22	0.022	0.24	0.012
PPD (%)	–0.22	0.022	–0.24	0.01
Ankles				
t_a (°C)	0.15	0.108	0.19	0.052
t_g (°C)	0.21	0.028	0.24	0.011
RH (%)	0.26	0.007	0.26	0.006
v_a (m/s)	0.24	0.012	0.25	0.008
PMV	0.22	0.022	0.24	0.012
PPD (%)	–0.19	0.048	–0.23	0.017
General indicators				
L_{cl} (clo)	0.12	0.201	0.09	0.328
M (W/m^2)	–	–	–	–
PMV[a]	0.22	0.022	0.24	0.012
PPD[a] (%)	–0.19	0.048	–0.23	0.017
Disillusion (LBQ scale) and microclimate				
Variable	Spearman (r) Coefficient	*p*-value	Spearman (r) Coefficient	*p*-value
	Raw scores		Sten scores	

Psycho-physical exhaustion (LBQ scale) and microclimate				
Variable	Spearman (r) Coefficient	*p*-value	Spearman (r) Coefficient	*p*-value
	Raw scores		Sten scores	
Head				
t_a (°C)	0.21	0.027	0.22	0.023
t_g (°C)	0.26	0.007	0.26	0.006
RH (%)	0.1	0.292	0.1	0.28
v_a (m/s)	0.21	0.026	0.2	0.04
PMV	0.19	0.043	0.2	0.035
PPD (%)	–0.24	0.01	–0.24	0.011
Abdomen				
t_a (°C)	0.21	0.027	0.22	0.023
t_g (°C)	0.26	0.007	0.26	0.006
RH (%)	0.1	0.292	0.1	0.28
v_a (m/s)	0.26	0.005	0.25	0.009
PMV	0.19	0.043	0.2	0.035
PPD (%)	–0.23	0.016	–0.24	0.013
Ankles				
t_a (°C)	0.21	0.027	0.22	0.023
t_g (°C)	0.26	0.007	0.26	0.006
RH (%)	0.1	0.292	0.1	0.28
v_a (m/s)	0.29	0.002	0.29	0.002
PMV	0.19	0.043	0.2	0.035
PPD (%)	–0.24	0.01	–0.24	0.011
General indicators				
L_{cl} (clo)	0.12	0.201	0.14	0.155
M (W/m^2)	–	–	–	–
PMV[a]	0.19	0.043	0.2	0.035
PPD[a] (%)	–0.24	0.01	–0.24	0.011

t_a – air temperature (°C); t_g – black globe temperature (°C); RH – air humidity (%); v_a – air velocity (m/s); PMV – predicted mean vote of thermal comfort; PPD – predicted percentage of those dissatisfied with thermal conditions (%); L_{cl} – thermal isolation of clothing (clo); M – metabolic rate (W/m^2); [a] – mean value

The study also showed a weak positive correlation between relational deterioration (in sten scores) and illumination uniformity in the operating room (Tab. 2). This correlation was statistically significant. The greater the uniformity of lighting in the operating room, the stronger the likelihood for a stressful situation to occur.

There was a significant correlation of the mean illumination at the operating table with the sense of disillusion. The correlation was weak in strength and was positive. There was also a statistically significant positive correlation between uniformity of illumination in the operating theatre and disillusion (Tab. 2). The surgeon's assistants felt disillusionment more strongly the higher and more uniform the illumination in the operating theatre.

Occupational burnout subscales and noise intensity in the workplace. In the examination of the correlation between the LBQ questionnaire results and noise intensity, it emerged that the level of daily noise exposure, daily noise exposure and the maximum levels of A and C-weighted frequencies, correlated with psycho-physical exhaustion. The correlations were negative, suggesting that increased noise levels reduced feelings of exhaustion (Tab. 3).

Examining the correlation of relational deterioration, measured in raw scores, with the variables describing workplace noise, such as the level of daily exposure to noise and daily exposure to noise, statistically significant results were obtained. The correlations were negative and weak. An increase in noise level and an increase in daily noise exposure resulted in the deterioration of the commitment in the patient-nurse relationship (Tab. 3).

Disillusion as assessed by the LBQ scale correlated with all the scores of the tested aspects of noise as a factor. The higher the intensity of the noise, as well as A and C-weighted frequencies, the more the sense of disillusion decreased. However, the relationship was statistically weak (Tab. 3).

