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29 Z.M. Przesmyckiego St.
05-510 Konstancin-Jeziorna, Poland
tel. +48 604 776 311
a.luczynska@wydawnictwo-aluna.pl

www.polskimerkuriuszlekarski.pl

Distribution and subscription
Bartosz Guterman
tel. +48 22 245 10 55
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ORIGINAL ARTICLE

Hybrid approach in patients with aortic valve disease and concomitant coronary heart disease: retrospective study

Kostiantyn Boyko[1, 2], Borys Todurov[1, 2], Andrii Khokhlov[1], Serhii Sudakevych[1, 2], Nataliia Yashchenko[2], Ihor Kuzmich[1, 2], Stepan Maruniak[2]

[1]HEART INSTITUTE MINISTRY OF HEALTH OF UKRAINE, KYIV, UKRAINE
[2]SHUPYK NATIONAL HEALTHCARE UNIVERSITY OF UKRAINE, KYIV, UKRAINE

ABSTRACT

Aim: The aim of the study was to analyze the effectiveness of the hybrid approach, which involves the combination of aortic valve replacement (AVR) with percutaneous coronary intervention (PCI), in patients with CHD and aortic valve disease.

Materials and Methods: For this study, analysis of medical records of adult patients (over 18 years old) who underwent AVR along with myocardial revascularization at the State Institution "Heart Institute Ministry of Health of Ukraine" in the period from 2018 to 2022 was carried out. Quality of life was assessed in 6 and 12 months after AVR with myocardial revascularization using Short Form 36 Survey (SF-36).

Results: We selected 130 patients who underwent AVR together with myocardial revascularization (first group (n=51) – a combination of AVR and percutaneous coronary interventions (PCI); second group (n=79) – a combination of AVR and coronary artery bypass grafting (CABG). The duration of cardiopulmonary bypass and aorta cross clamping in first group was recorded by 1.5 times and by 1.4 times significantly lower compared to the second group (p=0.0001). The pain index after 6 months according to the SF-36 questionnaire was found to be 13.5% (p=0.017) significantly higher in patients of the first group compared to the second group, while other indicators did not differ among groups.

Conclusions: Patients with the hybrid approach of treatment were characterized by a similar level of postoperative complications with the surgical group. At the same time, this cohort of patients had a better SF-36 pain index in 6 months after the hybrid intervention.

KEY WORDS: aortic valve replacement, coronary artery bypass grafting, percutaneous coronary interventions, myocardial revascularization, quality of life

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INTRODUCTION

Today, cardiovascular disease is one of the leading causes of mortality worldwide, with coronary heart disease (CHD) and valvular disease responsible for severe life-threatening cardiovascular events. [1, 2]. In turn, degenerative lesions of the aortic valve are the most common cause of valve disease in Western countries, and they often occur in elderly patients who are also at higher risk of developing atherosclerotic disease [3]. According to a systematic study, conducted by Manjunath CN et al., the overall prevalence of CAD in patients undergoing aortic valve replacement (AVR) varies from 9% to 41% [4].

Studies published in the 1960s and 70s led some authors to suggest that the development of aortic stenosis may have a protective role against coronary atherosclerosis [5]. In fact, this was probably just a consequence of selection bias, in which the indication for coronary angiography depended on symptoms. Patients with aortic valve disease and coronary heart disease showed symptoms earlier, which may explain the lower incidence and severity of coronary disease compared to patients without valvular disease.

In turn, Matta A et al., in a recent study among 1, 308 patients with valvular heart defects showed that CAD is significantly correlated with aortic valve stenosis [6]. According to the authors, myocardial ischemia caused by the narrowing of coronary arteries with age leads to a decrease in myocardial compliance, causing heart failure by changing the systolic and diastolic function of the heart. These abnormalities in turn contribute to heart valve calcification and contribute to the progression of heart valve damage, which can lead to increased coronary artery ischemia.

For quite a long time, the main method of treatment in this cohort of patients was open surgical intervention by AVR together with coronary artery bypass grafting (CABG), which at the same time was characterized by a higher frequency of postoperative mortality compared to patients with only isolated AVR [7].

A growing number of research suggests that hybrid interventions should be considered in patients with aortic valve disease and significant CAD who are candidates for revascularization. In particular, the hybrid strategy studied by Rzucidło-Resil JM et al. showed similar results in terms of mortality and morbidity and may be an alternative to conventional AVR with CABG in selected patients [8]. At the same time, despite numerous reports in the literature, recently published guidelines indicate that there remains concern regarding the optimal management strategies for CHD in patients with valvular disease [9].

AIM

The aim of the study was to analyze the effectiveness of the hybrid approach, which involves the combination of AVR together with percutaneous coronary intervention (PCI), in patients with CHD and aortic valve disease.

MATERIALS AND METHODS

CHARACTERISTICS OF PATIENTS

Adult patients (over 18 years of age) who underwent AVR with myocardial revascularization between 2018 and 2022 are included in this study. Exclusion criteria were: concomitant cardiosurgical interventions; age younger than 18 years; decompensated diabetes, acute cerebrovascular accident in history, EuroSCORE II >5.0%.

Before AVR, all patients underwent coronary angiography in the catheterization laboratory on the day of surgery, based on the results of which, if necessary, a decision was made to revascularize the myocardium. The main methods of myocardial revascularization were PCI, which was performed during the patient's stay in the catheterization laboratory, and CABG, which was performed directly with AVR. Both cardiac surgeon and interventional cardiologist was involved in the decision-making process.

ANESTHESIA, CARDIOPULMONARY BYPASS AND CARDIOPROTECTION

Intraoperative monitoring included electrocardiogram, invasive arterial pressure, central venous pressure, arterial oxygen saturation, end-tidal sevoflurane concentration, nasopharyngeal temperature and urine output.

General anesthesia was maintained by titrating sevoflurane from 1.5 vol% to 2.5 vol% to maintain BIS values from 40 to 60. Sevoflurane was administered to the oxygenator circuit during cardiopulmonary bypass (CPB) through a calibrated vaporizer.

Mechanical ventilation of the lungs was carried out using «Dräger» anesthesia machines (Germany) with FiO_2 50% air-oxygen mixture under the control of arterial blood gases (pCO2 values of arterial blood were maintained at the level of 35-40 mm Hg).

After achieving moderate hypothermia – 32*C, the aorta was clamped. Myocardial protection was achieved in all patients by antegrade administration through coronary cannulas of cold crystalloid cardioplegic solution «Kustodiol».

SURGICAL INTERVENTION

All patients were operated on through a median approach. In parallel with the sampling of the left internal thoracic artery, the large subcutaneous vein was isolated. After clamping the aorta and introducing cardioplegia, distal anastomoses were first applied to the heart, followed by excision of the affected aortic valve and placement of nodal sutures in the aortic annulus for implantation of a prosthetic aortic valve. The aortic incision was closed using a double-layer technique. Deaeration was performed in the Trendelenburg position by stopping left ventricular drainage, suctioning from the aortic root drainage hole, and ventilating the lungs before removing the aortic clamp. After reaching the patients' body temperature of 34°C, electrical defibrillation of the heart was performed. Later, proximal anastomoses were imposed to the aorta when the heart works

DATA COLLECTION

At the preoperative stage, such indicators as demographic characteristics (age, sex, body weight), anamnesis data, and an assessment of operational risk according to EuroSCORE II were recorded , echocardiographic indicators, results of coronary angiography and concomitant diseases.

Intraoperative data included the duration of the operation, the duration of anesthesia, the duration of CPB and aorta cross clamping, the need for erythrocyte blood mass.

Data collected during the postoperative period included frequency of postoperative complications (acute kidney injury, bleeding, major adverse cardiac and cerebro-vascular event (MACCE)), echocardiogram results, length of the intensive care unit stay and duration of hospitalization. MACCE that was defined as any of the following complications from admittance to discharge: cardiac death, cerebrovascular death, non-fatal cardiac arrest, acute myocardial infarction, new cardiac arrhythmia, angina, or stroke. Postoperative blood loss volume etimated by using chest drainage system.

QUESTIONNAIRE

Quality of life was assessed in 6 and 12 months after AVR with myocardial revascularization using Short Form 36 Survey (SF-36) [10]. Standardized assessment of quality of life is carried out by self-administered 10-15-minute questionnaires by patients after obtaining consent after explaining the rules for filling in during repeated examinations of patients. The questionnaire includes 36 items, which are grouped into 8 scales: physical functioning (PF), role functioning (RF), pain intensity (PI), general health status (GH), life activity (LA), social functioning (SF), emotional state (ES) and mental health (MH). The patient chooses the answer to the proposed question. Each answer is evaluated on a scale from 0 to 100 points. A higher score indicates a higher subjective perception of the quality of life and health.

The study also analyzed the complications observed on the lower extremities, due to venous grafts harvesting during CABG using its own questionnaire. In this questionnaire, they were asked to answer yes/no about the presence of such complications as pain, swelling, numbness, and infection in 6 and 12 months after surgery during repeated examinations (Table 1).

STATISTICAL ANALYSIS

Study results were reported as mean (M) ± standard deviation (SD). In case of non-normal distribution of the results, data were presented as median (Me) and 1st (Q25) and 3rd (Q75) quartiles – Me (Q25; Q75). In the case of a normal distribution of data, the Student's t-test is used to determine the reliability of statistical indicators, and at the same time, in the absence of a normal distribution, the non-parametric Mann-Whitney U-test is used. Pearson's xi-square test or Fisher's exact test (as appropriate) was used to analyze categorical variables, such as the rate of

Table 1. Questionnaire for the assessment of remote complications on the lower extremities

Do you feel pain in the limb after the operation at the moment ?	
Yes	No
Are you experiencing numbness in your limb after surgery at this time?	
Yes	No
Are you experiencing swelling in your limb after surgery at this time?	
Yes	No
Is there an infection of the wound at the site of venous graft harvesting after surgery at the moment?	
Yes	No

Table 2. Analysis of preoperative indicators

Parameters		The first group (n= 51)	The second group (n= 79)	p
Age, years		66 (57.5;69.5)	66 (63;71)	0.189
Male sex, n (%)		36 (70.5%)	53 (67.1%)	0.675
BMI, kg / m ^{2}		30.9 ± 4.66	29.6 ± 4.97	0.198
EuroSCORE II, %		2.31 ± 1.71	2.44 ± 1.82	0.242
NYHA , f.c.				
	I	1 (1.96%)	1 (1.29%)	
	II	14 (27.5%)	37 (46.8%)	
	III	31 (60.8%)	35 (44.3%)	0.658
	IV	5 (9.74%)	6 (7.61%)	
Previous interventions, n (%)		3 (5.88%)	6 (7.59%)	0.934
Concomitant disaeses	CKD	3 (5.88%)	4 (5.06%)	0.965
	COPD	2 (3.92%)	4 (5.06%)	0.954
	DM	16 (31.3%)	22 (27.8%)	0.666
	IM	7 (13.7%)	11 (13.9%)	0.974
	AF	13 (25.5%)	16 (20.3%)	0.483
	AH	46 (90.2%)	74 (93.7%)	0.965
Bilirubin, µmol / l		14.5 ± 6.43	13.6 ± 7.03	0.496
Urea, mmol / l		7.29 ± 4.67	7.46 ± 3.15	0.816
Creatinine, µmol / l		85.1 ± 25.4	93.5 ± 20.7	0.066
Albumin, g/l		41.8 ± 4.39	41.6 ± 3.64	0.793

*Notes: * – Fisher's exact test; BMI – body mass index; EuroSCORE – European System for Cardiac Operative Risk Evaluation; CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; DM – diabetes mellitus; MI – myocardial infarction; AF – atrial fibrillation; AH – arterial hypertension.*

postoperative complications in both groups. Differences at $p < 0.05$ (95.5%) were considered reliable. The statistical data processing program «SPSS" was used to analyze the obtained data Statistics ver . 27 «

RESULTS

Among 158 medical recordes selected for research, 28 were excluded during detailed analysis. In particular, in 7 cases, the medical recordes did not reflect all the necessary parameters for the study, in 19 cases, AVR with revascularization was accompanied by other concomitant cardiac surgical interventions, and in 2 patients, decompensated diabetes mellitus was detected.

Depending on the method of myocardial revascularization, all patients were divided into two groups:

- the first group (n = 51) – a combination of AVR and PCI;
- the second group (n =79) – a combination of AVR and CABG.

A detailed analysis of the initial data among the studied groups is given in Table 2.

We also conducted a comparative analysis of the main preoperative echocardiogram parameters; these results are presented in Table 3.

The analysis of intraoperative data showed that the duration of CPB and aortic cross clamping in patients of the first group was recorded by 1.5 times and 1.4 times, respectively, significantly lower compared to the second group (p=0.0001) (Table 4). Also, in patients of the first group, the duration of surgical intervention was significantly shorter by 1.3 times compared to patients of the second group (p=0.0001).

Table 3. Analysis of preoperative echocardiogram results

Parameters	The first group (n= 51)	The second group (n= 79)	p-value
LV EF, %	54.9 ± 11.4	54.0 ± 11.1	0.678
ESV LV, ml	153.8 ± 55.9	140.3 ± 54.1	0.226
EDV LV, ml	67.7 ± 37.9	65.2 ± 39.7	0.768
$_{\Delta}p_{max}$, mmHg	77.8 ± 29.5	70.1 ± 31.5	0.228
$_{\Delta}p_{mean}$, mmHg	44.2 ± 19.1	40.6 ± 20.7	0.378
Area of AV, cm ^{2}	0.70 ± 0.15	0.77 ± 0.17	0.061
Aortic ring, see	2.26 ± 0.18	2.25 ± 0.22	0.748
Bicuspid AV, n (%)	12 (23.5 %)	11 (13.9%)	0, 317
Aortic stenosis, n (%)			
+	1 (1.96%)	3 (3.79%)	
++	8 (15.7%)	16 (20.3%)	
+++	35 (68.6%)	48 (60.8%)	0.512
++++	7 (13.7%)	6 (7.59%)	
Aortic regurgitation, n (%)			
+	26 (50.9%)	46 (58.2%)	
++	11 (21.6%)	18 (22.8%)	0.416
+++	3 (5.88%)	9 (11.4%)	

*Notes: * – Fisher's exact test; LV EF – ejection fraction of the left ventricle; ESV LV – end-systolic volume of the left ventricle; EDV LV – end-diastolic volume left ventricle; AV – aortic valve; Δp_{max} – the maximum pressure gradient on the aortic valve; Δp_{mean} – the average pressure gradient on the aortic valve.*

Table 4. Analysis of intraoperative data

Parameters	The first group (n= 51)	The second group (n= 79)	p- value
Duration of CPB, min	77.0 ± 18.0	113.1 ± 31.6	0.001
Aorta cross-clamping, min	56.1 ± 13.5	75.7 ± 20.6	0.001
Duration of the surgery, hours	2.47 ± 0.49	3.29 ± 0.73	0.001
Number of stents, n	2 (1;2.5)	-	-
Number of grafts, n (%)			
- 1	0 (0.00%)	28 (35.4%)	-
- 2	0 (0.00%)	38 (48.1%)	-
- 3	0 (0.00%)	13 (16.5%)	-
Need for RBCM, n (%)			
0	23 (45.1%)	26 (32.9%)	
1	20 (39.2%)	32 (40.5%)	0.575
> 2	8 (15.7%)	21 (26.6%)	

*Notes : * – Fisher's exact test; CPB – cardiopulmonary bypass; RBCM – red blood cell mass.*

Although the study groups did not differ significantly in terms of length of ICU stay (p=0.279) and hospitalization (p=0.215), however, in the early postoperative period, a lower level of bleeding was observed in patients of the first group compared to the second group (p=0.028) (table 5).

Among patients of the first group, in-hospital mortality was 0.00%, while among patients of the second group it was determined at the level of 1.26%, but without a significant difference between the groups (p=0.907). The cause of death in one case in the second group was irreversible ventricular fibrillation, which developed immediately after transporting the patient from the operating room to the intensive care unit.

One of the key indicators of the success of surgical intervention is the quality of life of patients in the distant postoperative period. Table 6 contains data on changes in quality of life on the SF-36 scale in 6 and 12 months after surgery.

Pain intensity was found to be 13.5% (p=0.017) significantly higher in patients of the first group compared to the second group, while other indicators did not differ among themselves.

The results of the survey of specified complications at the site of venous graft harvesting are presented in Table 7.

DISCUSSION

Our study showed that patients with hybrid treatment had significantly shorter duration of aortic cross-clamping and cardiopulmonary bypass during surgery, lower blood loss in the early postoperative period, and a better pain

Table 5. Analysis of early postoperative outcomes

Parameters	The first group (n= 51)	The second group (n=79)	p-value
EDV LV, ml	125.9 ± 38.7	118.1 ± 33.6	0.154
LVEF, %	55.3 ± 8.03	54.4 ± 8.5	0.0574
$_{\Delta}p_{max}$., mmHg.	17.6 ± 8.49	19.9 ± 8.87	0.135
$_{\Delta}p_{mean}$., mmHg.	8.41 ± 5.05	9.65 ± 5.52	0.196
Bleeding, ml	180 (150; 250)	250 (200 ;305)	0.028
IM, n (%)	1 (1.96%)	10 (12.7%)	0.392
AKI, n (%)	5 (16.1%)	8 (16.7%)	0.949
Arritmias, n (%)	7 (22.6%)	7 (14.6%)	0.363
Length of ICU stay, hours	47.0 ± 10.5	49.9 ± 18.1	0.279
Duration of hospitalization, days	13.5 ± 5.17	14.6 ± 4.78	0.215
Hospital mortality, n (%)	0 (0.00%)	1 (1.26%)	0.907
MACCE	9 (17.6%)	17 (21.5%)	0.589

*Notes : * – Fisher's exact test; EDV LV – end-diastolic volume of left ventricle; LVEF – ejection fraction of the left ventricle; MI – myocardial infarction; AKI – acute kidney injury; ICU – intensive care unit; MACCE – major adverse cardiac and cerebro-vascular event.*

Table 6. Assessment of quality of life according to the SF -36 questionnaire

Time	The first group	The second group	The value of
Physical functioning			
6 months (n= 31-50)	69.3 ± 17.5	75.4 ± 16.1	0, 1 20
12 months (n=23-39)	71.8 ± 16.0	76.4 ± 13.3	0.199
Role functioning due to physical condition			
6 months (n= 31-50)	87.6 ± 6.65	85.6 ± 6.63	0.188
12 months (n=23-39)	87.7 ± 7.82	87.6 ± 5.73	0.960
Pain intensity			
6 months (n= 31-50)	25.2 ± 10.5	21.8 ± 11.3	0, 0 17
12 months (n=23-39)	21.6 ± 12.0	19.6 ± 10.9	0.457
General health			
6 months (n= 31-50)	49.9 ± 6.18	49.8 ± 7.49	0.989
12 months (n=23-39)	49.4 ± 8.10	48.1 ± 6.61	0.467
Life activity			
6 months (n= 31-50)	50.6 ± 8.58	47.9 ± 8.38	0.176
12 months (n=23-39)	46.5 ± 8.23	46.4 ± 7.94	0.967
Social functioning			
6 months (n= 31-50)	49.2 ± 15.4	49.1 ± 13.7	0.968
12 months (n=23-39)	48.2 ± 15.7	50.5 ± 12.6	0.504
Role functioning caused by emotional state			
6 months (n= 31-50)	71.3 ± 21.0	74.9 ± 19.4	0.435
12 months (n=23-39)	70.7 ± 22.7	74.2 ± 15.4	0.466
Mental health			
6 months (n= 31-50)	58.5 ± 10.5	56.4 ± 8.49	0.342
12 months (n=23-39)	57.9 ± 11.2	56.6 ± 7.77	0.572

Table 7. Results of a questionnaire of complications on the lower extremities after venous grafts harvesting

Complication	6 months (n=50)	12 months (n=39)	p-value
Pain, n (%)	4 (8.00%)	2 (5.13%)	0.204
Edema, n (%)	5 (10.0%)	3 (7.69%)	0.395
Numbness, n (%)	8 (16.0%)	4 (10.2%)	0.210
Infection, n (%)	3 (6.00%)	1 (2.56%)	0.102

index score in 6 months after hybrid intervention compared to the surgery-only group.

Today, the use of hybrid approaches in cardiac surgery allows to reduce the relative risks of postoperative complications and the level of mortality observed in open interventions [11, 12].

In particular, the hybrid methods in cardiac surgery that are actively used include hybrid coronary revascularization, in which an open surgical anastomosis of the left internal thoracic artery with the left anterior descending coronary artery is performed together with the implantation of a stent in the right coronary artery, open surgical intervention on the heart valves in combined with percutaneous coronary interventions on coronary vessels, hybrid aortic arch debranching combined with endovascular intervention for thoracic aortic aneurysms and carotid artery stenting together with aortocoronary bypass [13].

At the same time, taking into account the development of new technological stents together with the use of modern surgical approaches, hybrid methods are an attractive alternative to isolated standard surgical interventions in patients with coronary heart disease in combination with valvular disease [14, 15].

Thus, in a large study by Byrne JG et al., of approximately 10, 000 patients, isolated valve surgery was associated with a 4.4% mortality rate, while the relative mortality rate for combined valve surgery and CABG was 9%. Comorbidities such as advanced age, low ejection fraction, morbid obesity, pulmonary and renal dysfunction, make the mortality rate even higher [12].

At the same time, a number of studies report low 30-day mortality rates ranging from 0 to 5.6% and a low frequency of severe complications when using hybrid techniques [16, 17].

In particular, as noted by Santana O et al. in their analysis of a 5-year experience using hybrid approaches, the combination of percutaneous coronary interventions together with minimally invasive mitral valve replacement was associated with good early and subsequent long-term outcomes [18]. Thus, 30-day mortality in CABG combined with mitral valve defect correction was 9.8%, while the use of a hybrid approach reduced it to 4.3%.

In a more recent study conducted by Rzucidło-Resil JM et al., the hybrid procedure was characterized by similar mortality results to surgical aortic valve replacement with CABG [8]. In particular, in-hospital mortality in the hybrid and surgical groups was 3.0% and 1.2%, respectively (p=0.237), while complications occurred significantly more often in the hybrid group compared to the surgical group (18.6% vs. 33.7% , p=0.020).

In our study, similar mortality results were obtained, with no in-hospital mortality observed in patients with the hybrid approach, compared with 2.08% in the surgical group. In our opinion, the reason for this low mortality was that our study included low surgical risk patients with EuroSCORE II less than 5%, while in the researched Rzucidło-Resil JM et al. patients of various risk groups are included. Also, in contrast to our study, where aortic valve replacement was used through a classic approach, in this study, the authors used a method of aortic valve replacement through a right minithoracotomy.

Although, minimally invasive interventions have shown good results, they are suitable for a very limited range of patients [19, 20]. Moreover, according to Leacche M et al. and Byrne JG et al. candidates for hybrid interventions are also patients who need repeated cardiosurgical interventions, in which the implementation of minimally invasive procedures is even more complicated [14, 21].

It is also worth noting that in our study, the hybrid approach was performed in one stage: after PCI, patients from the catheterization laboratory were admitted to the operating room, where aortic valve replacement was performed. As noted by Santana O et al. the one-stage hybrid approach reduces the risk of bleeding and more cost-effective compared to the two-stage procedure. However, a special hybrid operating room is required [22].

Moreover, Byrne JG et al. also emphasize the fastest possible transfer of the patient from the catheterization laboratory to the operating room to reduce complications [21] .

In contrast to the above studies, Ranucci M et al. showed that the shorter the interval between the two procedures, the greater the risk of acute kidney injury, which at the same time in our study did not differ significantly between the study groups [23].

Analysis of quality of life in our study showed that the groups did not differ according to the SF-36 questionnaire, with the exception of the pain index in 6 months, which was most likely due to additional traumatization of the lower extremities during the venous grafts harvesting. Thus, as shown by the results of the survey, more than 8% had pain at the site of harvesting in 6 months after coronary artery bypass grafting.

LIMITATIONS OF THE STUDY

This study is retrospective and single-center with a relatively small number of patients, so it is subject to bias. Surgical interventions were performed by different cardiac surgical teams, which may also affect the results of the study. Also, there are no baseline results of patients' quality of life in the study, which is due to its retrospective nature.

CONCLUSIONS

Patients treated with the hybrid method had significantly lower duration of aortic cross-clamping and cardiopulmonary bypass during surgery, lower rate of blood loss in the early postoperative period, and a better pain index score in 6 months after the hybrid intervention compared to the surgery-only group.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Stepan Maruniak
Shupyk National Healthcare University of Ukraine
9A Dorohozhytska St., 20017 Kyiv, Ukraine
e-mail: maruniak.stepan@gmail.com

ORCID AND CONTRIBUTIONSHIP
Kostiantyn Boyko: 0000-0003-2468-3224 A D
Borys Todurov: 0009-0000-2047-4447 E F
Andrii Khokhlov: 0000-0003-1688-0500 A B
Serhii Sudakevych: 0000-0002-9253-9593 C F
Nataliia Yashchenko: 0000-0002-3421-8580 C E
Ihor Kuzmich: 0000-0002-8646-7271 B E
Stepan Maruniak: 0000-0001-7538-2443 C E

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

The beneficial impact of interval training on cardiorespiratory fitness in patients after myocardial infarction and Covid-19 undergoing early cardiac rehabilitation

Iwona Korzeniowska-Kubacka[1], Krzysztof Sadowski[1], Ewa Rydzewska[1], Edyta Smolis-Bąk[1], Ilona Kowalik[2], Rafał Dąbrowski[1]

[1]DEPARTMENT OF CORONARY ARTERY DISEASE AND CARDIAC REHABILITATION, NATIONAL INSTITUTE OF CARDIOLOGY, WARSAW, POLAND

[2]CLINICAL RESEARCH SUPPORT CENTER, NATIONAL INSTITUTE OF CARDIOLOGY, WARSAW, POLAND

ABSTRACT

Aim: Patients referred for cardiac rehabilitation after myocardial infarction (MI) often had a Covid-19 infection. To date, there is no evidence-based guidelines of cardiac rehabilitation in this group. The aim of the study was to assess cardiorespiratory fitness using the cardiopulmonary exercise test (CPET) in patients after MI and Covid-19 infection undergoing interval trainings(IT).

Materials and Methods: 30 patients mean age: 55.4±12.2 years, after MI and Covid-19 infection up to 6 months before MI were included in the study (SG, study group). The control group (CG) consisted of 30 men without a history of Covid-19. All subjects completed a series of 24 IT on a cycloergometer and 30 minutes of breathing exercises after the IT.CPET was performed before and after rehabilitation.

Results: After rehabilitation, a significant increase in the following parameters based on CPET was achieved in the SG –peak oxygen consumption(pVO2) 20.3±4.8 vs. 23.4±4.6 ml/kg/min, p<0.001; oxygen pulse: 13.3±3.4 vs. 14.4±3.4 ml/beat, p<0.001; respiratory exchange ratio(RER) 1.12±0.1 vs. 1.26±0.1, p<0.01;minute ventilaton(VE) 56.4±19 vs. 71.2±21.9 l/min, p<0.001;max voluntary ventilation(MVV) 106.3±37.0 vs. 118.0±28.2 l, p=0.02. The percentage of patients with severe and moderate symptoms of cardiorespiratory insufficiency was significantly reduced, respectively: 16.7% vs. 6.7% and 46.7% vs. 26.7%, p<0.01.The percentage of patients with mildly reduced performance increased: 16.7% vs. 46.7%, p<0.05. Patients from the CG had good physical performance at the beginning, which did not significantly improve after rehabilitation.

Conclusions: Interval trainings and breathing exercises were safe and significantly improved the cardiorespiratory fitness of patients with a history of myocardial infarction and Covid-19 infection.

KEY WORDS: Covid-19, myocardial infarction, interval training, cardiorespiratory fitness

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INTRODUCTION

Due to Covid-19 (Coronavirus disease – 19) pandemic patients after myocardial infarction (MI) who also had Covid-19 infection are referred for cardiac rehabilitation. So far, there are no evidence-based rehabilitation methods for returning to physical activity after Covid-19 and a subsequent MI**.** An individual approach and personalized exercise load are recommended [1, 2].

The main pathophysiological mechanisms of cardiovascular complications caused by SARS-CoV_2 virus infection and subsequent inflammatory reactions include: impairment of endothelial function, damage to cardiomyocyte function and coagulation disorders increasing the risk of thrombotic complications, resulting in thromboembolic episodes and heart failure [3]. It is believed that physical training is a kind of biological medicine that, when properly dosed, can prevent and reverse the effects of these complications [4].

Such opportunities are created by interval training, which is a form of endurance training. A cardiac rehabilitation program based on interval training is a recognized method of improving physical performance in patients with ischemic heart disease [5,6,7]. Training loads can be adjusted in terms of intensity, frequency and speed of execution also in patients after Covid-19 [8]. The basic factor determining the body's endurance to perform specific efforts at the desired intensity for a long time, is physical performance determined by the maximal oxygen uptake (VO_2 max). The higher the VO_2 max value. The higher percentage of this value, the greater human body's ability to absorb oxygen.

It is believed that cardiopulmonary exercise testing (CPET) is the best tool for assessing cardiorespiratory fitness also in patients after Covid-19 [9]. CPET is also used, among others, for qualifying patients with cardiovascular diseases for cardiac rehabilitation and assessing the performance of patients with heart failure. So far, there is a lack of research on specific rehabilitation models in patients after Covid-19 and MI.

AIM

The aim of the study was to assess cardiorespiratory fitness based on the cardiopulmonary exercise testing

in patients after Covid-19 and myocardial infarction who underwent cyclic interval training.

MATERIALS AND METHODS

The prospective, observational, single-center study included 60 patients after MI referred for cardiac rehabilitation at the Outpatient Rehabilitation Center of our hospital in the period: Jan 01, 2022 – June 30, 2023. The inclusion criteria in the study group were: expressing informed consent to participation in the study, history of Covid-19 infection (without hospitalization) <6 months and MI <3 months before enrolment in the study, and the ability to perform planned physical training. Criteria for inclusion in the control group: informed consent to participate in the study, history of myocardial infarction <3 months before inclusion in the study, and the ability to perform planned physical training. Exclusion criteria: systemic diseases, and diseases that prevent training (e.g. neurological diseases, diseases of the musculoskeletal system).

The subjects were divided into 2 groups. 1.Study group (SG) – patients who had a mild or moderate Covid-19 infection before the MI , not requiring hospitalization in the period up to 6 months before entering the study. 2.Control group (CG) – patients after MI without a history of Covid-19. All subjects completed a series of 24 interval training sessions on a cycle ergometer three times a week and 20 minutes of breathing exercises after the interval training. Before starting and after completing the training cycle, CPET was performed on a treadmill. Training intensity was determined based on CPET results using the first (V1) and second (V2) ventilatory threshold. The thresholds were extrapolated to the appropriate heart rate and used to establish the training heart rate limit. Selected parameters of circulatory system performance and function were assessed: peak oxygen consumption (pVO_2, ml/kg/min), oxygen consumption at the anaerobic threshold (AT) VO_2 in AT (ml/kg/min), oxygen pulse VO_2/HR (ml/ beat), respiratory exchange ratio (RER, VCO_2/VO_2), metabolic equivalent (MET), duration (min), heart rate (x/min), arterial pressure (mm Hg) and ventilation parameters: maximum voluntary ventilation (MVV, L), minute ventilation (VE, L/min), respiratory reserve (BR, L), ventilation efficiency (VE/VCO_2 slope). During training, the saturation level was checked using a pulse oximeter. This study was approved by local Ethics Committee at the National Institute of Cardiology in Warsaw (IK.NPIA.1956/22, March 2022 and adhered Helsinki Declaration as revised in 2013.

STATISTICAL ANALYSIS

All analyses were performed using SAS version 9.4 (SAS Institute NA, USA). Numerical variables were summarized as mean ±SD or median and interquartile range (25th to 75th percentile: Q1, Q3). Shapiro-Wilk test was applied to verify the normality of data. Categorical variables were reported as counts and percentages. The student's T-test or Mann-Whitney test for continuous data and the chi-square Pearson's test or Fisher's exact test for categorical data were used to compare baseline characteristics between groups. A comparison of changes in CPET results were performed by one-way analysis of variance adjusting for baseline level of measure and left ventricular ejection fraction (LVEF). The results for this analysis are presented as means with 95% confidence interval [95% CI]. Pearson's or Spearman correlation coefficient assuming a linear regression was calculated to investigate the associations between changes in CPET measurement and selected features (including training loads). Paired Student's t-test, Wilcoxon test and symmetry tests were used to assess changes occurring as a result of rehabilitation in the Covid-19 group. We performed multiple linear regression to examine the relationships between change in peak VO_2 and other features. To identify independent predictors, all candidate variables were considered, and backward stepwise elimination (significance level of stay in the model: p=0.01) was applied to arrive at the parsimonious model. All tests were two-sided. The p-value of 0.05 was the threshold used in determining the level of significance.

RESULTS

The analysis included 60 patients after MI referred to cardiac rehabilitation at the Outpatient Rehabilitation Center, 30 patients in the study and 30 in control groups. Patients from the study group had 14 STEMI infarctions (ST-elevation myocardial infarction) and 16 NSTEMI (Non-ST-elevation myocardial infarction) infarctions; patients from the control group: 16 STEMI and 14 NSTEMI, ns. The demographic and clinical characteristics of the study subjects are presented in Table 1. Patients from both groups did not differ in terms of age and cardiovascular risk factors.

Patients from the study group after Covid-19 presented significantly worse physical performance assessed on the basis of the CPET initial test and worse left ventricular function (LVEF) assessed by echocardiography. Moreover, patients from the study group started interval training significantly later, after the infarction (39 vs. 21 days, p<0.001). Exercise tolerance during trainings was normal. Maximum training load increased from 59.8±14.9 watts in the first training, to 76.3±22.3 watts in the 24th training, p<0.001. Saturation in the study group was normal and ranged from 96-100%. After rehabilitation, patients from the study group significantly improved their cardiorespiratory fitness based on CPET parameters. A significant increase in oxygen consumption at peak exercise was achieved by 3.1 ml/kg/min, p<0.001, and in the anaerobic threshold by 3.0 ml/kg/min, oxygen pulse by 1.1 ml/beat, p<0.001, in respiratory exchange ratio (RER) by 0.08, p<0.01 and in metabolic equivalent by 0.87 MET, p<0.01. Ventilation parameters also improved: minute ventilation by 14.8 l/min, p<0.001, maximum voluntary ventilation by 11.7 l, p<0.05 and expiratory volume in one second by 9.7%, p=0.02 (Table 2).

A significant improvement in physical performance assessed as a percentage of predicted VO_2 max was demonstrated. The percentage of patients with severely and moderately reduced capacity decreased significantly, and the percentage of patients with mildly reduced capacity increased (Fig. 1).

Table 1. Demographic and clinical characteristics of study groups.

	Covid-19 group	Control group	p
Time since infection to rehabilitation (days)	81 [60 – 150]	Not concern	
Age (years)	55.4 ± 12.2	55.5 ± 7.2	0.969
BMI (kg/m^2)	27.6 ± 5.1	27.9 ± 3.1	0.886
Hypertension (n,%)	19 (63.3)	21 (70.0)	0.584
Diabetes mellitus type 2 (n,%)	5 (16.7)	3 (10.0)	0.706
Dyslipidemia (n,%)	22 (73.3)	23 (76.7)	0.766
Smoking (n,%)	10 (33.3)	13 (43.3)	0.426
LV EF (%)	53.6 ± 7.6	58.9 ± 7.8	0.011
Time since MI to rehabilitation (days)	39 [26 – 92]	21 [16 – 30]	<0.001
Duration (min)	8.12 ± 3.17	11.98 ± 1.99	<0.001
Metabolic equivalent (MET)	5.95 ± 1.67	7.16 ± 1.32	0.003
Peak VO_2 (ml/kg/min)	20.3 ± 4.8	26.1 ± 3.8	<0.001
HR rest (x/min)	71.7 ± 10.0	67.6 ± 9.9	0.120
HR peak (x/min)	127.0 ± 20.3	121.5 ± 14.3	0.224
BP syst.rest (mm Hg)	127.1 ± 14.9	121.2 ± 13.7	0.116
BP diast.rest (mm Hg)	82.3 ± 8,8	77.5 ± 6.1	0.017
BP syst.peak (mm Hg)	177.7 ± 28.5	169.7 ±26.9	0.264
BP diast.peak (mm Hg)	85.0 ± 12.3	87.8 ± 8.8	0.308

Abbreviations: BMI – body mass index, MI- myocardial infarction; LVEF – left ventricular ejection fraction; HR- heart rate; BP- blood pressure; peak VO_2 – peak oxygen consumption

Table 2. Comparison of selected cardiorespiratory parameters based on the CPET exercise test before and after rehabilitation in the study group after Covid-19 and MI.

	Before rehabilitation	After rehabilitation	
Duration (min)	8.12 ± 3.17	8.95 ± 2.91	0.101
Metabolic equivalent (MET)	5.95 ± 1.67	6.82 ± 2.47	0.001
Peak VO_2 (ml/kg/min)	20.3 ± 4.8	23.4 ± 4.6	<0.001
% Max VO_2 predicted	70.8 ± 23,0	81.9 ± 20.4	<0.001
VO_2 in AT (ml/kg/min)	13.3±3.4	16.3±4.2	<0.001
VE (l/min)	56.4 ± 19.0	71.2 ± 21.9	<0.001
HR rest (x/min)	71.7 ± 10.0	73.5 ± 13.6	0.423
HR peak (x/min)	127.0 ± 20.3	139.0 ± 17.4	<0.001
HR in AT (x/min)	97.1 ± 12.6	102.2 ± 13.2	0.014
BP syst.rest (mmHg)	127.1 ± 14.9	127.0 ± 14.8	0.979
RR diast.rest_(mmHg)	82.3 ± 8.8	82.5 ± 10.2	0.928
BP syst.peak (mmHg)	177.7 ± 28.5	178.3 ±29.2	0.921
RR diast.peak (mmHg)	85.0 ± 12.3	86.7 ± 17.7	0.629
RER	1.12 ± 0.15	1.20 ± 0.14	0.009
Pulse O_2 (VO_2/HR ml/beat) % pulse O_2	13.3 ± 3.4 87.6 ± 19.4	14.4±3.4 95.9 ± 17.5	<0.001 0.009
VE/VCO2 slope	26.0 ± 5.5	28.1 ± 6.1	0.286
FEV1(l)	2.66 ± 0.93	2.95 ± 0.71	0.020
FEV1 (%)	81.9 ± 24.3	91.6 ± 18.4	0.010
MVV(l)	106.3 ± 37.0	118.0 ± 28.2	0.020
BR (l)	50.4 ± 19.0	46.9 ± 25.3	0.424

Abbreviations: MET – metabolic equivalent, peak VO_2 – peak oxygen consumption, AT – anaerobic threshold; VE – ventilation; HR – heart rate; BP – blood pressure; RER – respiratory exchange ratio; FEV1 – forced expiratory volume in 1 second; MVV- maximum voluntary ventilation; BR – breathing reserve

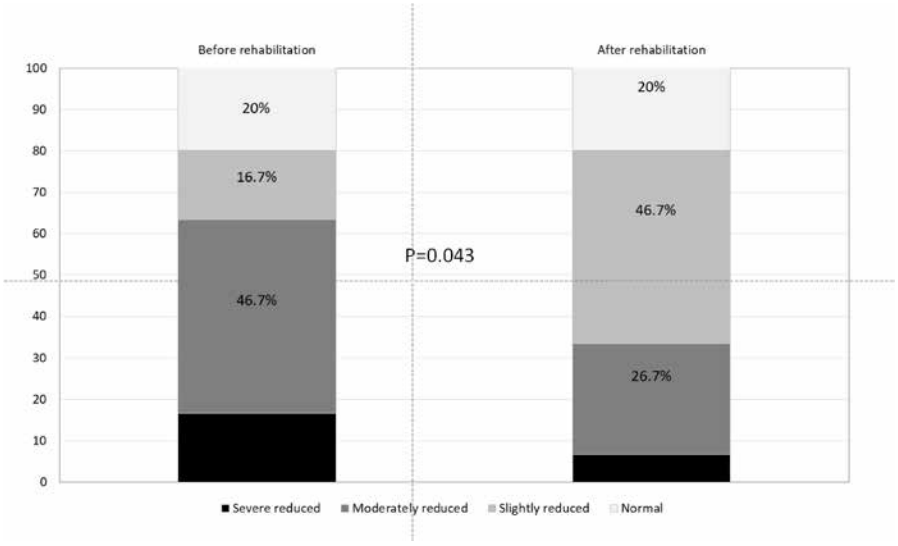

Fig. 1. Classification of physical capacity assessed as a percentage of predicted VO_2 max in the study group after MI and Covid-19. *p<0.05. (VO_2 – peak oxygen consumption).

Table 3. Comparison of changes after rehabilitation using covariance method corrected for the baseline measurement in both group.

After rehabilitation	Covid group Mean[95% CI]	Control group Mean[95% CI]	Delta Mean[95% CI]	p
Duration (min)	-0.3 [-1.1 ; 0.5]	2.3 [1.5 ; 3.0]	-2.6 [-3.8; -1.3]	<0.001
MET	0.7 [-0.1 ;1.4]	0.8 [0.1 ; 1.5]	-0.1 [-1.2 ; 1.0]	0.818
% Max VO_2 predicted	15.1 [8.0 ; 22.2]	6.2 [-0.4 ; 12.9]	8.9 [-1.2 ; 18.9]	0.083
Peak VO2 (ml/kg/min)	2.8 [1.8 ; 3.9]	0.8 [-0.2 ; 1.8]	2.0 [0.5 ; 3.6]	0.012
HR rest (x/min)	3.4 [-0.5; 7.4]	-2.1 [-6.0 ; 1.7]	5.5 [-0.2 ; 11.3]	0.057
HR peak (x/min)	14.5 [10.6 ;18.3]	2.5 [-1.2 ; 6.2]	12.0 [6.4;17.6]	<0.001
HRR 1' min.	8.7 [4.1 ; 13.3]	6.9 [2.4 ; 11.3]	1.8 [-4.8 ; 8.5]	0.579
HRR 2' min.	8.1 [4.4 ; 11.8]	2.2 [-1.4 ; 5.9]	5.9 [0.5 ; 1.3]	0.033
BP syst.rest (mmHg)	0.6 [-4.0 ; 5,2]	-0.9 [-5.3 ; 3.5]	1.5 [-5.1 ; 8.1]	0.656
BP diast.rest (mmHg)	1.6 [-1,8 ; 5.0]	-1.6 [-4,8 ; 1.6]	3.2 [-1.7 ; 8.2]	0.196
BP syst.peak (mm Hg)	2.5 [-7.3 ; 12.3]	3.8 [-5.7 ; 13.2]	-1.3 [-15.4 ; 12.8]	0.852
BP diast.peak(mm Hg)	1.8 [-3.4 ; 7.0]	1.6 [-3.4 ; 6.6]	0.2 [-7.2 ; 7.6]	0.957

Abbreviations: MET – metabolic equivalent, peak VO_2 – peak oxygen consumption, HR- heart rate; HRR – heart rate recovery, BP- blood pressure

Patients from the control group had good physical performance at the beginning, which did not change significantly after rehabilitation (pVO_2: 26.1±3.8 *vs.* 26.5±4.3 ml/kg/min), p=NS. After series of trainings, these patients still had significantly better physical performance compared to patients after Covid-19. However, comparison of changes in both groups using the covariance method, adjusted for the baseline measurement and ejection fraction, showed a significantly greater improvement in pVO_2, exercise HR and Heart Rate Recovery (HRR) 2 minutes after the CPET in the study group (Table 3).

Based on multivariate analysis using multivariate regression method, it was shown that the improvement of physical capacity pVO_2 depended on the initial pVO_2. The worse the physical performance before rehabilitation, the higher pVO_2 they achieved after rehabilitation (β±SE: -0.30±0.09, p<0.01). Improvement in physical performance also depended on training intensity. The more intense the training, the greater the increase in pVO_2 obtained during the CPET exercise test at the end of rehabilitation (β±SE: 0.08±0.04, p<0.05). Moreover, a subgroup of smokers achieved poorer improvement in peak oxygen consumption: pVO_2 (β±SE: -1.4±0.9, p=0.06) after completion of rehabilitation. However, the increase in physical performance due to rehabilitation did not depend on the time from Covid-19 infection to the start of training (r=0.11, p=0.55).

DISCUSSION

The advantages of the work are the homogeneous nature of the study groups and uniform evaluation

conditions – the planned training program and study conditions, as well as the use of a control group. The main conclusion of the current work is that interval training is an effective and safe form of cardiac rehabilitation for patients after Covid-19 infection and MI**,** especially for those with severe and moderate degrees of reduced physical capacity measured by peak oxygen consumption – pVO_2. After a series of 24 training sessions as part of outpatient rehabilitation, patients significantly improved their physical performance measured on the basis of CPET. Improvement in physical performance depended on baseline pVO_2. The worse the physical performance before rehabilitation, the higher the peak oxygen uptake (pVO_2) after rehabilitation. Under the influence of training, the percentage of patients with severely and moderately reduced physical capacity decreased significantly, and the percentage of patients with mildly reduced physical capacity increased significantly.

The benefits of comprehensive cardiac rehabilitation and supervised exercise training in patients after myocardial infarction are well documented [7, 10-12]. On the other hand, reduced physical capacity is the most common symptom in most people after Covid-19 infection, including patients with concomitant heart diseases, which further worsens their condition. There is a need to develop rehabilitation models dedicated to these patients. In one of the studies, 553 people with impaired functions of the circulatory, respiratory, nervous and musculoskeletal systems after Covid-19 underwent rehabilitation. The rehabilitation program also included interval trainings and breathing exercises. After rehabilitation, the patients showed improved performance measured by walking distance in the 6-minute walk test (6MWT). Similarly to our study, the lower the physical capacity at the beginning, the greater the increase in capacity at the end of rehabilitation. Moreover, no desaturation was observed in any patient, and the mean SpO_2 value (97.35) was comparable to the values obtained in our study [13]. Interval training involves dividing the basic work into smaller parts performed repeatedly with appropriate breaks, at an intensity or load greater than that which can be performed during one training session. Breaks are selected so as not to allow for complete rest. Therefore, each subsequent work interval is performed with symptoms of slight fatigue. Patients tolerated the efforts during interval training well. The maximum training load increased significantly from the first to the 24th training session. The more intense the training, the greater the pVO_2 increase during the exercise test at the end of rehabilitation. Similar results were presented in a meta-analysis in the group of patients with ischemic disease and heart failure [14].

Many studies to date have shown that interval training is more beneficial for patients with cardiovascular diseases, especially those with impaired left ventricular function [15]. The main symptoms identified by patients after Covid-19 infections are fatigue, shortness of breath and reduced exercise tolerance. In published reports, these symptoms occurred in 58% of subjects and even in 96.1% of patients [16, 17]. The reasons for this phenomenon are not fully understood. Szekely et al. evaluated 71 patients after Covid-19 infections based on CPET and stress echo, but without MI. In the group after Covid-19, pVO_2 values were significantly lower, which was also confirmed in our study. The authors stated that the reason for this reduction could be a combination of chronotropic insufficiency and insufficient increase in stroke volume during exercise, which are observed in patients after Covid-19 infections [18]. In the study by Clavario et al., 225 patients were examined 3 months after the infection. It was found that reduced physical performance measured by pVO_2 could be related to abnormal oxygen extraction caused by damage to skeletal muscles by the SARS-CoV_2 virus. In addition to the increase in pVO_2, after interval training, there was also a significant increase in other parameters of cardiovascular performance and function, such as oxygen pulse and respiratory exchange ratio (RER). The respiratory reserve and the efficiency of gas exchange in the lungs were normal and after rehabilitation these parameters did not change, which was also confirmed in other studies [19, 20]. In the current study, patients without a history of Covid-19 had good physical performance before rehabilitation, which did not significantly improve following rehabilitation. Bolatbekov et al. provided cardiac rehabilitation to patients after MI divided into groups with and without Covid-19. Both groups presented reduced exercise tolerance before rehabilitation (pVO_2, 12.4 and 12.6 mL/kg/min, respectively) [21].

After rehabilitation, exercise capacity increased significantly in both groups, which confirms our observations that patients with reduced physical fitness achieve the greatest benefits from rehabilitation [21]. The subject of our study were patients with a history of infection up to 6 months, i.e.relatively recently. The average time to start exercising was 81 days and the increase in physical performance resulting from rehabilitation did not depend on the time from the onset of Covid-19 infection to the start of training, which was also confirmed in another study [13]. So far, no recommendations have been presented regarding the time to begin rehabilitation in patients with cardiovascular diseases after Covid-19 infection. It is considered appropriate to start rehabilitation from the 4th week after Covid-19, taking into account possible cardiovascular complications during the infection. In confirmed cases of myocarditis, it is recommended to avoid exercise for up to 6 months, pericarditis – up to 6 weeks from the acute phase, and in the case of unstable heart failure or severe ventricular arrhythmias, rehabilitation should be postponed [22]. According to the Delphi EAPC (European Society of Preventive Cardiology) consensus, it was agreed that ensuring cardiac rehabilitation after the pandemic is crucial for all patients with cardiovascular diseases, regardless of the history of Covid-19 infection. The basic elements of rehabilitation should remain the same as before the pandemic, including providing education and prevention regarding Covid-19 infection in those who have not had the infection and regarding cardiovascular complications in those who have had the infection [23,24]. To sum up, the research results presented so far, prove the benefits of personalized rehabilitation, including interval

training, in patients after MI and Covid-19, especially with severe and moderate degrees of reduced physical capacity. This procedure should be an important element of the treatment of these patients.

LIMITATIONS

The limitations of the project are the small sizes of the study groups and the single-center design of the study.

CONCLUSIONS

Interval training and breathing exercises significantly improved the cardiorespiratory fitness of patients after Covid-19 and MI. The greatest benefits were achieved by patients with severe and moderate decline in physical performance. The improvement in physical performance did not depend on the time of onset of Covid-19 until the start of training. Interval training was a safe and effective form of physical rehabilitation.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Iwona Korzeniowska-Kubacka
Coronary Artery Disease and Cardiac Rehabilitation Department
National Institute of Cardiology
Alpejska 42, 04-628, Warszawa, Poland
e-mail: drkubacka@wp.pl

ORCID AND CONTRIBUTIOSHIP
Iwona Korzeniowska-Kubacka: 0000-0001-5343-8418 A B C D
Krzysztof Sadowski: 0000-0002-1472-9842 B C
Ewa Rydzewska: 0000-0002-5185-233X B
Edyta Smolis-Bąk: 0000-0002-8706-4247 A B C
Ilona Kowalik: 0000-0002-8040-5109 A C
Rafał Dąbrowski: 0000-0002-5602-0313 E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Histostructure of bone tissue after restoration of blood flow in patients with ischemic form of diabetic foot syndrome

Tamara I. Tamm, Valentyn V. Nepomniashchyi, Sergey B. Pavlov, Ivan M. Mamontov, Olena A. Shakalova, Olga B. Litvinova

KHARKIV NATIONAL MEDICAL UNIVERSITY, KHARKIV, UKRAINE

ABSTRACT

Aim: To study the histostructure of bone tissue in case of disruption of its blood supply and after restored blood flow in patients with ischemic form of diabetic foot syndrome.

Materials and Methods: The histostructure of bone fragments in 25 patients with isolated ischemic form of diabetic foot syndrome was studied. Bone tissue biopsy specimens from 6 patients against the background of progressive ischemia were studied. In addition, the histostructure of bone tissue after revascularization with complete restoration of blood flow in 19 patients was studied.

Results: The analysis of bone tissue biopsy specimens showed that disruption of blood supply of the limb tissues for a long time leads to impaired matrix calcification, decreased cortex thickness, widening of osteon channels and sparse trabecular network in the bone structure**.** Such changes were the signs of bone resorption that was not clinically or radiologically apparent. Revascularization with full restoration of blood flow promoted the appearance of signs of bone tissue regeneration in the form of vessel formation in bone and periosteum.

Conclusions: Adequate blood flow is an important clinical factor contributing to the restoration of bone regeneration in patients with ischemic form of diabetic foot syndrome.

KEY WORDS: diabetic foot syndrome; ischemia; revascularization; histostructure of bone

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INTRODUCTION

Lower extremity vasculopathy is an independent risk factor for the development of diabetic foot syndrome (DFS). It can lead not only to delayed wound healing but also directly to tissue ischemia and necrosis [1]. Several studies have reported five-year mortality rates as high as 50% for patients with diabetic foot complicated by lower extremity vasculopathy [2].

Reduced arterial blood supply in the lower extremities for a long time leads to changes in the trophicity of soft tissues and a decrease in their resistance to infection. As a rule, a purulent focus that develops in soft tissues does not have clear boundaries, and its depth can reach bone structures, involving them in the pathological process.

The indication for surgery in patients with DFS in such cases is the presence of purulent-necrotic processes on the foot. The choice of the volume of surgical intervention is influenced not only by the depth of soft tissue lesions but also by the involvement of bone structures in the inflammatory process. As a rule, changes in the structure of bone tissue, confirmed by radiological diagnostic methods, are an indication for performing "carrying away" surgical interventions, i.e. amputation at various levels.

The literature widely covers the pathomorphological changes occurring in bones in osteoarthropathy and osteomyelitis, that is, in those diseases when the pathological process is localized directly in the bone [3, 4].

The data on the state of bone structure with impaired blood flow in patients with DFS over the last 10 years in the literature are contradictory. The authors mainly try to explain the disorders of bone structure and its blood supply by the type of diabetes mellitus (DM).

In our previous work, we studied the state of bone tissue histostructure depending on the DFS form. The study was performed in patients with mixed forms of DFS when the blood flow disorder was incomplete and the blood supply of tissues was partially preserved. At the same time, patients with the mixed form had purulent foci on the foot, which could also affect the bone histostructure [5]. No data on how bone morphology changes under the influence of progressive ischemia and after restoration of blood flow without the presence of purulent focus were found in the literature. The classic model of progressive reduction of blood flow in soft and bone tissues is the isolated ischemic DFS form in patients with DM.

AIM

The work aimed to study the histostructure of bone tissue in patients with ischemic DFS when its blood supply is disrupted and after the blood flow is restored.

MATERIALS AND METHODS

The treatment results of 3200 patients with DFS in the "Diabetic Foot" department of the municipal non-commercial enterprise "City Clinical Hospital No. 2 named after prof. A.A. Shalimov" were analyzed. Isolated ischemic DFS form was found in 25 (0,78%) patients who were included in the study.

Inclusion criteria: patients with isolated ischemic DFS form; absence of clinical manifestations of soft tissue infection; type 2 DM. Exclusion criteria: patients with isolated neuropathic and mixed DFS form; presence of purulent-inflammatory processes on the foot; type 1 DM.

Examination and treatment were based on the recommendations of the International Consensus on the treatment of patients with diabetic foot syndrome (2015) [6] and "Unified clinical protocol of primary and secondary medical care. Type 2 diabetes mellitus", approved by the order of the Ministry of Health of Ukraine No. 1118 dated 12/21/2012 [7]. The classification by clinical forms adopted at the First International Symposium on the Diabetic Foot in the Netherlands (1991) was used, where the concept of DFS included the presence of purulent-necrotic changes of tissues on the foot only up to the ankle joint level [8]. This research was approved by the Ethics and Bioethics Committee of Kharkiv Medical Academy of Postgraduate Education. The research was conducted by the fundamental principles outlined in the «Rules of Ethical Principles for Conducting Medical Research Involving Human Subjects», as stated in the Helsinki Declaration (1964-2013) [9]. All participants in the study were informed about the goals and methods of the research and provided written consent to participate. The confidentiality of individual patients was protected, and no personal information, such as medical card numbers, was included in the dataset. All subjects described in the study remained anonymous.

The diagnosis of ischemic DFS was made based on the exclusion of innervation disorders (sensory, motor, autonomic) and the identification of circulatory disorders (weakening or absence of the pulse in the foot arteries and the hamstring artery), as confirmed by clinical and instrumental research methods. The data on patients' age, gender, DM compensation, and severity are presented in Table 1.

The mandatory examination, in addition to sensory impairment, included radiography of the foot. The ankle-brachial index (ABI) was studied using Doppler data [10]. An ABI decrease below 0,9 (0,8 and below) is suggestive for an ischemic form of DFS. Dopplerography of the main vessels was performed using ultrasound duplex scanning with color mapping on the Sonoline Elegra device from Siemens (Germany). A 4 MHz ultrasound transducer was used to visualize the femoral and popliteal arteries, and a frequency of 8 MHz was used for the posterior tibial artery, anterior tibial artery, and dorsalis pedis artery. The transducer was installed in the projection of the artery at the point of maximum pulsation at an angle of 45° to the skin surface and was moved along the artery during the study. During this, ultrasound Doppler parameters of blood flow velocity signal, sound signal analysis, and segmental arterial pressure measurements were recorded to determine the type of blood flow.

Changes in tissue partial oxygen tension (pO_2) were determined at the back of the foot using a TCM4 oxygen monitor (Radiometer, Denmark). A pO_2 decrease to 30 mm Hg indicates significant ischemia. In practical work, we used the classification of the University of Texas [11], which takes into account these indicators and most fully reflects the nature and degree of tissue ischemia. Lower extremity perfusion was assessed according to the criteria proposed by the TASC working group [12]. Neurological status was assessed according to the standard (Order of the Ministry of Health of Ukraine No. 574 dated 08/05/2009) [13]. To exclude foot neuropathy, peripheral sensory-motor innervation was investigated using the "Neuropathy Disability Score" scale, which included a score of pain, temperature, tactile and vibration sensitivity disorders, as well as tendon reflexes examined [14].

The study included 25 patients with DFS and the absence of clinical manifestations of soft tissue infection on the foot. The degree of blood supply disorder according to the proposed classification in 4 (6 %) patients was in the form of superficial soft tissue lesions (1A), in 1 (4 %) patient the interphalangeal joint was involved (2A), and in 20 (80 %) patients there was 1C form of the lesion. In all cases, there were no clinical manifestations of purulent infection.

Table 1. The data on patients' age, gender, DM compensation, and severity

Characteristics		N	%
Age (WHO, 1963), years*	44–60	7	28
	61–75	18	72
Gender	Male	9	36
	Female	16	64
DM compensation	Subcompensated	23	94
	Decompensated	2	6
DM Severity	Moderate	9	36
	Severe	16	64

Note: mean age (mean ± standard deviation) 60 ± 4,1 years.

Of the 25 patients, 19 (76%) underwent blood flow restoration through revascularization: balloon angioplasty was performed in 17 (68%), and bypass surgery in 2 (8%). Vascular surgery was refused in 6 (24 %) patients. Surgical interventions involving necrectomy with resection of the phalanges of the fingers were performed in 19 patients who underwent revascularization. The indication for the surgery was formed necrotic foci on the foot without clinical manifestations of infection (dry gangrene). In 6 patients without revascularization, the volume of the surgery consisted of resection of the forefoot. Bone tissue biopsies were taken from the area that clinically and radiologically did not have signs of osteomyelitis, however, in these areas (phalanges of the fingers), there was dry necrosis of soft tissues. Surgical interventions in the form of amputation of the fingers on the foot were performed on the 7th to 8th day after the restoration of blood flow. Histological examination of bone biopsies was performed in all patients who underwent revascularization. The results were compared with bone tissue biopsies of patients who refused revascularization.

The removed bone fragments were fixed in 10 % neutral formalin solution, decalcified in 10% nitric acid solution, dehydrated in alcohols of increasing concentration, and then in alcohol with chloroform, chloroform, and paraffin. The 10 μm thick sections were stained with hematoxylin-eosin and van Gieson's picrofuchsin. The preparations were examined in the view field of the PrimoStar microscope (Zeiss, Germany). Photographs of preparations were taken using a digital camera.

RESULTS

The degree of blood flow disturbance in the lower extremities was assessed by the determination methods of ABI and oxygen tension in tissues, as well as by Doppler ultrasound. Table 2 shows the values of ABI in patients with ischemic DFS form.

The Table 2 shows that 24 (97%) had an ABI of 0,8 or lower, which is a sign of ischemic form with marked impairment of blood flow.

Table 3 presents data reflecting the blood flow the extremities in the studied patients.

The table shows that the main blood flow was preserved in only 36 % of cases, and collateral blood flow developed in 64 %. The determination of the type of blood flow was the basis for the indications for different types of revascularization.

The degree of tissue ischemia, including bone ischemia, on the affected limb, was determined using pO_2 in the foot tissues (Table 4).

The Table 4 shows that in 97 % the pO_2 was below 60 mmHg, corresponding to stages II and III of the TASC classification, as proposed for assessing tissue perfusion [12].

Overall, it is clear from the studies that changes in bone structure before and after revascularization can only be attributed to changes in blood flow in the foot.

Intraoperative sampling of bone tissue biopsy specimens was performed from the macroscopically unchanged bone area, showing no signs of destruction on radiographs. Histological examination of surgical material samples from 6 patients without revascularization revealed pronounced

Table 2. ABI values in the studied patients (n=25)

ABI value	N	%
0,9	1	3
0,9-0,8	14	57
<0,8	10	40

Table 3. The types of blood flow in the studied patients (n=25)

Type of blood flow	N	%
Altered main blood flow	9	36
Collateral high-velocity	9	35
Collateral low-velocity	7	29

Table 4. The pO_2 in the studied patients (n=25)

pO_2, mmHg	N	%
>60	1	3
60-30	22	87
<30	2	10

changes in histoarchitectonics in the fragments of the removed metaphyses.

Osteons of different diameters were found in the compact bone substance of the cortex and diaphysis fragments. The central canals of osteons were dilated and their walls were sharply basophilic. In the lumen of the majority of central channels thrombi, vessels with erythrostasis or desolation were noted. A significant part of lacunae was empty or contained osteocytes with pycnotic nuclei, with signs of karyo- and plasmolysis.

Mosaic coloration of the matrix and microcracks were noted (Fig. 1).

The metaphyses cancellous bone tissue was also characterized by destructive changes. Trabeculae did not form a characteristic network, did not connect with each other and with the cortex, and often had blind ends. In the intertrabecular space, there was yellow bone marrow, fibrin deposits, and a few vessels with signs of erythrostasis. Bone beams were of varying thickness and shape, with irregular contours, areas without cells, and empty lacunae. The matrix was unevenly colored, cement lines were sharply basophilic, chaotic, and stratified. Osteon and fragmentary structures and microfractures were noted in part of the trabeculae (Fig. 2).

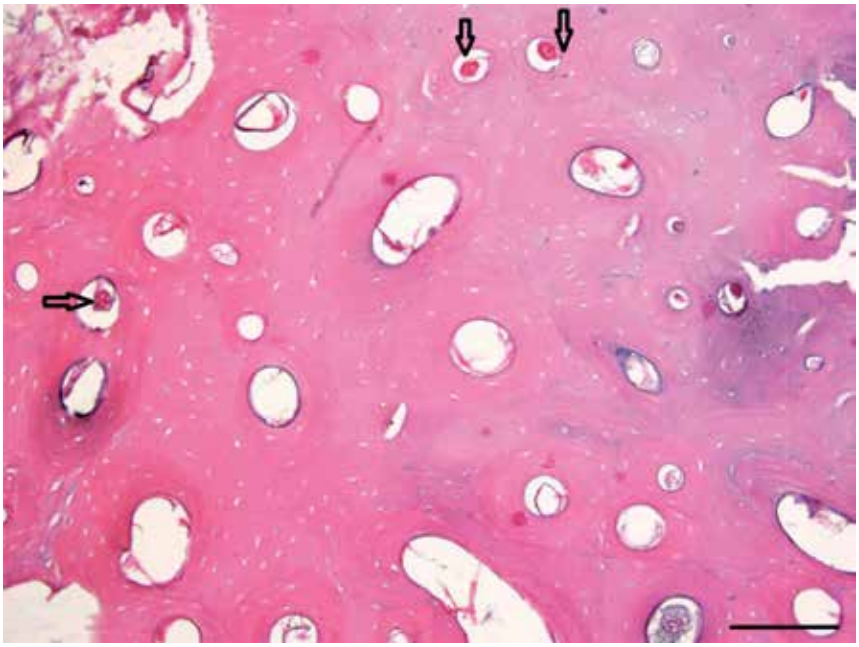

Fig. 1. Fragment of the patient's diaphysis without revascularization. The compact bone substance with signs of destruction: osteons of different diameters, thrombi in the central channels of osteons (arrows), mosaic-stained matrix, microcracks. Hematoxylin and eosin. Scale bar 200 μm.

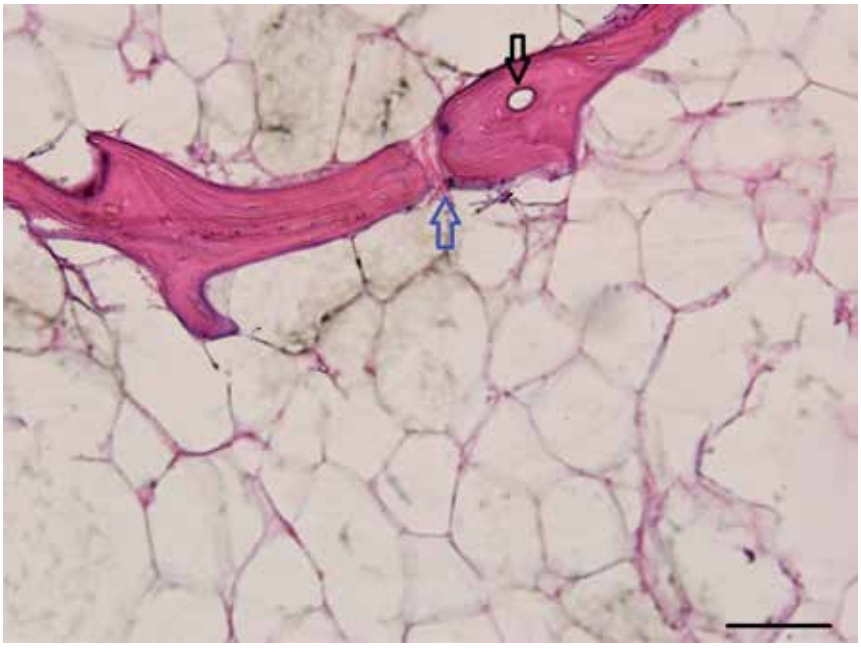

Fig. 2. Fragment of the patient's metaphysis without revascularization. The spongy bone substance with signs of destruction: against the background of yellow bone marrow trabecula with irregular edges, empty lacunae, osteon structure (black arrow), and microfracture (blue arrow). Hematoxylin and eosin. Scale bar 100 μm.

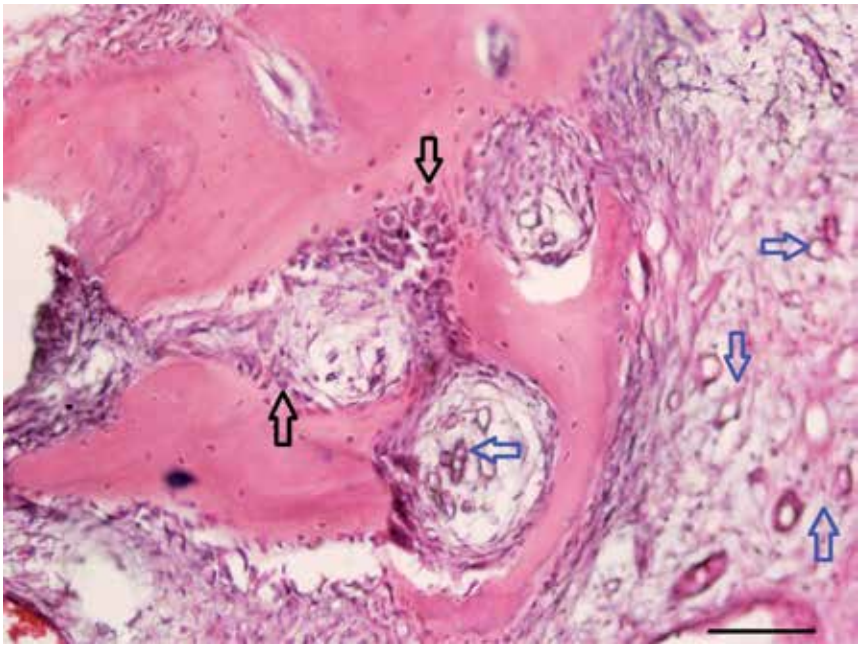

Fig. 3. A section of the patient's metaphysis after revascularization. The spongy bone substance with signs of osteogenesis: on the background of reticular-fibrous tissue with many vessels (blue arrows) newly formed bone tissue of trabeculae with osteocytes in lacunae, osteoblasts (black arrows). Hematoxylin and eosin. Scale bar 100 μm.

Fragments of hyaline and fibrous cartilage in histopreparations showed disruption of the characteristic arrangement of lacunae, mosaic staining of the matrix, delamination, and fragmentation of collagen fiber bundles. Chondrocytes at different stages of necrobiosis, sharply basophilic calcification foci, brown structureless cartilage necrosis foci, and cracks were observed.

In 19 patients who underwent necrectomy, signs of reparative process development were detected in bone tissue samples 7-8 days after blood flow restoration, compared to those in patients without revascularization. Against the background of destructive changes similar to those described above, there were areas of new bone tissue formation. They consisted mostly of chaotic layering of bone plates. The number of osteoblasts and osteocytes was different in individual sections. Another characteristic feature was the formation of reticular-fibrous tissue with a significant number of vessels of different diameters in the intertrabecular space. Many of the same vessels were also found in the periosteum, where they were located between the bundles of newly formed collagen fibers (Fig. 3).

DISCUSSION

Surgeons have long been interested in the influence of bone blood supply on its regenerative ability. In 2002, J. Field and G. Sumner-Smith showed in an animal experiment how trauma to bone tissue with impaired blood flow and the presence of a foreign body affects its regenerative ability [15]. Some authors have specifically studied changes in bone blood flow in healthy young adults under the influence of the sympathetic nervous system [16].

Many authors conclude about the importance of preserving bone vascularization based on experimental and clinical studies. Blood flow disturbance in the bone can be influenced by insufficiency of vitamin D, parathyroid hormone, calcitonin, and estrogens. These factors by reducing blood flow cause disorders of bone mineralization, reduce its ability to regenerate, and contribute to the development of osteoporosis [17-19].

The relationship between impaired blood supply in the foot and osteoporosis and bone fragility in diabetes mellitus has been reported by many authors. This phenomenon has been traced in both experimental and clinical studies [20-22]. The authors consider the impaired blood supply to the foot in the aspect of osteoporosis development and relate it to the type of DM.

Researchers say that changes in the bones of type 1 and type 2 DM patients are due to impaired blood flow in them. In type 1 DM against the background of microvascular disorders, low bone mineral density develops, leading to a violation of bone microarchitectonics due to an increase in cortical porosity [23]. There is a report that the pathologic changes occurring in osteoclasts during critical disruption of blood flow in the foot may be irreversible [24].

In the analyzed literature, we did not find studies devoted to the study of changes in bone tissue histostructure in patients depending on the DFS form lesion – neuropathic, ischemic, and mixed. In these DFS forms lesions the degree of blood flow disturbance is different. The study of bone tissue histostructure in patients with neuropathic DFS form and the presence of purulent foci was conducted by T. Tamm et al. [5]. Clinicians need to know the nature of

changes occurring in patients with DFS, not only in soft tissues but also in bone. It is important for the surgeon what has a greater effect on the structure of bone tissue – a purulent process in soft tissues or their critical ischemia.

V. Shanbhogue et al. consider that the statement "... direct deleterious effects of microangiopathy on bone..." remains uncertain and its evidence is questionable [25]. Studies of bone histostructure in ischemic DFS and after restoration of blood flow are not evidence-based but may require further in-depth studies.

The analysis of our clinical material has shown that the isolated ischemic DFS form in patients with DM develops quite rarely. Over 5 years, 3200 patients were treated in the DFS pathology department, and only 25 (0,78 %) had an isolated ischemic DFS form.

Clinically, anamnestically, and according to the data of instrumental methods of investigation, all 25 patients showed decreased blood flow in the main and peripheral arteries of the lower limbs against the background of preservation of sensory sensitivity. This was confirmed by ultrasound findings, which revealed stenosis of the tibial arteries by up to 40 %, decreased ABI by up to 0,7, and pO_2 values were below 50 mmHg in all cases.

It should be emphasized that the degree of DM decompensation does not significantly influence the development of an ischemic form of the disease. Thus, ischemic DFS form was found in 94 % of patients with subcompensated and 6 % of cases with decompensated DM form. Some regularity between age and the formation of ischemic DFS form was revealed. Thus, isolated limb ischemia in DM develops 2,5 times more often in elderly people.

Reduced blood flow in the foot is clinically manifested by impaired trophism of soft tissues with the formation of "dry" necrosis. Simultaneously, there are changes in the structure of bone tissue, which are detected by histologic examination but are not manifested radiologically.

Ischemia of the peripheral arteries of the lower extremities is known to increase the risk of non-healing ulcers, infections, and amputation [26]. Thus, in our study, the analysis of the revealed morphological changes of bone tissue in all samples showed that against the background of deterioration of its blood supply, the destruction processes are gradually occurring in the bone structure. Both large vessel ischemia and microvascular dysfunction are important in this case [27]. Previous studies have also shown rarefaction of capillary density, impaired endothelial regulatory functions, and basal membrane dilation [28].

In our study, a local circulatory disturbance was expressed in the desolation and thrombosis of vessels, reduction of their total number in bone tissue, intertrabecular space, and periosteum. As a consequence of trophic deterioration, there was a disturbance in the process of calcification of bone and cartilage matrix – mosaicity of its staining, and sharp basophilia of cement lines and walls of osteon central canals. Reduced cortex thickness, enlargement of the osteon central canals, and sparse trabecular network probably reflected the predominance of the bone resorption process over the osteogenesis. The detected signs of destructive changes in the bone on the background of blood supply disorder for a long time do not manifest themselves clinically and are absent on radiographs. Moreover, by their nature, the revealed changes in bone tissue against ischemia were close to the changes occurring in the bones of patients with a mixed DFS form and the presence of purulent foci [5].

After the restoration of blood flow in 19 patients the processes of soft tissue destruction were still irreversible, but they did not progress. At the same time destructive processes in bones partially leveled off. The studies of bone tissue histostructure on the 7-8 days after revascularization showed that the restoration of blood flow stimulated the formation of vessels in bone tissue and periosteum, which in turn promoted the reparation of damaged areas, i.e. the formation of new bone substance.

Clinical studies show that revascularization in patients with ischemic diabetic foot allows to reach an amputation-free survival rate of 85.4%, 62.6% wound healing, and preservation of foot support function in 79.7% at 12 months postoperatively [29].

Our studies were conducted on a limited patient population and the result cannot be considered as evidence-based. Additionally, when comparing two groups, the influence of individual characteristics on the course of the disease can be observed. However, the revealed regularity of the processes occurring in bones in patients with ischemic DFS form after the restoration of blood flow is of some interest.

The performed revascularization was an impetus to the formation of vessels in bone tissue and periosteum, which in turn promoted the formation of bone substance in patients with ischemic DFS form.

It can be assumed that impaired blood supply to the limb of any genesis contributes to the formation of destructive processes in both soft and bone tissues. However, with complete restoration of blood flow, necrotic changes in soft tissues remain the same, and destructive processes in the bone can undergo reverse development.

CONCLUSIONS

Disruption of blood supply of limb tissues in patients with ischemic DFS for a long time leads to impaired matrix calcification, reduced cortex thickness, widening of osteon channels, and sparse trabecular network. In the bone structure, such changes are a sign of bone resorption processes, but they are not clinically or radiologically detectable. Revascularization with full restoration of blood flow promotes the emergence of signs of bone tissue regeneration in the form of vessel formation in bone and periosteum, which contributes to the formation of new bone substance.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Olga B. Litvinova
Kharkiv National Medical University
4 Nauky Avenue, 61022 Kharkiv, Ukraine
e-mail: o-b-l@i.ua

ORCID AND CONTRIBUTIONSHIP
Tamara I. Tamm: 0000-0001-6372-2092 A
Valentyn V. Nepomniashchyi: 0000-0001-6262-6795 C
Sergey B. Pavlov: 0000-0002-3952-1511 E
Ivan M. Mamontov: 0000-0003-0059-2715 F
Olena A. Shakalova: 0000-0003-3401-4278 B
Olga B. Litvinova: 0000-0002-4558-6979 D

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

MiNa scale: Assessing mindfulness in nature and its impact on the mental health, wellbeing and holistic development of young children

Agathi Argyriadi[1,2], Alexandros Argyriadis[2,3], Emmanuel Kopanakis[4], Panagiotis Koutras[4], Isabel Vieira[5], Olga Drakopoulou[6], Konstantinos Louvaris[6], Zoi Mammi[6], Dimitra Katsarou[7], Panagiotis Paoullis[1]

[1]FREDERICK UNIVERSITY, NICOSIA, CYPRUS
[2]UNITED ARAB EMIRATES UNIVERSITY, AL AIN, UNITED ARAB EMIRATES
[3]HELLENIC MEDITERRANEAN UNIVERSITY, CHANIA, GREECE
[4]CENTER OF CENTER FOR ENVIRONMENTAL EDUCATION AND SUSTAINABILITY (KEPEA) OF KARPENISI, KARPENISI, GREECE
[5]CASA DO PROFESSOR, PORTUGAL
[6]HELLENIC MINISTRY OF EDUCATION, ATHENS, GREECE
[7]UNIVERSITY OF THE AEGEAN, GREECE

ABSTRACT

Aim: The aim of this study was to design, validate, and assess the effectiveness of the MiNa scale in measuring mindfulness and its impact on young students' mental health and holistic development, with a focus on diverse educational needs.

Materials and Methods: This study utilized a mixed-methods approach to validate the MiNa Questionnaire. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted on a sample of 224 students from Greece and Cyprus, who completed the questionnaire. Psychometric properties, including reliability and validity, were also assessed using standard statistical methods.

Results: EFA revealed a three-factor structure explaining 53% of the variance, with strong factor loadings and reliability (Cronbach's $\alpha > 0.7$). CFA further confirmed the model fit, with RMSEA = 0.03, CFI = 0.97, and SRMR = 0.08. The results indicated significant improvements in students that attended mindfulness interventional programs, especially on their emotional regulation, and cognitive focus. It is important to note that positive results were predominantly observed among the sample of students characterized by vulnerability.

Conclusions: The MiNa Questionnaire has proven to be a reliable and valid tool for assessing mindfulness in students from diverse educational backgrounds. Its adaptability for students with disabilities, combined with its cultural inclusivity, makes it a valuable resource for educators seeking to implement mindfulness programs in varied educational contexts.

KEY WORDS: Mindfulness, MiNa Questionnaire, psychometric validation, emotional regulation, special education, inclusive education

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INTRODUCTION

Mindfulness has emerged as a critical area of focus in educational settings, among others and it is recognized for its potential to enhance cognitive, emotional, and social functioning in students [1]. This burgeoning interest has prompted researchers to develop various scales aimed at measuring mindfulness, catering to both students with disabilities and those with typical development. The creation of these tools involves nuanced considerations to ensure they are both effective and inclusive. Mindfulness, defined as a state of active, open attention to the present moment, is increasingly integrated into educational curricula [2]. It is associated with numerous benefits, including reduced anxiety, enhanced attention, and improved emotional regulation [3]. Research indicates that mindfulness enhances cognitive functioning, particularly in areas related to attention, working memory, and executive control [4]. This improvement in attentional capacity allows students to maintain focus on academic tasks, reducing susceptibility to distractions and improving overall academic performance [5]. Moreover, mindfulness contributes to emotional regulation, a critical factor in the development of resilience and stress management. Studies have shown that individuals who engage in mindfulness practices are better equipped to manage emotional responses, leading to reduced levels of anxiety, depression, and stress [6]. This ability to self-regulate emotions is particularly valuable in educational settings, where students often face high levels of academic pressure.

Furthermore, mindfulness has been linked to improved social-emotional skills, such as empathy, compassion, and interpersonal communication. In classrooms, these enhanced social skills foster a more positive learning environment and contribute to better peer relationships and collaboration [7]. Additionally, mindfulness programs have shown efficacy in reducing disruptive behaviors and increasing prosocial

behaviors, making them an effective tool for improving classroom dynamics and promoting inclusive education. Finally, mindfulness has been identified as a facilitator of well-being and mental health. By promoting present-moment awareness and reducing rumination, mindfulness helps mitigate symptoms associated with mental health disorders such as ADHD and anxiety disorders [8]. For students, this means fewer mental health barriers to learning and a greater capacity for engagement and success in academic and social activities.

These combined cognitive, emotional, and social benefits highlight the value of integrating mindfulness into educational curricula to support holistic student development. For students with disabilities, mindfulness practices can offer tailored support to address specific needs, promoting greater inclusion and academic success [4]. Conversely, for students with typical development, mindfulness can bolster overall well-being and academic performance [5].

Recent trends emphasize the importance of designing mindfulness scales that are also inclusive and accessible [6, 7]. For example, questionnaires are being adapted with simplified language, visual supports, and alternative formats (e.g., digital versions with assistive technologies) [8]. Ensuring the validity and reliability of mindfulness questionnaires is a critical research focus [9]. Studies often involve rigorous psychometric testing to confirm that the tools accurately measure mindfulness across different student populations [10]. This includes assessing the internal consistency, test-retest reliability, and construct validity of the questionnaires [11]. Mindfulness practices are rooted in diverse cultural traditions, and recent research emphasizes the need for culturally sensitive questionnaires [12]. This involves adapting items to be culturally relevant and ensuring that mindfulness constructs are interpreted consistently across different cultural contexts [13]. Such adaptations are crucial for accurately assessing mindfulness in multicultural educational settings [14]. The integration of technology in questionnaire administration is another emerging trend [15]. Digital platforms enable more dynamic and engaging questionnaire experiences, which can be particularly beneficial for students with disabilities who may require alternative means of communication [16]. These platforms also facilitate large-scale data collection and analysis, enhancing the scope and impact of mindfulness research [17]. To gain a comprehensive understanding of a student's mindfulness, researchers are increasingly using multi-informant approaches [18-21]. This involves collecting data from various sources, including self-reports, teacher observations, and parental feedback [22]. Such approaches provide a holistic view of the student's mindfulness and its impacts across different contexts [23].

Despite the growing body of research highlighting the benefits of mindfulness for children, there remains a notable research gap in the development and validation of scales specifically designed to measure mindfulness in younger populations. Existing mindfulness scales, such as the Mindful Attention Awareness Scale (MAAS) and the Five Facet Mindfulness Questionnaire (FFMQ), were primarily developed for adults and adolescents, raising concerns about their applicability and reliability when used with children [24]. Children, particularly those in early and middle childhood, experience cognitive and emotional development that differs significantly from older age groups, necessitating the need for developmentally appropriate assessment tools. The absence of mindfulness scales tailored to the unique cognitive, linguistic, and emotional capabilities of younger children limits the ability of researchers and educators to accurately capture the effects of mindfulness interventions. Additionally, there is a lack of inclusivity in many of the available mindfulness scales for children. Most scales do not account for the diverse needs of children with disabilities, such as those with Autism Spectrum Disorder (ASD) or Attention Deficit Hyperactivity Disorder (ADHD). These populations may experience mindfulness differently due to their unique sensory, cognitive, and attentional challenges, yet few scales are adapted to address these specific needs [24, 25]. Another critical gap involves cultural sensitivity in mindfulness measurement tools. Many mindfulness scales have been developed in Western contexts, with little consideration of how mindfulness is perceived and practiced in non-Western cultures. This oversight risks producing biased results when applying these tools in culturally diverse educational settings. To foster accurate and inclusive research, it is essential to develop mindfulness scales that are culturally adaptable and can account for varying interpretations and expressions of mindfulness across different cultural contexts.

Addressing these gaps requires the creation of new mindfulness scales for children that are developmentally appropriate, inclusive of diverse abilities, and culturally sensitive. Such tools would provide a more reliable foundation for understanding how mindfulness impacts the holistic development of children and would guide more effective interventions in educational settings.

AIM

The aim of this study was to design, validate, and assess the effectiveness of the MiNa Questionnaire in measuring mindfulness and its impact on young students' mental health and holistic development, with a focus on diverse educational needs. The mindfulness scale described in this study was designed to assess children's ability to engage with and be aware of their emotions, thoughts, physical sensations, and the environment around them.

MATERIALS AND METHODS

THE RESEARCH TOOL

The scale draws from existing literature on mindfulness, particularly focusing on mindfulness-based interventions in children and adolescents, such as the works of Greco et al. [10] and Brown et al. [9], as well as on culturally sensitive adaptations from mindfulness assessments like the Child and Adolescent Mindfulness Measure (CAMM). Key themes from these studies informed the scale's development, emphasizing emotional regulation, attentional control,

and the recognition of thoughts and physical sensations in real-time.

The scale is consisted of 30 questions designed to measure mindfulness across multiple dimensions, including awareness of emotions, bodily sensations, and attention to the environment. It is divided into four thematic units, each addressing different aspects of mindfulness:

Emotional Awareness: Questions focused on recognizing and labeling emotions as they occur. Number of questions: 7

Bodily Sensations: Questions related to physical awareness, including muscle tension, breathing patterns, and sensory experiences. Number of questions: 8

Attention to the Environment: This section addresses awareness of external surroundings, focusing on the details of nature and environmental stimuli. Number of questions: 5

Cognitive Mindfulness and Thought Patterns: This theme examines how participants engage with their thoughts, differentiate between reality and imagination, and observe cognitive processes. Number of questions: 10

The responses were measured on a 5-point Likert scale, where participants indicate how frequently they experience each statement. The scale ranges from 1 (Never) to 5 (Always).

VALIDITY AND RELIABILITY

The English language version of the MiNa Scale was tested for validity and reliability. The reliability was tested using the Cronbach's α method. In addition, the internal structure was tested by a confirmatory factor analysis (CFA), and the validity analysis has also been considered. In fact, the measurements of the Cronbach alpha values were adequate, indicating a reliable tool.

DATA COLLECTION AND SAMPLE OF THE STUDY

The validation of the MiNa scale took place between October 2023 and February 2024 with 224 students in Greece, Cyprus and Portugal using convenient sampling. The sample consisted of all grade students (Table 1). Initially, a pilot administration of the questionnaire was performed with to a sample of 52 students. The purpose of the pilot administration was to examine if the questions were well conceived by the participants in order to make improvements. The pilot testing's outcome was satisfactory, with a Cronbach alpha of 0.85.

DATA ANALYSIS

Descriptive statistics for the participants' characteristics were calculated. For the numerical variables the mean and standard deviation (mean, ± SD) were included, whereas for categorical variables, frequency counts and percentages [n, (%)] were calculated. In order to assess the factorial structure of the proposed scale, both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed. Specifically, the final sample (n=224) was randomly divided in two parts to obtain two mutually independent samples for the EFA (n=124) and CFA (n=100).

EXPLORATORY FACTOR ANALYSIS

On the first sample (n = 124) EFA analysis was performed. Items were analysed using the mean, standard deviations, skewness, and kurtosis of each item. Items with skewness larger than 3 or with kurtosis larger than 7 were removed from the questionnaire scale. On the remaining items, the Bartlett's test of sphericity with $p < 0.05$ and a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of 0.6 was used in order to confirm the suitability of the dataset for the factor analysis. The parallel analysis was employed to determine the number of components (Horn, 1965). In addition, the principal components method with an oblique rotation was used to examine item loadings. Oblique rotation (direct oblimin) with Kaiser normalisation was conducted, since this rotation method does not restrict factors to be uncorrelated, but results in a factor solution similar to an orthogonal one. Items with communality $h2 < 0.30$ or factor loadings $\lambda < 0.50$ were removed from the questionnaire scale. It was also expected that the extracted factors should have at least three items fulfilling relevant criteria and that the resulting factor solution should explain at least 50% of the total variance. Internal consistency of the scale was evaluated using Cronbach's alpha coefficient, with alpha >0.7 and alpha >0.6 indicating good and adequate value of the scale.