Linear regression models in explaining the different occupational burnout subscales in relation to harmful and arduous factors. In analyzing the results of each of the 4

Table 2. Correlation table regarding the results of psycho-physical exhaustion, relational deterioration and disillusion (LBQ scales) and the electric light factor measurements

Psycho-physical exhaustion (LBQ scale) and electric light				
Variable	Spearman (r) coefficient	*p*-value	Spearman (r) coefficient	*p*-value
	Raw scores		Sten scores	
$E_{śr}$ (lx) – mean illuminance				
Operating table	0.2	0.033	0.2	0.033
Operating room	0.11	0.238	0.09	0.33
Medical documentation desk	0.13	0.165	0.12	0.231
Circulation area	0.23	0.018	0.21	0.026
U_o – uniformity of illuminance				
Operating table	0.11	0.261	0.09	0.328
Operating room	0.12	0.213	0.18	0.066
Medical documentation desk	–0.15	0.116	–0.17	0.074
Circulation area	0.2	0.037	0.21	0.027
Relational deterioration (LBQ scale) and electric light				
Variable	Spearman (r) coefficient	*p*-value	Spearman (r) coefficient	*p*-value
	Raw scores		Sten scores	
$E_{śr}$ (lx) – mean illuminance				
Operating table	0.14	0.139	0.14	0.149
Operating room	0.06	0.529	0.02	0.871
Medical documentation desk	0.11	0.26	0.07	0.5
Circulation area	0.06	0.523	0.02	0.848
U_o – uniformity of illuminance				
Operating table	0.12	0.223	0.08	0.432
Operating room	0.18	0.055	0.19	0.041
Medical documentation desk	–0.16	0.087	–0.13	0.163
Circulation area	0.07	0.465	0.04	0.715
Disillusion (LBQ scale) and electric light				
Variable	Spearman (r) coefficient	*p*-value	Spearman (r) coefficient	*p*-value
	Raw scores		Sten scores	
$E_{śr}$ (lx) – mean illuminance				
Operating table	0.25	0.008	0.27	0.005
Operating room	–0.02	0.823	–0.001	0.992
Medical documentation desk	0.03	0.74	0.06	0.552
Circulation area	0.09	0.353	0.11	0.272
U_o – uniformity of illuminance				
Operating table	0.02	0.835	0.04	0.642
Operating room	0.22	0.018	0.22	0.021
Medical documentation desk	–0.1	0.305	–0.11	0.242
Circulation area	0.09	0.376	0.09	0.342

subscales of the LBQ questionnaire, linear regression models were calculated to explain the effect of harmful and arduous factors on occupational burnout in a participant group. The raw questionnaire scores for each subscale were used for the calculations. The factors that were significantly correlated with results of a select subscale of the questionnaire were used as explanatory variables. The selection of the variables for the final models was carried out based on the stepwise backward-elimination method. All explanatory variables

Table 3. Correlation table regarding the results of psycho-physical exhaustion, relational deterioration and disillusion (LBQ scales) and the noise factor measurements

Psycho-physical exhaustion (LBQ scale) and noise				
Variable	Spearman (r) coefficient	*p*-value	Spearman (r) coefficient	*p*-value
	Raw scores		Sten scores	
$L_{EX,8h}$ (dB) - daily noise exposure level	–0.25	0.008	–0.26	0.005
$E_{A,8h}$ (Pa^2s) – daily noise exposure	–0.25	0.008	–0.26	0.005
L_{Amax} (dB) – A-weighted maximum value	–0.25	0.009	–0.25	0.009
L_{Cpeak} (dB) – C-weighted peak measurement	–0.25	0.009	–0.25	0,009
Relational deterioration (LBQ scale) and noise				
Variable	Spearman (r) coefficient	*p*-value	Spearman (r) coefficient	*p*-value
	Raw scores		Sten scores	
$L_{EX,8h}$ (dB) - daily noise exposure level	–0.2	0.039	–0.17	0.082
$E_{A,8h}$ (Pa^2s) – daily noise exposure	–0.2	0.039	–0.17	0.082
L_{Amax} (dB) – A-weighted maximum value	–0.18	0.058	–0.14	0.137
L_{Cpeak} (dB) – C-weighted peak measurement	–0.18	0.058	–0.14	0.137
Disillusion (LBQ scale) and noise				
Variable	Spearman (r) coefficient	*p*-value	Spearman (r) coefficient	*p*-value
	Raw scores		Sten scores	
$L_{EX,8h}$ (dB) - daily noise exposure level	–0.23	0.017	–0.25	0.01
$E_{A,8h}$ (Pa^2s) – daily noise exposure	–0.23	0.017	–0.25	0.01
L_{Amax} (dB) – A-weighted maximum value	–0.19	0.05	–0.21	0.026
L_{Cpeak} (dB) – C-weighted peak measurement	–0.19	0.05	–0.21	0.026

were also rescaled. Linear regression models for psycho-physical exhaustion, relational deterioration, feelings of professional inefficacy and disillusion (LBQ subscales).