CONFIRMATORY FACTOR ANALYSIS

CFA with structural equation modelling (SEM) was used on the second dataset (n = 100) to examine whether the data fit the model proposed from EFA and thus verify the factor structure. The maximum likelihood method was

Table 1. Demographic characteristics of students (n = 124)

		n(%) or	factor1	factor2	factor3
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Gender	Male	89(39.7)	2.78(0.76)	3.62(0.76)	3.33(0.87)
	Female	135(60.3)	2.97(0.83)	3.66(0.82)	3.33(0.96)
Age		14.20 ± 2.27			
School	Primary/Pre-primary	29(12.9)	3.07(0.68)	3.76(0.64)	3.98(0.69)
	Secondary	121(54)	2.76(0.83)	3.61(0.78)	3.28(0.81)
	High school	74(33)	3.03(0.80)	3.67(0.89)	3.15(1.06)
Nationality	Greek	190(84.8)	3.00(0.90)	3.59(0.81)	3.32(0.96)
	Cypriot	34(15.2)	2.87(0.79)	3.65(0.80)	3.33(0.92)

used for parameter estimation. Standardised estimates of factor loadings as well as (residual) variances were obtained. The model goodness of fit was tested considering the following indices: Chi-square value (Alavi et al., 2020), comparative fit index (CFI) (Bentler, 1990), Tucker-Lewis index (TLI) (Tucker & Lewis, 1973), root mean square error of approximation (RMSEA) (Steiger, 1990) and standardised root mean square residual (SRMR) (Jöreskog & Sörborn, 1993). The model was considered to have a good fit with x2/df < 5, a RMSEA < 0.1, a SRMR < 0.05, a CFI, and NFI > 0.90 Hair. Item factor loadings higher than 0.3 were considered satisfactory (Hair et al., 2014).

Differences in score means in relation to demographic characteristics were also examined (i.e. gender, educational level, and nationality). Specifically, two independent groups for each categorical demographic variable were created (i.e. gender: male, female; educational level: primary and pre-primary education, secondary and high school; and nationality: Greek and Cypriot). Then, the students' independent sample t-test was employed to identify any statistically significant difference in score means for each factor between characteristics with two groups and the analysis of variance (ANOVA) was employed to identify different between more groups, Bonferroni was used as a post-hoc procedure to correct the error rate following ANOVA. Finally, Pearson correlation coefficient was used to analyse the correlation between the factors scores.

Statistical analysis for both EFA and CFA was performed using version R 3.6.2.

ETHICS

The research adhered to rigorous ethical standards and guidelines to ensure the rights and well-being of the participants and the integrity of the study. The study was approved by the Ethics in Research Committee of Frederick University (N. E22427) and followed the principles outlined in the declaration of Helsinki. Informed consent was obtained from all participants before they participated in the study. They were provided with comprehensive information about the purpose, procedures, potential risks, and benefits of the research. Participants were assured that their participation was voluntary and that they could withdraw from the study at any point without facing any consequences. To ensure confidentiality, all data collected were anonymised and stored securely. Personal identifiers were removed from the dataset to protect the privacy of the participants. Only the research team had access to the raw data, and all data were stored in compliance with data protection regulations.

RESULTS

Table 1 summarises participating students' (n=224) demographic characteristics. The majority of participants were females (60.3%). The mean age of the sample was 14.2 (SD= 2.27) and 12.9%, 54% and 33% of the students studied at primary/pre-primary, secondary and high school respectively. The majority of participating students were Greek (84.8%).

EFA

As mentioned, two mutually independent samples were created. Explanatory factor analysis was performed on the first sample (n=124) in order to access the factorial structure of the scale. Table 2 presents descriptive statistics for the responses of the participants. The items were analysed using the mean, standard deviations, skewness, and kurtosis of each item. Based on the analysis, all items have skewness smaller than 3 and kurtosis smaller 7. The dataset was considered suitable for EFA, since the Bartlett's Test of Sphericity was found to be significant (Bartlett's Test of Sphericity = 1004.50, p < 0.001) and the KMO was found to be satisfactory (0.71) (Hair et al., 2014). Next, parallel analysis 26 items were used to determine the number of components. Screen plot (Figure 1a) suggested a three components (factors) structure. The Principal Components Analysis with Oblique rotation (Kaiser's normalisation) was used as the extraction method for the three components (factors). Based on the analysis, Items 1, 3, 4, 5, 13, 17, 18,

Table 2. Descriptive statistics for the responses of participants (n=124), EFA

Item	Mean	Sd	Skew	Kurtosis
1	3.69	1.05	-0.41	-0.55
2	3.61	1.12	-0.54	-0.49
3	3.72	1.07	-0.53	-0.4
4	3.86	1.07	-0.76	-0.09
5	3.2	1.11	-0.05	-0.69
6	3.58	1.24	-0.51	-0.87
7	3.19	1.19	-0.15	-0.8
8	3.78	1.24	-0.83	-0.28
9	2.41	1.29	0.46	-0.97
10	3.48	1.28	-0.38	-1
11	3.14	1.26	-0.14	-1.03
12	2.44	1.22	0.32	-1.2
13	3.02	1.25	-0.23	-1.08
14	2.81	1.36	0.08	-1.28
15	2.92	1.27	0.1	-1.1
16	2.81	1.09	0.09	-0.79
17	2.56	1.38	0.39	-1.16
18	2.9	1.14	0.01	-0.78
19	2.77	1.17	0.37	-0.69
20	3.44	1.14	-0.46	-0.51
21	3.49	1.18	-0.31	-0.91
22	3.14	1.26	-0.35	-0.81
23	3.38	1.19	-0.26	-0.79
24	3.02	1.25	-0.15	-1.05
25	2.81	1.14	-0.08	-0.94
26	2.81	1.28	-0.01	-1.22

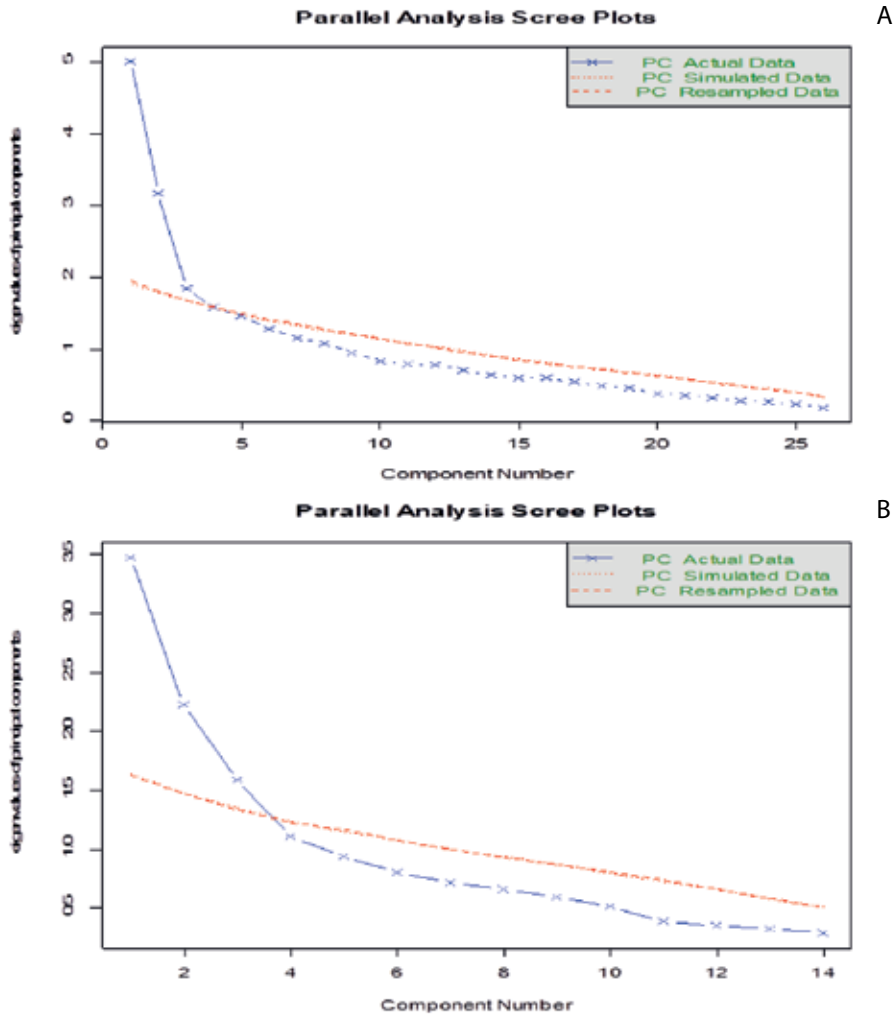

Fig. 1. a) Results of the parallel analysis in EFA for 26 items, (n=124); b) Results of the parallel analysis in EFA for 14 items, (n=124).

Table 3. Exploratory Factor Analysis (Principal component analysis with oblique rotations), n=124

Item	Factors			communality (h2)	std.alpha
15	0.76	0.02	-0.08	0.58	
12	0.76	0.14	-0.07	0.59	
14	0.72	-0.30	0.11	0.62	0.81
10	0.71	-0.05	0.12	0.53	
9	0.69	0.14	-0.14	0.5	
11	0.59	0.13	0.04	0.38	
16	0.54	-0.17	0.10	0.34	
7	-0.11	0.83	-0.11	0.69	
6	0.29	0.72	0.13	0.64	0.62
2	-0.06	0.55	0.13	0.33	
8	-0.11	0.50	0.32	0.38	
22	0.01	-0.05	0.80	0.64	
23	0.07	0.08	0.76	0.6	
21	-0.14	0.02	0.68	0.47	0.64
proportion of variance	0.25	0.14	0.14		Overall std.alpha 0.71
KMO=0.71, Bartlett's Test of Sphericity = 460,917 ($p < .001$)					

19, 20, 24, 25 and 26 had communality h2 < 0.30 or factor loadings λ < 0.50, and were therefore removed from the questionnaire scale.

The Bartlett's Test of Sphericity and the KMO were calculated and Parallel Analysis was performed to the remaining set of 14 items. Screen plot (Figure 1b) confirmed the three components (factors) solution and the Bartlett's Test of Sphericity = 460,917 (p < .001), while the KMO = 0.71 indicated that the dataset was suitable for EFA. Principal component analysis with oblique rotations was performed to the remaining set of items. EFA results are presented in Table 3. The tree-factor solution (14 items) explains 53% of the total variance. Specifically, Factor 1 has 7 items (Items 9,10,11,12,14,15 and 16) with loadings between 0.54 and 0.76 and explains 25% of the variance. Factor 2 has 4 items (Items 2, 6, 7 and 8) with loadings between 0.5 and 0.83 and explains 14% of the variance. Finally, factor 3 has 3 items (Item 21, 22 and 23) with loadings between 0.68 and 0.87 and explains 14% of the variance. The internal consistency for Factors 1,2 and 3 is 0.81, 0.62 and 0.64, respectively, which shows good reliability for factor 1 and adequate value for factors 2 and 3. The overall internal consistency (alpha = 0.71) for the final scale (fourteen items) shows good reliability.

CFA

Next, CFA with structural equation modelling was performed on the other half of the sample (n=100). The Maximum Likelihood method was employed for parameters' estimation for the model. Specifically, CFA for the three-factor model with the 14 items suggested from EFA was considered. Table 4 provides an overview of fit indices for factor solutions of the CFA and the fully standardised factor loadings with (residual) variances for the fitted models are presented in Figure 2. Model gave satisfactory fit indices (x2/df =1,09, RMSEA =0.03, CFI =0.97, TLI = 0.96) and very close to satisfactory indices for SRMR (SRMR = 0.08). Factor 1 (7 items) has standardised items loadings between 0.33 and 0.65, factor 2 (4 items) has loadings between 0.35-0.72 and factor 3 has loadings between 0.39-0.90.

The correlation analysis for all factors is presented in Table 5. A moderate positive correlation between Factor 2 and 3 was identified. Furthermore, differences in factors score means in relation to demographic characteristics were also examined. No significant differences in the factors score were identified when the demographic characteristics; gender and nationality. A higher mean score for Factor 3 was observed in primary and pre-primary students compared to secondary and high school students.

DISCUSSION

The findings from this study provide evidence for the psychometric validity and reliability of the MiNa scale, particularly its applicability in diverse educational settings.

The internal consistency of the MiNa scale was demonstrated through Cronbach's alpha values across the three identified

Table 4. Results of the Confirmatory Factor Analysis: Estimated Models (n=100)

		χ^2	df	χ^2/df	RMSEA	CFI	TLI	SRMS
Model:	14-items (three factors)	80.78	74	1.09	0.03	0.97	0.96	0.08

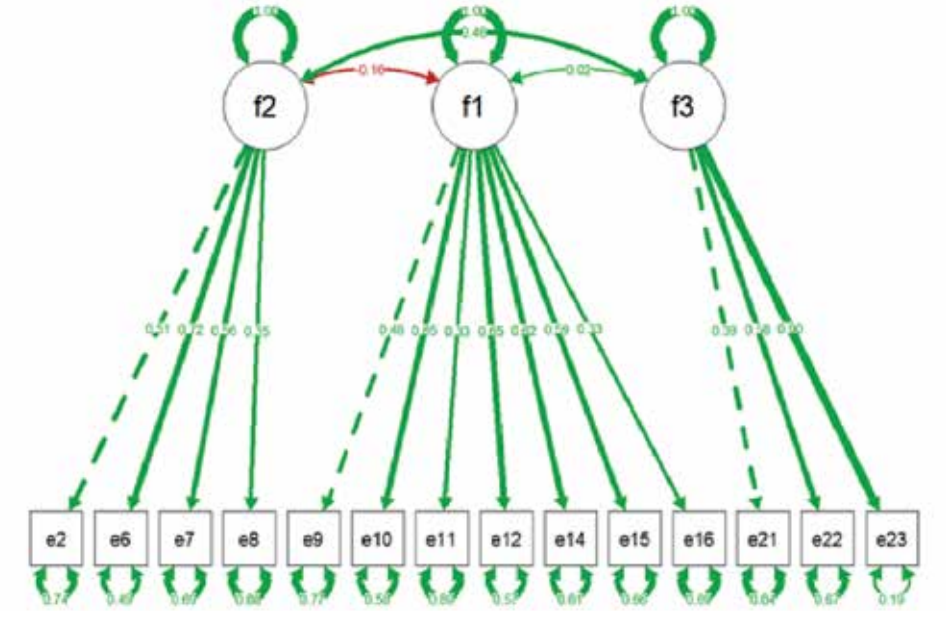

Fig. 2. Results of the confirmatory factor analysis: Model 1 (14-items model (3 factors)).

Table 5. Correlation table for the 3 factors

	factor1	factor2	factor3
factor1	1	-0.042	0.082
factor2		1	0.256
factor3			1

factors – Emotional Awareness, Bodily Sensations, and Cognitive Mindfulness and Thought Patterns. Factor 1 (Emotional Awareness) achieved a Cronbach's alpha of 0.81, indicating good internal consistency, while Factor 2 (Bodily Sensations) and Factor 3 (Cognitive Mindfulness) had alphas of 0.62 and 0.64, respectively, which indicate adequate internal consistency. These results align with prior research suggesting that mindfulness scales designed for younger populations often show moderate to good reliability in specific subscales, particularly when cognitive processes and emotional awareness are measured separately [4]. The overall Cronbach's alpha for the final 14-item version of the MiNa scale was 0.71, demonstrating adequate internal consistency for the tool as a whole. This finding is consistent with similar studies on mindfulness scales, such as the Child and Adolescent Mindfulness Measure (CAMM), which reported Cronbach's alpha values in the range of 0.70 to 0.80 [12]. Given that the MiNa scale was developed with both typical and special education students in mind, the results indicate that it maintains reliability across different educational needs, further supporting its use as an inclusive mindfulness measurement tool.

The results of the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) lend strong support to the validity of the MiNa scale. EFA revealed a three-factor structure that explained 53% of the total variance, with Factor 1 (Emotional Awareness) accounting for the largest proportion (25%), followed by Factor 2 (Bodily Sensations) and Factor 3 (Cognitive Mindfulness), which each explained 14% of the variance. This three-factor structure is consistent with mindfulness models in the existing literature, where mindfulness is typically operationalized as a multi-dimensional construct, encompassing emotional regulation, attentional control, and bodily awareness [13]. The confirmatory factor analysis provided further validation for this three-factor structure, with excellent model fit indices ($\chi^2/df = 1.09$, RMSEA = 0.03, CFI = 0.97, TLI = 0.96, SRMR = 0.08). These fit indices surpass the thresholds commonly considered acceptable in psychometric validation studies. For instance, RMSEA values below 0.05, CFI values above 0.95, and SRMR values below 0.08 indicate a strong model fit, in line with guidelines outlined by Hu and Bentler (1999) [4]. These findings demonstrate that the MiNa scale is structurally sound and capable of measuring mindfulness with high precision.

In addition to assessing the overall factor structure, the performance of individual items in the MiNa scale was also evaluated. Factor loadings across the three factors were robust, ranging from 0.33 to 0.90. These values fall within the range considered acceptable for psychological measurement tools, where loadings above 0.30 are typically seen as indicative of meaningful item contributions to the underlying factor [25]. Notably, Factor 1 (Emotional Awareness) included the highest loadings, reflecting the importance of this dimension in measuring mindfulness in children and adolescents. This is consistent with previous findings, where emotional regulation is often cited as a central component of mindfulness-based interventions for children [26]. However, Factor 2 (Bodily Sensations) and Factor 3 (Cognitive Mindfulness) demonstrated slightly lower loadings, particularly in items measuring bodily awareness (e.g., items assessing muscle tension and relaxation). This may be attributed to the age-related cognitive development of the respondents, as younger students might not be as attuned to their bodily sensations as older participants or adults. Similar trends were observed in other mindfulness questionnaires designed for younger populations, where bodily awareness is often less developed compared to emotional and cognitive awareness [9].

The cultural sensitivity and inclusivity of the MiNa scale were also crucial aspects of this study. Given that the sample included students from Greece and Cyprus, the scale's ability to perform well across these diverse educational contexts reinforces its adaptability for use in multicultural environments. This adaptability is especially important in the context of mindfulness, where cultural perceptions of emotions, attention, and bodily sensations can vary significantly [8]. The MiNa scale's ability to maintain consistent psychometric properties across different national contexts aligns with recent research emphasizing the need for mindfulness measures that are culturally sensitive and inclusive [30]. Moreover, the study revealed significant differences in Factor 3 (Cognitive Mindfulness) between younger students (primary and pre-primary education) and older students (secondary and high school), with younger students scoring higher on average. This finding suggests that younger students may be more receptive to mindfulness interventions that emphasize thought regulation and emotional awareness. Previous studies have indicated that mindfulness programs targeting emotional regulation and cognitive focus tend to yield the most significant results in younger populations, who are still developing their ability to manage stress and emotional responses [12].

CONCLUSIONS

The MiNa scale has proven to be a valid and reliable tool for assessing mindfulness in young students from diverse educational contexts. This study demonstrated the scale's internal consistency, with good reliability across its three dimensions. The MiNa scale's ability to capture mindfulness in both mainstream and special education students, while maintaining cultural sensitivity, highlights its utility as an inclusive tool in educational settings. Its structure aligns with existing mindfulness literature, demonstrating that emotional awareness plays a central role in students' mindfulness experiences, while bodily sensations and cognitive mindfulness also contribute significantly to their overall mindfulness. Moreover, the differences observed between younger and older students, particularly in their cognitive mindfulness, underscore the developmental aspect of mindfulness and suggest that tailored interventions may be needed to address the specific needs of different age groups. The tool's adaptability across national and cultural contexts further solidifies its relevance for educators and researchers seeking to implement mindfulness programs aimed at improving emotional regulation, cognitive focus, and overall well-being in students.

Although the MiNa scale demonstrated strong psychometric properties, several limitations should be acknowledged. First, the sample size, while sufficient for factor analysis, may not be fully representative of the broader student population. Future studies should aim to validate the MiNa scale with larger, more diverse samples to confirm its applicability in different cultural and educational contexts. Additionally, while the scale performed well in measuring mindfulness among students, its applicability in special education contexts should be further explored to ensure that it fully captures the unique mindfulness experiences of students with disabilities. Future research could also benefit from longitudinal studies to assess the stability of the MiNa scale over time. Such studies would provide insights into how students' mindfulness evolves with age and whether mindfulness-based interventions have sustained long-term effects. Moreover, incorporating a broader range of demographic variables, such as socioeconomic status and parental education, could shed light on how these factors influence students' mindfulness and its impact on their holistic development.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Alexandros Argyriadis
Frederick University
7 Gianni Freiderikou, Nicosia 1036, Cyprus
e-mail: argyriadis@hmu.gr

ORCID AND CONTRIBUTIONSHIP
Agathi Argyriadi: 0000-0003-3935-0414 A
Alexandros Argyriadis: 0000-0001-5754-4787 A B D
Emmanuel Kopanakis: 0009-0000-2432-418X C
Panagiotis Koutras: 0009-0001-9540-028X D
Isabel Vieira: 0009-0000-3775-8534 E
Konstantinos Louvaris: 0009-0004-1013-5192 E
Olga Drakopoulou: 0009-0006-3823-789X A E
Zoi Mammi: 0009-0008-3929-0291 F
Dimitra Katsarou: 0000-0001-8690-0314 E
Panagiotis Paoullis: 0009-0000-3964-4995 C

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Educational needs of medical service providers on issues of continuous improvement of the quality of integrated medical care and ways of providing them

Nataliia M. Mykytenko[1], Mykhailo D. Diachuk[2], Yaroslava S. Demydenko[1], Hanna V. Inshakova[1,2], Tetiana S. Gruzieva[1,2]

[1]BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE
[2]STATE INSTITUTION OF SCIENCE «CENTER OF INNOVATIVE HEALTHCARE TECHNOLOGIES» STATE ADMINISTRATIVE DEPARTMENT, KYIV, UKRAINE

ABSTRACT

Aim: To determine modern strategies of quality assurance in medical care and to meet educational needs of health care professionals regarding the quality of medical care.

Materials and Methods: The study programme included sociological surveys of healthcare professionals on their educational needs in terms of quality assurance of medical care. The study used bibliosemantic, sociological, medical and statistical methods, and content analysis. The study materials included scientific publications, the WHO program documents, national-level regulations and questionnaires on their educational needs in terms of quality of care and patient safety.

Results: Data show that, there are still a lot of problems in quality assurance and safety of health care services. The respondents highly appreciated the results of implemented JCI requirements at the healthcare facility ([mean ± standard error] 4,3±0,07 points on a five-point scale), the level of information about current operational processes, changes, plans etc. (4,4±0,06), the clarity and comprehensibility of the quality assurance tasks (4,5±0,04), the control method (4,6±0,05), and the attitude of the management (4,6±0,05). The need to improve knowledge and acquire more competencies in health care quality was identified ([rate ± standard error] 88,4±2,30 respondents per 100 respondents).

Conclusions: The assessments by health care providers of the quality of medical care, level of knowledge on these issues and the need to improve them, with prioritization of topics and forms of training, found in the course of the study, form the basis for the programs of continuous improvement of medical care quality.

KEY WORDS: health care system; policy and strategy; quality assurance of medical care; educational needs; continuous professional development

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INTRODUCTION

The Sustainable Development Goals set by the international community envisage achieving universal coverage of quality healthcare services globally. The 2019 UN Political Declaration reaffirms the commitment to gradually provide quality basic healthcare services to an additional 1 billion people by 2023, and to the entire world population by 2030. Improving the quality of healthcare services is seen as a priority factor in strengthening healthcare systems and improving public health [1, 2].

It is well known that the quality of health services is measured by the following characteristics: efficiency, safety, humaneness, timeliness, equity, comprehensiveness, rationality [3]. The national quality policy and strategy is an organized effort to stimulate and plan quality improvement activities on a national scale [4].

Health care quality policies and strategies are based on a set of actions that need to be taken within the national health care system to create an enabling environment, reduce harm, improve care and engage with patients, families and communities. In this regard, an indicative list of measures for each of these areas of quality assurance has been developed for use by countries [3, 4].

As it is important to achieve high quality health care, the World Health Organization (WHO) supports countries in developing, improving and implementing national quality assurance policies and strategies to ensure a comprehensive approach to quality health care [5].

However, despite the efforts made by countries to ensure the quality of healthcare services, the results of this work are not always sufficient. In high-income countries, 7 per cent of hospitalized patients develop avoidable hospital-acquired infections. In low- and middle-income countries, 5,7-8,4 million deaths are registered annually, which are associated with poor quality of healthcare. At the same time, 60% of deaths from conditions requiring medical care in these countries are caused by inadequate medical care, while other deaths occur as a result of non-use of the healthcare system [5, 6].

Around 15% of hospital costs in high-income countries are allocated to address preventable complications arising

from healthcare and patient harm. The economic and social costs of patient harm, including disability, incapacity for work and lost productivity, are estimated at trillions of dollars annually [7].

WHO proposes a number of approaches and tools to improve activities aimed at achieving an appropriate level of quality of care for different population groups. In particular, a network for improving the quality of maternal, newborn and child health care has been established [8], which proposes the Five Functions for Improving the Quality of Maternal, Newborn and Child Health Care [9], maternal and perinatal death surveillance and response [10]; Standards for Improving the Quality of Maternal and Newborn Care in Health Care Facilities [11]; Standards for Improving the Quality of Child and Adolescent Health Care in Health Facilities [12]; Standards for Improving the Quality of Child and Adolescent Health Care in Health Facilities [13]. The WHO Concept for Integrated People-Centred Health Services [14], Practical approaches and resources to support policies, strategies and practices for quality health services and palliative care [15], Guidelines for planning quality immunization services [16], Guidelines for planning quality health services [17], etc. were also developed.

The frameworks, strategies and standards developed by WHO provide a sound basis for defining national quality policies and strategies for health services in each country, taking into account the national context.

The issue of ensuring high quality healthcare services is extremely relevant for Ukraine. The current vector of development of the national healthcare system of Ukraine is defined by the Strategy for the Development of the Healthcare System until 2030. Among a number of directions of the Strategy, one of the main ones is universal healthcare coverage, which involves improving people's health through the implementation of an effective integrated model that ensures balanced, evidence-based, continuous provision of quality and safe services [18].

Achieving the goals of universal coverage of the population with quality healthcare services requires an in-depth analysis of the current state and existing approaches to ensuring the quality of service at various levels of government, recommendations of international organizations on these issues, and experience in this area with due attention to all components, including human resources.

AIM

The aim of the study was to improve the quality of medical care by identifying the educational needs of healthcare professionals on the quality of medical care.

MATERIALS AND METHODS

The bibliosemantic, sociological, medical and statistical methods, and content analysis were used in the study. The study materials included scientific publications, WHO and WHO Regional Office for Europe policy documents, national-level regulations, and sociological survey questionnaires among healthcare professionals. The study programme included sociological surveys of healthcare professionals on their educational needs in terms of quality assurance of medical care. Average and relative values were presented with standard errors.

The study complied with the basic principles of the Council of Europe Convention on Human Rights and Biomedicine, World Medical Association Declaration of Helsinki on the ethical principles for medical research involving human subjects, and current national regulations. As the surveys were anonymous, the respondents' participation was assumed to be voluntary, the principles of medical ethics were not violated.

RESULTS

The analysis of WHO strategic and programme documents demonstrates the relevance of improving the quality of health care services to achieve the strategic goals of sustainable development in the context of universal health coverage.

The WHO Guidelines for National Quality Policy and Strategy (2018) pay considerable attention to the development of national policy and strategy, setting goals and priorities, defining quality at the local level, involving stakeholders in this process, situational analysis of the quality status, creating management and organizational structures for quality assurance, management information systems, defining quality attributes and key parameters, planning methods and measures aimed at introducing innovations, and the development of an operational plan for implementation [3].

Since human resources are the key determinants of the quality of healthcare, the issues of personnel development and retention in healthcare institutions are becoming a priority. Training and engagement of human resources is an effective measure to address the problem of limited human resources. It is advisable to use incentive mechanisms that influence the attitude of employees towards quality assurance processes. It is important that the attitude of medical personnel towards ensuring good quality of services becomes a sustainable norm in the provision of health care.

The WHO document "Delivering Quality Health Services: a Global Imperative for Universal Health Coverage" (2018) emphasizes the five most important components of quality health care, which are health workforce, health care organizations, medicines, devices and other technologies, information systems and financing. To ensure quality of care as one of the pillars of the health system, governments, policy makers, health system leaders, patients and providers should work together to ensure a highly qualified health workforce; excellence in all health care settings; safe and effective use of medicines, devices and other technologies; efficient use of health systems; and the development of financial mechanisms that support continuous quality improvement [4].

Of particular note is the WHO document "Quality Health Services: a Planning Guide" [17], which focuses on the basic requirements for quality initiatives, such as local support, quality measurement, exchange and learning, stakeholder and community involvement, and governance. There is a need for careful planning of local support at different levels

of government based on the identified gaps. A structured approach to improving the performance of healthcare workers in healthcare facilities through visits to support quality assurance of service delivery is advisable. Particular attention should be paid to the development of coaching and mentoring mechanisms and their implementation in the activities of healthcare facilities.

The WHO publication Five Functions to Improve Maternal, Newborn and Child Health is aimed at ensuring the quality of obstetric, gynecological and pediatric care [9]. It presents five interrelated functions that support and scale up the implementation of quality of care interventions from the national and subnational levels to the health facility level. Clear information is provided to support policy makers, managers, practitioners and implementing partnerships working to improve the quality of care for maternal, newborn and child health. The paper points out that learning and the sharing of good practices and mistakes are fundamental to the improvement of the quality of services. A training system between health professionals and managers enables regular exchange of experience and can lead to adaptation and extension.

Since the quality of health care is crucial for achieving universal health coverage and sustainable development, and a significant proportion of the world's population lives in environments that are considered fragile, conflict-affected and vulnerable, the WHO resource "Quality of Care in Fragile, Conflict-Affected and Vulnerable Settings: Taking Action" was launched in 2020 [19]. This report states that delivering quality health services to fragile, conflict and vulnerable environments is challenging. Despite the difficulties of quality assurance in such conditions, there is an urgent need for action to provide quality health care in view of the significant needs of the population. "Quality of Care in Fragile, Conflict-Affected and Vulnerable Settings: Tools and Resources Compendium" [20] is a collection of accompanying tools and resources offered as a means of supporting efforts and actions to improve the quality of health care. It recognizes the urgent and specific needs and challenges related to quality of care in situations of fragility, conflict and vulnerability.

An important aspect of ensuring quality of care for mothers and children is maternal and perinatal mortality surveillance [10]. Maternal and perinatal mortality surveillance and response is a continuous cycle of identifying reports, analyzing cases, and taking action to improve the quality of care and prevent future deaths.

Given the importance of external quality assessment in ensuring the quality of care for the population, in 2022, WHO prepared the publication Healthcare Accreditation and Quality of Care: Exploring the Role of Accreditation and External Evaluation of Healthcare Facilities and Organizations [21]. It presents a broad view of accreditation as an intervention to ensure the quality of healthcare using the evidence base of accreditation and other similar external assessments along with global interdisciplinary experience and knowledge.

The WHO European Region has developed the resource "Improving Healthcare Quality in Europe. Characteristics, Effectiveness and Implementation of Different Strategies" [22]. It emphasizes various forms of quality assurance in healthcare services, including the creation of standards for healthcare professionals, healthcare technologies and healthcare facilities; audit and feedback; fostering a culture of patient safety; public reporting; and payment for quality.

Thus, information and education play an important role in improving the quality of healthcare services. WHO therefore urges countries to create and maintain a high level of professionalism in the health workforce, capable of meeting the needs of the population for high-quality health services; to advocate for the introduction of organizational culture and working methods that reduce harm to patients; to create the necessary infrastructure for training and learning; to provide technical support and manage information bases for quality improvement. These requirements determine the need for healthcare professionals to have continuous professional development and increase their knowledge of quality assurance.

An analysis of the national legal framework for ensuring the quality of healthcare services shows the importance of this issue and its regulation by a number of legal acts. For example, Article 16 of the Law of Ukraine "Fundamentals of the Legislation of Ukraine on Healthcare" stipulates that the network of state and municipal healthcare institutions is formed taking into account the development plans of hospital districts, the needs of the population in healthcare, the need to ensure the proper quality of such services, timeliness, accessibility to citizens, and the efficient use of material, labor and financial resources [23].

Back in 2011, the Concept of Healthcare Quality Management in Ukraine for the period up to 2020 was approved [24]. A number of sectoral orders approved the Procedure for controlling the quality of medical care; organization of clinical expert assessment of the quality of medical care; monitoring of clinical indicators of the quality of medical care; Sectoral programme for standardization of medical care for the period up to 2020; creation and implementation of medical and technological documents for standardization of medical care, creation of a formulary system for the provision of medicines to healthcare facilities, the Procedure for monitoring compliance with the Licensing Conditions for Medical Business Activities etc. [25-32].

One of the priority areas for ensuring the quality of medical care in the healthcare sector is the creation of programmes for continuous improvement of the quality of medical care, which are applied at various levels of healthcare and involve different categories of medical professionals; development and implementation of measures to train healthcare professionals in the field of quality management of medical care.

A sociological study was carried out among health care workers using an anonymous questionnaire to clarify the problems of identifying the educational needs of health care providers in relation to the quality of health care. Its results established the relevance of the issues of ensuring the quality of medical care and patient safety and the importance of paying due attention to these issues in the work of the

institution. On a five-point scale, healthcare professionals rated the results of implementing JCI requirements in a healthcare facility at (hereinafter – mean ± standard error of the mean) 4,3±0,07 points, the state of information about current operational processes, changes, plans etc. at 4,4±0,06 points, the clarity and comprehensibility of quality assurance tasks at 4,5±0,04 points, the method of control at 4,6±0,05 points, and the attitude of direct management at 4,6±0,05 points (Fig. 1).

The study found a significant commitment of medical personnel to patient safety activities (3,95±0,10 points on a five-point scale), openness to discussing problems of quality of care and patient safety (4,03±0,10), ways to improve them (4,1±0,09), and the creation of an environment in the healthcare facility that promotes quality of care and patient safety (3,7±0,11).

There is a high need for further continuous improvement of quality assurance activities. Healthcare professionals supported the implementation of measures to improve their knowledge and competencies in healthcare quality assessment, quality assurance and quality management. It was found that the vast majority of respondents ([hereinafter – rate ± standard error] 91,9±2,90 per 100 respondents) consider the existing level of knowledge on healthcare quality to be sufficient; only a few answers were related to its insufficiency or problems with its definition.

At the same time, 88,4±2,30 per 100 respondents indicated the need to improve their knowledge on healthcare quality in the context of continuous professional development. The overwhelming majority of respondents expressed a desire to deepen their theoretical training on modern strategies for ensuring the quality of healthcare services; regulatory and legal regulation of healthcare quality control; conceptual models of healthcare quality assurance; accreditation of healthcare facilities; licensing of medical practice; legal basis of standardization; examination of the volume and quality of medical services; assessment of medical technologies; development of clinical pathways for patients; patient safety; quality management; continuous improvement of the quality of service; international experience and national strategies for ensuring the quality of medical care etc.

The overwhelming majority of respondents indicated full-time training at the in-service training courses as a priority form of professional development (42,4±3,50 per 100 respondents). Moreover, remote on-the-job training courses (33,3±3,30 per 100 respondents), trainings, and webinars were also mentioned as desirable forms of training. The sociological survey showed the prospects of conducting training activities in healthcare facilities to meet the educational needs of healthcare professionals.

DISCUSSION

The analysis of the results obtained in the course of the study demonstrates the importance of ensuring the quality of medical care by providing it with adequate resources through improving the competence of medical professionals in this area. A number of strategic and programme documents at the international level emphasize the relevance of ensuring the quality of human resources in healthcare as a prerequisite for achieving high quality of medical care for patients. These priorities are emphasized in the WHO Guidelines for National Quality Policy and Strategy [3]. The WHO Guidelines for National Quality Policies and Strategies emphasize the need to train service providers in patient empowerment, concepts, principles and skills to ensure quality of medical care.

Informing and training of health workers is considered as one of the areas of work of stakeholders interested in

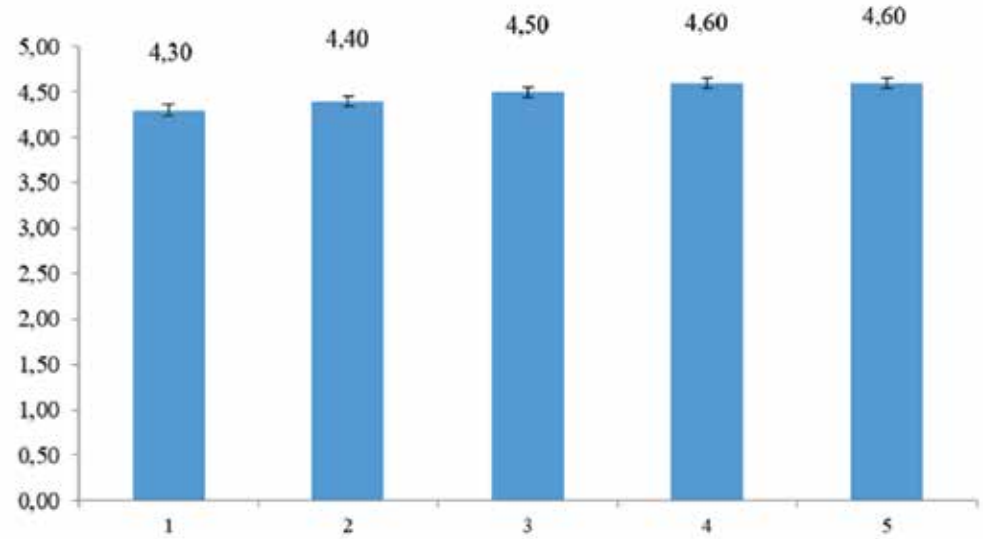

Fig.1. Assessment by of health care providers of various quality of care aspects (on a 5-point scale [mean ± standard error of the mean]): 1 – results from the implementation of JCI requirements; 2 – the state of information about current operational processes, changes, plans etc.; 3 – clarity and comprehensibility of quality assurance tasks; 4 – control method; 5 – attitude of direct management.

improving the quality of health care in the WHO documents "Delivering Quality Health Services: a Global Imperative for Universal Health Coverage" [4], "Quality Health Services: a Planning Guide" [17], "Five Functions to Improve Quality of Care for Maternal Newborn and Child Health" [9], "Quality of Care in Fragile, Conflict-Affected and Vulnerable Settings: Taking Action" [19], "Health Care Accreditation and Quality of Care: Exploring the Role of Accreditation and External Evaluation of Health Care Facilities and Organizations" [21], in the WHO Regional Office for Europe documents, in particular "Improving Healthcare Quality in Europe. Characteristics, Effectiveness and Implementation of Different Strategies" [22] etc. It is recommended to develop coaching and mentoring mechanisms in the course of educational activities, implement them in the activities of healthcare facilities; support healthcare providers in their workplaces to learn and share their knowledge, skills and motivation, and provide opportunities to share experiences on improving the quality of service.

Educational activities should be aimed at developing the competencies of medical personnel to provide high-quality and safe medical services and the need for continuous improvement of the quality of medical care; at creating appropriate infrastructure in healthcare facilities for training medical personnel and learning from experience; and at ensuring the continuous professional development of healthcare human resources.

In Ukraine, the regulatory framework for quality assurance of healthcare services has been formed, and the Concept of Quality Management in Healthcare and sectoral orders regulating quality assurance of healthcare are being implemented [23-32]. At the same time, the development of modern strategies and programmes and the introduction of innovations require constant attention to the issues of quality assurance, primarily to the educational aspects of personnel training and the creation of conditions for their continuous professional development in the context of healthcare quality management.

A sociological survey among healthcare providers confirmed the importance and priority of ensuring the quality of care and patient safety in the activities of healthcare professionals. On average, employees of the facility rated the results of implementing JCI requirements, activities to inform employees about current operational processes, innovations, plans, etc., the clarity and comprehensibility of the quality assurance tasks formulated by the management, the quality control method, and the attitude of the direct management towards employees from 4,3 to 4,6 points on a five-point scale. The commitment of the healthcare facility's specialists to work on patient safety, openness to discuss issues related to the quality of care and patient safety, areas for their improvement, and the development of conditions in the professional environment that contribute to improving the quality of care and patient safety were identified.

Despite the respondents' high assessment of their own knowledge and skills in healthcare quality assurance, the vast majority of healthcare professionals (88,4±2,30 per 100 respondents) reported a need to improve their competencies in healthcare quality. The survey identified priority topics for advanced training of healthcare providers, which relate to various aspects of the problem of ensuring the quality of healthcare for the population. The preferred forms of educational activities within the framework of continuing professional development were also established, primarily full-time training at refresher courses and distance learning courses without interrupting production activities.

CONCLUSIONS

Improving the quality of healthcare services is seen as a priority factor in strengthening healthcare systems and improving public health, with a focus on educational aspects. However, a number of challenges remain to ensure the quality and safety of healthcare services. A sociological survey conducted at the healthcare facility revealed that healthcare providers highly appreciate the results of implementing JCI requirements, the appropriate level of employee awareness of current operational processes, changes, plans, etc., the clarity and comprehensibility of quality assurance tasks, an acceptable and effective method of quality control, and the proper attitude of management towards subordinates. The commitment of employees to quality assurance and patient safety, openness to discuss these issues and ways to solve them, and the creation of a microclimate in the facility that promotes quality of care and patient safety were confirmed. The need for healthcare professionals to improve their knowledge and acquire competencies in healthcare quality assessment, quality assurance and quality management was identified; the desired topics of the educational process and the desired forms of educational activities were determined.

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CONFLICT OF INTEREST
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CORRESPONDING AUTHOR
Tetiana S. Gruzieva
Bogomolets National Medical University
34 Beresteiskyi Ave., 03680 Kyiv, Ukraine
e-mail: gruzieva@ukr.net

ORCID AND CONTRIBUTIONSHIP
Nataliia M. Mykytenko: 0000-0002-6402-4533 A B C D E F
Mykhailo D. Diachuk: 0000-0003-0390-4489 A B E
Yaroslava S. Demydenko 0000-0002-5683-136X B C D
Hanna V. Inshakova: 0000-0002-3984-8864 B C D E
Tetiana S. Gruzieva: 0000-0001-9254-7561 A B C D E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

The impact of the COVID-19 pandemic and martial law on the health and physical fitness of Ukrainian students

Grygoriy P. Griban[1], Nataliia Liakhova[2], Mykola O. Nosko[3], Yuliia M. Nosko[3], Oksana P. Kanishcheva[4], Halyna Yu. Kurtova[3], Tetiana O. Stechenko[3]

[1]ZHYTOMYR IVAN FRANKO STATE UNIVERSITY, ZHYTOMYR, UKRAINE
[2]POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE
[3]T.H. SHEVCHENKO NATIONAL UNIVERSITY "CHERNIHIV COLEHIUM", CHERNIHIV, UKRAINE
[4]KHARKIV STATE ACADEMY OF PHYSICAL CULTURE, KHARKIV, UKRAINE

ABSTRACT

Aim: The aim is to study the impact of prolonged quarantine related to COVID-19 and martial law on the health and physical fitness of students in Ukrainian higher educational institutions.

Materials and Methods: Research methods: literature analysis, surveys, testing of students' health and physical fitness, methods of mathematical statistics. The research was conducted in 2019-2023. The survey involved 462 (143 males and 319 females) students. Health assessments and physical fitness tests were conducted with second-year students (before quarantine (2019): males – n = 63; females – n = 78; after quarantine (2023): males – n = 51; females – n = 67).

Results: The negative attitude of the majority of students (66.4 % of men and 76.5 % of women) to distance learning in physical education was revealed. A significant deterioration of all studied indicators of students' health and physical fitness during the quarantine period related to COVID-19 and martial law in Ukraine was revealed.

Conclusions: Since the state of health and level of physical fitness of students is the main criterion for the effectiveness of physical education in higher educational institutions of Ukraine, physical education departments should focus their work on modernizing traditional and developing new forms and methods of physical education, shaping students' civic consciousness and behavior, their readiness to serve society and protect the state with dignity.

KEY WORDS: health, physical fitness, COVID-19 pandemic, students

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INTRODUCTION

Constant mental and psycho-emotional tension, information stress, insufficient material security, low motor activity, inadequate nutrition, polluted environment, etc. play an important role among the factors that negatively affect students' health [1]. The health of the entire population of Ukraine and student youth, in particular, is deteriorating as a result of prolonged quarantine restrictions related to COVID-19 and the large-scale war in Ukraine, the unstable socio-economic situation, and the growing number of families forced to change their usual way of life (temporarily emigrate to other places of residence), and insufficient funding for the health care system.

The deterioration of the health of today's youth may lead to the loss of the gene pool and the biological extinction of the nation shortly. That is why one of the leading tasks of physical education of students in higher educational institutions (HEIs) at this stage is to preserve their health and foster motivational and value-based attitudes to physical exercise, to develop healthy lifestyle skills because the health of the future generation will depend on the health of the country's modern youth [2].

Health is formed under the influence of a large number of factors i. e. social and biological, material and spiritual, which interact with each other in a complex and contradictory way. Scientists [3] include physical education among the conditions that determine the preservation of health. Several studies have shown that out of the total number of factors that influence the formation of students' health (taken as 100 %), physical exercises account for 15-30 %, sleep – 24-30 %, nutrition – 10-16 %, and 24-50 % are due to the total effect of the remaining factors [4]. That is why the system of physical education, especially in higher educational institutions, is tasked with preserving the physical, mental, and moral health of young people.

According to the WHO, one in four adults and four in five adolescents have low motor activity [5]. During the COVID-19 pandemic, when students were at home for a lot of time, the quantity and quality of daily exercise were very important [6]. COVID-19 has caused devastating global morbidity and mortality not only among the elderly but also among young people. Measures have been taken around the world to prevent the transmission of the virus from person to person and improve overall health. As a result of these actions, the level of motor activity of

the population has decreased. Daily sedentary behavior has led to a decrease in the level of health and physical fitness of students and, as a result, a decrease in the body's protective functions.

AIM

The aim is to study the impact of prolonged quarantine related to COVID-19 and martial law on the health and physical fitness of students in Ukrainian higher educational institutions.

MATERIALS AND METHODS

The research was conducted at the Ivan Franko Zhytomyr State University in 2019-2023. The survey, aimed at studying students' attitudes towards distance learning in the discipline referred to as "Physical Education," involved 462 (143 males and 319 females) students of the Faculties of Physics and Mathematics, History, Socio-Psychological, Natural Sciences, and the Institutes of Foreign Philology, Pedagogics, Philology, and Journalism. Health assessments and physical fitness tests were conducted with second-year students (before quarantine, men – n = 63; women – n = 78; after quarantine, men – n = 51; women – n = 67) who were engaged in physical exercises during the discipline referred to as "Physical Education" according to the university curriculum in September-December 2019 (before the COVID-19 quarantine) and in March-May 2023 when distance learning ended.

To achieve this aim, the following research methods were used: literature analysis, surveys, testing of students' health and physical fitness, and methods of mathematical statistics. For the research, 13 sources from the scientometric databases Index Copernicus, Scopus, PubMed, Web of Science, and others were analyzed and studied. The survey, which was conducted according to the author's questionnaire, allowed us to study students' attitudes towards distance learning in the discipline referred to as "Physical Education" and evaluate its consequences. The questionnaire contained 10 questions related to the dynamics of students' motor activity during quarantine, their physical fitness and health, mental state, level of theoretical knowledge and methodological skills in physical education, and reasons for students' absence from physical education training sessions during distance learning. The state of students' health was assessed by the method of qualitative rapid assessment of the level of somatic health by G. L. Apanasenko [7], which is based on the calculated indices of body weight, vital and strength indices, Robinson Index and Martine-Kushelevsky tests. Physical fitness was assessed by the following tests: men – 100 m run, pull-ups, standing long jump, lifting torso to the sitting position over 1 min, 4 x 9 m shuttle run, leaning torso forward; women – 100 m run, push-ups, standing long jump, lifting torso to the sitting position over 1 min, 4 x 9 m shuttle run, leaning torso forward.

Methods of mathematical statistics were used to assess the reliability of the difference between the studied indicators and to correctly process the results. The compliance of the sample with the normal law was checked using the coefficient of variation (V), which allowed the use of Student's t-test. The significance for all tests was set at $p<0.05$. This research followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all students who took part in this research.

RESULTS

The introduction of the self-isolation regime in 2019 restricted motor activity on the streets and sports grounds, which means that the only place where Ukrainian students were allowed to exercise was their place of residence. Training sessions were held according to the schedule via the Zoom system. Due to the transition to distance learning, students spent most of their time at the computer, in a "sitting" position, which led to physical inactivity, eye diseases, spinal curvature, and a decrease in the level of activity of their body's functional systems. The quarantine has led to the fact that such a discipline as "Physical Education" has faced the problem of a kind of incomplete implementation, since the computer, and home conditions of quarantine restrictions cannot replace the gym, training grounds, and stadium, which were previously the usual locations for training sessions.

Currently, distance learning is one of the most common forms of education in Ukraine. The quarantine restrictions (since December 2019) and martial law (since February 2022) have forced higher educational institutions to switch to distance learning. Distance learning allowed to preserve and ensure the continuity of the educational process, which was of great social and psychological importance, especially during the war. The distance learning process made it possible to control students, provide them with psychological and moral, and sometimes material support, which united society against russian aggression. The resumption of distance learning in Ukraine during the war also slowed down the departure of students abroad and facilitated their return to study, which influenced the rise of the patriotic movement of Ukrainians to fight the enemy.

At the same time, distance education has several disadvantages in conducting practical training sessions in physical education, namely: 1) high dependence of students on the quality of the Internet network; 2) lack of opportunity to communicate with the instructor and colleagues; 3) low motor activity of practical training sessions; 4) impossibility of timely intervention of the instructor in the educational process; 5) difficulty in timely correction of student's mistakes during exercises; 6) lack of individual and differentiated approach to students; 7) no possibility to control all students and provide them with timely methodological advice, etc. Studies have shown that between 9.7 and 13.8 % of students missed distance learning training sessions in the Zoom system and continued their studies in other forms. The reasons for students' absence from training sessions during the COVID-19 epidemic and martial law in Ukraine were identified as lack of an Internet network, phone, or computer, staying in places with strangers, power outages, inability to connect to

training sessions remotely, etc. (Table 1). The reasons also include the following: lack of desire to study (12.6 % – men; 9.7 % – women); poor psychological state, anxiety (16.1 % – men; 18.5 % – women); simulation (7.7 % – men; 6.0 % – women), etc.

The questionnaire survey of students allowed us to identify their attitude towards distance learning in the discipline referred to as "Physical Education" and assess its consequences. A positive assessment of the distance learning process was given by 35.7 % of male and 23.5 % of female students. The explanation for this is that these students do not prioritize studying, or have a long distance to the educational institution, work, or lack of desire to study. Most students had a negative attitude towards the distance learning process in physical education, namely: 66.4 % of men and 76.5 % of women (Table 2).

At the same time, distance learning proved to be effective in conducting theoretical, informational, cognitive, methodological, and motivational classes. An increase in the level of theoretical knowledge in the field of physical culture was indicated by 90.2 % of men and 94.4 % of women, and the level of methodological training of students increased similarly. The situation was much worse when conducting practical physical education training sessions remotely. It was impossible to complete tasks in sports games, athletics, strength exercises, etc. Students did not comprehensively develop all physical qualities, but only partially during the period of distance learning. A decrease in the level of motor activity during the COVID-19 epidemic and russia's armed aggression against Ukraine was reported by 91.6 % of men and 91.9 % of women. Distance learning has led to a deterioration in health (96.5 % of men and 89.0 % of women) and a decrease in the level of physical fitness of students (88.8 % of men and 92.8 % of women). 93.7 % of men and 86.5 % of women showed symptoms of psychological discomfort and nervousness.

Table 1. Reasons for students' absence from physical education training sessions during distance learning (number of people / %)

Reasons	Gender	
	Males (n = 143)	Females (n = 319)
Lack of an Internet network	17 / 11.9	34 / 10.7
Lack of a phone or computer	7 / 4.9	9 / 2.8
Staying in places with strangers	8 / 5.6	17 / 5.3
Power outages	13 / 9.1	29 / 9.1
Inability to connect to the training session remotely	8 / 5.6	22 / 6.9
Air raid alarms	112 / 78.3	307 / 96.2
Simulation	11 / 7.7	19 / 6.0
Lack of desire to study	18 / 12.6	31 / 9.7
Poor psychological state, anxiety	23 / 16.1	59 / 18.5

Table 2. Assessment of distance learning in the discipline referred to as "Physical Education" by students of higher educational institutions (number of people / %)

Assessment	Gender	
	Males (n = 143)	Females (n = 319)
Positive	51 / 35.7	75 / 23.5
Negative	92 / 66.4	244 / 76.5
As a temporary necessity	137 / 95.8	294 / 92.2
Increased level of theoretical knowledge	129 / 90.2	301 / 94.4
Increased level of methodological preparedness	123 / 86.0	298 / 93.4
Decreased level of motor activity	131 / 91.6	293 / 91.9
Decreased level of physical fitness	127 / 88.8	296 / 92.8
Deteriorated state of health	138 / 96.5	284 / 89.0
Psychological discomfort and nervousness	134 / 93.7	276 / 86.5
Decreased ability to communicate	119 / 83.2	307 / 96.2

Table 3. Comparative analysis of students' physical health indicators before and after quarantine

Physical health indicators	Research stages		Difference	Reliability of the difference	
	Before quarantine	After quarantine		t	p
		Males			
Body mass index, kg/m^2	23.2 ± 0.25	24.7 ± 0.29	1.5	3.92	< 0.01
Vital index, ml/kg	57.8 ± 0.83	55.1 ± 0.96	2.7	2.13	< 0.05
Strength index, %.	54.5 ± 1.17	49.6 ± 1.23	4.9	2.89	< 0.05
Robinson index, c. u.	85.6 ± 1.21	89.4±1.27	3.8	2.17	< 0.05
Martinet-Kushelevsky test, s	132.4 ± 3.21	141.8±3.38	9.4	2.02	< 0.05
		Females			
Body mass index, kg/m^2	20.7±0.28	22.3±0.30	1.6	3.90	<0.01
Vital index, ml/kg	48.5±1.06	44.9±1.13	3.6	2.32	<0.05
Strength index, %.	42.3 ± 1.13	37.2±1.19	5.1	3.11	<0.01
Robinson index, c. u.	85.1 ± 1.09	88.4 ± 1.14	3.3	2.09	< 0.05
Martinet-Kushelevsky test, s	136.7±3.52	147.5±3.71	10.8	2.11	<0.05

Table 4. Comparative analysis of students' physical fitness before and after quarantine

Tests	Research stages		Difference	Reliability of the difference	
	Before quarantine	After quarantine		t	p
		Males			
100 meters run (s)	14.53 ± 0.64	15.78 ± 0.83	1.25	2.41	< 0.05
Pull-ups (times)	8.93 ± 0.91	6.47 ± 0.94	2.46	3.38	< 0.01
Standing long jump (cm)	228.41 ± 2.13	220.26 ± 1.79	8.15	2.54	< 0.05
Lifting torso to the sitting position over 1 min (times)	38.29 ± 1.84	29.97 ± 1.83	8.32	3.21	< 0.01
4 x 9 m shuttle run (s)	9.13 ± 0.96	10.83 ± 0.89	1.70	2.82	< 0.01
Leaning torso forward (cm)	14.81 ± 0.97	10.18 ± 0.87	4.63	2.57	< 0.05
		Females			
100 meters run (s)	17.34± 1.19	18.67 ± 1.28	1.33	2.46	< 0.05
Push-ups (times)	14.57 ± 1.36	8.67 ± 1.29	5.90	3.58	< 0.001
Standing long jump (cm)	174.21 ±7.48	165.46 ± 7.64	8.74	2.23	< 0.05
Lifting torso to the sitting position over 1 min (times)	35.23 ± 2.75	27.51 ± 2.69	7.72	2.82	< 0.01
4 x 9 m shuttle run (s)	10.87 ± 0.68	11.96 ± 0.83	1.09	2.79	< 0.01
Leaning torso forward (cm)	15.76 ± 0.93	12.24 ± 0.91	3.52	2.24	< 0.05

The results of a comparative analysis of students' physical health indicators before and after quarantine are presented in Table 3. The analysis showed that all the studied indicators of students (both men and women) significantly ($p < 0.05$-0.01) deteriorated during the quarantine period. Thus, the difference between the values of body mass index of students before and after quarantine was 1.5 kg/m^2 in men and 1.6 kg/m^2 in women; between the values of vital index – 2.7 ml/kg in men and 3.6 ml/kg in women; between the values of strength index – 4.9 % in men and 5.1 % in women; between the values of Robinson index – 3.8 c. u. in men and 3.3 c. u. in women; between the values of the Martine-Kushelevsky test – 9.4 s in men and 10.8 s in women.

It was also found that distance learning during quarantine had the worst effect on the indicators of vital, strength indices and the Martine-Kushelevsky test (the duration of heart rate recovery after 20 squats over 30 seconds). The values of these indices after quarantine correspond to below-average and low levels in students of both sexes. The analysis reliably indicates a low motor activity of students during quarantine and martial law, which led to an increase in students' body weight, deterioration of their cardiovascular and respiratory systems, and a decrease in strength indicators, which in general led to a deterioration in their health. The comparative analysis of the physical fitness of students before the pandemic (2019) and after, when they started studying as usual (2023), showed a significant

decrease in physical fitness during the period of distance learning (Table 4). In all physical fitness tests, there was a significant decrease in men's indicators, namely: in 100 m run by 1.25 s, in pull-ups – by 2.46 times, in standing long jump – by 8.15 cm, in lifting torso to the sitting position over 1 min – by 8.32 times, in 4 x 9 m shuttle run – by 1.7 s, in leaning torso forward – by 4.63 s ($p < 0.05$-0.01).

Similar results in physical fitness testing were obtained for female students, where the indicators decreased in 100 m run by 1.33 s, in push-ups – by 5.9 times, in standing long jump – by 8.74 cm, in lifting torso to the sitting position over 1 min – by 7.72 times, in 4 x 9 m shuttle run – by 1.09 s, in leaning torso forward – by 3.52 s ($p < 0.05$-0.001). This indicates that students' motor activity during the period of distance learning associated with quarantine and martial law in Ukraine was very low, which negatively affected their physical fitness.

DISCUSSION

According to the results of scientific research [8], students are the most vulnerable to health deterioration in Ukraine, as they face several difficulties related to low motor activity, increased academic workload, and problems in social and interpersonal communication. One of the most serious reasons for the indifferent attitude of young people towards maintaining their health is the state of the current system of physical and health education in Ukrainian higher educational institutions of various professional orientations [9]. There has been a loss of the educational focus of the physical education process, which has resulted in a low level of physical education among students. As a result of the COVID-19 pandemic and the full-scale war in Ukraine, negative trends in the deterioration of student health continued at an even faster pace. Currently, Ukraine's health care system is not able to solve the problem of improving student health.

In modern conditions, scientists [10] consider health as a multidimensional phenomenon with a heterogeneous structure that combines qualitatively different components and reflects the fundamental aspects of human existence. At the same time, the system of physical education does not help to solve the problems of preserving students' health. The concept of "health" in our minds turns into a rather mundane, widely used term, the content of which is not necessary to think about every day, which practically does not stimulate the assessment of its importance in everyday life. The whole complexity of organizing health education in the system of physical education of students in a distance format is a complex, dynamic process and belongs to the spheres of both education and attitude development.

A high degree of academic load connected with distance learning for most students led to a decrease in the level of motor activity, which resulted in the development of various diseases, and a decrease in their mental and physical working capacity [11, 12]. At the same time, the authors [13] point out that performing daily physical exercises for 20-50 minutes will improve physical and mental health, ensure that physical fitness is maintained at the proper level, and strengthen the immune system. Therefore, physical education departments in distance learning should recommend that all students train and exercise (subject to quarantine conditions) to promote their health in order to maintain a sufficient level of motor activity, promote health, and spend time in self-isolation not only without negative consequences for the body but also with benefit.

CONCLUSIONS

1. Quarantine restrictions have created extremely difficult conditions for ensuring the quality of the educational process in physical education, especially practical training sessions. The issue of organizing and conducting physical education training sessions during quarantine has become extremely acute: lack of necessary information on working in such conditions, a completely new format of physical education training sessions to ensure the necessary motor activity of students with a safe and interesting approach, skepticism of the general public about physical education through a computer monitor, etc. At the same time, distance learning in physical education has provided ample opportunities for students to acquire theoretical knowledge on healthy lifestyles, health care, knowledge of their bodies, and mastery of health-saving technologies. On the other hand, distance physical education has significantly limited the motor capabilities of students, reduced the level of their motor activity, health, and physical fitness, and limited the mastery of skills in various sports.

2. The comparative analysis of the state of health and physical fitness of students before quarantine restrictions and after their completion convincingly confirmed the low quality of practical physical education training sessions in remote mode, and low level of motor activity, which significantly reduced the level of health and physical fitness of students, both men and women.

3. Physical education in a distance format is the process of students' learning the values of physical culture, and mastering special knowledge and vital motor actions, which results in their ability to independently "manage" their health, carry out preventive, and, if necessary, rehabilitation and corrective measures. Designing the process of distance learning for students is a new direction in pedagogical science that requires the development of special pedagogical methods and physical education and health technologies for their implementation during quarantine conditions. At the same time, it is necessary to develop students' responsible attitudes towards their health, and not just the accumulation and expansion of health-saving methods and teaching technologies. On the contrary, it is necessary to specify, define, and substantiate the content of students' physical education and health activities in distance learning. During distance learning in physical education, it is important to form fundamental general theoretical health-preserving knowledge, methodological skills, and practical implementation of available physical exercises.

Prospects for further research are aimed at testing the effectiveness of the author's methodology for conducting physical education training sessions in the distance learning mode.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Nataliia Liakhova
Poltava State Medical University
24 Shevchenko St., 36000 Poltava, Ukraine
e-mail: NataNew2017@ukr.net

ORCID AND CONTRIBUTIONSHIP

Grygoriy P. Griban: 0000-0002-9049-1485 B
Nataliia Liakhova: 0000-0003-0503-9935 E
Mykola O. Nosko: 0000-0001-9903-9164 A
Yuliia M. Nosko: 0000-0003-1077-8206 D
Oksana P. Kanishcheva: 0000-0002-5030-5318 C
Halyna Yu. Kurtova: 0000-0002-6939-631X D
Tetiana O. Stechenko: 0000-0002-5672-3457 F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Mandible bone remodeling after natural collagen transplantation: morphological and radiological aspects

Ilona V. Chelpanova
DANYLO HALYTSKY LVIV NATIONAL MEDICAL UNIVERSITY, LVIV, UKRAINE

ABSTRACT

Aim: To investigate in an experiment the dynamic changes in the mandible bone following traumatic injury and subsequent defect replacement with an osteoplastic material - natural collagen.

Materials and Methods: Experiments were conducted on 45 male rabbits aged 6-7 months, weighing 2.5-3.0 kg. The control group included 20 animals with a bone tissue defect that healed under a blood clot. The experimental group consisted of 20 rabbits where the bone defect was filled with natural collagen (Col-C). Post-traumatic bone tissue status within the defect area was monitored for 84 days by The assessment of jaw macrostructure, radiographic examination, radiovisiography, examination of bone sections under a microscope, and lectin-histochemical analysis of decalcified bone sections.

Results: A comprehensive examination of the experimental bone defect in the rabbit mandible, following implantation of natural collagen revealed extensive regenerative processes. These processes were observed at both the macroscopic and microscopic levels, corroborating the findings of radiographic and radiovisiographic analyses. Microscopic evaluation further elucidated the sequential nature of these regenerative changes and provided insights into the composition of the newly formed bone tissue.

Conclusions: The application of the osteoplastic material (Col-C) demonstrated a high capacity to positively influence the processes of neo-osteosynthesis, followed by remodeling of the damaged bone. This ensures reliable functionality of the entire dentoalveolar system.

KEY WORDS: rabbits, lower jaw/mandible, dentoalveolar system, bone tissue, regeneration, colagen, , radiographic method, lectin-histochemistry

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INTRODUCTION

The development of new technologies for bone tissue regeneration is a priority area in dentistry and traumatology [1]. Bone substitutes are becoming increasingly popular as an alternative to autologous transplantation in experimental bone engineering and clinical practice. Taking into account the natural regenerative capacity of bone tissue, the occurrence of such conditions as extensive post-traumatic bone defects, especially infected ones, significantly slows down the rate of regeneration and causes a number of complications that significantly hinder complete remodeling [1, 2]. In such cases, surgical intervention using synthetic osteoplastic materials, often enriched with antibacterial components, is necessary [3]. Collagen, the main component of the bone matrix, has long been a key element in the development of ideal synthetic bone tissue substitutes. However, despite the wide application of collagenous materials, their weak mechanical properties, susceptibility to rapid degradation, and lack of osteoconductive activity hinder their effectiveness in bone tissue replacement and limit their widespread clinical use [4-7]. The choice of material for bone grafting depends on many factors, such as availability, size of the defect, biomechanical properties, ease of processing, cost, ethical aspects, biological properties, and potential complications [8, 9].

AIM

The aim of this study is to investigate in an experiment the dynamics of changes in the lower jaw bone after its traumatic injury with subsequent replacement of the defect with osteoplastic material – natural collagen.

MATERIALS AND METHODS

The study involved 45 adult male rabbits, aged 6-7 months, with a weight range of 2.5-3 kg. The animals were divided into control and experimental groups (20 animals in each). An additional 5 intact animals were used to study the normal structure of bone tissue in the studied area of the lower jaw.

Animals in both groups, under general anesthesia by intraperitoneal injection of Thiopental ("Brofarma", Ukraine) at a dosage of 25 mg/kg body weight, were subjected to a bone-destructive injury in the form of a shaft 4 mm deep and 3 mm wide at the level of the edentulous segment of the mandibular body using a dental drill. The control group consisted of animals with a bone defect that healed under a blood clot. The experimental group consisted of rabbits in which the bone defect was filled with natural collagen Collacone «Botiss dental», Germany (Col-C). Post-traumatic bone tissue status within the defect area was monitored at 1, 7, 14, 21, 28, 35, 56 and 84 days after the injury using the

following methods: bone defect modeling, assessment of jaw macrostructure, radiographic examination, radiovisiography, examination of bone sections under a microscope, and lectin-histochemical analysis of decalcified bone sections.

The Bioethics Committee of Danylo Halytsky Lviv National Medical University (protocol No. 3 dated March 11, 2020) has established that all animals were housed in a vivarium and procedures for cleaning, inspection, marking and all other manipulations were carried out in accordance with the provisions of the "European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes" (Strasbourg, 1985), the "General Ethical Principles of Experiments on Animals" adopted by the First National Congress on Bioethics (Kyiv, 2001), the Law of Ukraine No. 3447-IV "On the Protection of Animals from Cruel Treatment" in accordance with the Directive of the Council of the European Union 2010/63/EU on compliance with the regulations, laws, and administrative provisions of the EU Member States on the protection of animals used for scientific purposes[10, 11].

The visual assessment of the jaw macrostructure was carried out according to the following criteria: condition of the mucousa, swelling, hyperemia, and the contours of the postoperative field. The bone tissue was examined after jaw maceration. X-rays of the jaw were taken using the ZooMax LG device (Hungary) with computer processing of the obtained data. Radiovisiography was used to determine bone density. Radiovisiograms were obtained using a dental radiovisiography device (Siemens) with Trophy Radiology software. To obtain micro-preparations of bone sections, bone samples along with surrounding tissues were fixed in glutaraldehyde, dehydrated, and embedded in a mixture of epoxy resins. Sections were obtained from the resulting blocks, polished, and then glued on to a glass slide. The detection of carbohydrate determinants (lectin histochemical study) was carried out using lectins of different carbohydrate specificity (Lectinotest, Lviv) - WGA, LABA, CNFA.

RESULTS

When filling the bone defect with Col-C material within the first week after injury, macroscopic examination of macerated preparations of the lower jaw in the invasion area revealed a clearly contoured defect with smooth edges, 4 mm deep and 3 mm wide. During the first two weeks, the defect zone didn`t exhibit any signs of ossification at the periphery of the defect. Starting from the 3rd week, the walls of the experimental defect in the macerated preparations were contoured indistinctly, with characteristic structural irregularities and protrusions, indicating the onset of osteoregenerative processes under the influence of Col-C. On the 28th day after the injury, the primary bone defect cavity contained mainly components of the Col-C material and, to a lesser extent, inorganic remnants of bone regenerate (Fig. 1). An unevenly closed defect with indistinctly contoured edges was observed during the 35-56th days after the injury. The newly formed regenerate began to fill the cavity and by the end of the experiment, on the 84th day, the surface of the bone smoothed out. In the area of the defect, there were weakly expressed irregularities and a slight elevation above the surface of the native bone, in contrast to the similar bone in intact animals. After 84 days of the experiment, the surface of the

Fig. 1. Macrophotograph of the rabbit's lower jaw 4 weeks after the injury and filling the defect with Col-C material. Lateral projection.

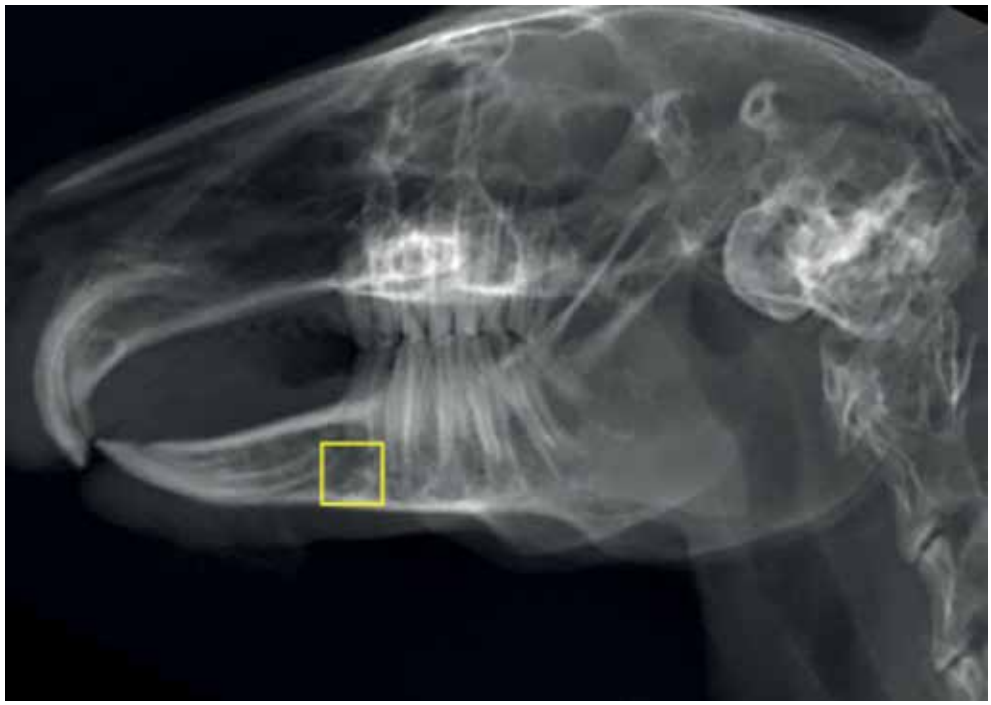

Fig. 2. Radiograph of the rabbit's lower jaw 4 weeks after the injury and filling the defect with Col-C material. Lateral projection. The augmentation area is highlighted in yellow.

Fig. 3. Radiograph of the rabbit's lower jaw 3 weeks after the injury and filling the defect with Col-C material. Determination of bone mineral density. Lateral projection.

bone smoothed out, with weakly expressed irregularities observed in the area of the defect.

During the X-ray examination of animals whose bone defect was filled with Col-C, one day after the injury, a shaft formed in the bone tissue of the alveolar region was clearly visualized against the background of the light zone, presumably due to swelling of soft tissues corresponding to the signs of the inflammatory phase. After 7 days, the light zone persisted, the bone defect was partially covered by an unevenly formed soft tissue callus. Over the next two weeks (on the 14th and 21st days of the experiment), a gradual darkening of the injured area was observed,

the soft tissue callus unevenly covered the defect, which corresponded to the recovery phase. On the 28th day of the experiment, the light area continued to darken, areas of ossification were identified in the soft tissue callus, which indicates the beginning of the remodeling phase (Fig. 2). 35 days after the injury and until the end of the experiment, the remodeling phase continued, the bone callus unevenly covered the defect.

The quality of bone tissue when filling the bone defect with Col-C material changed significantly over 12 weeks of the experiment. One day after the injury, bone tissue density increased to 86.48±2.55 HU, exceeding the normal value by 21%. Over the next two weeks of the experiment, the studied value continued to increase and 7 days after the injury was 91.03±5.63 HU, and after 14 days reached its maximum value – 92.34±2.07 HU, exceeding the norm by 29.6%. A gradual decrease in bone tissue density in the area of the injury was observed starting from the 21st day and until the end of the experiment (Fig. 3).

After 21 days after the injury, the studied value was 88.93±1.83 HU, after 28 days – 84.24±2.66 HU, after 35 days – 86.49±3.97 HU, after 56 days – 81.71±1.83 HU. Bone tissue density in the area of the injury dropped to the minimum level for the entire study period on the 84th day of the experiment, reaching 78.66±1.74 HU and remaining 10.4% ($p<0.01$) higher than the normal value.

Comparison of the dynamics of bone tissue density in the alveolar region of the lower jaw after filling the defect with Col-C material with the control level made it possible to establish its features, characteristic of the experimental and control groups of animals. Analysis of the absolute values of the studied indicator showed that until the 28th day after the application of Col-C it was inferior to the corresponding control values, on the 35th day - it exceeded the control level, on the 56th and 84th day, no significant difference was found between the indicated groups of animals (Fig. 4).

In both groups, the bone tissue density index in the studied area had maximum values on the 14th day of the experiment, however, unlike the control group, where the studied index doubled compared to the norm, after filling the defect with Col-C material on the same term, bone tissue density exceeded the norm by only 30%. At the final stage of the experiment, the studied indicator in both groups remained higher than normal, while the indicator of the experimental group did not significantly differ from the control level (Fig. 5).

Thus, the most statistically significant difference ($p<0.001$) in the values of the studied indicators with control was established on the 1st, 7th, and 14th day of the experiment, a less significant difference ($p<0.01$) - on the 21st, 28th, and 35th day, and after 56 and 84 days after osteoplasty, no significant difference was observed. When comparing the bone density indicators that were determined during different periods of bone defect regeneration after filling it with Col-C material, a statistically significant difference was determined when comparing the normal value with the parameters established at different periods of post-traumatic bone defect regeneration using Col-C after 1, 7, 14, 21, 28, 35 and 56 days ($p<0.001$), as well as after 84 days ($p<0.05$). When comparing the studied indicators established for this experimental group during different

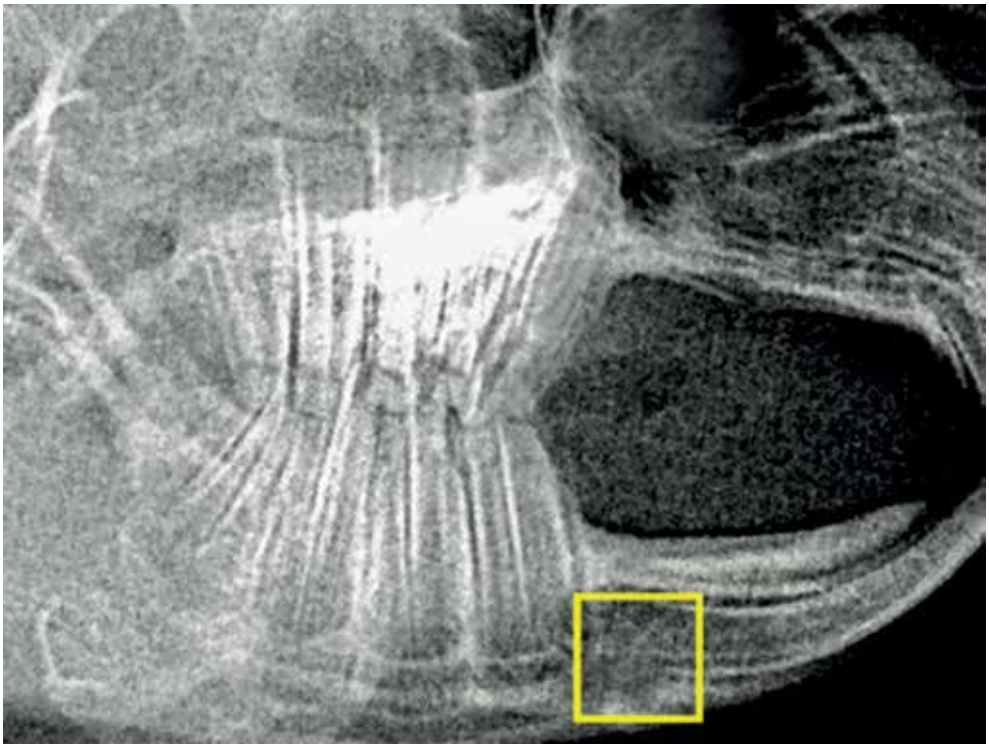

Fig. 4. Radiovisiogram of the rabbit's lower jaw 8 weeks after the injury and filling the defect with Col-C material. Lateral projection. The augmentation area is highlighted in yellow.

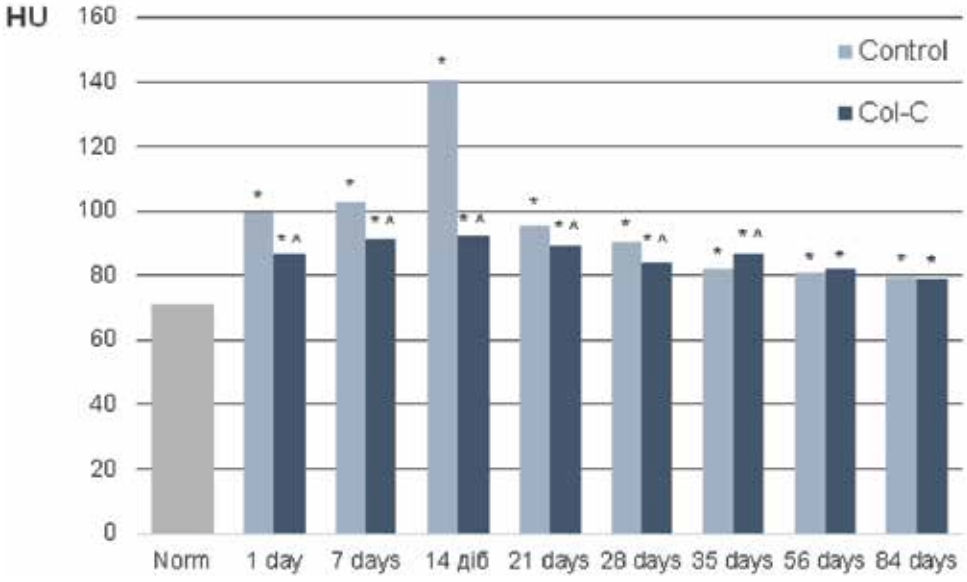

Fig. 5. Dynamics of changes in bone tissue density in the alveolar region of the lower jaw after filling the defect with Col--C material:
* – statistically significant difference when compared to the norm (71.25 HU);
^ – statistically significant difference when compared to the control group.

periods of the experiment, a significant difference was found between the values recorded after 1 day and 56 days ($p<0.05$), 1 day and 84 days ($p<0.05$), 14 days and 28 days ($p<0.05$), 14 days and 56 and 84 days ($p<0.01$), 21 days and 84 days ($p<0.05$), 35 days and 84 days ($p<0.05$).

The microstructure of mandible bone sections after augmentation of a bone defect with Col-C, showed a number of features of bone tissue remodeling in response to the applied material. The structure of bone tissue in the area of the defect and areas somewhat distant from it in the early stages of the experiment (up to 21 days) didn`t significantly differ from the animals in the control group (Fig. 6).

Starting from the 28th day of the experiment, while using Col-C, certain structural features of the regenerative process were registered. Thus, in the outer bone plate of the alveolar process, against the background of persistence of remnants of individual destroyed osteons, the appearance of fairly large zones of homogeneous substrate with isolated islands of coarse-fibrous bone was observed. On the surface of these islands, cells of slightly oval or flattened shape were located,

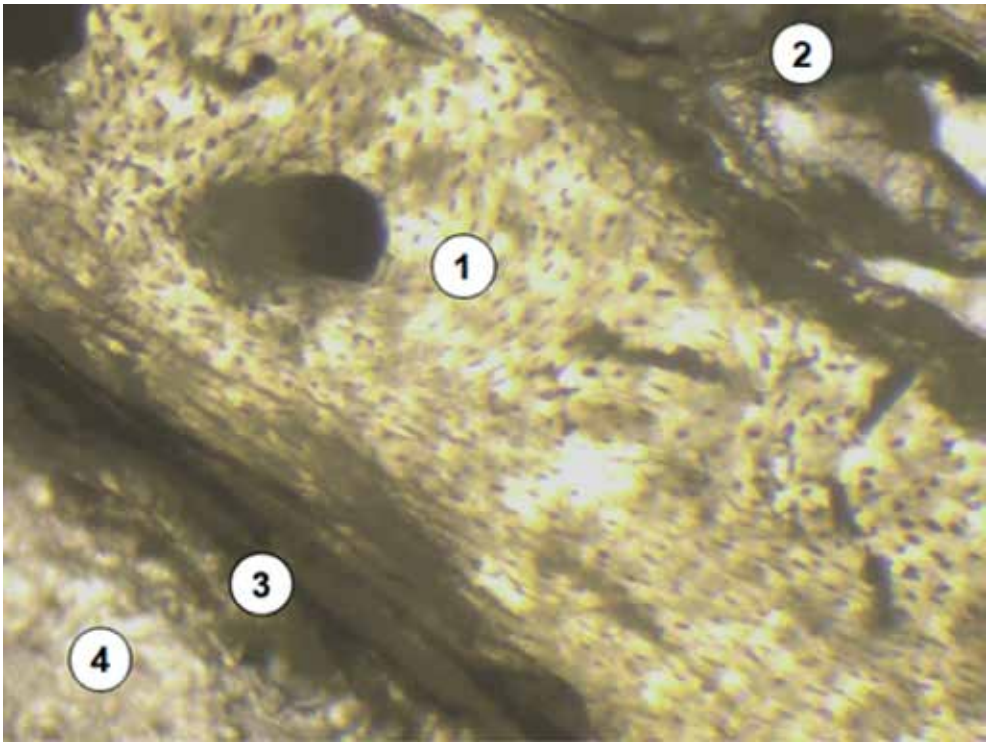

Fig. 6. Micrograph of the rabbit mandible bone section 2 weeks after trauma and filling the defect with Col-C material. ×200.
1 – osteon layer of the trabecula;
2 – periodontal ligament; 3 – endosteum of the bone beam;
4 – implanted material.

which morphologically corresponded to osteoblasts. It is important to note that in these areas, an increased density of micro vessels was observed. In places of contact of the Col-C mass with the bone, the content of osteogenic cells increased with the simultaneous presence of osteolysis zones. In the inner bone plate of the alveolar processes, which is directly connected to the periodontium, the preservation of most osteons, which had a predominantly perpendicular orientation relative to the surface, was noted. At the base of the bone of the alveolar processes, starting from the 28th day of the experiment, a decrease in the number of fragments of destroyed bone trabeculae and the formation of separate islands of woven bone were revealed.

When examining the prepared bone sections at later stages (35 days), an intensification of regenerative processes was observed, followed by significant remodeling of the bone towards its normal structure. This primarily concerned the outer bone plate of the alveolar processes. In its structure, a high content of blood micro vessels was observed, the mass of woven bone increased, which at later stages (8 and 12 weeks) showed signs of remodeling into lamellar compact bone, as evidenced by the high content of osteons.

At the same period, the inner bone plate of the alveolar processes exhibited a typical structure, resembling intact tissue in terms of overall histoarchitecture. Notably, it was densely permeated by a large number of Volkmann's canals, suggesting a reliable connection with the periodontium of the roots of adjacent teeth. The base of the alveolar process bone from the 8th to 12th week of the experiment also underwent some remodeling: signs of transformation of woven bone into lamellar bone were observed (Fig. 7). Signs of this process included the recruitment of a large number of cellular elements, presumably osteoclasts and osteoblasts. The osteoclasts were responsible for resorbing the woven bone, while the osteoblasts synthesized collagen fibers and components of osteoid, followed by its mineralization. Evidence of this was the formation of cancellous lamellar bone, observed by us at the 12th week of the experiment. Additionally, the surface of the newly formed bone trabeculae was covered with single cells and structurally resembled the endosteum, known to be a vital stromal component of red bone marrow.

Therefore, the results of studying the bone sections of the rabbit mandible after application of the osteoplastic material Col-C demonstrate its considerable capacity to positively influence the processes of neo-osteosynthesis with subsequent remodeling of the damaged bone, ensuring reliable functioning of the entire dentoalveolar complex. The peroxidase-labeled lectins we used during bone defect augmentation with Col-C revealed significant variation in the intensity of binding to carbohydrate determinants of structural components of bone tissue in the alveolar processes of the mandible, periodontium, and gums. In particular, when studying lectin WGA, high reactivity was observed in early stages of the research (2-3 weeks) in structures such as the endothelium of microcirculatory vessels, individual cellular elements of the periodontal ligament, and fibroblast-like cells of the propria lamina of the gums. At later stages of the experiment (5-12 weeks), the lectin exhibited a somewhat different binding activity with these structures. Notably, the vascular endothelium was predominantly unreactive, however, isolated loci of carbohydrate-containing determinants of the basal

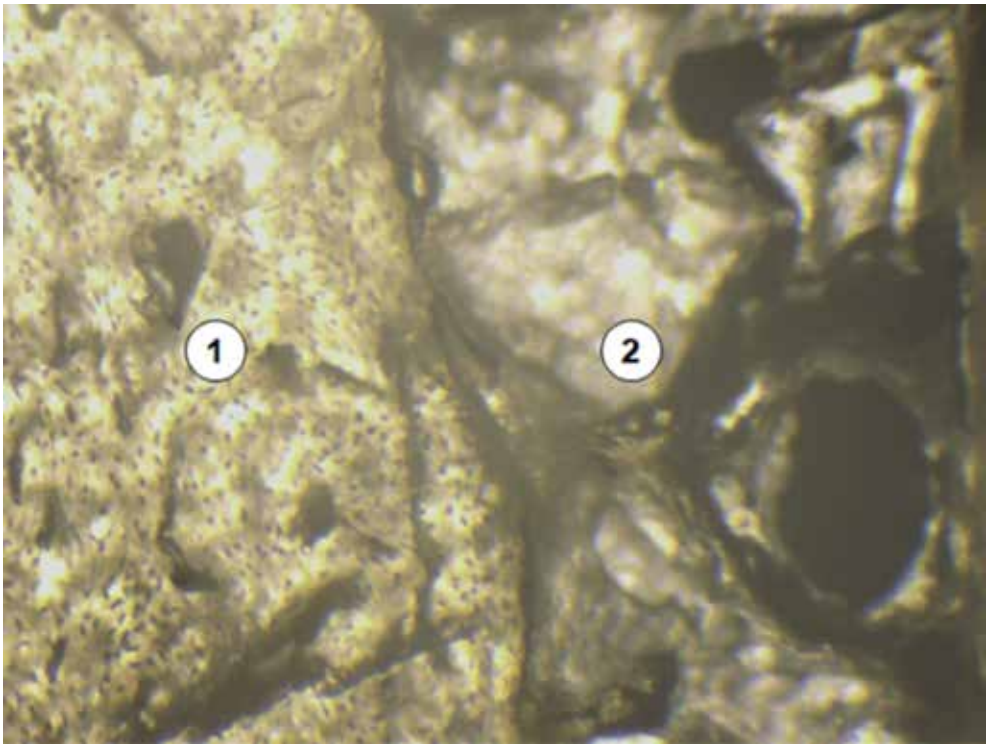

Fig. 7. Micrograph of the rabbit mandible bone section 8 weeks after trauma and filling the defect with Col-C material. ×200. 1 – native bone; 2 – distorted mineralization of the regenerate.

membranes of small blood vessels were observed. The lectin-histochemical reactivity of cellular elements at these time points didn`t tend to undergo significant changes in either the experimental or control groups of the study.

When studying the galactose- and fucose-specific lectin LABA after osteoplasty using Col-C, predominantly isolated labeled cellular elements were observed in the examined preparations. Notably, at the end of the first day of the experiment, against the background of bone-destroying trauma, clusters of cells were observed in directly adjacent tissues, whose surface intensely bound this lectin. This carbohydrate specificity is known to be possessed by cells of the macrophage system, thus, the obtained result indicates the presence of an acute inflammatory process with the involvement of a large number of macrophages we identified. At the same time, other cell populations, such as osteogenic cells, fibroblast-like cells, and migrating cells, were unreactive throughout the study period. The content of cells of macrophage origin in the dynamics of the experiment tended to decrease, which is probably due to the slowing down of the macrophages migration to the focus of inflammation, first of all, or the masking or loss of the corresponding carbohydrate determinants. Starting from the 4th week of the experiment and until its completion, the lectin did not show any noticeable activity, and the results obtained at this time did not differ from the research objects of the control group. However, it should be noted that the lectin showed little specificity to the endothelium and subendothelial layer of small arteries, the basal membrane of the gingival epithelium.