There was a significant effect of maximum value of A-weighted frequencies on psycho-physical exhaustion. An increase in the A-weighted maximum value was associated with a decrease in the level of exhaustion. No significant effect of illumination uniformity in an operating theatre, or daily noise exposure was found on relational deterioration. Daily noise exposure did not significantly affect the feeling of professional inefficacy. Air temperature significantly affected the surgeon assistant's sense of disillusion. An increase in temperature was associated with an increase in disillusionment (Tab. 4).

DISCUSSION

The evaluatiomns conducted included the operating table (direct operating field), the surgeon's assistant's desk, the overall lighting of the room and the lighting of the circulation areas.

Table 4. Linear regression models explaining psycho-physical exhaustion, relational deterioration, professional inefficacy and disillusion in terms of significant predictors

Psycho-physical exhaustion				
	Coefficient	2.5%	97.5%	*p*-value
Constant	17.491	16.475	18.507	< 0.001
A-weighted maximum value, L_{Amax} (dB)	–1.11	–2.13	–0.089	0.033
Relational deterioration				
	Coefficient	2.5%	97.5%	*p*-value
Constant	14.364	13.567	15.161	< 0.001
Uniformity of illuminance in the operation room	0.704	–0.113	1.521	0.090
Daily noise exposure, EA,8h (Pa^2s)	–0.665	–1.482	0.152	0.109
Professional inefficacy				
	Coefficient	2.5%	97.5%	*p*-value
Constant	13.164	12.447	13.88	< 0.001
Mean illuminance at the medical documentation desk	0.622	–0.097	1.341	0.089
Disillusion				
	Coefficient	2.5%	97.5%	*p*-value
Constant	15.982	14.849	17.115	< 0.001
Air temperature, ta (°C) – head	1.244	0.106	2.382	< 0.001

Noise levels during investigation of the physical conditions in operating theatres included measurements of air temperature, black globe temperature, air humidity, and air velocity. The illumination in the operating theatre was also surgical procedures were also measured for the purpose of the study.

Harmful factors, the effects of which can lead to the deterioration of health and would classify as occupational disease, arduous factors, such as lighting or microclimate, can cause poor well-being or fatigue, but do not lead to permanent health damage [4]. Within the investigated rooms, noise levels met the required norms stipulated by relevant laws and regulations [5].

The thermal isolation of the clothing ranged from 0.54 – 0.58 clo, reaching a mean value of 0.57 clo, which is within the accepted norms for this type of clothing. The metabolic rate was equal to 100 units for each facility. The mean percentage of those who were dissatisfied with the thermal conditions at the investigated site was about 8.33%.

Thermal comfort in the operating theatre has been addressed in a few studies, with most focussing on regulating individual parameters of the air supply (temperature, airflow rate). The thermal environment in the operating theatre is complex, and significantly impacts the thermal comfort of its occupants. Factors such as heat dissipation from equipment and staff activities also influence the thermal environment in the operating theatre [20]. From analyzing global reports on thermal comfort (microclimate), it can be deduced that there is a large deficit in the knowledge on temperature, humidity and airflow in operating theatres as far as the influence of these parameters on feelings of stress in staff is concerned [21]. Being in an uncomfortable thermal environment in the operating theatre can lead to problems such as physical fatigue and reduced concentration for surgical nurses [22]. Research shows that thermal comfort varies significantly among operating theatre staff due to their occupational activities and location, and that heat demand varies depending on the workstation. The temperature perception of surgical nurses in the operating theatre is closely related to age [18, 20, 22].

Lighting is a physical factor of the work environment, classified as an arduous factor [4]. This is due to the fact that inadequate lighting of workplaces may lead to excessive eye fatigue, vision-related complaints, a decrease in work productivity and an aggravation of existing visual defects. Limited access to daylight contributed to fatigue and led to stress [23, 24].

Results obtained in individual hospitals met all the required norms elaborated upon in national laws and regulations [5, 8, 9, 11] and in the literature [17, 20, 24, 25].

The work environment factors analyzed in the study influenced the level of burnout among surgical nurses, which is also confirmed by other studies [26, 27].