Treatment of the preparations with lectin CNFA demonstrated a certain mosaicism of its binding to carbohydrate determinants of individual structures. Thus, this lectin unexpectedly bound to destroyed tissue material (detritus) already one day after the application of Col-C material. In the dynamics of the experiment, lectin CNFA had a selective ability to bind to cellular elements of the periodontium (2-3 weeks), the walls of hemocapillaries (5-8 weeks). Other CNFA-positive cellular elements included, primarily, fibroblast-like cells within the periodontium and gums in both the experimental and control groups of the study. It should also be noted that lectin CNFA, unlike other lectins we studied, selectively conjugated with carbohydrate residues of the endosteum of bone trabeculae, which was most pronounced at late stages of the experiment (8-12 weeks), while the endosteum of bone trabeculae in intact animals was unreactive.

DISCUSSION

Bone grafting is a common procedure in dentistry, traumatology, and regenerative medicine, finding widespread application in various clinical scenarios. [12,13]. It is utilized in periodontal surgery, dental implant placement, sinus lifts, socket preservation, and numerous other procedures [14, 15, 16]. Bone is a complex, hierarchically organized material. Its unique architecture and optimal composition allow for a rare combination of high strength and flexibility, a challenging balance in traditional material design. [17]. Hydroxyapatite nanocrystals deposited by osteoblasts onto collagen fibrils form the inorganic and organic phases of the bone matrix. The work of Fan L, Ren Y et al. shows that the bone matrix has a hierarchical structure, consisting of 65% mineral phase, hydroxyapatite, 35% organic phase (~90% type I collagen, 5% non-collagenous proteins, and 2% lipids by weight) and a small amount of water. [4]. Collacone (Col-C) is a 100% natural collagen preparation in a conical form that is used to stimulate wound healing. It acts as a natural matrix for the formation of new osteogenic cells. Collacone exhibits high biocompatibility and a predictable outcome in preserving the height of the mandible alveolar process . Main characteristics of Collacone include: a high resorption rate, lasting for 2-4 weeks, ensuring blood clot stabilization, and effective local hemostasis. Collagen cones have found widespread application in various fields of dentistry, including implantology, periodontology, and maxillofacial surgery. They are used to control bleeding and hemostasis after tooth extraction, during biopsies, and during closed sinus lifts [18]. Collagen-based materials in various forms, including membranes, sponges or matrices, hydrogels and composite scaffolds, are also widely used in vivo to support bone tissue regeneration in various clinical applications [19].

Collagen type I, according to research, is becoming an increasingly important component of bone substitutes. Osteoplastic materials based on collagen do not require additional surgical intervention to harvest bone tissue. This significantly reduces the risks of infection, scarring, and other complications, as well as shortens the surgery time. Wide availability, biocompatibility, osteoconductivity, and ease of manipulation with this material meet the growing demand for bone reconstruction. Continuous improvement of collagen-based materials and their combinations will pave the way for innovative approaches in dentistry, which will ultimately benefit patients who require regenerative treatment.

CONCLUSIONS

The study of the macrostructure of the experimental mandible bone defect after implantation of natural collagen revealed numerous regenerative changes that occurred after trauma and correlated with the data of radiographic and radiovisiography studies. The study of microsections of bone samples enabled us to establish the phased nature of the dynamics of the investigated regenerative changes and the composition of the regenerate. Examining bone sections of rabbits mandible after applying the osteoplastic material Col-C revealed its significant capacity to positively influence neo-osteosynthesis processes followed by remodeling of the damaged bone, ensuring the reliable functioning of the entire dentoalveolar complex. Furthermore, the use of peroxidase-labeled lectins during Col-C bone defect augmentation revealed significant differences in the intensity of binding to carbohydrate determinants of the structural components of bone tissue in the alveolar processes of the mandible, periodontium, and gums. The quality of bone tissue during the filling of the bone defect with Col-C material significantly changed throughout the 12 weeks of the experiment.

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CONFLICT OF INTEREST

The Author declare no conflict of interest

CORRESPONDING AUTHOR

Ilona V. Chelpanova
Danylo Halytsky Lviv National Medical University
52 Pekarska St., 79010 Lviv
e-mail: ilona.med75@gmail.com

ORCID AND CONTRIBUTIONSHIP

Ilona V. Chelpanova: 0000-0001-5215-814X A - F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Effectiveness of a skill lab on nursing students' knowledge to perform peripherally inserted central catheter insertion: a quasi-experimental study

Ioannis Kouroutzis, Maria Malliarou
UNIVERSITY OF THESSALY, LARISSA, GREECE

ABSTRACT

Aim: To evaluate the knowledge and confidence of nursing students of a Greek university related to Peripherally Inserted Central Catheter (PICC) insertion and care.
Materials and Methods: A quasi-experimental study using a one-group pretest–posttest design consistent with Transparent Reporting of Evaluations with Nonrandomized Designs guidelines. The study was conducted in a university laboratory in March 2024. Participants were followed before and after the training lab. The lab involved 80 nursing students. For the comparison of evaluation score before and after the intervention Mann-Whitney, McNemar and Wilcoxon singed rank tests were used. Repeated measures analysis of variance (ANOVA) was adopted, based on scores' logarithmic transformation. Spearman correlations coefficients (rho) were used to explore the association between knowledge and evaluation scores.
Results: The knowledge score increased significantly after the lab in total sample and regardless of students' gender and age. The satisfaction was higher regarding the new and important knowledge that students gained and the usefulness of this knowledge in their professional activity.
Conclusions: The findings underscore the value of incorporating specialized, hands-on training into nursing curricula to enhance students' competencies in advanced clinical procedures.

KEY WORDS: nursing, education, PICC, vascular access, advanced practice, quasi-experimental

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INTRODUCTION

Vascular access is the most commonly performed invasive procedure in the healthcare system [1] while Peripherally Inserted Central Catheters (PICCs) offer several advantages over traditional Central Venous Catheters [2]. However, PICCs can lead to complications. To address this issue, not only theoretical but practical training as well must be optimized as there is a wide evidence that PICC insertion and effective management has great correlation with nurses' training on the procedure [3].

Preparing university nursing students for administering advanced practice and cultivating their skills and competencies since their Bachelor studies is really important in the provision of safe care that is needed when dealing with PICCs' insertion and management [3, 4].

Vascular access is the most commonly performed invasive procedure in the healthcare system, involving the insertion of vascular access devices (VADs) into central or peripheral veins or arteries, which are crucial for delivering fluids, medications, and monitoring patient status. Their use has expanded beyond hospitals into alternative healthcare settings, making it essential to support healthcare professionals, patients, as well as their families [1].

It is estimated for US Adult Inpatient Population at Acute Care Hospitals that the length of stay increased about 10.4 days, because of central line-associated bloodstream infections (CLABSI) [5]. The same researchers identified CLABSI as the most expensive healthcare-associated infections, with a cost per case of $45, 814 (95% CI, $30, 919-$65, 245). According to Loftus et al. [6], the estimated mortality rate associated with CLABSI was 23.8%.

Vascular access is vital for safe and effective care, but it carries additional risks, like catheter occlusion, breakage, leakage, bleeding, thrombosis, vessel perforation, pneumothorax, cardiac arrhythmias, air embolisms, and central venous stenosis, phlebitis, infiltration, and extravasation, so there is a significant need for up-to-date, evidence-based guidelines to guide healthcare providers in safe practices [1].

In response to this need, there are promptings to hospitals worldwide to invest in specialized teams known as vascular access teams (VATs). In the U.S., approximately 63% of hospitals have VATs, and this model is being adopted in other countries as well. These teams, typically led by registered nurses, are trained to insert various vascular access devices, and some VATs also contribute to device selection, management, and the education and training of staff. Data indicates that hospitals with these teams tend to follow evidence-based practices more closely and experience fewer complications like infections and deep vein thrombosis (DVT) [7].

Lastly, there is also a strong recommendation for healthcare organizations to implement practical education programs focused on the insertion and maintenance of VADs [1].

It is recognized that anything related to advanced practice is inherently complex, and rightfully so, as patient safety is on the line [8].

University nursing education is essential in developing and sustaining a skilled nursing workforce. It is advised that nursing students start considering their career paths strategically from the undergraduate level, while seeking the necessary support and mentoring. Preparing university nursing students for advanced practice roles in the future and enhancing opportunities for developing APN (Advanced Practice Nurse) competencies are important. One effective intervention to support the transition from RN (Registered Nurse) to APN could involve focusing on improving clinical competencies and providing evidence-based patient care [4].

APNs play an important role in a rapidly changing and demanding global health care environment characterized by an aging population, increasing chronic disease and workforce shortages. Nurses make up nearly half of the global health workforce, and their roles, particularly in advanced practice, are expanding to meet these challenges. APNs have taken on innovative roles such as clinical nurse specialists and nurse practitioners, but there is no global consensus on their core competencies. To maximize the impact of APNs, the need for a competency-based training need to be emphasized. APNs have the potential to improve health outcomes across various settings, from hospitals to community care [9].

International evidence highlights the positive impact of advanced practitioners on healthcare delivery due to their specialized knowledge, broad qualifications, and ability to provide comprehensive care. The roles of accountability, higher-level decision-making, and autonomy distinguish advanced practice from other frontline nursing roles. However, advanced practitioners are expected to address complex issues ethically for both individuals and populations, using their advanced expertise to make senior clinical decisions and contribute to the knowledge base in their specialty [10].

Peripherally inserted central catheters (PICCs) have become increasingly important in both inpatient and outpatient settings for providing long-term vascular access, especially in patients requiring extended treatments like chemotherapy, long-term antibiotic therapy, or intravenous fluids [11]. PICCs offer several advantages over traditional central venous catheters, including greater reliability for intermediate to long-term use, and lower complication rates during insertion [2]. They are typically inserted through peripheral veins, such as the basilic, cephalic, or brachial veins, and advanced to a central vein, offering a safe and efficient alternative to surgically inserted venous catheters [12].

However, PICCs are not without risks. They can lead to complications like thrombosis, bloodstream infections, accidental dislodgement, and catheter occlusion [12]. The success of PICC insertion is significantly influenced by the experience and education of the nurses performing the procedure, as well as the frequency with which these procedures are carried out. This highlights the critical need for specialized training and regular practice to ensure effective and safe PICC insertions [3].

Ultrasound-guided venous selection is widely regarded as a best practice for inserting PICCs, as it helps avoid complications, such as injury to the brachial artery or median nerve, and ensures the selection of an appropriately sized vein [11]. Different methods are available to confirm PICC placement, including chest radiography, magnetic navigation with electrocardiogram confirmation, and fluoroscopy-guided insertion. Nurse-led PICC insertion services are also available in some hospitals, though these are sometimes associated with higher rates of malposition compared to fluoroscopy-guided insertions, particularly in complex cases like those involving patients with cystic fibrosis or lung transplants [11].

To minimize complications and maximize the safety of PICCs, it is essential for nurses to be thoroughly trained and educated on best practices for PICC management, including blood draws, flushing, and troubleshooting [12]. Routine practices, such as flushing catheter lumens with sterile normal saline and using turbulent flushing techniques, are recommended to maintain catheter patency and prevent complications. Additionally, proper dressing and timely changes to the administration set are crucial for minimizing infection risks [12].

Finally, while PICCs offer a less invasive and effective option for long-term vascular access, their successful use depends heavily on the expertise of the healthcare providers managing them. Enhanced training, adherence to best practices, and ongoing evaluation are essential to reducing complications and improving patient outcomes.

AIM

The aim of this research is to evaluate the knowledge and the confidence of the first-year nursing students of a Greek university related to the Peripherally Inserted Central Catheter insertion and care, before and after a training lab.

We sought to answer the following question:

Does the lab increase student knowledge scores on PICC lines insertion and care?

We also tested the following hypotheses:

1. The training lab predicts students' increase of knowledge about PICC line insertion and care.
2 The students' evaluation feedback predicts high level of satisfaction.
3. No significant difference on knowledge scores between male and female students.
4. Significant difference on knowledge scores between <19 and >19 years old student groups.

MATERIALS AND METHODS

STUDY DESIGN AND PARTICIPANTS

We conducted a quasi-experimental study using a one-group pretest–posttest design consistent with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines [13].

We conducted our study according to the Kirkpatrick model [14] in order to evaluate the training related to the Peripherally Inserted Central Catheter insertion and care assessing reaction and learning criteria. This study

involved first-year nursing students, where assessing behavioral criteria is challenging, leading us to focus on reaction and learning criteria rather than behavioral and results criteria, as the latter emphasize changes beyond the training program [15].

The Kirkpatrick model is a widely acknowledged approach for assessing the outcomes of training and educational programs [16]. Kirkpatrick proposed a four-level model for evaluating training: reaction criteria, learning criteria, behaviour criteria and results criteria [17]. The Kirkpatrick's model was originally developed to evaluate the training process in organisations, but it can also be used in the academic context [14]. According to Heydari et al. [18], the Kirkpatrick's model is suitable and has an acceptable performance record for assessing educational programmes. The reaction and learning criteria focus on what occurs within the training and they are considered as internal criteria while behaviour and results criteria focus on changes that occur outside the training and therefore are seen as external criteria [15].

The reaction level can measure either one dimension, such as satisfaction, or multiple dimensions, such as the content of the training material, timing, delivery methods or trainers [19].

Learning outcomes can be categorized into three main aspects: cognitive, skill-based, and attitudinal [20]. Cognitive outcomes pertain to the acquisition of knowledge [21], while skill-based outcomes involve the development of technical or motor skills.

Behavioural criteria evaluate positive change in behavior and researcher can use either interviews, questionnaires or observations to assess it while results criteria measures effectiveness of training in terms of quality or quantity improvement [17]. Attitudinal outcomes encompass elements such as goals, motivation, and attitudes that align with the objectives of the training program [20]. Successful learning is demonstrated at the conclusion of the training if participants have enhanced their knowledge, developed new skills, or adopted a different attitude, indicating that they have gained value from the training [22, 23].

We conducted our study in March 2024 in the Laboratory of Education and Research of Trauma Care and Patient Safety of the Department of Nursing of the University of Thessaly (Greece). This Laboratory aims to prepare nursing students to provide high-quality nursing health care and protect individuals and populations from harmful health outcomes.

The lab was organised within the course "Nursing Fundamentals" of the curriculum of the first cycle of studies (EQF level 6), that had a total of 105 students enrolled during the academic year 2023-2024. Of those, 80 students (n=80) participated in the study. The sample of the study was collected with convenience sampling technique.

The inclusion criterion was everyone who filled in the three questionnaires. The exclusion criterion was anyone who was either unwilling/unable to participate or did not complete the training lab that were part of the intervention. Twenty-five did not fill in the three questionnaires, that is the reason the final sample was 80 students (n=80).

The lab involved two main training sessions (one for the theory and one for the practice). The training sessions were carried out by the researchers and two Laboratory collaborators with 105 students. Each session lasted approximately two hours.

In the first session, researchers provided further information about the survey to the students, who filled in informed consent for their participation directly in the online form. The form was anonymous and unique codes were blindly distributed to participants to allow identification of pre- and post-experimental measurements, and the students filled in the first measurement. We, then, provided further information about the lab content. The fundamentals of vascular access, the most common complications that occur and the costs they impose on healthcare systems, as well as the importance of advanced skills in daily clinical practice, such as the insertion and maintenance of the Ultrasound-guided Peripherally Inserted Central Catheters, were discussed. We presented the characteristics of these catheters, the insertion points and indications of placement, drugs with acidic pH, the flow rates in the vessels, and the use of correct solutions for PICC care and hand hygiene. We comprehensively analyzed all evidence-based nursing interventions before, during and after the catheter insertion. At the end of the first session, we discussed several case studies, choosing the right device, based on the algorithm that was designed by Manrique-Rodríguez et al [24].

The second session included, also, training in the use of ultrasound, and the Seldinger technique in a special training model. Then, students had the opportunity to practice their skills in a simulated procedure about the PICC insertion and care. The students were asked to fill in the same questionnaire again, and a satisfaction questionnaire about the lab, evaluating various parameters.

At the end, students took a trifold brochure issued by the Laboratory with basic information about PICC lines and a surgical cap for everyone as a memento and reminder of the principles of the correct PICC care and patient safety.

Following van Daele et al. [25] recommendations about assessing intervention fidelity, we took a collaborative approach by discussing and adapting practical and content-related aspects. The training was conducted by a certified team who are experts in PICC line insertion and care. These instructors were well-versed in both the theoretical and practical aspects of the procedure, ensuring a high level of consistency across all training sessions. To maintain fidelity, each training session followed a detailed protocol. Consistency in delivery was monitored through direct observation by the lead researchers, to ensure all critical components were covered.

We developed an online 20-item questionnaire using the Google Forms tool to collect responses about the knowledge of the students about PICC line insertion and maintenance, in which we included questions about age, sex, and semester in addition to the measurement items, in order to identify the participants' characteristics. Before formulating the questions, which relied on the content of the theoretical part, we reviewed the relevant literature

and we used expert reviews which are frequently used as a questionnaire evaluation method [26].

As for their satisfaction from the lab, we developed another online questionnaire using the Google Forms tool. We collected responses about the assessment of the new important knowledge, the duration, the fulfillment of expectations, the usefulness in professional activity and parameters such as the content, the organization, the guest instructors, the quality of material, the possibility of practical application and the laboratory infrastructure, on Likert scales from 1 to 5, where 1 is the worst and 5 is the best.

Before starting the lab, each student completed the pre-experimental questionnaire and immediately after the post-experimental and the satisfaction one. Distribution was by sharing the questionnaire via a QR code and we received it immediately upon online submission. All questionnaires were anonymous as we blindly distributed unique codes to participants to identify the pre- and post-experimental data.

STATISTICAL ANALYSIS

Quantitative variables were tested via Kolmogorov-Smirnov test for their normality. They were expressed as mean values (Standard Deviation) and as median (interquantile range), while categorical variables were expressed as absolute and relative frequencies. Mann-Whitney test was used for the comparison of evaluation score between two groups. McNemar test was used for comparison of the percentages of correct answers between pre- and post-lab measurements. Wilcoxon singed rank test was used for knowledge score comparison between pre- and post-lab measurements. In order to examine if the degree of change in the knowledge score was associated with students' age and gender, repeated measures analysis of variance (ANOVA) was adopted, based on scores' logarithmic transformation. Spearman correlations coefficients (rho) were used to explore the association between knowledge and evaluation scores. All reported p values are two-tailed. Statistical significance was set at $p<0.05$ and analyses were conducted using SPSS statistical software version 26.0[27].

ETHICS

We obtained ethical approval from the Research Ethics Committee of the Department of Nursing of the University of Thessaly (Decision Number and Date: 318/21-03-2024). Additionally, we received informed consent for their participation from the students.

RESULTS

Sample consisted by 80 students (85% females; n=68), with mean age 19.2 years (SD=3.3 years). Almost all students were at the 2nd semester (98%; n=79).

In table 1, students' answers in the knowledge questions are provided, pre and post lab. Before the lab, the percentages of correct answers ranged from 5% (in question 7) to 87.5% (in question 8). After the lab, the percentages of correct answers ranged from 3.8% (in question 7) to 100% (in question 1).

The percentages of answering correctly increased significantly after the lab in questions 1 (from 73.8% to 100%; $p<0.001$), 2 (from 40% to 92.5%; $p<0.001$), 3 (from 78.8% to 92.5%; $p=0.013$), 4 (from 56.3% to 85%; $p<0.001$), 5 (from 11.3% to 71.3%; $p<0.001$), 6 (from 65% to 90%; $p<0.001$), 9 (from 47.5% to 81.3%; $p<0.001$), 10 (from 53.8%

Table 1. Pre and post lab answers in knowledge questions

		Pre		Post	
		n	%	n	%
01. In which of the following vessels can the PICC catheter be inserted?	a) Cephalic, brachial or basilic	59	73.8	80	100.0
	b) Subclavian	16	20.0	0	0.0
	c) Inferior Vena Cava	2	2.5	0	0.0
	d) Femoral	3	3.8	0	0.0
02. The tip of a PICC catheter ends:	a) Right Atrium	32	40.0	74	92.5
	b) Middle of the Clavicle	36	45.0	4	5.0
	c) Right Ventricle	12	15.0	2	2.5
03. Indications for placing a PICC catheter include:	a) Drug administration	10	12.5	4	5.0
	b) Parenteral nutrition administration	0	0.0	1	1.3
	c) Blood collection	1	1.3	1	1.3
	d) Blood products administration	4	5.0	0	0.0
	e) None	2	2.5	0	0.0
	f) All of the above	63	78.8	74	92.5
04. Drugs with a low pH can cause:	a) Burn in the tunica intima of the vessels	45	56.3	68	85.0
	b) Bleeding	4	5.0	2	2.5
	c) Damage in the tunica externa	31	38.8	10	12.5

Table 1. cd.

05. The flow rate in the superior vena cava is:	α) 90-150mL/min	36	45.0	17	21.3
	β) 1000mL/min	35	43.8	6	7.5
	γ) 2000mL/min	9	11.3	57	71.3
06. Only 20% of the complications are due to wrong handling by the staff during use.	False	52	65.0	72	90.0
	True	28	35.0	8	10.0
07. Both adherence to a protocol and the application of subjective procedures by nurses contribute to the reduction of catheter complications.	False	4	5.0	3	3.8
	True	76	95.0	77	96.3
08. Aseptic technique is not necessary for catheter placement.	False	70	87.5	74	92.5
	True	10	12.5	6	7.5
09. Place the hand hygiene products that follow in an order of the most effective to the least: a. alcohol-based formulation b. soap c. antimicrobial soap	a) Alcohol-based formulation	0	0.0	0	0.0
	b) Soap	0	0.0	0	0.0
	c) Antimicrobial soap	0	0.0	0	0.0
	d) a-b-c	5	6.3	4	5.0
	e) b-c-a	38	47.5	65	81.3
	f) b-a-c	32	40.0	6	7.5
	g) None	5	6.3	5	6.3
10. The use of antibiotics for prophylaxis can have economic benefits for the health organization.	False	43	53.8	62	77.5
	True	37	46.3	18	22.5
11. To reduce contamination rates, the use of sterile gloves is sufficient provided that a sterile drape is placed.	False	42	52.5	57	71.3
	True	38	47.5	23	28.8
12. Daily PICC line care includes:	a) Overview of the insertion site	3	3.8	5	6.3
	b) Daily dressing change	0	0.0	3	3.8
	c) Dressing change only in case of blood or fluid accumulation	3	3.8	2	2.5
	d) a+b	31	38.8	29	36.3
	e) a+c	43	53.8	41	51.3
13. Complications include:	a) Phlebitis	3	3.8	7	8.8
	b) Extravasation	1	1.3	2	2.5
	c) Colonization of the catheter	0	0.0	0	0.0
	d) Probe rupture	2	2.5	0	0.0
	e) All of the above	61	76.3	63	78.8
	f) a+c	9	11.3	6	7.5
	g) b+c	4	5.0	2	2.5
14. After administration of parenteral nutrition, the recommended amount of N/S 0.9% for flushing the PICC is:	a) 10mL	48	60.0	49	61.3
	b) 20mL	22	27.5	25	31.3
	c) 100mL	10	12.5	6	7.5
15. The preparation of the PICC line placement includes:	a) Hand hygiene	48	60.0	22	27.5
	b) Placement of cap and mask	1	1.3	0	0.0
	c) Surgical gown with sterile apron	4	5.0	2	2.5
	d) All of the above	27	33.8	56	70.0
16. The suggested antiseptic for the insertion site is:	a) Povidone-iodine	9	11.3	1	1.3
	b) Alcohol	31	38.8	4	5.0
	c) Chlorhexidine	21	26.3	20	25.0
	d) All of the above	19	23.8	55	68.8
17. We stabilize using the Statlock Stabilization Device and not with sutures to avoid infections and thrombosis of the peripheral vein.	False	14	17.5	16	20.0
	True	66	82.5	64	80.0
18. The confirmation of the PICC line tip position is made only by fluoroscopic visualization.	False	43	53.8	30	37.5
	True	37	46.3	50	62.5

to 77.5%; p=0.001), 11 (from 52.5% to 71.3%; p=0.009) and 15 (from 33.8% to 70%; p<0.001), while the percentage of answering correctly decreased after the lab only in question 18 (from 53.8% to 37.5%; p=0.021) (Table 2 and Fig. 1).

The knowledge score before the lab ranged from 22.2% to 66.7%, while after the lab it ranged from 27.8% to 88.9%. The scores are presented in table 3, in total sample as well as by gender and age. The knowledge score increased significantly after the lab in total sample (Fig. 2) and regardless of students' gender and age. No significant differences were found between males and females in the measurements before (p>0.999) and after (p=0.553) the lab and in the degree of increase in their knowledge scores (p=0.581). Before the lab, students under 19 years old had significantly lower score (p=0.029), while after the lab no significant difference was found between the

Table 2. Percentages of correct answers in each question, before and after the lab

Item	Pre		Post		P McNemar test
	n	%	n	%	
1	59	73.8	80	100.0	<0.001
2	32	40.0	74	92.5	<0.001
3	63	78.8	74	92.5	0.013
4	45	56.3	68	85.0	<0.001
5	9	11.3	57	71.3	<0.001
6	52	65.0	72	90.0	<0.001
7	4	5.0	3	3.8	>0.999
8	70	87.5	74	92.5	0.289
9	38	47.5	65	81.3	<0.001
10	43	53.8	62	77.5	0.001
11	42	52.5	57	71.3	0.009
12	43	53.8	41	51.3	0.804
13	61	76.3	63	78.8	0.791
14	22	27.5	25	31.3	0.678
15	27	33.8	56	70.0	<0.001
16	21	26.3	20	25.0	>0.999
17	66	82.5	64	80.0	0.824
18	43	53.8	30	37.5	0.021

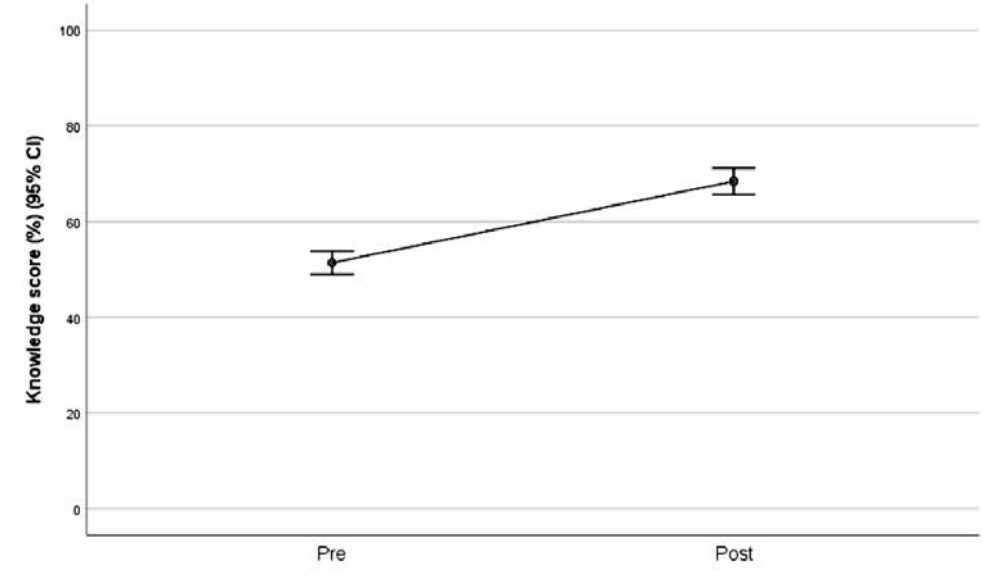

Fig. 1. Percentages of correct answers in each question, before and after the lab.

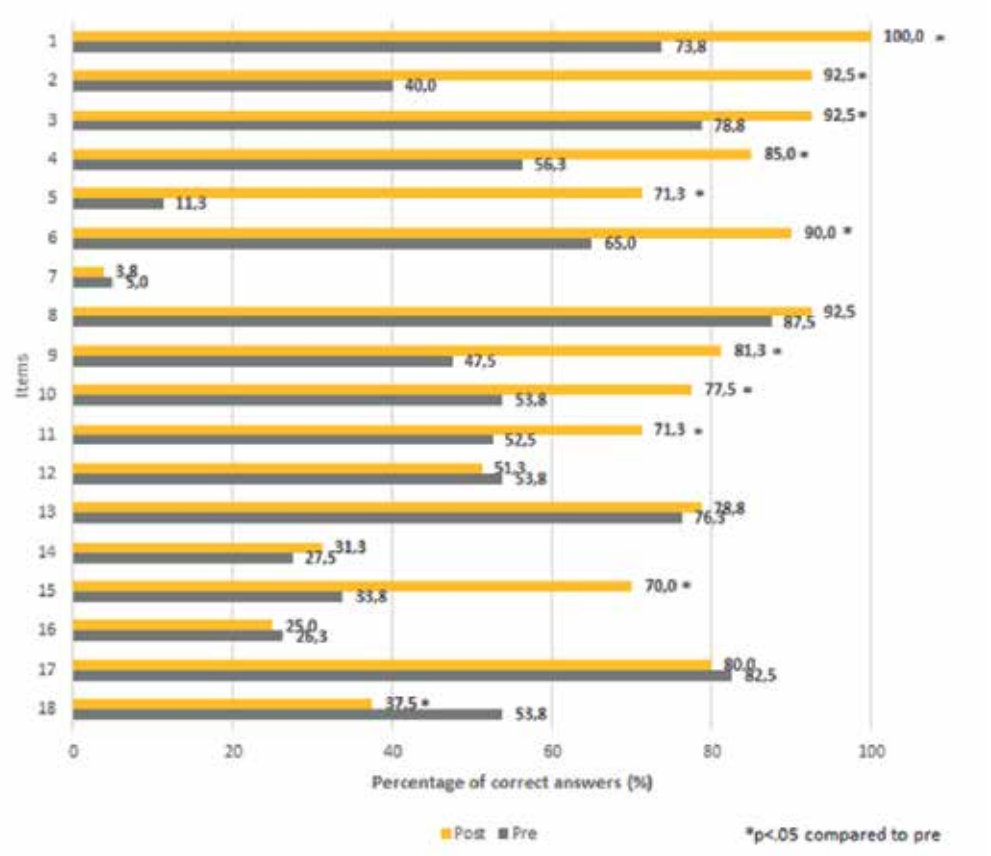

Fig. 2. Change in knowledge score.

Table 3. Changes in knowledge score, in total sample and by gender and age

	Knowledge score %						
	Pre		Post		Change		
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	P[2]	P[3]
Total sample	51.4 (10.8)	50 (44.4-61.1)	68.4 (12.4)	72.2 (61.1-77.8)	17.0 (13.3)	<0.001	-
Gender							
Females	51.4 (11)	50 (44.4-61.1)	68.1 (12.8)	72.2 (61.1-77.8)	16.7 (13.4)	<0.001	0.581
Males	51.4 (10.4)	50 (44.4-58.3)	70.4 (9.9)	69.4 (63.9-77.8)	19.0 (12.6)	<0.001	
P[1]	>0.999		0.553				
Age (years)							
<19	47.9 (12.1)	50 (38.9-55.6)	67.6 (14.8)	72.2 (66.7-77.8)	19.7 (13.7)	<0.001	0.132
≥19	53.4 (9.6)	55.6 (44.4-61.1)	68.8 (10.9)	72.2 (61.1-77.8)	15.5 (12.9)	<0.001	
P[1]	0.029		0.674				

Note. Age was divided into two groups according to its median. Analysis was based on logarithmic transformations
*[1]p-value for group effect; [2]p-value for time effect; [3]repeated measures ANOVA p-value, regarding time*group effect.*

two age groups (p=0.674). Also, the degree of increase in their knowledge score was similar in the two age groups (p=0.132).

Information regarding students' evaluation of the lab is provided in table 4. The evaluation was higher regarding the new and important knowledge that students gained and the usefulness of this knowledge in their professional activity. Also, the material quality and the educators where the elements of the lab that were evaluated more highly.

The evaluation score ranged from 42.5% to 100%, with mean being 76% (SD=14.9%), Table 5. The evaluation score was not found to be significantly different between males and females (p=0.414), as well as between students younger than 19 years old and students at least 19 years

Table 4. Lab evaluation

	Not at all 1	2	3	4	Absolutely 5
	n (%)	n (%)	n (%)	n (%)	n (%)
Do you think you gained new and important knowledge at the Lab?	0 (0)	0 (0)	9 (11.3)	24 (30)	47 (58.8)
The duration of the Lab was:	0 (0)	2 (2.5)	44 (55)	25 (31.3)	9 (11.3)
Your expectations from the Lab were met:	0 (0)	1 (1.3)	16 (20)	45 (56.3)	18 (22.5)
Do you think that the knowledge you gained will be useful in your professional activity?	0 (0)	2 (2.5)	7 (8.8)	21 (26.3)	50 (62.5)
Evaluate the lab regarding:	The worst 1	2	3	4	The best 5
Content	1 (1.3)	1 (1.3)	17 (21.3)	27 (33.8)	34 (42.5)
Organization	1 (1.3)	9 (11.3)	15 (18.8)	23 (28.8)	32 (40)
Educators	0 (0)	2 (2.5)	14 (17.5)	19 (23.8)	45 (56.3)
Material quality (portable ultrasound, p reforms)	1 (1.3)	2 (2.5)	14 (17.5)	16 (20)	47 (58.8)
Possibility of practical application	4 (5)	15 (18.8)	23 (28.8)	17 (21.3)	21 (26.3)
Space infrastructure	0 (0)	12 (15)	19 (23.8)	30 (37.5)	19 (23.8)

Table 5. Students' evaluation score in total sample and by gender and age

	Evaluation score %		P+
	Mean (SD)	Median (IQR)	
Total sample	76 (14.9)	77.5 (65-87.5)	
Gender			
Females	75.2 (15.4)	77.5 (63.8-87.5)	0.414
Males	80.2 (11.7)	77.5 (70-90)	
Age (years)			
<19	75.9 (13.8)	77.5 (65-85)	0.790
≥19	76 (15.6)	77.5 (65-87.5)	

Note. Age was divided into two groups according to its median.
+Mann-Whitney test.

old (p=0.790). The evaluation score was not significantly associated with the knowledge score (rho=-0.09; p=0.407 for pre-score and rho=-0.13; p=0.259 for post score).

DISCUSSION

The present study evaluated the effectiveness of a targeted skill lab designed to enhance knowledge and confidence of first year nursing students related to PICC lines insertion and care. The analysis and results from the lab revealed significant improvements in knowledge scores and highlighted the overall positive reception of the lab content and structure. The lab can prepare them for their advanced roles, enabling them to acquire the required skills for performing PICC line insertion and care.

According to Armstrong [28], the purpose of the trainings is to enhance the levels of awareness and understanding of the trainees through the building of skills and knowledge. In our study the lab resulted in a statistically significant increase in knowledge scores among participants, as indicated by the results of the Wilcoxon signed rank test and repeated measures ANOVA. Pre-lab scores varied widely among participants, with correct answer percentages ranging from 5% to 87.5% on different questions. Post-lab, these percentages increased significantly for most questions, with correct answers reaching up to 100% in some cases.

This increase in knowledge scores underlines the effectiveness of the lab format and content in enhancing student understanding and confidence of PICC lines insertion and care. The p-values in questions 1, 2, 4, 5, 6, 9 and 15 (all <0.001) suggest that specific areas of the training were particularly impactful. For example, the 60% improvement in the correct response rate for question 5 (regarding the flow rate in the superior vena cava) reflects a substantial gain in knowledge essential for the clinical practice.

The literature suggests that trainees' personal characteristics, such as demographics, significantly influence the variation

in training outcomes [29, 30]. This study did not find a significant difference related to gender, age, or experience; however, the results align with the literature in suggesting that trainees' qualifications impact training outcomes. Analysis by gender in our study revealed no significant differences in knowledge scores either before or after the lab, nor in the degree of improvement. The post-lab results showed no significant age-related differences, and both age groups experienced similar degrees of improvement.

The literature emphasizes that satisfaction with the trainer is crucial for achieving effective training [31]. Students in our study evaluated the lab positively, with high scores for the acquisition of new and important knowledge, the usefulness of the knowledge gained, and the quality of educational materials. These evaluations, captured through quantitative feedback, highlight the lab's success in meeting its educational objectives. The mean evaluation score of 76% reflects general satisfaction, although some aspects, such as the duration of the lab and opportunities for practical application, received slightly lower scores.

The positive evaluation scores suggest that the lab's structure – combining theoretical with practical sessions – was well-received. An effective trainer can significantly impact training success, as they play a crucial role in facilitating the transfer of learning for trainees [32, 33]. Marsh and Overall [34] found that trainees who liked their instructor were more likely to be satisfied and motivated to perform better in the course. Therefore, it is evident that satisfaction with the trainer influences the trainees' ability to transfer the skills and knowledge gained from the training program [35]. Morgan and Casper [36] also emphasized that the trainer plays a crucial role in shaping trainees' overall perceptions of the training. The high rating for educators (56.3% rating them as 'the best') emphasizes the crucial role of competent and engaging instructors in the success of educational interventions.

The findings from this study have several practical implications for nursing education and clinical practice. Firstly, the significant improvement in knowledge scores indicates that similar labs could be a valuable addition to nursing curricula, particularly in areas requiring advanced practices such as PICC lines maintenance. The lab's format, which effectively combined theoretical and practical sessions, and interactive discussions, could serve as a model for other training programs.

The students invited were 105. Using the sample size calculator by Raosoft, Inc. [37] with margin of error 5%, confidence level 90% and response distribution 50%, the representative sample amounts to 76 students and for margin of error 5%, confidence level 95% and response distribution 50% to 83. Therefore, the final sample size (n=80) was quite satisfactory.

Initially, the study was conducted at a single university laboratory, which may limit the generalizability of the findings to other settings or student populations. Then, the quasi-experimental design, specifically the one-group pretest-posttest format, lacks a control group, which limits the ability to establish a causal relationship between the training intervention and the observed improvements in knowledge. Also, while the use of simulated learning environment, it may not entirely capture the real-world variability and unpredictability encountered during PICC insertion and care in clinical settings. Additionally, the study did not assess the long-term retention of the knowledge gained during the lab, which is an important consideration for evaluating the lasting impact of the training.

Future research could address these limitations by including a control group and conducting follow-up assessments to evaluate knowledge retention over time. Finally, implementing the training in real clinical settings could provide more accurate insights into its effectiveness and practical applicability.

This approach not only enhances students' competencies but also boosts their confidence in performing advanced practices, which are crucial for patient safety and quality care. Also, the success of the lab in improving knowledge across students suggests that similar training programs could be standardized and implemented across different nursing departments. Additionally, the study highlights the potential of specialized training to reduce the incidence of complications associated with PICC lines. This has significant implications for improving patient outcomes and reducing healthcare costs associated with complications from vascular access devices. Given the expanding role of advanced practice nurses in addressing global healthcare challenges, the study's findings support the need for competency-based training programs that can quickly and effectively equip nurses with the skills needed to meet the demands of modern healthcare. The study's findings highlight areas for further research, particularly in their effectiveness, and their applicability in different healthcare settings.

CONCLUSIONS

Based on the findings of this study utilizing the adapted Kirkpatrick model, it can be argued that this framework offers valuable insights into the key factors that contribute to the effectiveness of a training lab offered by the Laboratory of Trauma Care and Patient Safety of the University of Thessaly. This study demonstrated the effectiveness of a targeted skill lab in improving the knowledge and confidence of first-year nursing students concerning the insertion and care of PICCs. The results indicated a significant increase in knowledge scores following the lab, with the most pronounced improvements seen in specific areas critical to clinical practice. The lab was also well-received by students, with high satisfaction scores regarding the content, instructional quality, and the practical relevance of the training.

The findings underscore the value of incorporating specialized, hands-on training into nursing curricula to enhance students' competencies in advanced clinical procedures. The absence of significant differences in knowledge improvement between different genders and age groups suggests that this type of educational intervention is broadly effective across diverse student populations.

These results suggest that similar training modules could be beneficial in other areas of nursing education, particularly those involving advanced practices. The positive reception of the lab's combination of theoretical instruction and practical application highlights the importance of interactive and experiential learning in nursing education.

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CONFLICT OF INTEREST
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CORRESPONDING AUTHOR
Maria Malliarou
University of Thessaly
Argonauts, Filellinon, Volos 382 21, Larissa, Greece
e-mail: malliarou@uth.gr

ORCID AND CONTRIBUTIONSHIP
Ioannis Kouroutzis: 0009-0001-9795-5107 A B D
Maria Malliarou: 0000-0002-6619-1028 A C E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Current clinical and pathogenetic characteristics of patients with chronic pancreatitis depending on biological age and smoking

Liliia Babinets[1], Iryna Halabitska[1], Nataliia Shevchenko[2], Olexandr Zemlyak[1], Zoreslawa Onufryk[1], Bogdan Migenko[1], Rostyslav Levchuk[1]

[1]I. HORBACHEVSKY TERNOPIL NATIONAL MEDICAL UNIVERSITY, TERNOPIL, UKRAINE
[2]ODESA NATIONAL MEDICAL UNIVERSITY, ODESA, UKRAINE

ABSTRACT

Aim: To investigate the relationships between age, smoking status, inflammatory markers, and endotoxicosis in patients with chronic pancreatitis, focusing on C-reactive protein (CRP) and middle molecular peptides, specifically MMP254 and MMP280.

Materials and Methods: The study involved the examination of 108 patients diagnosed with chronic pancreatitis. These patients were categorized by age according to the World Health Organization (WHO) guidelines. Additionally, patients were stratified based on smoking status. Key biochemical markers were assessed, including fecal α-elastase, medium molecular weight peptides, and C-reactive protein levels. This approach allows for a comprehensive evaluation of how age and smoking may influence the course of chronic pancreatitis, while also considering the diagnostic value of these specific biomarkers in monitoring pancreatic function and inflammatory responses in these patients.

Results: A statistically significant impact of age on fecal α-elastase, C-reactive protein, and medium molecular peptides levels has been identified. Additionally, smoking has been shown to exacerbate pathological changes in these markers.

Conclusions: these findings underscore the necessity for individualized treatment approaches that consider age and smoking history, particularly in older patients. Future research should further explore the underlying mechanisms linking these variables to chronic pancreatitis, with an emphasis on the long-term effects of smoking cessation and interventions targeting inflammatory markers and endotoxicosis. This understanding is crucial for enhancing management strategies and improving the quality of life for patients suffering from chronic pancreatitis.

KEY WORDS: Chronic Pancreatitis, Fecal α-elastase, C-reactive Protein, Middle Molecular Peptides, Endotoxicosis, Smoking Status, Age

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INTRODUCTION

Chronic pancreatitis (CP) is a progressive inflammatory disorder characterized by irreversible damage to the pancreas, leading to exocrine and endocrine insufficiency [1-3]. The pathophysiology of CP involves repeated episodes of inflammation, resulting in fibrosis and functional impairment of the pancreas [2, 4-6]. Fecal α-elastase, middle molecular peptides (MMPs), and C-reactive protein (CRP) are biomarkers commonly used to assess pancreatic function, endotoxicosis, and inflammation in patients with chronic pancreatitis [7-9]. Investigating the variations in these biomarkers across different patient demographics, such as age and smoking status, provides valuable insights into the progression and systemic effects of chronic pancreatitis [10-12].

Several studies have highlighted the importance of age and lifestyle factors, such as smoking, in the development and progression of chronic pancreatitis [10, 13, 14]. Aging is associated with a decline in pancreatic exocrine function, and smoking has been shown to exacerbate inflammation and tissue damage in CP patients [4, 15-17]. The fecal α-elastase enzyme serves as an indicator of pancreatic exocrine function, while middle molecular peptides (MMPs) are markers of endotoxicosis and tissue damage [18]. Elevated CRP levels, a marker of systemic inflammation, are often observed in patients with chronic inflammatory diseases, including CP [16, 19, 20]. Therefore, evaluating the age- and smoking-related changes in these biomarkers is essential for understanding the disease progression and tailoring clinical management strategies.