Analysis of noise-related factors showed a significant, negative correlation between noise intensity and psycho-physical exhaustion. An increase in A and C-weighted values noted in some facilities would result in a decrease in exhaustion. When examining the association of relational deterioration, as measured in raw scores, with noise-related variables, such as the level of daily exposure to noise and daily exposure to noise, statistically significant negative correlation values of weak strength were obtained. Disillusion, as measured on the LBQ scale, also negatively correlated with all measures of noise as a factor in the study. It can be assumed that the increase in noise levels in the operasting theatres was due to louder conversations among the operating staff, which may have been the result of an increased sense of partnership and friendly atmosphere. Such working conditions result in reduced stress and psycho-physical exhaustion. It should be noted that safety standards with regard to noise levels were met in all the operating theatres examined.

During the examination of the microclimate, it was noted that the LBQ questionnaire scores were affected by temperature and humidity. Psycho-physical exhaustion showed significant positive correlations with the black globe temperature, air humidity, and predicted mean vote of thermal comfort. Similar results on the LBQ scale were obtained for the disillusion subscale, which correlated significantly with air temperature and the black globe temperature. Both of these correlations were positive. A positive correlation was also observed between disillusion and air velocity, as well as the predicted mean vote of thermal comfort.

The study analyzed the effect of operating theatre lighting on the level of perceived stress. Positive correlations were obtained between psycho-physical exhaustion and the mean illumination intensity of the circulation area, as well as the mean illumination intensity of the operating table. This means that an increase in lighting intensity increased the psycho-physical exhaustion of the subjects. A significant positive correlation of weak strength was also established between the light uniformity of the circulation area and psycho-physical exhaustion. An increase in the uniformity of lighting in the circulation area was associated with an increase in the exhaustion of the participant group. Light dispersion and penumbrae in the operating theatres reduced psycho-physical exhaustion. Similar results were obtained in a study of the relationship between relational deterioration and lighting uniformity in an operating theatre. The mean lighting intensity at the operating table was shown to be significantly correlated with feelings of disillusion. The correlation was weak in strength and was positive. Another statistically significant correlation

was found between the uniformity of lighting in the operating room and disillusionment. This was a positive correlation of weak strength. The results of the study highlighted the significant effect of lighting intensity and uniformity on the emergence of stress reactions in the participants.

CONCLUSIONS

1) Measurements of the lighting, noise and microclimate in working environments, such as operating theatres, did not reveal any breaches of the recommended hygiene and sanitary norms.
2) The impact of lighting, noise and microclimate on nursing staff employed to work in operating theatres can affect the feelings of stress resulting from those factors, and the development of occupational burnout syndrome.
3) Increased temperature and non-uniform lighting have an effect of increasing psycho-physical exhaustion and disillusionment among the nursing staff employed to work in operating theatres.

Recommendations for nursing practice. The issue of occupational exposure to harmful, hazardous and arduous factors in the workplace is a leading topic insofar as occupational health and safety in medical facilities is concerned. Studies conducted in Poland and worldwide highlight the significance of this problem. Nursing staff employed to work in operating theatres, given the nature of their duties and the risk of contact with harmful, hazardous and arduous factors, as well as the psychosocial burden associated with the way they work, are exposed to many such occupational hazards. The situation is aggravated as a result of insufficiently developed medical-preventive recommendations, which is often commonplace due to the poor knowledge of the managerial staff about the intensity and magnitude of the effects of harmful factors in the work environment, and the nature of the risks they pose. In this regard, it seems purposeful and reasonable to monitor occupational exposures in a way which would take into account the factors present in the working environment, as well as the implementation of preventive programmes. The management of medical facilities should pay attention to whether or not relevant norms are complied with and ensure the frequency and sufficiency of testing of the working environment by certified laboratories. Nursing personnel should diligently adhere to the safety and health regulations established in the context of operating theatres.

The knowledge of the managerial staff on the impact of the workplace environmental factors on the occupational burnout of the nursing staff should ensure appropriate decision-making which would lead to the creation of a positive work environment. Medical facilities introducing a programme which could prevent the occurrence of occupational burnout of surgical nurses would require the teaching and consolidation of appropriate behavioural patterns and their practical application within and outside work, changing and adapting working conditions to the capabilities of the nursing staff, as well as the implementation of correct forms of physical activity, recreation, and leisure in their day-to-day life.

Limitations of the study. Some limitations must be taken into account when interpreting the results. The data used in the study was obtained from a sample consisting of a selected group of nursing personnel working in operating theatres of Świętokrzyskie hospitals who agreed to participate in the study. However, the participating sample does not represent the broader population of nursing staff working in the operating theatres of Świętokrzyskie hospitals. On the basis of the opinions of 110 respondents, only general conclusions directed at the entire professional group employed there can be drawn. In the future, the survey should include a larger sample of participants, while maintaining a higher degree of gender variance, in order to increase representativeness and the possibility of a more universal interpretation of the study's results.

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