AIM

This study aims to analyze the levels of fecal α-elastase, middle molecular peptides (MMP254 and MMP280), and CRP in patients with chronic pancreatitis across different age groups and smoking statuses.

MATERIALS AND METHODS

This study included 108 patients diagnosed with chronic pancreatitis (CP) and 30 healthy individuals as the control group. The diagnosis of CP was confirmed based on clinical symptoms, imaging studies (ultrasound, CT, or MRI), and laboratory tests following international guidelines. The study population was stratified into three age groups: up to 45 years, 46-65 years, and over 65 years. Additionally,

participants were categorized by smoking status into smokers and non-smokers. Informed consent was obtained from all participants, and the study was approved by the institutional ethics committee. The inclusion criteria for this study were as follows: patients aged 18 years and older with a confirmed diagnosis of chronic pancreatitis based on clinical symptoms, laboratory tests, and imaging studies (ultrasound, CT, or MRI). All participants provided written informed consent for participation and for the collection of biological samples (feces and blood) for analysis. Additionally, participants were required to have no acute exacerbations of chronic pancreatitis for at least 4 weeks prior to the study. The exclusion criteria included a history of acute pancreatitis within the last 6 months, significant gastrointestinal disorders (e.g., pancreatic cancer, inflammatory bowel disease) that could affect biomarker levels, severe comorbidities (e.g., cardiovascular, renal, or hepatic diseases) that may confound the study results, use of medications known to affect pancreatic function or inflammatory markers within 3 months prior to the study (e.g., corticosteroids, non-steroidal anti-inflammatory drugs), a history of alcohol abuse or substance dependence within the last year, and pregnancy or lactation.

Fecal samples were collected from all participants to measure α-elastase levels, which serve as a marker of exocrine pancreatic function. The enzyme-linked immunosorbent assay (ELISA) method was used to quantify fecal α-elastase concentrations, following the manufacturer's protocol. The results were expressed in micrograms per gram (μg/g) of feces.

To assess endotoxicosis, serum samples were analyzed for middle molecular peptides (MMP254 and MMP280), which are indicators of toxic metabolite accumulation. Blood samples were drawn from all participants after an overnight fast. MMP levels were determined using UV-spectrophotometry at wavelengths of 254 nm and 280 nm.

CRP levels, a marker of systemic inflammation, were measured using a high-sensitivity CRP assay (hs-CRP) in serum samples collected from each participant. The analysis was performed using an automated immunoassay analyzer. CRP concentrations were expressed in milligrams per liter (mg/L).

For the statistical analysis, continuous variables were expressed as mean ± standard deviation (SD). Parametric tests, including one-way ANOVA for comparisons among multiple groups, were used where data followed a normal distribution. Post-hoc analysis was performed using the Tukey test. For data not following a normal distribution, non-parametric tests, the Kruskal-Wallis test for multiple group comparisons, were applied. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Among the etiological factors associated with the development of chronic pancreatitis, 22.3% of patients had biliary tract disease, 9.92% reported a history of acute pancreatitis, 36.5% engaged in alcohol consumption, 15.4% experienced metabolic disorders, and 5.8% were diagnosed with autoimmune diseases.

An analysis was conducted to compare fecal α-elastase concentrations across different age groups in patients with chronic pancreatitis (Table 1).

The analysis demonstrated statistically significant differences in fecal α-elastase levels across the comparison groups in patients with chronic pancreatitis ($p < 0.05$). In the control group, the concentration was the highest. Among participants aged up to 45 years, the value decreased, reflecting a 33.4% reduction compared to the control group. In the 46-65 years age group, the concentration further declined, representing a 49.2% decrease relative to the control. In the oldest group, aged over 66 years, the levels were the lowest, showing a significant 65.3% reduction compared to the control. These findings indicate a clear age-related decline.

An analysis was conducted to compare fecal α-elastase concentrations between smokers and non-smokers in patients with chronic pancreatitis (Table 2).

The analysis revealed statistically significant differences in fecal α-elastase levels between the comparison groups in patients with chronic pancreatitis ($p < 0.05$). The control group exhibited the highest concentration. In non-smokers, a reduction of 40.4% was observed compared to the control group. Smokers demonstrated slightly higher fecal α-elastase levels than non-smokers, though still showing a 35.6% decrease relative to the control. These results indicate a significant decrease in fecal α-elastase levels in both non-smokers and smokers, with the decline being somewhat less pronounced in the smoking group. The comparison between smokers and non-smokers highlights that smoking may have a moderate impact on fecal α-elastase levels, though both groups exhibit a notable reduction compared to the control group.

An analysis was conducted to compare the levels of middle molecular peptides, MMP254 and MMP280, across different age groups in patients with chronic pancreatitis (Table 3).

Table 1. Comparison of Fecal α-Elastase Concentrations by Age

Indicator	Group			
	Control (n=30)	under 45 years (n=34)	46-65 years (n=39)	over 65 years (n=35)
Fecal α-elastase, μg/g	278.57 ± 6.74	185.57 ± 5.71	141.57 ± 5.54	96.76 ± 4.81

** – statistically significant difference between comparison groups ($p < 0.05$)*

Table 2. Comparison of Fecal α-Elastase Concentrations in Smokers and Non-Smokers

Indicator	Group		
	Control (n=30)	Non-Smokers (n=67)	Smokers (n=41)
Fecal α-elastase, μg/g	278.57 ± 6.74	165.97 ± 7.61	179.52 ± 8.02

** – statistically significant difference between comparison groups (p < 0.05)*

Table 3. Comparison of MMP254 and MMP280 Measurements by Age

Indicator	Group			
	Control (n=30)	under 45 years (n=34)	46-65 years (n=39)	over 65 years (n=35)
MMP254, con. unit	254.45 ± 3,57	385.56 ± 5.87	428.65 ± 4.98	459.88 ± 5.07
MMP280, con. unit	137.49 ± 4,07	209.65 ± 3.45	228.96 ± 3.56	± 4.16

** – statistically significant difference between comparison groups (p < 0.05)*

Table 4. Comparison of CMP254 and CMP280 Measurements Based on Smoking Status

Indicator	Group		
	Control (n=30)	Non-Smokers (n=67)	Smokers (n=41)
MMP254, con. unit	254.45 ± 3,57	412.52 ± 8.56	450.72 ± 9.18
MMP280, con. unit	137.49 ± 4,07	209.45 ± 7.16	239.45 ± 8.56

** – statistically significant difference between comparison groups (p < 0.05)*

The analysis revealed statistically significant differences in MMP254 and MMP280 levels across the comparison groups in patients with chronic pancreatitis ($p < 0.05$). For MMP254, the control group exhibited the lowest values. In participants under 45 years old, MMP254 levels increased by 51.5% compared to the control group. In the 46-65 years age group, levels were 68.4% higher than the control, and the oldest group (over 65 years) showed the highest increase, with MMP254 levels 80.7% above the control.

A similar pattern was observed for MMP280 levels. The control group had the lowest values, while those under 45 years old demonstrated a 52.5% rise in MMP280 compared to the control. In the 46-65 years group, levels were 66.5% higher, and in the over 65 years group, MMP280 levels were 79.5% higher than in the control group. These results highlight a clear age-related increase in both MMP254 and MMP280 levels.

A study was performed to assess the levels of middle molecular peptides, MMP254 and MMP280, in relation to smoking status among patients with chronic pancreatitis (Table 4).

The analysis revealed statistically significant differences in MMP254 and MMP280 levels between the groups in patients with chronic pancreatitis ($p < 0.05$). MMP254 levels were the lowest in the control group. Among non-smokers, MMP254 levels increased by 62.1% compared to the control group, while smokers showed an even greater increase of 77.1%.

A similar pattern was observed for MMP280 levels. The control group had the lowest values, with non-smokers showing a 52.4% increase compared to the control. Smokers exhibited an even larger rise, with MMP280 levels 74.2% higher than in the control group. These results indicate significant increases in MMP254 and MMP280 levels in both non-smokers and smokers, with the highest levels in smokers.

A study was carried out to evaluate C-reactive protein (CRP) levels across various age groups in patients with chronic pancreatitis (Table 5).

The analysis demonstrated statistically significant differences in CRP levels across the comparison groups in patients with chronic pancreatitis ($p < 0.05$). In the control group, CRP levels were the lowest. Among participants aged up to 45 years, CRP levels increased by 170.1% compared to the control group. In the 46-65 years age group, CRP levels were 193.5% higher than the control. The oldest group, aged over 65 years, showed the highest CRP levels, with an increase of 222.7% relative to the control group. These findings indicate a significant age-related rise in CRP levels across the groups.

A study was performed to evaluate C-reactive protein (CRP) levels in relation to smoking status among patients with chronic pancreatitis (Table 6).

The analysis revealed statistically significant differences in CRP levels among the comparison groups in patients with chronic pancreatitis ($p < 0.05$). The control group exhibited

Table 5. Comparison of CRP Measurements by Age

Indicator	Group			
	Control (n=30)	under 45 years (n=34)	46-65 years (n=39)	over 65 years (n=35)
CRP, mg/L	1.54 ± 0.19	4.16 ± 0.28	4.52 ± 0.25	4.97 ± 0.22

** – statistically significant difference between comparison groups ($p < 0.05$)*

Table 6. Comparison of CRP Measurements Based on Smoking Status

Indicator	Group		
	Control (n=30)	Non-Smokers (n=67)	Smokers (n=41)
CRP, mg/L	1.54 ± 0.19	4.37 ± 0.87	4.81 ± 0.97

** – statistically significant difference between comparison groups ($p < 0.05$)*

the lowest levels. Non-smokers showed an increase in CRP levels of 183.4% compared to the control group. Smokers demonstrated even higher levels, with a 211.7% increase relative to the control. These findings suggest a significant rise in CRP levels in both non-smokers and smokers, with smokers displaying the highest levels overall.

DISCUSSION

The findings of this study highlight the significant differences in C-reactive protein (CRP) levels and middle molecular peptides (MMP254 and MMP280) among patients with chronic pancreatitis based on age and smoking status. The observed age-related increase in CRP levels suggests that older patients may experience more severe inflammatory processes associated with chronic pancreatitis. This is consistent with existing literature indicating that inflammation tends to escalate with age [21-23]. Several studies have reported a similar trend, where older adults exhibit elevated levels of pro-inflammatory cytokines, correlating with increased disease severity [24, 25]. These findings underscore the need for careful monitoring and tailored management strategies for elderly patients to mitigate the risks of exacerbated inflammation and related complications.

Furthermore, our results demonstrate that smoking significantly impacts inflammatory markers in patients with chronic pancreatitis. Smokers exhibited markedly higher CRP levels compared to non-smokers, indicating that smoking may exacerbate the inflammatory response associated with the disease. Previous research has found that smokers with chronic pancreatitis experience worse clinical outcomes and higher hospitalization rates [26, 27]. The detrimental effects of smoking on pancreatic health are well-documented, emphasizing the importance of smoking cessation as a crucial component of management for individuals with chronic pancreatitis [28].

The analysis of fecal α-elastase levels revealed a clear age-related decline in pancreatic exocrine function, which could contribute to the overall inflammatory status observed in patients. Similar correlations have been reported in the literature, indicating that reduced α-elastase levels are indicative of pancreatic insufficiency in older adults, often leading to malnutrition and further deterioration of health [29-31]. These relationships highlight the importance of early detection and intervention for pancreatic insufficiency in elderly patients, potentially improving their quality of life and reducing hospitalizations [32-34].

This study has several limitations that should be considered when interpreting the results. Firstly, the patient sample was limited to a specific geographic region, which may reduce the generalizability of the findings to other populations. Additionally, the study utilized a cross-sectional design, making it difficult to establish causal relationships between inflammatory markers, age, and smoking status. Potential variations in data collection methods may also affect the accuracy of the results; for instance, C-reactive protein and middle molecular peptide levels were measured based on single samples, which may not capture fluctuations over time. Moreover, the study did not account for potential confounding factors such as comorbidities, dietary habits, and levels of physical activity, which could also influence inflammatory marker levels. Finally, smoking data were self-reported, potentially introducing bias as participants may underestimate or overestimate their smoking habits. These limitations highlight the need for further research with larger and more diverse samples, as well as the inclusion of additional variables to provide a clearer understanding of the impact of age and smoking on chronic pancreatitis.

CONCLUSIONS

In conclusion, this study highlights significant associations between age, smoking status, and levels of inflammatory markers in patients with chronic pancreatitis. The results indicate a clear age-related increase in C-reactive protein (CRP) levels, suggesting that older individuals may experience

heightened inflammatory responses that could contribute to disease progression. Additionally, the study demonstrates that smoking significantly elevates CRP levels, indicating a potential exacerbation of inflammatory processes among smokers with chronic pancreatitis. The analysis of middle molecular peptides, MMP254 and MMP280, further supports the notion that both age and smoking status are critical factors influencing pancreatic function and inflammatory responses. An important aspect to note is that middle molecular peptides may serve as indicators of endotoxicosis, which can arise from a compromised intestinal barrier function. This increases the risk of systemic inflammation, which may, in turn, worsen the condition of patients with chronic pancreatitis. These findings underscore the necessity for individualized treatment approaches that consider these variables, particularly in older patients and those with a history of smoking. Future research should aim to explore the underlying mechanisms driving these associations, as well as the long-term effects of smoking cessation and age-related interventions on inflammatory markers, endotoxicosis, and middle molecular peptides. Deepening our understanding of these relationships may assist healthcare providers in enhancing treatment strategies and improving the quality of life for patients suffering from chronic pancreatitis.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Liliia Babinets
I. Horbachevsky Ternopil National Medical University
14 Kupchyns'ky St., 46400 Ternopil, Ukraine
e-mail: lilyababinets@gmail.com

ORCID AND CONTRIBUTIONSHIP
Liliia Babinets: 0000-0002-0560-1943 A-F
Nataliia Shevchenko: 0000-0001-8963-4680 A-F
Olexandr Zemlyak: 0000-0002-6346-0931 A-F
Zoreslawa Onufryk: 0000-0002-0054-5495 A-F
Bogdan Migenko: 0000-0003-2192-7238 A-F
Rostyslav Levchuk: 0009-0007-2134-4506 A-F
Iryna Halabitska: 0000-0002-9028-7230 A-F

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ORIGINAL ARTICLE

Dynamics of future law enforcement officers' psychophysical state indicators in the course of their diverse training sessions on motor activity

Ivan M. Okhrimenko[1], Victoria A. Shtykh[2], Tetiana M. Kostenko[3], Ivan I. Lukasevich[4], Tetiana M. Grebeniunk[5]

[1]NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE
[2]KHARKIV STATE ACADEMY OF PHYSICAL CULTURE, KHARKIV, UKRAINE
[3]ASSOCIATION OF EFFECTIVE PSYCHOLOGISTS OF UKRAINE, KYIV, UKRAINE
[4]NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORTS OF UKRAINE, KYIV, UKRAINE
[5]UKRAINIAN STATE UNIVERSITY NAMED AFTER MYKHAILO DRAHOMANOV, KYIV, UKRAINE

ABSTRACT

Aim: The aim is to study the impact of training sessions in various service-applied sports on the dynamics of cadets' psychophysical state indicators in the course of their instruction at a higher educational institution with specific learning environment.

Materials and Methods: The research was conducted in 2019-2023. The research involved 155 male cadets aged 17-23 who were divided into those who were additionally engaged in various service-applied sports during their instruction (n = 115) and those who, in addition to compulsory physical training, did not additionally engage in sports (group d, n = 40). Cadets' physical state was assessed by the indicators of their body weight, body length, age, heart rate, blood pressure and physical state index. The mental state was studied by the indicators of cadets' emotional resilience.

Results: It has been found that most indicators of physical state and emotional resilience of cadets who were engaged in sports significantly improved in the course of their instruction. The most pronounced effect on the indicators of physical state was found in the group of cadets who were engaged in all-around sports, and on the indicators of emotional resilience – in the group of cadets who were engaged in martial arts.

Conclusions: The research showed that additional training in service-applied sports has a more effective impact on the psychophysical state of future law enforcement officers compared to traditional physical training sessions. Improving the psychophysical state of cadets in the training process will help to improve their future law enforcement activities.

KEY WORDS: psychophysical state, cadets, future law enforcement officers, service-applied sports

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INTRODUCTION

One of the leading functions of any modern state is to ensure the protection of the rights and legitimate interests of citizens, individuals, and legal entities from unlawful encroachments, to ensure the principle of legality, and to protect the law and order established in the state. Each of these tasks is fulfilled through law enforcement activities, which in Ukraine are carried out by the National Police. A special place among the tasks of law enforcement is the protection of human rights and freedoms, life, health, honor, dignity, inviolability, and security [1, 2].

Law enforcement activities are carried out in extreme conditions associated with a risk to the life and health of law enforcement officers, as well as civilians. The tasks of ensuring law and order during national events, public, political, cultural, and religious occasions, suppression of public order violations, riots, and various manifestations of separatism, conducting special operations to detain armed criminals and neutralize criminal groups, eliminating accidents and natural disasters, as well as providing protection to officials and individuals are particularly dangerous [3, 4]. The above requires a high level of professional training for future law enforcement officers (cadets) during their instruction at higher educational institutions with specific learning environment (HEIs SLE).

According to scientists [5], physical training is one of the main subject areas of future law enforcement officers' professional training in the course of their instruction at a HEI with SLE, which is aimed at forming and improving their motor skills, developing physical qualities and abilities, promoting health and forming physical and psychological readiness for future extreme professional activities. According to experts [6], the purpose of physical training of future law enforcement officers is to preserve health, creative and labor activity, ensure an adequate level of physical and psychological readiness and comprehensive development of physical qualities, acquire theoretical knowledge, form specially applied and vital skills necessary for the performance of operational and service tasks. Scientists [7] add that a modern law enforcement officer should have not only

knowledge of the legislative block but also developed physical qualities and formed skills and abilities to use police coercive measures. The use of diverse service-applied sports is an important direction of forming law enforcement officers' psychophysical readiness in the course of their instruction at HEIs SLE. A series of studies are devoted to this problem [8, 9]. However, a comparative analysis of the level and dynamics of future law enforcement officers' psychophysical state in the process of practicing various service-applied sports during their instruction at HEIs SLE is the least studied, which stipulated the choice of the topic of the article.

AIM

The aim is to study the impact of training sessions in various service-applied sports on the dynamics of cadets' psychophysical state indicators in the course of their instruction at a higher educational institution with specific learning environment.

MATERIALS AND METHODS

The research was conducted in 2019-2023 at the National Academy of Internal Affairs (Kyiv, Ukraine). The research involved 155 male cadets aged 17-23 who were studying in the specialty referred to as "Law Enforcement": The cadets under research were divided into those who were additionally engaged in various service-applied sports during their instruction (n = 115) and those who, in addition to compulsory physical training, did not additionally engage in sports (group d, n = 40). The cadets who were involved in sports were divided into 3 groups by sports: cadets who were engaged in service-applied all-around (heptathlon, pentathlon, triathlon, group a, n = 31); martial arts (sambo, judo, hand-to-hand combat, group b, n = 46); and strength sports (powerlifting, crossfit, kettlebell lifting, group c, n = 38).

Research methods: analysis and generalization of literature sources, medical and biological methods, psychodiagnostic methods statistical methods. 17 sources from the databases PubMed, Web of Science Core Collection, Scopus and others were analyzed.

Cadets' physical state was assessed by the indicators of their body weight, body length, age, heart rate, and blood pressure and was determined by the formula of the physical state index (PSI) proposed by Ye. A. Pirohova [10]:

- PSI = (700 – 3 HR – 2.5 BPaver – 2.7 age + 0.28 body weight) / (350 – 2.6 age + 0.21 body length),
- where HR is the resting heart rate in 1 minute (beats per minute);
- BPaver – average arterial blood pressure (mm Hg), determined by the formula:
- BPaver = ((SBP – DBP) / 3) + DBP.

The level of physical state was assessed as low if the PSI was ≤ 0.375 c. u.; below average – at 0.376-0.525 c. u.; average – at 0.526-0.675 c. u.; above average – at 0.676-0.825 c. u.; high – at ≥ 0.826 c. u.

The mental state was studied by the indicators of cadets' emotional resilience, which was assessed using the method referred to as the "Diagnostics of Emotional Resilience of Personality" [11]. The method contains statements that allow identifying cadets' psychological properties and behavioral peculiarities and reflecting the levels of manifestation of the components of their emotional resilience. The main scales of the method are designated as psychological factors of emotional resilience: factor 1 – emotional maturity; factor 2 – willpower; factor 3 – motivation to succeed; factor 4 – intelligence self-assessment (tendencies of intelligence development); factor 5 – neurotization of a personality; factor 6 – stress resistance; factor 7 – self-control of behavior; factor 8 – anxiety-calmness; factor 9 – rationality of thinking; factor 10 – externality-internality; factor 11 – reflects the general level of emotional resilience of the personality (defined as the average score for factors 1-10). The overall level of emotional resilience was determined in points and was assessed as high if the cadet scored from 1 to 4 points, average – 5-7 points, and low – 8-10 points. The study of cadets' psychophysical state indicators was conducted in two stages: the first stage – in the first instructional year (beginning); and the second – in the fourth instructional year (end).

The statistical method was used to process the experimental data obtained. The compliance of the sample data distribution with the Gauss' law was assessed using the Shapiro-Wilk W test. The reliability of the difference between the indicators was determined using the Student's t-test. The reliability of the difference was set at $p < .05$. All statistical analyses were performed using SPSS software, version 10.0, adapted for medical and biological research. The procedure for organizing the study and the topic of the article were previously agreed with the committee on compliance with Academic Integrity and Ethics of the National Academy of Internal Affairs. Also this study followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all participants who took part in this study.

RESULTS

The results of the study of the physical state of cadets who were engaged in diverse service-applied sports in the course of their instruction at the HEI SLE compared to cadets who did not additionally engage in sports are presented in Table I.

It was found that all indicators of cadets' physical state of groups a, b, c, and d were significantly the same ($p > .05$) at the beginning of the research. However, certain changes occurred, in the course of instruction at the HEI SLE, depending on the involvement in a particular sport. Thus, the indicators of body weight in cadets who were engaged in all-around and martial arts tended to improve (decrease), and in cadets who were engaged in strength sports and in cadets who did not additionally engage in sports, there was an increase in body weight. However, the changes in cadets who were engaged in various service-applied sports were not significant ($p > .05$), and in cadets who did not engage in additional sports, there was a significant increase in body weight by 2.7 kg ($p \leq .05$). At the same time, the body weight of cadets of groups a and b was significantly lower than in group d ($p \leq .05$-$.01$)

Table 1. Level and dynamics of physical state indicators of cadets who were engaged in diverse service-applied sports in the course of their instruction (X ± m, n = 155)

Stages of research	Groups of cadets				The Student's t-test value (t)					
	a (n=31)	b (n=46)	c (n=38)	d (n=40)	a-b	b-c	a-c	a-d	b-d	c-d
Body weight, kg										
Beginning	72.2±0.79	73.1±0.68	73.6±0.74	72.8±0.70	0.86	0.50	1.29	0.57	0.31	0.79
End	71.7±0.71	73.3±0.65	74.9±0.77	75.5±0.78	1.66	1.59	3.06	3.60	2.17	0.55
t	0.47	0.21	1.22	2.58						
Body length, cm										
Beginning	176.8±0.51	176.5±0.43	175.9±0.54	176.2±0.50	0.45	0.87	1.21	0.84	0.45	0.41
End	177.9±0.49	177.6±0.41	176.7±0.57	177.4±0.52	0.47	1.28	1.60	0.70	0.30	0.91
t	1.56	1.85	1.02	1.66						
HR, beats / min										
Beginning	70.8±0.68	71.5±0.55	70.9±0.59	71.2±0.57	0.80	0.74	0.11	0.45	0.38	0.37
End	68.7±0.61	70.3±0.52	71.2±0.60	72.9±0.58	2.00	1.13	2.92	4.99	3.34	2.04
t	2.30	1.59	0.36	2.09						
SBP, mm Hg										
Beginning	120.4±0.45	120.1±0.42	120.8±0.46	120.5±0.53	0.49	1.12	0.62	0.14	0.59	0.43
End	119.1±0.38	119.2±0.39	121.1±0.47	122.1±0.56	0.18	3.11	3.31	4.43	4.25	1.37
t	2.21	1.57	0.47	2.08						
DBP, mm Hg										
Beginning	71.3±0.55	72.2±0.49	71.5±0.51	71.8±0.47	1.22	0.99	0.27	0.69	0.59	0.43
End	70.9±0.53	71.8±0.46	72.0±0.48	73.2±0.50	1.28	0.30	1.54	3.16	2.06	1.73
t	0.52	0.60	0.71	2.04						
Physical state index, c.u.										
Beginning	0.708±0.009	0.706±0.008	0.705±0.010	0.706±0.008	0.08	0.08	0.15	0.08	0.00	0.08
End	0.721±0.008	0.718±0.007	0.694±0.011	0.667±0.010	0.28	1.84	1.99	4.22	4.18	1.82
t	1.16	1.13	0.74	3.05						

Legend: Reliably significant differences between the indicators of physical state of cadets in a, b, c, d groups are indicated in bold

at the end of their instruction in the HEI SLE. The dynamics of body length indicators in cadets of all groups had a similar character i. e. an insignificant increase in the course of their instruction ($p > .05$). The dynamics of all indicators of the functional state of cadets' cardiovascular system had the same tendency – improvement in groups a and b, unreliable deterioration in group c ($p > .05$) and reliable deterioration in group d ($p \leq .05$). Thus, in the group of cadets who were engaged in all-around sports, resting heart rate improved by 2.1 beats / min ($p \leq .05$), systolic pressure – by 1.3 mm Hg ($p \leq .05$), diastolic pressure – by 0.4 mm Hg ($p > .05$). In the group of cadets who were engaged in martial art, the changes were less pronounced: HR improved by 1.2 beats / min ($p > .05$), systolic pressure – by 0.9 mm Hg ($p > .05$), diastolic pressure – by 0.4 mm Hg ($p > .05$). In representatives of strength sports functional indicators remained unchanged ($p > .05$), and in the group of cadets who did not additionally engage in sports, all indicators significantly deteriorated ($p \leq .05$) and were significantly ($p \leq .05$-$.001$) worse at the end of the research than those of cadets of groups a, b and c. The index of physical state of cadets of groups a and b improved in the course of their instruction at the HEI SLE ($p > .05$), in group c – insignificantly deteriorated ($p > .05$), and in group d – deteriorated significantly ($p \leq .01$). The negative dynamics of physical state indicators in cadets of group d is explained by high volumes of academic load, insufficient motor activity, nervous and emotional stress and acute situational reaction. Sports activities help to increase motor activity, improve well-being, recover from the working day and week, emotional release, and prevent the effects of stress. The best indicators of physical state in group a are explained by the focus of service-applied all-around events on the development of endurance in cadets, which leads to improved cardiorespiratory system performance and stabilization of body weight in future law enforcement officers. The ratio of physical state levels in cadets of different groups is shown in Table 2.

It was found that the majority of cadets in all groups had above-average physical state (39.5-58.1 %) and average

Table 2. Correlation of the levels of the physical state of cadets who were engaged in diverse service-applied sports in the course of the academic training process (n = 155), %

Stages of research	Levels of physical state	Groups of cadets			
		a (n=31)	b (n=46)	c (n=38)	d (n=40)
Beginning	High	16.1	15.2	10.5	10.0
	Above average	58.1	54.3	39.5	45.0
	Average	19.3	19.6	34.2	37.5
	Below average	6.5	10.9	15.8	7.5
	Low	0	0	0	0
End	High	29.0	28.3	13.2	12.5
	Above average	64.5	63.0	36.8	32.5
	Average	6.5	8.7	42.1	47.5
	Below average	0	0	7.9	7.5
	Low	0	0	0	0

(19.3-37.5 %) at the beginning of the research. And, the vast majority of cadets had above-average (64.5 % and 63.0 %) and high (29.0 % and 28.3 %, respectively) levels of physical state in groups a and b at the end of the research. At the same time, there were no cadets with low or below-average levels. In group c, the number of cadets with a high level of physical state increased (up to 13.2 %), the number of cadets with a below-average level decreased (to 7.9 %), and the ratio of cadets with an average and above-average level remained virtually unchanged. In group d, the largest percentage at the end of the research was made up of cadets with an average level of physical state (47.5 %).

Emotional resilience is one of the most important professional qualities of law enforcement officers necessary to preserve their mental health and prevent emotional exhaustion and burnout. The study of indicators of cadets' emotional resilience showed a more pronounced positive effect of training in service-applied sports on the formation of cadets' emotional resilience: cadets of groups a, b, and c showed a significant ($p \leq .01$) improvement in all factors and the overall level of emotional resilience in the course of their instruction at the HEI SLE (Table 3).

The cadets of group d also showed an improvement in the overall level of emotional resilience, but the difference between the indicators at the beginning and the end of the research was not significant ($p > .05$). It is also worth noting that while at the beginning of the research the indicators of emotional resilience in cadets of all groups were significantly the same ($p > .05$), at the end of the research, cadets engaged in all sports performed significantly ($p \leq .05$-$.01$) better than cadets who did not do any additional sports.

The correlation between the levels of cadets' emotional resilience is shown in Table 4. The vast majority of cadets of all groups had an average level of emotional resilience (60.0-77.4 %) at the beginning of the research, and at the end – cadets of groups a, b, and c had a high level (51.6-54.3 %), and in group d – an average level (57.5 %).

Interestingly, in the group of cadets who practiced martial arts, no cadets with a low level of emotional resilience were found, which indicates a more pronounced impact of these sports on improving all components of emotional resilience. Instead, in other groups, the number of such cadets ranged from 3.2 % in group a to 12.5 % in group d. Cadets with a high level of emotional resilience had sufficiently pronounced volitional qualities (endurance, determination, perseverance, purposefulness), realistic expectations, and constant interests. Cadets with a low level of emotional resilience showed dependence on mood, irritability, and mild neurotic symptoms.

Table 3. Level and dynamics of mental state (emotional resilience) indicators of cadetswho were engaged in diverse service-applied sports in the course of their instruction (X ± m, n = 155), points

Stages of research	Groups of cadets				The Student's t-test value (t)					
	a (n=31)	b (n=46)	c (n=38)	d (n=40)	a-b	b-c	a-c	a-d	b-d	c-d
Beginning	5,82±0,37	5,59±0,31	6,03±0,35	5,98±0,32	0,48	0,94	0,41	0,33	0,88	0,11
End	4,25±0,34	4,06±0,28	4,41±0,33	5,53±0,34	0,43	0,81	0,34	2,66	3,34	2,36
t	3,12	3,66	3,37	0,96						

Legend: Reliably significant differences between the indicators of mental state of cadets in a, b, c, d groups are indicated in bold.

DISCUSSION

The intense nature of law enforcement officers' professional activities, high responsibility and the cost of the results of their activities, the presence of uncertainty and information overload, a high probability of unforeseen events, as well as a threat to their health and life cause various difficulties in carrying out professional activities in special conditions, cause tension among the personnel and threaten to disrupt the performance of their professional task [12]. Scientists [13] note that modern law enforcement activities are carried out in conditions of increased danger and are marked by the negative impact of several unfavorable, uncomfortable, and threatening factors, which under certain circumstances provoke not only the development of neuropsychiatric disorders in law enforcement officers, deterioration of their physical state and health but also pose a threat to their lives. According to experts [14], the performance of service duties in difficult conditions, where there is a threat to the health and life of not only the individual but also other persons, leads to negative consequences, primarily in the deterioration of the psychophysical state of law enforcement officers. Exacting requirements for law enforcement officers' actions and strict legal regulation of their professional activities are one of the levers of negative impact on their physical and mental health, which requires them to be highly psychophysically prepared for their service activities [15]. Therefore, solving the problem of the psychophysical readiness of future law enforcement officers for their professional activities is of particular importance in modern conditions and confirms the expediency of continuing scientific research within the chosen area of study.

As noted by scientists [16], modern society faces many problems, and only experienced and professionally trained law enforcement officers can find solutions to any situation quickly and efficiently. Therefore, according to scientists, one of the most important issues in the instruction of future law enforcement officers is their physical training. Since in the activities of law enforcement agencies, there are often situations where there is a need to use physical coercion to protect themselves or others or to detain an offender, the issue of physical improvement of future law enforcement officers is beyond doubt [17]. Our research found that training in service-applied sports is more effective than traditional physical training in improving future law enforcement officers' physical state and emotional resilience.

CONCLUSIONS

The influence of training sessions in various service-applied sports on the dynamics of indicators of the psychophysical state of cadets in the course of their instruction at the HEI SLE was investigated. It has been found that most indicators of physical state and emotional resilience of cadets who were engaged in sports significantly improved in the course of their instruction. The most pronounced effect on the indicators of physical state was found in the group of cadets who were engaged in all-around sports, and on the indicators of emotional resilience – in the group of cadets who were engaged in martial arts. In the group of cadets who did not engage in additional sports, all the studied indicators of physical state deteriorated significantly in the course of their instruction, and emotional resilience improved insignificantly.

The research showed that additional training in service-applied sports in the course of instruction at HEIs SLE has a more effective impact on the psychophysical state of future law enforcement officers compared to traditional physical training sessions. Improving the psychophysical state of cadets in the training process will help to improve their future law enforcement activities.

PROSPECTS FOR FURTHER RESEARCH

We plan to study the impact of service-applied sports on the dynamics of mental cognitive processes in cadets.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Ivan M. Okhrimenko
National Academy of Internal Affairs
1 Solomyanska Square, 03035 Kyiv, Ukraine
e-mail: ivango-07@ukr.net

ORCID AND CONTRIBUTIONSHIP

Ivan M. Okhrimenko: 0000-0002-8813-5107 A B
Victoria A. Shtykh: 0000-0002-6881-7047 C
Tetiana M. Kostenko: 0000-0002-4976-1236 B D
Ivan I. Lukasevich: 0000-0001-8186-6292 E
Tetiana M. Grebeniunk: 0000-0002-8919-087X F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Problematic issues in developing public health policy based on data usage

Tetiana S. Gruzieva[1, 2]

[1]BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE
[2]STATE INSTITUTION OF SCIENCE «CENTER OF INNOVATIVE HEALTHCARE TECHNOLOGIES» STATE ADMINISTRATIVE DEPARTMENT, KYIV, UKRAINE

ABSTRACT

Aim: To identify the opportunities, approaches, challenges, and needs of professionals at disease control and prevention centers in the process of using data for developing public health policy.

Materials and Methods: The program provides for sociological surveys of professionals from disease control and prevention centers regarding the opportunities, needs, and challenges in using data to develop public health policy.

The research materials included scientific publications, national-level regulatory legal acts, WHO program documents and sociological research questionnaires. The study utilized bibliosemantic, sociological, medical-statistical methods, and content analysis.

Results: A range of issues was identified regarding the use of data for substantiating and developing public health policy. A survey of professionals from disease control and prevention centers indicated that they encounter a lack of data on social and mental health ([rate ± standard error] 19,7±3,5 per 100 respondents); work with at-risk populations (15,0±3,2); socioeconomic determinants (14,2±3,1); occupational diseases and labor protection (13,4±3,0); and non-communicable diseases and behavioral risk factors (11,0±2,8). Every sixth to tenth respondent reported challenges in obtaining and analyzing data. A high need (74,8±3,8 per 100 respondents) was identified for professional development in data usage for policy substantiation, along with preferred formats. Priority measures for improving data use in public health policy development were identified.

Conclusions: The identified issues in data usage for public health policy development, as well as the needs of professionals at disease control and prevention centers concerning data collection and analysis, and the priority measures for improvement, should be considered.

KEY WORDS: public health, policy, data usage, professional development needs, priorities

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INTRODUCTION

The progressive development of the public health system at the global, regional, and national levels is of critical importance due to significant challenges to population health and well-being. These challenges include the epidemic of non-communicable diseases, widespread risk factors for health disorders, the COVID-19 pandemic, adverse socio-economic and environmental health determinants, wars, natural and technological emergencies, climate change, and more. Addressing current and potential threats to population health requires the establishment of robust healthcare systems, with effective public health systems as an essential component. Such public health systems must be capable of justifying, developing, and implementing effective policies to strengthen and protect population health and prevent health disorders [1].

There are many examples of successful implementation of public health policies aimed at combating health disorders and their causes. Examples include the WHO's MPOWER package of tobacco control measures and the WHO's Special Initiative on Mental Health [2, 3]. The development of the document "Reducing Non-Communicable Diseases: A Main Roadmap for the WHO European Region", prepared by the Advisory Council on Innovations for Non-Communicable Diseases, helped identify key initiatives that focus on cardiovascular diseases (hypertension and salt consumption), childhood obesity, digital marketing, greener and healthier cities, alcohol taxes as health taxes, data and digital health. These initiatives aim to bridge gaps between knowledge and implementation, as well as promote innovation. These efforts are designed to accelerate progress in combating major non-communicable diseases through innovation, knowledge development, or the creation of new tools [4].

According to WHO, Denmark, Norway, Sweden, and Estonia have achieved some success in reducing premature mortality rates from non-communicable diseases, particularly cardiovascular diseases, cancers, diabetes, and chronic respiratory diseases, through the implementation of relevant policies. Their experience shows that by using reliable scientific data and evidence-based approaches, taking into account national and local contexts, countries can achieve significant success in addressing these challenges. In this regard, knowledge and data are crucial for the effectiveness of actions taken. They help identify health problems, their

causes, the strengths and weaknesses of existing healthcare systems, enabling policymakers to implement evidence-based measures to improve the situation [5].

It is well known that the development of public health policy is based on factual data, which allows for reliable measurement of the scope of health problems, setting priorities, and developing corresponding programs and strategies.

According to the European Work Programme for 2020–2025, "Joint Actions for Better Health", the ability to collect and analyze data is one of the most significant aspects of WHO's work in improving health throughout life. The development of public health policy based on data has become particularly significant in the European region during the recovery period after the COVID-19 pandemic [6].

For the systematic collection and use of data at all levels of healthcare systems, reliable information systems are necessary to provide a foundation for making informed decisions. Countries need reliable data for planning and managing healthcare services, as well as for monitoring progress toward the Sustainable Development Goals, including universal health coverage [7, 8].

However, despite significant investments, many countries continue to face numerous challenges in using data to inform public health policy. In this regard, WHO, together with the University of Oslo, the Global Fund, GAVI (Global Alliance for Vaccines and Immunization), UNICEF, and other health data partners, is working on an integrated, standards-based approach to improve the quality of data from healthcare institutions, enhance their analysis, and increase their use [9].

The issue of improving the use of data for developing healthcare policies in general, and public health policies in particular, is extremely relevant for Ukraine. The current direction for building the national healthcare system in Ukraine is outlined in the "Health System Development Strategy until 2030". Among the various directions of the Strategy, one of the main priorities is public health, preparedness, and response to emergencies [10].

In Ukraine, the strategic priority in the area of "Public Health, Preparedness, and Response to Emergencies" focuses on ensuring the functioning of an effective public health system aimed at preserving and strengthening the health of the population, preventing diseases, timely identifying health threats and challenges, and responding appropriately to them. A key task in implementing this priority is ensuring the planning and implementation of public health programs, which should be developed based on factual data and focused on health determinants and reducing health inequalities. Achieving this task will create the necessary conditions for regularly determining priorities in public health and developing relevant programs at the national, regional, and local levels.

AIM

The aim of the research is to identify the opportunities, approaches, challenges, and needs of professionals at disease control and prevention centers in the process of using data for developing public health policy.

MATERIALS AND METHODS

The materials of the study included scientific publications, national-level legal and regulatory documents, WHO program documents and the European Regional Bureau of WHO, and sociological survey questionnaires among public health professionals. The research program involved conducting sociological surveys of 127 professionals from disease control and prevention centers in various regions of the country regarding the adequacy of data for developing policy and making informed decisions, challenges encountered in the process of data collection and analysis, needs for professional development in data usage for public health policy development, preferred forms of professional improvement, the necessity of investing in the development of public health information resources, and priority actions to improve data usage for public health policy formation. The scientific basis of the study included regional disease control and prevention centers. The study used bibliosemantic, sociological, medical-statistical methods, and content analysis. Statistical processing and mathematical analysis of the materials were conducted using the «EXCEL» program and modern statistical analysis methods.

The study adhered to the basic principles of the Council of Europe Convention on Human Rights and Biomedicine, World Medical Association Declaration of Helsinki on the ethical principles for medical research involving human subjects, and current Ukrainian regulations. Since the sociological surveys among public health professionals were conducted anonymously and participation was voluntary, the principles of bioethics were upheld throughout the study.

RESULTS

An analysis of the legal and regulatory framework on this issue highlights the importance of forming public health policy and clearly defining the responsibilities for developing this policy among various stakeholders in the public health sector. According to Article 4 of the Law of Ukraine "On the Public Health System," among the main tasks and operational functions of the public health system is the development, approval, and implementation of procedures and policies that positively influence the determinants of public health [11]. Ensuring the fulfillment of this function requires the implementation of several other operational public health functions, including epidemiological surveillance, monitoring and assessment of the health and well-being of the population; monitoring, readiness, and timely response to health threats, events, and emergencies in the public health sector; conducting scientific research, etc.

Article 7 defines the powers of the Cabinet of Ministers of Ukraine in the healthcare sector, which include ensuring the formation and implementation of state policy in the field of public health. Article 8 outlines the powers of the central executive body responsible for the formation and implementation of state policy in healthcare and public health. This body is tasked with shaping state policy in the field of public health.

Article 10 outlines the functions and powers of the main expert institution in the public health sector, namely the

State Institution "Center for Public Health" of the Ministry of Health of Ukraine. These functions include preparing proposals, action plans, program drafts, strategies, and recommendations on measures aimed at improving health and well-being indicators; setting national and regional priorities; creating and maintaining a monitoring and evaluation system; developing a medium-term program for public health development; and developing and implementing comprehensive measures and programs for the prevention and treatment of diseases.

Article 9 defines the functions of the disease control and prevention centers, including preparing proposals, action plans, and recommendations on measures aimed at improving health and well-being indicators; and preparing recommendations for the development of local public health programs.

The legal framework also specifies the powers of the Council of Ministers of the Autonomous Republic of Crimea and local executive authorities in organizing the development and implementation of regional and local public health programs, as well as participating in the development and implementation of state-targeted programs (Article 12). It also outlines the powers of local government bodies regarding the approval and funding of local public health programs and their participation in the development and implementation of state and regional programs in this field (Article 13).

The analysis of WHO strategic and programmatic documents indicates a growing need for a reliable data source to develop public health policy [12-15]. The prerequisites for using data to develop national, regional, and local public health policy include the presence of health information systems for systematic collection, analysis, and use of data at all levels; the functioning of institutional structures and resources for data analysis, problem identification, needs assessment, priority setting, and the formation of health policies; and the existence of monitoring and evaluation systems to assess the effectiveness of policy implementation.

In the WHO material "Support Tool for Strengthening Health Information Systems: A Guide for Health Information Systems Assessment and Strategy Development", emphasis is placed on the necessity of a strategy in the field of health information systems and a reliable health information system for policy formation based on factual data [12]. Reliable data on the health status and determinants of the health and well-being of the population form the foundation for components of the policy-making cycle such as problem identification, understanding the causes of the problem, and developing policies for change. In this context, the collection, management, analysis, and communication of data are of paramount importance.

To develop public health policy, a wide range of data is used, including the health status of the population based on medical and demographic characteristics, morbidity, disability, injury rates, and integral health assessments; social, economic, environmental, and psychological health determinants; behavioral and biological risk factors; health threats; population well-being status; resource provision for the health system, including public health; the functioning of the health system and public health (service availability, service quality, service coverage, performance indicators); progress towards the Sustainable Development Goals (SDGs); and public health system evaluation by the population, among others. Undoubtedly, the data that forms the basis for policy development must meet rigorous requirements, including reliability, completeness, relevance, differentiation, simplicity, and consistency. Each selected indicator must have a specific structure and scheme: indicator description, detail, data source, data collection tool, data collection frequency, responsible person or structure, quality assurance mechanism, baseline values, and objectives.

WHO recommends using the Global List of Core Health Indicators, including indicators related to the achievement of the SDGs related to health [16]. This is a standard set of priority health indicators at the global level, providing concise information about the state of health and trends, including responses at the national and global levels. The goal of the Global List is to provide normative guidance for selecting standard indicators and definitions that countries and interested stakeholders can use for monitoring according to the characteristics and trends in population health, priorities, and available potential.

The demanded data sources for developing public health policy traditionally include population censuses, civil registration systems, household surveys, health management information systems (at local, regional, and national levels), health surveillance systems, national health accounts, environmental and occupational health monitoring systems, and data from scientific research.

The approaches to developing public health policy should align with the key directions of national health policy; strategic planning based on health assessments, problems, causes of ill health, forecasts, priority setting, and evaluations of the existing public health system's capacity; consideration of WHO recommendations; and the application of approaches such as health promotion, community orientation, health in all policies, a nationwide approach, a whole-of-society approach, a participatory approach, an intersectoral approach, and an evidence-based approach.

When developing public health policy based on data, it is crucial to follow key stages, including the creation of a working group (comprising leaders, managers, experts in relevant fields, and stakeholders), data collection and analysis, an analytical review of the collected data, organizing consultative dialogues with stakeholders, setting goals and tasks for the program, developing a plan, monitoring and evaluation activities, and budgeting.

The problematic issues regarding the use of data for developing public health policy in the WHO European Region include an often suboptimal approach to policy development despite the availability of vast amounts of information, challenges with standardization, the ability to interact and integrate health information systems, the need for comprehensive national strategies for public health research, investment in the training of researchers, and the

limited role of scientific facts in the policy-making process, which requires improvement in the practical application of knowledge.

In response to these challenges, the "Action Plan to Support the Use of Evidence, Information, and Research in Policy-Making in the WHO European Region" outlines guiding principles for decision-making based on the best available evidence, the use of local knowledge for decision-making at the local level, investing in innovation, promoting intersectoral and interdisciplinary approaches, and strategic leaderships of action in this plan include: strengthening national health information systems, harmonizing health indicators, and creating an integrated health information system for the European Region; developing national health research systems to support the development of priorities for public health; integrating the use of evidence, information, and research into the implementation of Health 2020 and other large regional policy mechanisms; and ensuring effective monitoring and evaluation.

The document "Accelerating the Implementation of the Action Plan to Strengthen the Use of Evidence, Information, and Research in Policy-Making in the WHO European Region: Opportunities, Lessons Learned, and Development Pathways" highlights that the synergy between health research and the evidence-based policy development system is crucial to achieving universal health coverage, a key commitment of the 2030 Agenda for Sustainable Development [18].

In 2017, representatives from several countries in the WHO European Region ratified the Sofia Declaration and established the European Network for Health Research under the WHO Health Information Initiative. Ukraine joined this network in 2018. The network provides strategic leadership in strengthening research within national health systems and serves as a platform for communication, exchange, and advocacy across the WHO European Region.

In 2019, a multinational seminar was organized by the WHO European Regional Office's Department of Evidence, Research, and Innovation, and the Special Program for Research and Training in Tropical Diseases, to analyze the experiences and lessons learned by member states and identify further steps for the implementation of the Action Plan.

The WHO recommendations for improving the use of data to support public health policy include improving data use by selecting indicators with measurable targets; converting risk factors into preventable mortality indicators; disaggregation of reporting data; identifying vulnerable population groups, as well as informing for better data use and building structures and institutional processes.

In the consolidated report "Evidence on Mechanisms and Tools for Using Health Information for Decision-Making" of the evidence network on health issues [19], the following mechanisms and tools for the practical application of health information in strategic decision-making are recommended: packaging tools, including synthesis and visualization tools; application tools, including simulation modeling; dissemination and communication tools, particularly methods of electronic, automated, and interpersonal information dissemination; tools for building connections and information exchange, including platforms and mediation in information sharing. The specific application of each tool and mechanism depends on the purpose, context, and conditions of the environment in which these methods will be used, the producers of the information, knowledge transfer intermediaries, or information users. Progress in using information to justify and develop public health policy requires technical, legal, and coordination strategies.

To clarify the problematic issues related to the use of data for public health policy development, a sociological survey was conducted among employees of disease control and prevention centers across various regions of Ukraine. The results revealed that the most significant data gaps for making informed decisions regarding public health policy were related to social and mental health ([hereinafter – rate per 100 respondents ± standard error] 19,7±3,5); working with individuals classified as at-risk groups (15,0±3,2); social-economic determinants (14,2±3,1); occupational diseases and labor protection (13,4±3,0); non-communicable diseases (11,0±2,8); and behavioral risk factors for disease development (11,0±2,8) (Fig. 1).

The problems encountered during the data collection process for justifying decisions include the inability to obtain necessary data (15,0±3,2); incompleteness of data (14,2±3,1); untimeliness of data collection (11,8±2,8); data unreliability (11,0±2,8); and insufficient data structuring (6,2±2,1).

During the data analysis process for justifying decisions, measures, programs, and public health policies, specialists faced issues such as insufficient data exchange capabilities with other stakeholders (15,7±3,2); absence of standard operating procedures for data analysis (11,8±2,8); limited data analysis and utilization opportunities due to insufficient professional training (12,6±2,9); lack of consultative assistance on data analysis, interpretation, and utilization (10,2±2,7); and limited technical capabilities of institutions regarding modern data collection and analysis technologies (10,2±2,7). Three-quarters of the respondents (74,8±3,8) confirmed the need for professional development on using data for policy justification. The optimal forms of such development were identified as in-person courses (19,7±3,5); training sessions (16,5±3,3); webinars (16,5±3,3); and online professional development courses (15,7±3,2). Over 80% of respondents confirmed the necessity of investing in the development of the public health information base using digital technologies.

Respondents identified priority measures for improving the use of data in shaping public health policy: investment in training and professional development of personnel; investment in innovations; use of diverse data sources from various disciplines and sectors; development of digitalization in public health; strengthening public health information systems; investment in the infrastructure of the public health information base; strengthening international cooperation; and the development of scientific research in healthcare.

DISCUSSION

Analysis of the results obtained during the study indicates the importance of using data for substantiating management

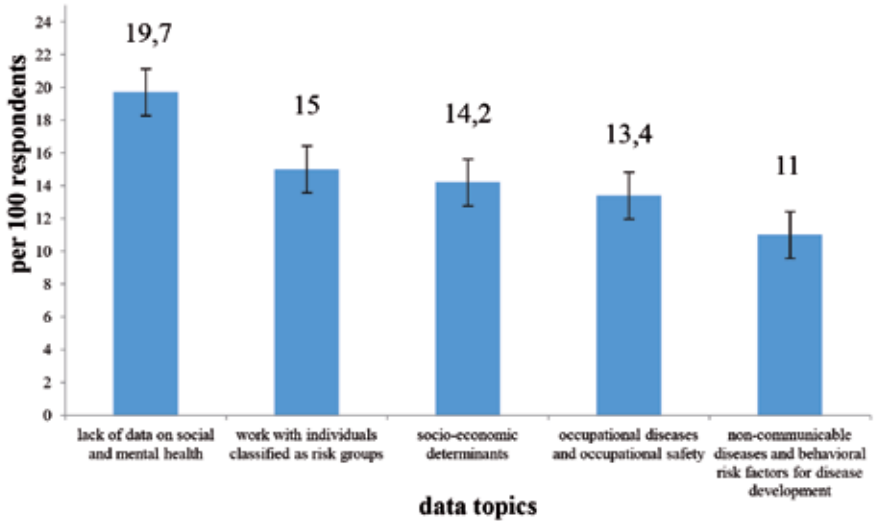

Fig. 1. Data deficiencies encountered by public health specialists when justifying public health policy (rate per 100 respondents [± error]).

decisions and shaping public health policy. Ukrainian legislation regulates the main operational functions of public health, one of the most important of which is the development, approval, and implementation of procedures and policies that positively affect the determinants of public health. The implementation of this function is impossible without fulfilling other important core operational public health functions, which lay the foundation for policy development. This concerns epidemiological surveillance, as well as the assessment, monitoring, and control of indicators and factors affecting the population's health; monitoring, preparedness, and timely response to hazardous factors, events, and emergencies in the public health sector; and scientific support for the public health system.

A clear distribution of powers among the entities involved in public health relations indicates that each of them has certain obligations concerning the formation, development, or implementation of public health policies at various levels of governance, including national, regional, and local levels. At the national level, the primary entities are government structures, the Ministry of Health of Ukraine, and the State Institution "Public Health Center of the Ministry of Health of Ukraine"; state supervisory bodies (control) ensuring compliance with sanitary legislation in the relevant areas; institutions, organizations, parts, and departments of central executive bodies implementing state policy in defense, military construction, public order protection, state border defense, criminal justice enforcement, State Affairs Management, Security Service of Ukraine, and other state authorities with specific powers in this area.

At the regional and local levels, the main players in the formation and implementation of regional and local public health policies are the centers for disease control and prevention; the Council of Ministers of the Autonomous Republic of Crimea, local executive authorities, and local government bodies; scientific institutions, healthcare establishments; international organizations; and other legal entities and public formations.

The collection, analysis, and use of data for the justification and development of public health policy face numerous challenges, as evidenced by the literature, strategic, programmatic, and instructional documents of the WHO and WHO Regional Office for Europe (WHO/EURO). Health information systems in the WHO European Region face issues with standardization, interoperability, and integration [17, 20].

Another significant issue is the use of scientific research data in shaping public health policy. As analysis shows, scientific facts often play a minimal role in the policy-making process. At the same time, the practical application of knowledge with a dynamic link between health information, scientific research, and policy and practice is a new technical field. In this field, both researchers and decision-makers have the opportunity to discover numerous tools to support the data-driven policy development process [21, 22].

In light of the existing challenges in data-driven policy development, the WHO proposes specific measures outlined in the Action Plan to support the use of factual data, information, and scientific research in policy development within the European Region. Specifically, the plan presents a forward-looking vision, objectives, guiding principles, and key areas of action, which include strengthening national health information systems, harmonizing health indicators, and creating integrated health information systems for the European region. It also emphasizes the creation and development of national structures and systems for health research to support the formulation of public health priorities, building countries' capacity to formulate policy based on factual data and its practical application, and integrating the use of factual data, information, and scientific research in the implementation of public health policies.

A sociological study among public health professionals in Ukraine confirmed global and European trends regarding the challenges of using data for substantiating and developing public health policies. Specifically, there is an issue of data insufficiency, pointed out by every fifth to ninth respondent; insufficient data exchange capabilities (reported by every sixth respondent); lack of standard operating procedures for data analysis (noted by every ninth respondent); limited capabilities for data analysis and use due to insufficient professional training (observed by every eighth respondent); and a lack of consultative support for data analysis, interpretation, and use (reported by every tenth respondent). A high demand for professional development in the use of data for policy justification was expressed by 75% of the respondents, with preferred formats including in-person courses (cited by one in five respondents). Additionally, specialists from disease control and prevention centers emphasized the importance of improving data use for public health policy formation through multifaceted interventions. These include training and professional development of human resources in this field, investing in innovations, adopting intersectoral and interdisciplinary approaches, advancing digitalization in public health, strengthening public health information systems, forming a public health information fund, fostering international cooperation, and supporting scientific research in public health.

CONCLUSIONS

The justification and development of policies in public health require the use of a wide range of high-quality data at the national, regional, and local levels, as well as the functioning of health information systems for the systematic collection, analysis, and use of data from all levels. Priority tasks for the implementation of the "Health System Development Strategy until 2030" in the context of ensuring the functioning of a capable public health system include: strengthening the health information system and investing in the infrastructure of the public health information fund; developing a health research system to support the formulation of priorities for public health; integrating the use of factual data, information, and scientific research in the justification and development of public health policies; investing in the training and professional development of public health personnel; enhancing coordination between different sectors in the process of justifying public health policies.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Tetiana S. Gruzieva
Bogomolets National Medical University
34 Beresteiskyi Ave., 03680 Kyiv, Ukraine
e-mail: gruzieva@ukr.net

ORCID AND CONTRIBUTIONSHIP
Tetiana S. Gruzieva: 0000-0001-9254-7561 A-F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Mindfulness in nature: Promoting mental health and well-being for young children

Alexandros Argyriadis[1], Agathi Argyriadi[2], Emmanuel Kopanakis[3], Isabel Vieira[4], Konstantinos Louvaris[5], Zoi Mammi[5], Olga Drakopoulou[5], Panagiotis Koutras[3], Louiza Ioannidou[6], Athina Patelarou[1]

[1]HELLENIC MEDITERRANEAN UNIVERSITY, CHANIA, GREECE
[2]UNITED ARAB EMIRATES UNIVERSITY, AL AIN, UNITED ARAB EMIRATES
[3]CENTER OF CENTER FOR ENVIRONMENTAL EDUCATION AND SUSTAINABILITY (KEPEA) OF KARPENISI, KARPENISI, GREECE
[4]CASA DO PROFESSOR, PORTUGAL
[5]HELLENIC MINISTRY OF EDUCATION, ATHENS, GREECE
[6]EUROPEAN UNIVERSITY OF CYPRUS, NICOSIA, CYPRUS

ABSTRACT

Aim: This study aimed to assess the effects of mindfulness practices conducted in natural settings on the mental health, emotional regulation, and attentional focus of young children (ages 6-15) and their teachers in Greece, Cyprus, and Portugal.

Materials and Methods: A mixed-methods design was employed, combining quantitative data from the MiNa (Mindfulness in Nature) scale with 673 children and 220 adults as well as qualitative interviews with 20 children and 20 teachers across the three countries. Quantitative data was analyzed using descriptive statistics and paired t-tests to measure pre- and post-intervention changes, while qualitative data was examined through thematic analysis to capture nuanced experiences and perceptions.

Results: Findings revealed significant improvements in emotional awareness, attentional focus, and stress reduction for both children and teachers. Children reported higher levels of emotional regulation and connection to their surroundings, while teachers experienced reduced stress and enhanced classroom dynamics. Cross-cultural comparisons indicated that nature-based mindfulness practices provided universal benefits, though participants from all countries Greece, Portugal and Cyprus.

Conclusions: Nature-based mindfulness interventions demonstrate promising outcomes in promoting emotional well-being, cognitive focus, and stress resilience for young children and adults. The findings underscore the potential of integrating mindfulness in nature into early childhood education as a holistic approach adaptable to diverse cultural and environmental contexts.

KEY WORDS: Mindfulness, nature-based mindfulness, emotional regulation, attentional focus, stress reduction

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INTRODUCTION

Mindfulness has emerged as a vital focus in several settings, deeply impacting mental health and overall well-being. Through fostering social, emotional, and cognitive growth, mindfulness offers a pathway to greater resilience and inner calm in the face of daily academic pressures [1].

Defined as a state of active, nonjudgmental awareness of the present moment, mindfulness has been shown to reduce stress, anxiety, and emotional distress while enhancing focus and emotional regulation [2]. In an environment where children often contend with significant academic and social pressures, mindfulness cultivates critical skills for mental and emotional resilience, creating a buffer against stress and promoting self-awareness. By enhancing executive function, attention, and working memory, mindfulness helps children stay engaged, fostering an academic environment where distractions are minimized, and productivity is elevated [3].

Mindfulness also promotes the development of empathy, compassion, and positive interpersonal connections, essential elements for a supportive classroom atmosphere when it is addressed to young children. These social-emotional skills promote stronger peer relationships, enhance collaborative efforts, and reduce disruptive behaviors, laying the groundwork for a more inclusive and harmonious learning space [4]. Evidence suggests that mindfulness programs not only improve peer communication dynamics but also provide meaningful support to children struggling with mental health challenges such as anxiety and ADHD, reducing their impact on wellbeing [6, 7].

For children, the advantages of mindfulness go beyond academic achievements; they extend to life skills that promote enduring mental health. The ability to self-regulate emotions, remain present, and respond with empathy supports children' holistic development and mental resilience, enabling them to navigate challenges with greater ease and confidence [8].

Ultimately, mindfulness cultivates a culture of awareness, inclusivity, and kindness, where every child – whether with disabilities or typical development – can participate fully and feel valued [9].

Mindfulness research has become a robust field, with numerous studies highlighting its positive effects on mental health, emotional regulation, and academic performance among children. For example, research by Zeidan et al. in 2010 demonstrated that brief mindfulness interventions could significantly improve attention and cognitive performance, even after only a few days of practice [10]. Similarly, studies by Flook et al. same year and Schonert-Reichl et al. in 2015 revealed that mindfulness practices enhance social-emotional skills, empathy, and prosocial behaviors, underscoring mindfulness as a valuable tool in educational settings [11, 12].

The natural environment plays a crucial role in supporting mental health, offering unique benefits that indoor settings often cannot replicate. Exposure to nature has been consistently linked to reductions in stress, anxiety, and depressive symptoms, as well as improvements in mood and overall psychological well-being. Studies indicate that spending time in green spaces can reduce cortisol levels (a biological marker of stress), enhance relaxation, and encourage a sense of calm and renewal. Natural settings also engage the senses more fully, which can enhance mindfulness practices by helping individuals become more attuned to their surroundings and emotions [13].

Research supports that nature immersion improves cognitive function, particularly attention and working memory, and can reduce symptoms of mental health conditions like ADHD and anxiety disorders. For example, Shin et al. in 2011 found that forest therapy, also known as "forest bathing" or *shinrin-yoku*, significantly decreased anxiety levels and increased positive mood in participants [15]. Similarly, studies by Berman et al. in showed that time spent in nature restores attentional capacity, providing mental clarity and focus. The restorative power of natural environments is often attributed to the "soft fascination" they offer, which gently draws attention and allows the mind to unwind from the constant demands of focused thought. This kind of mental rest can be profoundly beneficial, helping individuals build resilience and cope better with the daily stresses of life [16].

Integrating natural environments into mindfulness practices may thus offer a powerful approach to mental health, deepening the effects of mindfulness through the inherent calming and rejuvenating qualities of nature. For children, who frequently face high levels of academic and social pressure, mindfulness in nature could provide an accessible, impactful way to foster emotional well-being and resilience [17].

While the bulk of mindfulness research has concentrated on indoor or classroom-based practices, a growing number of studies are now exploring mindfulness in natural settings, examining how the outdoor environment may uniquely benefit participants [18-21]. Such studies are expanding the scope of mindfulness research by showing that nature-based practices may provide even deeper benefits than traditional indoor settings, such as a greater sense of tranquility, emotional grounding, and environmental connection. Yet, despite these promising findings, more empirical research is needed to fully understand how natural settings impact mindfulness outcomes for children.

While numerous studies have examined the effects of mindfulness on children, particularly within classroom settings, there is a notable gap in research exploring the impact of mindfulness activities conducted in natural environments. The majority of mindfulness research has focused on indoor practices, which may overlook the unique benefits that natural settings can offer, such as enhanced relaxation, improved mood, and a heightened sense of connection to the environment. Although preliminary studies suggest that practicing mindfulness outdoors can amplify its mental health benefits – such as reducing stress, increasing emotional resilience, and promoting attentional focus – there remains a need for more structured research on the subject. Expanding mindfulness studies to include activities in nature could provide valuable insights into how outdoor environments influence children' mental and emotional well-being, offering schools and educators new strategies to support holistic student development.

AIM

The aim of this study was to explore the impact of mindfulness activities conducted in natural settings on the mental health and well-being of young children and their teachers. Specifically, the study examines whether nature-based mindfulness interventions enhance emotional resilience, reduce stress, and improve attention and social-emotional skills among participants.

MATERIALS AND METHODS

RESEARCH QUESTIONS

This study seeks to answer the following research questions:

What impact does engaging in mindfulness activities in natural environments have on the mental health and well-being of young children and their teachers?

Does participating in nature-based mindfulness activities improve emotional resilience, attention, and social-emotional skills among young children?

Are there differences in the effectiveness of nature-based mindfulness activities compared to indoor mindfulness practices in terms of children's and teachers' well-being?

METHOD SELECTION

This research employed a mixed-methods approach, integrating both quantitative and qualitative data to provide a comprehensive understanding of the effects of mindfulness in nature. Quantitative data was collected through a structured questionnaire specifically designed and validated for this study to assess changes in emotional well-being, attentional focus, and social skills among young children and their teachers. Qualitative data was gathered through in-depth interviews with participating teachers to gain nuanced insights into their experiences, perceptions,

and observations regarding the impact of nature-based mindfulness activities.

SAMPLE AND SAMPLING METHOD

The sample included 673 young children (ages 6-15) enrolled in primary and secondary education programs from Greece, Portugal and Cyprus and and 220 of their teachers. A purposive sampling method was used to select participants who regularly engaged with mindfulness activities in nature as part of the MiNa Erasmus+ funded project. Moreover, interviews were also conducted to 20 children and 20 teachers.

THE RESEARCH TOOL

The scale was grounded in mindfulness literature, with particular emphasis on mindfulness-based interventions targeted at children and adolescents. It draws on foundational works by Greco et al. [22] and Brown et al. [23], as well as culturally relevant adaptations from tools like the Child and Adolescent Mindfulness Measure (CAMM). These sources helped shape the scale's structure, emphasizing areas such as emotional regulation, attentional control, and real-time awareness of thoughts and physical sensations.

Comprised of 30 items, the scale assesses mindfulness across several dimensions, including emotional awareness, bodily sensations, and environmental attentiveness. It is organized into four thematic categories, each capturing a distinct mindfulness aspect. A) Emotional Awareness: Focused on recognizing and labeling emotions in the moment (7 items). B) Bodily Sensations: Addresses physical awareness, such as muscle tension, breathing, and sensory experiences (8 items). C) Attention to the Environment: Concentrates on awareness of one's surroundings, with a focus on nature and environmental cues (5 items) and D) Cognitive Mindfulness and Thought Patterns: Examines participants' engagement with their thoughts, including differentiating reality from imagination and observing thought processes (10 items).

Responses were recorded on a 5-point Likert scale, where participants rate how frequently they experience each statement, ranging from 1 (Never) to 5 (Always).

VALIDITY AND RELIABILITY

The English version of the MiNa Scale was evaluated for both validity and reliability. Reliability was assessed through Cronbach's α, while confirmatory factor analysis (CFA) was applied to test the scale's internal structure. The obtained Cronbach's alpha values demonstrated strong reliability, confirming that the scale is a dependable measure for assessing mindfulness.

RESEARCH PROCEDURE

Teachers involved in the study underwnet a short training session to understand the specific mindfulness practices deriving from MiNa Project being evaluated and the procedures for data collection. This training also covered ethical guidelines, mindful facilitation techniques, and instructions for implementing the mindfulness activities in natural settings.

Over a 12-week period, teachers conducted mindfulness sessions with children in outdoor environments, focusing on nature-based mindfulness activities that encourage attentional focus, relaxation, and present-moment awareness. The minimum practice was four (4) weeks.

DATA COLLECTION

Pre- and post-intervention questionnaires were administered to both teachers and children to assess changes in the mental health and well-being of both children and teachers.

Semi-structured interviews were conducted with both groups after the 12-week intervention period to gather in-depth reflections on the perceived impact of the mindfulness activities in natural settings.

DATA ANALYSIS

Quantitative data was analyzed using descriptive and inferential statistics to evaluate the pre- and post-intervention scores on the validated mindfulness questionnaire, examining changes in well-being, attention, and social-emotional skills. Paired t-tests or ANOVA were used to analyze within-group changes for children and teachers.

Qualitative data from the interviews were transcribed, coded, and analyzed using thematic analysis. This allowed for the identification of recurring themes and insights related to the effectiveness, perceived benefits, and challenges of implementing mindfulness activities in natural settings. Triangulation of quantitative and qualitative data was employed to draw comprehensive conclusions about the impact of nature-based mindfulness on mental health and well-being.

This mixed-methods approach aimed to provide both statistical evidence and contextualized insights into the role of nature-based mindfulness for young children and their teachers.

ETHICS

Ethical approval for the study was obtained from Frederick University Research Committee (no E2132). Informed consent was obtained from all participants, including parental consent for child participants. To maintain privacy and confidentiality, all data were anonymized, and participation in the study was voluntary, with participants free to withdraw at any point without consequences. Special considerations had been made to ensure the well-being of young children during mindfulness sessions, and teachers were encouraged to create a safe and supportive environment throughout the intervention.

RESULTS

The results are presented in four (4) thematic units: A) Quantitative results from children, B) Quantitative results from adults, C) Interview results from children, and D) Interview results from adults.

A. The MiNa scale responses from 673 children across Greece, Cyprus, and Portugal were analyzed. Each question used a 5-point Likert scale (1 = "Never", 5 = "Always"). The following subsections detail the results for each question,

organized by thematic units: Emotional Awareness, Bodily Sensations, Attention to the Environment, and Cognitive Mindfulness and Thought Patterns.

1. EMOTIONAL AWARENESS (QUESTIONS 1-7)

The first item, *"When my mood changes, I notice it immediately,"* had a mean score of 3.69 (SD = 1.05). Of the children, 13.7% responded with "Never" or "Rarely," 47.3% selected "Sometimes," and 39% indicated frequent awareness by selecting "Often" or "Always."

For the second item, *"When I talk to other people, I notice what emotions I am feeling at the moment,"* the mean score was 3.61 (SD = 1.12), with 14% selecting "Never" or "Rarely," 48.7% responding with "Sometimes," and 37.3% selecting "Often" or "Always."

The item *"I notice the emotions I am feeling as they happen,"* had a mean score of 3.72 (SD = 1.07), with 12% of children selecting "Never" or "Rarely," 50% choosing "Sometimes," and 38% selecting "Often" or "Always."

The fourth item, *"I notice details in nature (such as the color of the sky or the shape of trees and clouds),"* had a mean score of 3.86 (SD = 1.07). Of the children, 9% selected "Never" or "Rarely," 43.7% selected "Sometimes," and 47.3% responded with "Often" or "Always."

The fifth item, *"I pay attention to the feeling of things like air on my hair or the sun on my skin,"* had a mean score of 3.20 (SD = 1.11), with 26.5% selecting "Never" or "Rarely," 41.3% selecting "Sometimes," and 32.2% selecting "Often" or "Always."

The sixth item, *"I notice small changes in my body, such as when my breathing slows or quickens,"* received a mean score of 3.58 (SD = 1.24). Approximately 16% responded with "Never" or "Rarely," 37.5% chose "Sometimes," and 46.5% selected "Often" or "Always."

For the seventh item, *"I pay attention to my muscles and notice when they feel tight or relaxed,"* the mean score was 3.19 (SD = 1.19), with 23% selecting "Never" or "Rarely," 47.5% choosing "Sometimes," and 29.5% selecting "Often" or "Always."

2. BODILY SENSATIONS (QUESTIONS 8-12)

The eighth item, *"I break or spill things because my thoughts are elsewhere (in other words, I am distracted),"* had a mean score of 3.78 (SD = 1.24). A total of 12.3% selected "Never" or "Rarely," 42.7% selected "Sometimes," and 45% responded with "Often" or "Always."

The ninth item, *"I get distracted by events from the past (such as a grade I received) or future (such as an experience I want to have),"* showed a lower mean score of 2.41 (SD = 1.29). About 45% of children selected "Never" or "Rarely," 35.7% selected "Sometimes," and 19.3% selected "Often" or "Always."

The tenth item, *"I focus so much on a future goal I want to achieve that I don't pay attention to what I'm doing in the moment to achieve it,"* had a mean of 3.48 (SD = 1.28), with 12.8% selecting "Never" or "Rarely," 43.3% choosing "Sometimes," and 43.9% selecting "Often" or "Always."

The eleventh item, *"I do chores, errands, or schoolwork automatically without being aware of what I'm doing,"* had a mean score of 3.14 (SD = 1.26), with 22.3% of children selecting "Never" or "Rarely," 47% selecting "Sometimes," and 30.7% selecting "Often" or "Always."

For the twelfth item, *"I listen to someone with one ear while doing something else at the same time,"* the mean score was 2.44 (SD = 1.22). Of the children, 40.4% selected "Never" or "Rarely," 33.5% selected "Sometimes," and 26.1% selected "Often" or "Always."

3. ATTENTION TO THE ENVIRONMENT (QUESTIONS 13-16)

The thirteenth item, *"I enter a room and then wonder why I went there,"* had a mean score of 3.02 (SD = 1.25), with 32% selecting "Never" or "Rarely," 38% selecting "Sometimes," and 30% selecting "Often" or "Always."

The fourteenth item, *"I tend to walk quickly to get to where I'm going without paying attention to what I experience along the way,"* scored a mean of 2.81 (SD = 1.36). About 43% selected "Never" or "Rarely," 34% selected "Sometimes," and 23% selected "Often" or "Always."

The fifteenth item, *"I tend not to notice feelings of physical tension or discomfort until they really grab my attention,"* had a mean of 2.92 (SD = 1.27), with 35.8% selecting "Never" or "Rarely," 39% selecting "Sometimes," and 25.2% selecting "Often" or "Always."

The sixteenth item, *"I forget the name of a person almost as soon as I've been told for the first time,"* had a mean score of 2.81 (SD = 1.09). About 33.7% selected "Never" or "Rarely," 42.7% selected "Sometimes," and 23.6% selected "Often" or "Always."

4. COGNITIVE MINDFULNESS AND THOUGHT PATTERNS (QUESTIONS 17-26)

The seventeenth item, *"I can distance myself from bad thoughts and emotions when I realize I'm giving them too much attention,"* had a mean score of 2.56 (SD = 1.38). Of the children, 40% selected "Never" or "Rarely," 33.6% selected "Sometimes," and 26.4% selected "Often" or "Always."

The eighteenth item, *"I notice my thoughts and emotions and can observe them as if they were someone else's,"* had a mean score of 2.90 (SD = 1.14). Approximately 27.5% selected "Never" or "Rarely," 43% selected "Sometimes," and 29.5% selected "Often" or "Always."

The nineteenth item, *"I try to stay busy to keep certain thoughts or emotions out of my mind,"* had a mean score of 2.77 (SD = 1.17), with 35.2% selecting "Never" or "Rarely," 38.2% selecting "Sometimes," and 26.6% selecting "Often" or "Always."

The twentieth item, *"When I feel difficult emotions, I try to do something to make them go away,"* had a mean score of 3.44 (SD = 1.14), with 16.3% selecting "Never" or "Rarely," 39% selecting "Sometimes," and 44.7% selecting "Often" or "Always."

The twenty-first item, *"Because I don't like feeling angry or scared, I try to make those feelings go away,"* scored a mean of 3.49 (SD = 1.18). Around 15% selected "Never" or "Rarely," 43.6% selected "Sometimes," and 41.4% selected "Often" or "Always."

The twenty-second item, *"Whenever possible, I try to avoid feelings that cause me pain,"* had a mean score of 3.14 (SD = 1.26). Of the children, 19.8% selected "Never" or "Rarely," 42.5% selected "Sometimes," and 37.7% selected "Often" or "Always."

The twenty-third item, *"I realize that my thoughts are not always facts (i.e., they only exist in my head),"* received a mean score of 3.38 (SD = 1.19). About 16.7% selected "Never" or "Rarely," 47.8% selected "Sometimes," and 35.5% selected "Often" or "Always."

The twenty-fourth item, *"I realize that my opinion is not always based on facts,"* had a mean score of 3.02 (SD = 1.25), with 23% selecting "Never" or "Rarely," 48% selecting "Sometimes," and 29% selecting "Often" or "Always."

The twenty-fifth item, *"When I notice that I've made things more complicated in my mind than they are in reality, I smile,"* had a mean score of 2.81 (SD = 1.14), with 30.5% selecting "Never" or "Rarely," 45.5% selecting "Sometimes," and 24% selecting "Often" or "Always."

Finally, the twenty-sixth item, *"I can distance myself from bad thoughts when I realize they are unnecessary,"* had a mean score of 2.81 (SD = 1.28), with 32.4% selecting "Never" or "Rarely," 41.8% selecting "Sometimes," and 25.8% selecting "Often" or "Always."

STATISTICAL SIGNIFICANCE

An independent sample t-test revealed no statistically significant differences between males and females in the majority of the items ($p > 0.05$). However, a significant correlation ($r = 0.26$, $p < 0.01$) was identified between Factor 2 (Bodily Sensations) and Factor 3 (Cognitive Mindfulness and Thought Patterns), indicating a relationship between physical awareness and cognitive mindfulness.

Children in primary and pre-primary education showed significantly higher scores on Factor 3 compared to secondary and high school children, highlighting a higher tendency for younger children to engage in cognitive mindfulness ($p < 0.05$).

B. The MiNa scale responses from 220 teachers across Greece, Cyprus, and Portugal were analyzed. The following subsections detail the results for each question, organized by thematic units: Emotional Awareness, Bodily Sensations, Attention to the Environment, and Cognitive Mindfulness and Thought Patterns.

EMOTIONAL AWARENESS (QUESTIONS 1-3)

For the statement, "When my mood changes (e.g., from happy to suddenly sad), I notice it immediately," responses indicated that 16.20% disagreed absolutely, 6.70% disagreed somewhat, 9.50% were neutral, while 25.33% agreed somewhat, and 26.44% agreed absolutely.

In response to "When I talk to other people, I notice what emotions I am feeling at the moment," 16.57% disagreed absolutely, 8.38% disagreed somewhat, 7.26% were neutral, with 24.39% agreeing somewhat and 24.58% agreeing absolutely.

For "I notice the emotions I am feeling as they happen," 11.55% disagreed absolutely, 13.41% disagreed somewhat, 11.36% were neutral, while 27.00% agreed somewhat, and 23.43% agreed absolutely.

ATTENTION TO THE ENVIRONMENT (QUESTIONS 4-8)

The item "I notice details in nature (such as the color of the sky or the shape of trees and clouds)" saw 10.96% disagreeing absolutely, 9.10% disagreeing somewhat, 7.45% being neutral, with 23.99% agreeing somewhat, and 27.71% agreeing absolutely.

Regarding "I pay attention to the feeling of things, like air on my hair or the sun on my skin," 12.34% disagreed absolutely, 7.09% disagreed somewhat, 7.27% were neutral, 22.88% agreed somewhat, and 25.17% agreed absolutely.

For "I notice small changes in my body, such as when my breathing slows or quickens," 12.38% disagreed absolutely, 10.93% disagreed somewhat, 7.35% were neutral, while 24.07% agreed somewhat, and 24.24% agreed absolutely.

In response to "I pay attention to my muscles and notice when they feel tight or relaxed," 14.79% disagreed absolutely, 9.45% disagreed somewhat, 6.97% were neutral, with 22.46% agreeing somewhat, and 23.72% agreeing absolutely.

COGNITIVE MINDFULNESS AND THOUGHT PATTERNS (QUESTIONS 9-26)

Participants indicated distraction by external thoughts with 15.56% disagreeing absolutely to "I break or spill things because my thoughts are elsewhere," 8.41% disagreeing somewhat, 7.88% being neutral, while 20.19% agreed somewhat, and 26.77% agreed absolutely.

For "I get distracted by events from the past or future," 13.02% disagreed absolutely, 8.84% disagreed somewhat, 6.29% were neutral, with 26.16% agreeing somewhat, and 25.96% agreeing absolutely.

Regarding "I try to stay busy to keep certain thoughts or emotions out of my mind," 12.38% disagreed absolutely, 10.07% disagreed somewhat, 6.36% were neutral, 21.88% agreed somewhat, and 24.76% agreed absolutely.

For "When I feel difficult emotions, I try to do something to make them go away," 11.43% disagreed absolutely, 8.98% disagreed somewhat, 7.14% were neutral, with 21.48% agreeing somewhat, and 26.99% agreeing absolutely.

Finally, the item "I realize that my opinion is not always based on facts" received 12.78% disagreeing absolutely, 8.75% disagreeing somewhat, 6.93% neutral responses, with 23.51% agreeing somewhat, and 25.89% agreeing absolutely.

C. INDICATIVE RESULTS FROM THE INTERVIEWS WITH CHILDREN

85% of children expressed that they enjoyed the mindfulness activities in nature, often mentioning specific elements like "listening to the birds" or "feeling the breeze."

"I loved hearing the birds sing," said one child, while another mentioned, "It was like a fun game outside!" A few children shared that "being with trees felt nice, like they were our friends."

78% of children reported feeling "calm" or "very calm" during or after the activities. Descriptions of "feeling like I was floating" and "feeling happy" were common.

"I felt like I was flying but sitting still," one child explained with a big smile. Another added, "It made me feel warm and happy inside."

82% noted they could concentrate better in activities following the mindfulness sessions. Many described being able to "listen better" or "stay on task."

"I could hear my teacher better, like my ears were bigger," one child explained. Another shared, "I felt like my brain was quiet so I could do my work better."

D. INDICATIVE RESULTS FROM THE INTERVIEWS WITH TEACHERS

The teachers' interviews (sample of 20) focused on perceived impacts on their stress levels, classroom behavior, and emotional well-being. They consistently described positive transformations for both themselves and their children.

90% of teachers reported a significant decrease in stress, noting the natural environment as "instantly calming."

"Stepping into nature feels like taking a deep breath," said one teacher, while another observed, "The fresh air made a difference; I felt myself calming down as soon as we started."

Teachers observed a 75% improvement in classroom behavior, with fewer disruptions and increased cooperation among children.

"The children seemed more patient with each other," noted one teacher. Another commented, "They took turns more easily and listened without me having to remind them as often."

85% noted that the program helped them become more patient and responsive, with statements like "I could manage the classroom better" and "I felt a stronger connection to the children."

"I felt more grounded, which made it easier to respond calmly," said one teacher. Another shared, "I noticed myself being less reactive and more understanding toward the kids."

DISCUSSION

This study examined the impacts of mindfulness in natural settings on young children's and teachers' mental health, emotional regulation, and attention. The findings demonstrate a positive reception and significant benefits of mindfulness activities in nature, resonating with emerging literature that underscores the unique advantages of outdoor mindfulness practices.

One of the core outcomes observed was the improvement in children's emotional awareness and teachers' emotional regulation. This aligns with the broader findings of Zeidan et al., who suggest that mindfulness practices bolster emotional self-awareness and cognitive control, critical skills for young learners navigating emotional development [24]. In the present study, the majority of children reported noticing their emotions more promptly, such as shifts in mood or physical sensations like tension, which are integral to self-regulation [25]. These results reinforce the importance of integrating mindfulness in educational settings, as seen in previous research linking emotional awareness to resilience and social harmony in classrooms [26].

For teachers, reduced stress and increased emotional regulation align with findings by Jennings et al., who highlighted that teachers engaging in mindfulness report better stress management and emotional resilience [27]. The natural setting appears to amplify these benefits by adding an element of environmental connection and tranquility, similar to the calming effects reported in studies on "forest therapy" by Shin et al. [28]. Such interventions support a balanced mental state, enabling teachers to maintain a nurturing and responsive classroom atmosphere.

In both children and teachers, attention and focus improved significantly post-intervention, supporting previous studies on the role of mindfulness in enhancing cognitive focus [21]. Children reported greater capacity to remain engaged and attentive during tasks, which aligns with findings by Schonert-Reichl et al., suggesting that mindfulness directly aids in attentional control and reduces the likelihood of cognitive distractions. This improvement is particularly noteworthy in outdoor settings, where natural stimuli such as sights and sounds encourage what Kaplan and Kaplan termed "soft fascination," which gently captivates attention without overstimulating the brain [16].

Teachers also noted improved focus in children, observing fewer disruptions and an increased tendency to remain engaged in classroom activities. This aligns with research suggesting that exposure to nature can restore attentional capacity, supporting a conducive learning environment and improving behavior management. Brymer, Freeman, and Richardson corroborate this finding, pointing to the inherent attentional benefits of natural settings that help counteract the mental fatigue often observed in traditional classroom environments [27].

Children and teachers alike reported feelings of calm, emotional balance, and satisfaction from the intervention. This is consistent with the findings of Passmore and Holder, who emphasized the profound influence of nature in reducing stress and fostering a sense of connectedness. In this study, children expressed joy in interacting with natural elements, such as "feeling the breeze" or "hearing birds," which supports findings by Capaldi et al. indicating that mindfulness in nature can increase environmental connectedness, a factor linked to greater happiness and mental resilience [18].

The teachers' experience further echoes research showing that nature-based mindfulness fosters mental clarity and reduces anxiety, attributed to the stress-reducing effects of natural environments [28]. The significant decrease in teachers' stress levels suggests that nature amplifies the calming effects of mindfulness, potentially offering a buffer against the occupational stress common in educational settings [29].

Based on the available data, we can draw the following comparisons and insights across Greece, Cyprus, and Portugal: Participants in Greece reported slightly lower overall scores compared to Cyprus and Portugal. This may be due to environmental or cultural factors, where the historical and philosophical context of nature in Greece could shape participants' expectations, potentially resulting in more critical self-assessments.

Cyprus participants generally reported higher scores indicating a strong connection to the mindfulness practice and a significant improvement post-intervention.

This could be influenced by Cyprus's natural landscapes, as participants in coastal and forested areas may experience a heightened sense of calm and connection to nature.

Portugal participants reported scores between those of Greece and Cyprus. Interestingly, Portugal also had

more participants who practiced mindfulness in urban parks, which could explain some variation in experiences compared to participants in more rural or coastal settings in Cyprus and Greece.

The study included participants from Greece, Cyprus, and Portugal, allowing for insights into how cultural and environmental contexts influence the mindfulness experience. Greek and Cypriot participants, for instance, reported a connection to the natural setting, which aligns with cultural perspectives that view nature as integral to well-being and historical traditions. This reflects literature that notes the cultural significance of nature in Mediterranean contexts, where natural landscapes are often intertwined with philosophical or spiritual practices. Portuguese participants, practicing more in urban settings, still derived significant benefits, showing that even urban green spaces can effectively support mindfulness.

CONCLUSIONS

This study provides evidence that nature-based mindfulness practices have a positive impact on both children and educators, enhancing emotional awareness, focus, and psychological well-being. Children reported greater emotional regulation, attention to the environment, and overall enjoyment of learning, which aligns with existing literature that emphasizes the cognitive and emotional benefits of mindfulness in nature. Educators, likewise, experienced reduced stress, improved classroom dynamics, and a deeper emotional connection with children, underscoring the utility of mindfulness practices as a valuable tool for educators' mental health and professional satisfaction.

The cross-cultural approach, with participants from Greece, Cyprus, and Portugal, revealed that nature-based mindfulness is adaptable across different environments and cultural contexts, providing universal benefits irrespective of the specific landscape. This reinforces the idea that mindfulness practices, especially when conducted in natural settings, can be a powerful addition to educational systems, promoting holistic development and mental health in young children while supporting teacher well-being.

LIMITATIONS

Despite the promising results, this study has several limitations. First, the sample size, although diverse, was limited to specific regions and age groups, which may affect the generalizability of the findings. Further research with a larger and more varied population across additional countries would provide a broader understanding of the intervention's effectiveness.

Finally, the study was conducted over a 12-week period. Longer-term studies are recommended to assess the sustained effects of nature-based mindfulness practices on mental health, behavior, and academic performance. Exploring differences between urban and rural environments, as well as examining the specific features of nature that may enhance mindfulness, could provide further insights into the most effective implementations of nature-based mindfulness in educational settings.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Alexandros Argyriadis
Frederick University
7 Gianni Freiderikou, 1036 Nicosia, Cyprus
e-mail: argyriadis@hmu.gr

ORCID AND CONTRIBUTIONSHIP
Alexandros Argyriadis: 0000-0001-5754-4787 A-D
Agathi Argyriadi: 0000-0003-3935-0414 A-D
Emmanuel Kopanakis: 0009-0000-2432-418X E
Isabel Vieira: 0009-0000-3775-8534 B E
Konstantinos Louvaris: 0009-0004-1013-5192 E
Zoi Mammi: 0009-0008-3929-0291 E F
Olga Drakopoulou: 0009-0006-3823-789X E F
Panagiotis Koutras: 0009-0001-9540-028X A B E
Louiza Ioannidou: 0000-0002-5320-1581 C
Athina Patelarou: 0000-0002-0300-0650 E

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ORIGINAL ARTICLE

Resilience factors of Ukrainian students in the conditions of a war situation

Nina V. Koliadenko[1], Inna V. Mykhailyuk[2], Mykola M. Shopsha[2], Olena L. Shopsha[2], Khrystyna S. Zhyvaho[1], Olena L. Turynina[2], Oksana O. Drevitska[3]

[1]KYIV INTERNATIONAL UNIVERSITY, KYIV, UKRAINE
[2]INTERREGIONAL ACADEMY OF PERSONNEL MANAGEMENT, KYIV, UKRAINE
[3]TARAS SHEVCHENKO NATIONAL UNIVERSITY OF KYIV, KYIV, UKRAINE

ABSTRACT

Aim: To investigate the peculiarities and factors of resilience of students' personalities in the conditions of martial law.

Materials and Methods: A total of 248 students of universities (Kyiv, Ukraine) participated in the study (126 undergraduate students and 122 master's students). The following psychodiagnostic methods were used: Connor–Davidson resilience scale-10; Investigation of the level of reactive and personal anxiety of the Spielberger-Hanin personality; "Coping behavior in stressful situations"; Test of emotional intelligence MSCEIT-V 2.0.

Results: The results of our study showed that the ability to perceive, evaluate, identify and express emotions in master's students is more developed than in undergraduate students, which determines the choice of more optimal coping strategies and a higher level of individual resilience.

Conclusions: It has been established that the long-term stressogenic influence of martial law causes a decrease in the level of resilience of students, insufficient compliance of their coping strategies and non-constructive coping behavior, an increase in the level of reactive anxiety and tension and exhaustion of adaptation resources, which justifies the need for appropriate psycho-corrective and psycho-prophylactic measures. The results of the study can be used to increase the resilience of students as a factor of ensuring the effectiveness of the educational process in the conditions of martial law.

KEY WORDS: difficult life situation, coping strategies, stress resistance, emotional intelligence

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INTRODUCTION

The relevance of the study is due to the long-term crisis stressogenic influence of the martial law in Ukraine, which negatively affects the mental health of students, depletes their adaptation resources and requires an increase in their resilience. The war situation in Ukraine caused negative consequences for all strata of the population, which makes it urgent to find out the characteristics of the resilience of student youth as a necessary condition for ensuring the effectiveness of the educational process. Resilience is a process of personal adaptation to difficult life circumstances and a resource for post-traumatic growth [1], a basis for achieving psychological well-being of a person in crisis conditions [2, 3]. Resilience in the conditions of martial law helps the individual to maintain constructive activity and the ability for self-development [9, 10], but its mechanisms are not sufficiently elucidated. At the same time, data from the sources of scientific literature indicate the presence of relationships between the level of resilience, stable personality traits and emotional intelligence [4]. The resilience of a person is determined by his individual traits and environmental factors, depends on psychophysiological parameters and psychological qualities [5], providing the ability to overcome stress [6-8]. Lack of resilience is an obstacle to optimal functioning, physical and mental health, and life preservation [9, 10].

AIM

The purpose of the study was to investigate the peculiarities and factors of resilience of students' personalities in the conditions of martial law.

MATERIALS AND METHODS

A sample of 248 subjects was formed by simple randomization from undergraduate and graduate students of various Kyiv universities (Ukraine). A total of 126 undergraduate students (group A: 65 boys and 61 girls, average age [mean (M) ± standard deviation (SD)] 19,8 ± 0,64 years) and 122 master's students (group B: 57 boys and 65 girls, average age 27,5 ± 0,78 years) took part in the study.

The research methodology was based on the Model of the development of stress resistance of students of higher education in the conditions of martial law, which is based on the philosophical understanding of a person as a biopsychosocial being and defines resilience as an individual property to overcome difficult life circumstances [10].

The following psychodiagnostic methods were used in the work:

– *Connor–Davidson resilience scale-10 in the modification of Shkolina (2020)* [11] — a questionnaire with 19 questions, the answers to which are evaluated on a five-point Likert scale (0 — "completely false; 1 — "occasionally true"; 2 — "true from time to time"; 3 — "often true"; 4 — "almost true" in all cases"): 0 to 15 points — low level of resilience; 16-20 points — lower than average level; 21-25 points — average level; 26-30 points — higher than average level; 31-40 points — a high level of resilience;

– *Investigation of the level of reactive and personal anxiety of the Spielberger-Hanin personality* [12] — a technique consisting of two scales — situational and reactive anxiety. The number of points less than 30 corresponds to a low level of anxiety, 31-45 points indicate moderate anxiety, and the value of the indicator 46 points and above indicates a high level of anxiety;

– *Determination of coping strategies of the individual using the method "Coping behavior in stressful situations" (S. Norman, D. Endler, D. James, M. Parker; adaptation by T. Kryukova)* [6] — a questionnaire containing 48 questions and 5 scales: 1 — Coping focused on problem solving; 2 — Coping focused on emotions; 3 — Avoidance-oriented coping; 4 — Aversion subscale; 5 — Social withdrawal subscale. Answers to the questions are evaluated on a 5-point Likert scale (1 — "never"; 2 — "rarely"; 3 — "sometimes"; 4 — "most often"; 5 — "very often"). The maximum number of points on scales 1, 2 and 3 is equal to 80 points, on scale 4 — 40 points, and on scale 5 — 25 points;

– *Test of emotional intelligence MSCEIT-V 2.0 (J. Mayer, P. Seloway, D. Caruso)* [13] — a technique that allows you to determine the level of development of the characteristics of emotional intelligence. Indicators are evaluated on a 5-point Likert scale, where 1 represents the minimum and 5 the maximum severity of one or another symptom.

STATISTICAL PROCESSING

The IBM SPSS program (Statistical Package for the Social Science) v. 27 (2022) and EZR v. 1.68 were used for statistical analysis of the received empirical data. Quantitative variables were indicated as mean ± standard deviation. The Shapiro-Wilk W-test was used to test the hypothesis of compliance of the quantitative variables with normal distribution. An F-test was used to compare the variances of the quantitative data between the independent samples. The quantitative variables in two independent samples were compared by the use of a Student`s T-test (in case of equal variances) or a Welch's T-test (in case of unequal variances). A correlation analysis was performed by using the Pearson`s correlation coefficient (r). The relationship between two indicators was considered as strong in case of $r \geq 0,7$. A 2-tailed $p<0,05$ was considered statistically significant.

ETHICAL ISSUES

The study was organized taking into account the provisions of the Declaration of Helsinki and other requirements of bioethics. The permission of the Ethics Commission was obtained for the research. All research participants signed the informed consent document. During the research, the confidentiality of respondents' personal data and the anonymity of their test results were ensured through the use of special encryption of questionnaires.

RESULTS

The summarized results of the study of resilience according to the Connor-Davidson 10-scale and the level of personal and reactive anxiety according to the Spielberger-Khanin method are presented in Table 1. As can be seen from this table, the level of resilience of the studied students was in the range of values below the average. At the same time, the level of resilience of undergraduate students turned out to be statistically significant and significantly lower than the level of resilience of graduate students.

The level of personal anxiety in both studied groups of students corresponded to the range of moderate values, while the level of reactive anxiety exceeded 45 points, which indicated its high level. At the same time, the level of personal anxiety in both studied groups was moderate, but it largely determined the level of reactive anxiety, as evidenced by a strong direct correlation ($r = 0,999$ [$n = 248$; $p < 0,05$]). The resilience of the individual is related to the adequacy of the construction of appropriate coping strategies. The results of determining the coping strategies of students' personalities in stressful situations are presented in Table 2.

A statistically significant difference was found between the indicators of coping strategies of students and master's students. It was found that master's students' coping strategies are more constructive, focused on maintaining emotional balance and solving problems. Bachelor's students, on the contrary, are more focused on avoidance and distraction, avoiding contact with the surrounding reality and solving problems.

To find out the relationship between students' coping strategies and anxiety and resilience, correlation coefficients were calculated, which are presented in Table 3.

Table 1. Results of determining the levels of resilience and anxiety among students (A) and graduate students (B) of Kyiv universities in conditions of martial law

Indicators	Group A n=126	Group B n=122	p
Level of resilience (points)	16,1±3,38	19,3±1,53	<0,001
Level of personal anxiety (points)	38,3±7,58	41,8±4,39	<0,001
Level of reactive anxiety (points)	57,8±12,38	59,8±18,57	0,321

Table 2. Results of the study of personality coping strategies in the conditions of martial law of undergraduate students (A) and master's students (B) of Kyiv universities

Indicators	Group A n=126	Group B n=122	p
Coping focused on problem solving (points)	39,2±10,49	46,6±16,55	<0,001
Coping focused on emotions (points)	43,9±19,08	63,4±16,17	<0,001
Avoidance-oriented coping (points)	57,6±17,36	44,63±16,41	<0,001
Aversion subscale (points)	30,25±7,89	22,43±5,89	<0,001
Social withdrawal subscale (points)	20,11±2,15	16,85±4,79	<0,001

Table 3. The correlations between indicators of resilience, anxiety and coping strategies of the individual in the conditions of martial law (n=248)

Indicators	Level of resilience	Level of personal anxiety	Level of reactive anxiety
Coping focused on problem solving	0,820*	0,917*	0,972*
Coping focused on emotions	0,266*	0,548*	0,776*
Avoidance-oriented coping	0,425*	0,680*	0,846*
Aversion subscale	0,313*	0,572*	0,729*
Social withdrawal subscale	0,240*	0,523*	0,825*

*Note: * – p<0,05.*

Table 4. Results of the study of the manifestation of emotional intelligence in the conditions of martial law of undergraduate students (A) and master's students (B) in Kyiv

Indicators	Group A n=126	Group B n=122	p
Ability to perceive, evaluate and express emotions or identify emotions (points)	4,2±0,54	6,1±0,58	<0,001
The ability to use emotions to increase the efficiency of thinking and activity (emotional facilitation of thinking) (points)	5,4±0,32	5,5±0,48	0,564
Ability to understand and analyze emotional information (points)	4,9±0,35	5,7±0,23	<0,001
Ability to consciously regulate emotions for personal growth and improvement of interpersonal relationships (points)	3,9±0,21	5,8±0,49	<0,001
General average coefficient of emotional intelligence (points)	4,6±0,36	5,8±0,45	<0,001

As can be seen from this table, the most optimal variant of the coping strategy, which consists in solving problems, has a very close direct correlation with indicators of resilience and personal anxiety. On the other hand, the level of reactive anxiety has a close direct correlation with all variants of coping strategies of the respondents. This indicates the existence of a relationship between a person's personal constructs, which determine the formation of his attitude to difficulties, and the choice of behavioral strategies for overcoming stressful and crisis situations.

As the results of the conducted research confirm, the resilience of students' personalities is related to the success of coping strategies for managing emotions, which determines the importance of taking into account the level of development of emotional intelligence to assess a person's viability. The results of the study of students' emotional intelligence using the MSCEIT-V 2.0 Test of Emotional Intelligence (J. Mayer, P. Seloway, D. Caruso) [13] are presented in Table 4.

The results of the study of students' emotional intelligence using the MSCEIT-V 2.0 Test of Emotional Intelligence (J. Mayer, P. Seloway, D. Caruso) [13] are presented in Table 4, testify that the indicators of emotional intelligence of undergraduate and graduate students are in the range of average values, however, the ability to perceive, evaluate, identify and express emotions in graduate students is more

developed than in undergraduate students, that is, they better understand their own emotions and relationships between them, their thoughts and actions.

DISCUSSION

Traumatic processes of experiencing the crisis of a war situation are exhausting for the adaptive resources of the individual and negatively affect his resilience [14]. As a result of this study, it was found that the level of resilience of both undergraduate and graduate students is below the range of the average statistical norm, while the level of reactive anxiety was high. Resilience contributes to the preservation of high productivity of an individual's activity in an extreme life space due to the adaptability of his coping strategies [10, 15]. It was found that the coping behavior of master's students to a somewhat greater extent ensured emotional balance and control over the situation, while the coping behavior of bachelor's students indicated their insufficient development of coping resources and active problem solving under martial law conditions. Among the predictors of achieving a state of psychological well-being in difficult life situations, researchers name a high level of emotional intelligence [9, 16]. The results of our research confirmed that the resilience of students' personality is related to the ability to manage emotions, but the ability to perceive, evaluate, identify and express emotions in master's students is more developed than in undergraduate students, which determines the choice of more optimal coping strategies and higher the level of individual resilience. Thus, the long-term stressogenic influence of the martial law causes in students a decrease in the level of resilience, insufficient compliance of coping strategies and non-constructive coping behavior, an increase in the level of reactive anxiety and tension and exhaustion of adaptation resources, which determines the need for appropriate psycho-corrective and psycho-prophylactic measures.

The limitations of the study were related to the fact that the survey was carried out only in higher educational institutions of Kyiv, Ukraine, not including institutions of secondary, pre-higher, post-graduate education. In addition, the research concerned only bachelor's and master's students and did not extend to other participants of the educational process, which is planned to be taken into account in our further research. There was also no differentiation of respondents by gender or other characteristics.

CONCLUSIONS

The individual and personal factors of the formation of resilience of students of higher educational institutions are revealed. A low level of resilience of both undergraduate and graduate students was revealed, which indicates a lack of adaptive resources and post-stress recovery opportunities. The impact of students' personal constructs on their choice of behavioral strategies for overcoming stressful and crisis events of martial law has been confirmed. It is shown that the resilience of the students' personality is related to the successful management of emotions, which is more developed in master's students than in bachelor's students.

It was found that the long-term stressogenic influence of the martial law causes a decrease in the level of resilience of students, insufficient compliance of their coping strategies and non-constructive coping behavior, an increase in the level of reactive anxiety and tension and exhaustion of adaptation resources, which indicates the need for appropriate psycho-corrective and psycho-prophylactic interventions.

The results of the study can be used to increase the resilience of students as a factor of ensuring the effectiveness of the educational process in the conditions of martial law.

Prospective studies are planned to be directed to the study of the features of resilience in the conditions of martial law of all participants in the educational process, taking into account gender and age characteristics, levels of education, as well as the region where educational institutions are located.

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CONFLICT OF INTEREST
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CORRESPONDING AUTHOR
Nina V. Koliadenko
Department of Psychology and Pedagogy
Kyiv International University
49, Lvivska St., 03179 Kyiv, Ukraine
tel. +38 (093) 594-03-04
e-mail: nina-k@ukr.net

ORCID AND CONTRIBUTIONSHIP
Nina V. Koliadenko: 0000-0003-2099-0163 A D
Inna V. Mykhailyuk: 0000-0002-0690-6837 B C
Mykola M. Shopsha: 0000-0002-4361-039X C E
Olena L. Shopsha: 0000-0002-2192-8911 B F
Khrystyna S. Zhyvaho: 0000-0002-4857-1924 B E
Olena L. Turynina: 0000-0002-3810-2040 E F
Oksana O. Drevitska: 0000-0002-1551-9329 E F

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ORIGINAL ARTICLE

Meta-analysis of studies on the mental state of Ukrainian students under martial law

Borys P. Savchuk[1], Olga Y. Snitovska[2], Oksana V. Vintoniak[3], Petro M. Koval[1], Nadiya O. Fedchyshyn[4], Larysa Ya. Fedoniuk[4], Halyna V. Bilavych[1]

[1]VASYL STEFANYK PRECARPATHIANNATIONAL UNIVERSITY, IVANO-FRANKIVSK, UKRAINE
[2]DANYLO HALYTSKY LVIV NATIONAL MEDICAL UNIVERSITY, LVIV, UKRAINE
[3]KOLOMYIA PEDAGOGICAL PROFESSIONAL COLLEGE, KOLOMYIA, UKRAINE
[4]I. HORBACHEVSKY TERNOPIL NATIONAL MEDICAL UNIVERSITY, TERNOPIL, UKRAINE

ABSTRACT

Aim: To develop and test a methodology for conducting a meta-analysis of studies on the mental state of Ukrainian students under martial law to determine and summarise their results.

Materials and Methods: The developed methodology of meta-analysis involves: determining the criteria for inclusion/exclusion of materials published by Ukrainian researchers in February 2022 – April 2024; search, selection, and assessment of content and quality; selection and interpretation of interdisciplinary analytical and operational meta-analysis tools (the concept of Effect Zize and Standardised Index; Fixed- and Random-Effects Models; chi-square and Q homogeneity test; actor-observer asymmetry effect; standard PHQ-9 GAD-7 methods); assessment of statistical heterogeneity of research results; preparation of a meta-analytical report.

Results: The search resulted in 135 articles on the issue. After the initial processing, 43 studies were selected for further analysis. They were structured and characterised according to the following criteria and features: types of research; time it was conducted; its authors; participants in sociological and experimental studies. The reflection of the dominant mental states (stress, anxiety, fear, depression, oppression, pessimism, confusion, apathy) in empirical, empirical-analytical, and experimental studies has been determined. The results of studies of mental states in the fields of medicine, psychology, etc.,have been characterised. A meta-analysis of studies that reflect the impact of mental states on students' attitudes to the learning process and allow tracking the dynamics of changes in their mental reactions at different stages and phases of martial law in Ukraine and related to evacuation has been carried out.

Conclusions: Based on the results of the studies that became the subject of the meta-analysis, the general reactions that arose in students as a result of traumatic experience have been identified: stress, anxiety, fear, anger, guilt, shame, helplessness, etc. They had a corresponding impact on the effectiveness of their academic performance.

KEY WORDS: meta-analysis, students, mental state, martial law in Ukraine.

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INTRODUCTION

Over the last decade, Ukraine has been in a difficult, tragic situation. Following Russia's invasion of Crimea in February-March 2014, an armed conflict in the east of the country erupted, escalating into a full-scale Russian-Ukrainian war on 24 February 2022. This led to the occupation of part of the country's territory, massive civilian casualties, a wave of refugees and internal displacement. According to UNICEF, about 4.3 million children and young people in Ukraine changed their place of residence in February 2022, with more than 1.8 million of them moving to European countries [1, 2].

Under such conditions, university and college students found themselves under a double burden of stress and anxiety: they had to continue their studies, which are a priori accompanied by a significant psychophysiological burden, despite the threat of rocket attacks, the pressure of information and psychological operations, and a difficult internal situation.Not having recovered from the stress caused by the COVID-19 epidemic (March 2020 – July 2021), students faced new threats to their mental health. The scale of this problem is evidenced by WHO data, according to which, as of the beginning of 2023, 25% of the population of Ukraine was at risk of serious mental disorders [3]. Our professional experience is confirmed by professional studies [4-6], which classify students as the 'most mentally vulnerable' categories of the population who suffer in critical situations.

Increased attention to this problem has resulted in the emergence of multidisciplinary studies that present empirical and theoretical materials that deserve a substantive, holistic understanding. An effective method of solving this problem is meta-analysis, which also allows us to look at this issue through the prism of the global discourse on the impact of war-related crises on the mental health of the population.

AIM

To develop and test a methodology for meta-analysis of research on the mental states of Ukrainian students under martial law to determine and summarise their results.

MATERIALS AND METHODS

Meta-analysis is viewed as a quantitative statistical method of assimilating, generalising and integrating a multitude of thematically similar studies conducted on different samples. It aims to find a balanced answer to the question: to what extent their results can be synthesised with the highest statistical probability, which characterises patterns in a statistical population.

The developed interdisciplinary methodology of meta-analysis defines its stages, content, and tools. It should provide answers to the key questions about establishing: the boundaries of the central tendency of the distribution of results obtained from various empirical and theoretical studies, their variability, and the possibility of explanation. Identification of the average result of research on the mental state of Ukrainian students under martial law is achieved by combining effect sizes, significance levels, and confidence intervals around the average effect size. Should significant differences in the results of the studies be found, the search for mediating variables that could have influenced them is carried out.

The experience of meta-analysis [7-15] provides the basis for determining the main stages of the study: 1) the development of criteria for inclusion/exclusion of original papers in the orbit of meta-analysis (relevance to the subject of research, time of appearance (February 2022 – April 2024); availability of empirical data that could be combined with analytical or experimental parts.); availability of empirical data that could be combined with the analytical or experimental parts; 2) identification, selection, evaluation of the content and quality of research (Google search on the keywords 'students', 'mental state', 'mental health', 'stress', 'anxiety', 'martial law', 'Ukraine', 'Russian-Ukrainian war'); 4) selection and interpretation of analytical and operational tools; 5) assessment of statistical heterogeneity of research results; 6) preparation of a meta-analytical report. The last three points will be clarified in more detail.

As a key tool of the methodological programme of meta-analysis, the concept of Effect Zize is used. Based on the Standardised Index, it ensures that the units of standard deviation of a normal distribution are determined for the correct comparison of the results of different independent studies. The weighted effect size determines the average effect relative to the entire population (student population). Effect sizes were calculated using the Cohen (1994) scale, according to which the correlation coefficient divides effects into small (r = .10), medium (r = .30), and large (r = .50) [8].

The potential of the fundamental meta-analytical Fixed- and Random-Effects Models [10, 15] has been combined to determine clear/constant research parameters and generalise the described variable/changing/specific samples of students' mental states.

Transparency in assessing the heterogeneity of research results implies clarifying its causes, manifestations, and other aspects. For this purpose, the chi-square and homogeneity test (Q test) criteria are used [12].

The effect of actor-observer asymmetry is taken into account, which is interpreted as an asymmetry in the context of the study: students-'actors' attribute their feelings, emotions, and behaviour to the contextual influence of the experienced situation, and 'observers' (researchers) interpret them as stable dispositions (acceptable scientific categories and methods) [16].

The preparation of the meta-analytical report involved: a) statistical analysis and synthesis of the effects obtained in the course of the study (search for outliers) and determination of the boundaries of the central tendency; b) interpretation, generalisation, and drawing conclusions using standard procedures that reveal the consistency of the data obtained and the range of deviations, heterogeneity of the study parameters and its results.

The following supplementary meta-analysis tools were used: standard methods for determining and assessing an individual's mental state (Patient Health Questionnaire – HQ-9; Generalised Anxiety Disorder Scale – GAD-7); cross-validation method (model evaluation by breaking it down into k parts [17]); content analysis; phenomenological method (to identify the general and specific features of each study).

The limitations of the meta-analysis method in the study of humanities research are taken into account since it does not isolate the subject of research and the researcher from the influences of the environment, which affects their results. However, if this tool allows us to establish at least 15-20% of the reliability of the results of humanities studies, then it is quite suitable for their analysis [15].

RESULTS

A search on Google and Ghat GPT has resulted in the discovery of 135 materials on the given issue. After initial processing, 43 studies were selected for further analysis. It is possible that a certain part of the works could have been overlooked, but we consider the volume of materials included in the meta-analysis to be sufficient to address the research objectives.

Based on the fixed effects model, these 135 articles included in the primary meta-analysis have been structured according to the following criteria and features:

I. Classification of research by: type: exploratory/sociological (results of sociological surveys – 27), empirical-analytical (analysis of factual data obtained by the authors – 36), theoretical (discussion of theoretical aspects of students' mental states – 61), applied, experimental (correction/improvement of students' mental health indicators – 11); categories and status: articles in Scopus and WoS databases – 2, professional journals of category B included in specialised international scientometric databases – 38, materials of scientific conferences – 55, others – 40; by fields of knowledge: psychology (52), medicine (23), education, pedagogy (25), with others being conventionally interdisciplinary.

II. The authors of the studies were: specialists in the fields of psychology (95), medicine (42), education and pedagogy (41), and sociology (7). They included: authors with academic degrees (61%), employees of educational (41) and scientific (9) institutions, postgraduate students (6), master and bachelor students (5). The initiators/organisers of the studies were individual researchers, educational and academic institutions and their psychological services, and sociological agencies.

III. The period when the studies were conducted and published is determined by the period of martial law in Ukraine. It is divided into 3 stages, covering: the first 6 months (March – September 2022) – 9 studies; the next year (October 2022 – September 2023) – 22; the next 6 months (October 2023 – April 2024) – 12. Along with the 'single-act' studies, we recorded 6 cyclical studies covering 2 or 3 of the above stages. This study also focused on theoretical studies that appeared before the outbreak of full-scale war.

IV. The participants of the sociological and experimental studies were college students (3) and university students (31), including future doctors (17) and specialists in other fields of knowledge. They were located in places that were subjected to periodic rocket attacks (Kyiv, Poltava, Zhytomyr, Chernihiv); in a relatively calm western region of Ukraine; and as refugees in the European countries of study. The age of the respondents ranged from 18 to 25 years (20 years ± 1 year, on average); women (67%) outnumbered men (33%). The sample was dominated by 50 to 65 people (65 %) and ranged from 33-37 to 1152 people [18].

V. The tools for conducting most (80%) of the studies were questionnaires posted on Google Forms (Alphabet Inc.) and distributed in social networks. The questionnaires were completed anonymously over a specific period of time. The selective bias of the sampling strategy (online surveys based on the voluntary participation of interested students) is taken into account, as their participants were more aware of personal mental health problems than those who avoided such involvement.

Therefore, a significant number of multidisciplinary studies, prepared by specialists in various fields of knowledge based on tested research tools, are devoted to the study of students' mental state.

Random-Effects Models are used to describe variable/changeable/specific samples of students' mental states. The model of students' mental activity manifestations [19] is used as a matrix for their reconstruction, which shows the interdependence and interconnection of the study of mental states with mental processes, properties and tendencies. The 'main' mental states that the authors of the 43 studies selected for analysis focused their attention on are shown in Table 1.

The authors interpret the mental/psychological/emotional state in concordant definitions as a unity of experiences and behaviour over a certain period of time; as a reaction of the body's functional systems to external and internal influences aimed at adaptation and maintaining human life activity under specific conditions and situations. In 40% of studies, mental state is considered to be a component of a student's mental health.

Scientists identify more than 60 concepts that nominate manifestations of different mental states [20]. The 43 studies included in the subject meta-analysis focus on 4 conditionally 'main' (Table 1) and a total of 10-12 mental states of students that were clearly manifested in the context of the Russian-Ukrainian war. In 8 out of 10 cases, these were negative affective-volitional mental states. They are regarded as situational (expressing the peculiarity of the situation and reaction to it); deep (by the strength of influence on experiences and behaviour); social, emotional, cognitive, behavioural (by functional levels); asthenic (demobilising, maladaptive), conscious/unconscious; and long-term.

The mental states of students are studied and evaluated from the perspective of certain branches of knowledge. In terms of psychology, they are described as changeable, emotionally charged phenomena determined by life circumstances, crisis situations, and individual characteristics [4-6, 18-32]. Medical studies focus on the physiological manifestations of mental states, while psychological and pedagogical studies focus on the impact of mental disorders on academic performance [33-36].

Stress, as the most common manifestation of traumatic experience, is considered in three main aspects: as a state of mental tension that a person experiences under the influence of difficult, unfavourable conditions; as an

Table 1. Dominant mental states of students in different types of research under martial law

Mental state	Types of research and their number		
	Intelligence-sociological (21)	Empirical-analytic (19)	Applied/ experimental (5)
Stress	16	12	3
Anxiety/concern	17	14	3
Depression/oppression	15	11	3
Fear	10	8	4
Pessimism/hopelessness	6	5	2
Despair, confusion	8	7	-
Apathy/indifference	6	5	2

interaction between a person and the environment; as a feeling of pressure, depression, inability to cope with a problem that arises due to emotional states of fear, anxiety, depression, pessimism, and aggression. The research focuses on behavioural reactions that arise as a result of emotional stress and lead to negative changes and functional disorders.

Researchers interpret anxiety, which is the second most dominant manifestation of traumatic experience, as a temporary/variable mental state that occurs under the influence of stressors when a person (student) perceives a situation as threatening or dangerous. In situations of anticipation and uncertainty, its common manifestations are observed: emotional tension, anxiety, mental discomfort, loss of balance, increased vulnerability, heightened feelings of guilt, and decreased self-esteem [4, 6, 18, 21-31, 33-36]. Students with high levels of anxiety were especially affected, as they quickly lost their balance, showed internal maladaptive and unpredictable behaviour (tearfulness, irritability, rude attitude to others, apathy, indifference).

The model of fixed effects (on a 40-point scale of severity: 0-5 – weak; 6-12 – moderate; 13-24 – marked; 24-40 – high) allows us to track changes in student stress components at separate stages of martial law (Table 2).

Researchers [4, 6, 18, 21, 22-28, 31, 33-36] have identified the factors that caused/enhanced the state of stress and anxiety. Their generalisation according to the Cohen (1994) scale [8], without reference to the time and place of students' location, shows that stress was caused primarily by the following stimuli: explosions (r = .45), news from the front line about the atrocities of the occupiers, etc. (r = .41); air raids (r = .35); social environment (conversations about the war, death of loved ones, etc. – r = .33%). They increased intrusive thoughts (r = .15) and disbelief in the future (12%). Despite the high level of stress and anxiety, students neglected safety requirements (r = .37) and never used a bomb shelter (r = .27) even in the first half of the year 2022.

Research in the fields of medicine [27, 33-36] and psychology [4, 6, 21, 25, 28, 29] has shown a deterioration in the psychophysiological state of students: a decreased attention span, thinking speed, memorisation, and sleep disturbance. A high level of empathy is observed: between 64% and 76% of respondents were more concerned about the safety and health of their loved ones than their own.

The calculation of fragmentary and time-varying research results [5, 6, 21, 22, 24, 25, 26-30, 33] shows that as of 2022, the war did not affect the attitude of 42% of students to study, while 38% began to pay less attention to it. 47% of students felt safe while studying as opposed to 53% of students. In the second half of 2023, these three indicators improved.

Empirical studies [4, 35, 36] provide an opportunity to track the dynamics of changes in students' mental reactions at different phases of the first 6-month stage of martial law, which was associated with evacuation (Table 3). The emotional triggers of this process were the information and psychological background, changes in the military and political situation, and personal life.

Table 2: Dynamics of changes in stress components and their elements based on the results of the analysis of scientific research [4, 6, 18, 21-31, 33-36].

Stress components and their elements	1-6 months	6-12 months	13-24 months
Intellectual (negative thoughts, difficulties in learning and concentration, impulsive thinking, etc.)	18-21	10-12	8-9
Behavioural (sleep disorders, passivity, inhibition, and proneness to conflict)	23-25	14-15	12-13
Emotional (suspiciousness, uncertainty, concern, anxiety, gloomy mood, dissatisfaction with life, feeling of guilt, low self-esteem, alienation)	34-36	12-14	10-11

Table 3. Changes in students' mental states/reactions and indicators of their manifestations at different phases of evacuation

Evacuation phases	Mental states/reactions and indicators of their manifestations
The first day of the war	Anxiety, fear of the unknown, depression, emotional tension – 80%; calmness, attention, concentration – 8.3%
Preparing to evacuate	Fear of loss, panic, despair, stress – 87%
Evacuation	The peak of stress and a mixture of emotions: anxiety regarding loved ones, a sense of possible death; indifference, despair and doom due to the inability to influence and control the situation – 88%
Accommodation at a new place during evacuation	Depression, difficulty/inability to adapt, frustration, aggressiveness are replaced by apathy – 50-75%; Calmness, sense of security – 25
Preparing to return home	Joy, elation, optimism – 42%; anxiety, nostalgia, despair, fatigue – 25%; frustration, helplessness – 8.3%
Returning home	Optimism, joy, restoring balance – 58.4%; Apathy, fear, fatigue, loss of hope – 25 %.

DISCUSSION

The Google search engine records more than 800 publications on the keywords 'mental health', 'mental state', 'students', 'meta-analysis'. 12 of them have been meta-analysed. In addition, more than 20 papers have been found on the impact of military conflicts on the traumatic experience of students and children and youth [14, 37-41]. They were related to countries (authors, universities, students) that were in a state of war or experienced armed conflicts. The analysis of the second group of studies aimed at answering the following questions: what special/different and common problems with Ukrainian studies were raised in them; how the experience of foreign studies can be interesting and useful for Ukraine, etc.

The difference in the results of foreign studies was determined by the peculiarities of the lifestyle, the nature of military conflicts, the mentality of students; scientific traditions and research methods, and other factors. Nevertheless, there are many similarities in the general matrix of cross-sectional research design, and their empirical findings are also based on students' self-esteem.

Foreign researchers focus their attention on post-traumatic stress disorder (PTSD) as the most common mental disorder in war-affected regions. They raise complex and sensitive issues more boldly. For example, in a study involving 833 students at a university in Deirez-Zor, which was besieged by ISIS for more than three years during the 9-year war in Syria, it was found that 86.4% of them had experienced at least one traumatic event. The overall prevalence of PTSD was 28.2%, and the highest rate was among students who had been forced to have sexual intercourse (46.3%) [37]. A study of 214 students from Afghan universities reported impressive rates of severe PTSD (70 per cent), clinically significant symptoms of depression (69.7 per cent), and suicidal behaviour (38.6 per cent). The authors argue that 'significant positive changes' in the mental health of victims occurred in the post-traumatic period due to social support [38].

In a study involving 550 Palestinian students from four universities in Gaza, the authors found that despite the absence of direct military/violent actions, the very fact of a prolonged experience of a 'quasi-total siege' destroys any hopes for positive change, and exacerbates mental disorders in the form of anxiety, depression, and acute stress. The situation was aggravated by the lack of social and psychological support [39].

In the long term, Ukraine should take into account the experience of studies that show that 40 years later, adult children whose parents took part in military operations in Afghanistan and Iraq were more likely to be diagnosed with anxiety, depression, suicidal thoughts, and self-harm. Compared to others aged 38-44, their mental health was diagnosed as 'significantly worse' [40].

The results of studies showing that during the war in Libya, medical students experienced an increase in anxiety, depressive disorders, and the threat of PTSD due to the awareness of their inability to help wounded soldiers in hospitals and relatives and friends who suffered from physical injuries and damages in the occupation zone are of interest [41].

The outlined vectors of foreign research define the prospects for the development of Ukrainian studies. At the same time, the latter offer a wider range of forms and means to improve students' mental health which has deteriorated during crisis situations. In addition to the help of mental health services, they offer effective author's techniques for reducing and preventing stressful situations [4], art therapy [21], coping strategies [28], etc.

CONCLUSIONS

The results of research on students' mental states under martial law in Ukraine (February 2022 – April 2024) turned out to be heterogeneous for objective reasons (different groups of students, time of research, different evaluation criteria and methods, etc.) However, the assessment of their statistical heterogeneity (by 12; 15) and the meta-analysis of the studies allows us to outline the main mental states and reactions that students experienced as a result of traumatic experiences. A significant part of them (53-42%) demonstrate reactions of fear, anger, guilt, shame, helplessness. They occurred/ intensified in situations when the psyche tried to understand and accept what had happened and protect itself from psychological pain and danger. Thoughts and memories of traumatic events cause indecision, confusion, difficulties in making choices, orientation and concentration. This leads to the fact that students find it difficult to cope with the routine tasks associated with their educational and professional activities. Proneness to conflict, aggressiveness, and irritability increase in interpersonal relationships. The authors of the analysed studies acknowledge that such reactions are an adequate response to a stressful situation. However, they mostly overlook the problem of individual perception and expression of traumatic experience. Therefore, in their professional activities, teachers should take into account the main ways of students' behaviour in crisis situations.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Larysa Ya. Fedoniuk
Ternopil National Medical University
1 Maidan Voli, 46001 Ternopil, Ukraine
e-mail: fedoniuklj@tdmu.edu.ua

ORCID AND CONTRIBUTIONSHIP
Borys P. Savchuk: 0000-0003-2256-0845 A D F
Olga Y. Snitovska: 0000-0002-3086-9503 B D
Oksana V. Vintoniak: 0000-0003-0040-3582 E D
Petro M. Koval: 0000-0001-7074-7984 E F
Nadiya O. Fedchyshyn: 0000-0002-0909-4424 B F
Larysa Ya. Fedoniuk: 0000-0003-4910-6888 B D
Halyna V. Bilavych: 0000-0002-1555-0932 C F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Cadets' physical development and functional state during the different types of motor activity

Kostiantyn Prontenko[1], Ivan M. Okhrimenko[2], Serhiy V. Cherednichenko[3], Oleksandr A. Tomenko[3], Olha M. Pasko[4], Liudmyla M. Prudka[4], Tetyana V. Matiienko[4]

[1]S.P. KOROLIOV ZHYTOMYR MILITARY INSTITUTE, ZHYTOMYR, UKRAINE
[2]NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE
[3]SUMY STATE PEDAGOGICAL UNIVERSITY NAMED AFTER A. S. MAKARENKO, SUMY, UKRAINE
[4]ODESA STATE UNIVERSITY OF INTERNAL AFFAIRS, ODESA, UKRAINE

ABSTRACT

Aim: The aim is to investigate the impact of the different types of motor activity on the indicators of cadets' physical development and functional state during their training.

Materials and Methods: The research, which was organized in 2019-2023, involved 145 male cadets, aged 17 to 23. We formed three groups of cadets. Group 1 (n=29) included cadets who were engaged in orienteering, cadets of Group 2 (n=84) were engaged in other sports (strength sport, all-around, martial arts, game sports), cadets of Group 3 (n=32) were engaged in the traditional method of training. The physical development was assessed by height, body weight, chest circumference, hand dynamometry, body mass index, the Bruksch index, and strength index. The functional state was assessed by heart rate, blood pressure, vital capacity of the lung, the Ruffier index, vital index, the Robinson index.

Results: We found a more positive effect of orienteering training sessions, compared to the traditional method of training, on the studied indicators of cadets. At the same time, no significant difference was found between Groups 1 and 2. This indicates that both orienteering and other types of motor activity are more effective in improving the physical development and functional state of cadets during their training.

Conclusions: A high level of physical development and functional state of cadets will help to improve the effectiveness of their educational and future professional as well as combat activities.

KEY WORDS: motor activity, physical development, functional state, orienteering, cadets

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INTRODUCTION

An important feature of modern combat activities is the enemy's insidious maneuvers and full envelopment of personnel and their disorganization using ambushes and "entrapments". The likelihood of being isolated, enveloped, captured, and disoriented during missions in enemy territory leads to losses of manpower, and combat materiel, and a decrease in the effectiveness of the combat mission as a whole [1, 2]. Therefore, modern combat activities place demands not only on a high level of development of motor skills in cadets i.e. graduates of higher military educational institutions (HMEIs), but also on the formation of professionally important military-applied skills that contribute to quick decision-making against the background of extreme psychophysical stress, skills to accurately navigate in unfamiliar terrain, both day and night, in all weather conditions [3-5]. Orienteering is the most effective means of forming cadets' psychophysical readiness for future professional and combat activities, as well as for participation in international peace and security activities (peacekeeping operations and missions).

Orienteering is a modern military-applied sport included in the competition program of the International Military Sports Council, which has made it quite popular among cadets [6, 7]. Orienteering is included in the combat training programs of the armed forces of most NATO countries [8, 9]. Orienteering contributes to the development of such motor skills as endurance, speed, coordination abilities, formation of military-applied skills in accelerated movement over a rough terrain, orienteering with the help of a map, compass, and natural landmarks (without the use of modern electronic means that disguise the location), contribute to the development of volitional qualities, improve the dynamics of mental cognitive processes of those involved in it [10-13]. At the same time, the influence of orienteering compared to other types of motor activity on the indicators of physical development and functional state of cadets during their training is not sufficiently studied, which led to the choice of the research topic. The necessity of our research is also caused by the deterioration in recent years of the level of physical development and functional state of candidates for studying in HMEIs.

AIM

The aim is to investigate the impact of the different types of motor activities on the indicators of cadets' physical development and functional state during their training.

MATERIALS AND METHODS

The research, which was organized in 2019-2023, involved 145 male cadets of the S.P. Koroliov Zhytomyr Military Institute (Ukraine), aged 17 to 23. We formed three groups of cadets: Group 1 (n=29), which included cadets who were engaged in orienteering in the course of their sporting and mass participation activities (SMPA), Group 2 (n=84) – cadets who were engaged in other sports (strength sport, all-around, martial arts, game sports), Group 3 (n=32) – cadets who were engaged in the traditional method of SMPA.

Training sessions during the SMPA were held 3 times a week in the afternoon. Each training session lasted 1 hour. Groups 1 and 2 were formed from the 1st year cadets (2019 enrollment) at their request by interviewing them to determine their interests in practicing the sports available in the HMEI. Group 3 included cadets of the same training year. They did not additionally engage in sports during their training in the HMEI and they practiced in SMPA according to the traditional method of training. The total number of hours of physical training per week for cadets of all three groups was the same. The initial level of indicators of physical development and functional state of cadets of Groups 1, 2, and 3 in the 1st training year did not differ significantly ($p>0.05$). The study of cadets' indicators was conducted during two stages: at the beginning of the 1st training year (first stage), and at the end of the 4th training year (second stage).

Research methods: theoretical analysis and generalization of literary sources, medical and biological methods, and statistical analysis. With the help of theoretical analysis and generalization, we got acquainted with the research of scientists in the field of physical training of cadets, found out the place of orienteering in the physical training of cadets. 18 sources from the scientometric databases PubMed, Scopus, Web of Science Core Collection and others were analyzed. Medical and biological methods were used to study the indicators of cadets' physical development and functional state. The physical development was assessed by height, body weight, chest circumference, hand dynamometry, body mass index, the Bruksch index, and strength index. The functional state was assessed by heart rate, blood pressure, vital capacity of the lung, the Ruffier index, vital index, the Robinson index, and the time to restore heart rate after standard exercise. The examination of cadets was carried out by medical personnel in the sanitary unit during their regular medical examinations in the morning.

Statistical analysis was used to process the experimental data obtained. The compliance of the sample data distribution with the Gauss' law was assessed using the Shapiro-Wilk W test. The reliability of the difference between the indicators was determined using the Student's t-test. The results were presented as M±m, where M is the arithmetic mean, m is the error of the arithmetic mean. The reliability of the difference for all statistical tests was set at $p<0.05$. All statistical analyses were performed using STATISTICA 6.1 software package (number AGAR909E415822FA), adapted for medical and biological research.

This research complies with the ethical standards of the Order of the Minister of Defense of Ukraine "On Approval of the Regulation on the Organization of Scientific and Technical Activity in the Armed Forces of Ukraine" No. 385 dated 27.07.2016. The procedure for organizing the study was previously agreed with The Committee on Compliance with Academic Integrity and Ethics of the S.P. Koroliov Zhytomyr Military Institute (Protocol No. 12 dated 30.08.2019). Also this research followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all cadets who took part in this research.

RESULTS

The comparative characteristics of cadets' physical development indicators in Groups 1, 2, and 3 are presented in Table 1. The analysis of cadets' height showed a slight increase in this indicator in all three groups of cadets in the process of their training, but no significant difference in height indicators between Groups 1, 2, and 3, both in the first and second stages, was found ($p>0.05$). The analysis of body weight of cadets showed no significant difference between the indicators of all three groups in the first stage of the research and between the indicators of Groups 1 and 2 in the second stage. At the same time, it was found that in Group 3, body weight in the second stage was significantly higher than in Group 1 – by 2.3 kg ($p<0.05$) and in Group 2 – by 1.6 kg ($p<0.05$). Comparing the indicators of cadets of individual groups, we found that in the second stage of the research, the body weight of cadets in all three groups was higher compared to the first stage. However, in Groups 1 and 2, body weight increased insignificantly ($p>0.05$) by 1.1 kg to 1.4 kg, which is due to physiological processes associated with the maturation of the body and an increase in muscle mass of the cadets' body due to regular exercise. In Group 3, body weight increased significantly by 3.7 kg ($p<0.01$) during the period of training at the HMEI. The analysis of body weight shows the positive impact of orienteering and other sports on the improvement of physical development of cadets and the absence of overweight cadets among Groups 1 and 2.

The analysis of resting chest circumference measurements did not show a significant difference ($p>0.05$) between the indicators of cadets of all study groups in the first stage. In the second stage, the chest circumference of cadets who were engaged in other sports was found to be 1.2 cm larger than that of cadets who were engaged in orienteering, but no significant difference was found between them ($p>0.05$). The worst indicators were found in the cadets of Group 3. It is important to note that during the period of training in the HMEI, the chest circumference of cadets of all groups significantly improved ($p<0.05$-0.001), but the most significant changes occurred in Groups 1 and 2.

This confirms the effectiveness of training in all military-applied sports during their studies in the HMEI to improve their physical development (Table 1).

The study of indicators of hand dynamometry showed that in the second stage in Group 2, the strength indicators of cadets were better than in Group 1 by 1.6 kg ($p>0.05$) and in Group 3 – by 2.3 kg ($p<0.05$). This is explained by the presence of representatives of strength sports in Group 2. At the same time, strength indicators in Group 1 were also better than in Group 3 by 0.7 kg ($p>0.05$). It should be noted that in Groups 1 and 2, in contrast to Group 3, there was a significant ($p<0.05$; $p<0.001$) improvement of strength indicators during the period of training in the HMEI. The analysis of the Bruksch index showed that the physique of cadets of all studied groups in all stages of the research was assessed as harmonious. During the period of training in the HMEI, the Bruksch index significantly improved in all three groups but was more pronounced in Groups 1 and 2. At the same time, in the second stage of the research, the Bruksch index in Groups 1 and 2 was significantly better than in Group 3, which confirms the positive impact of orienteering and other military-applied sports on the physical development of cadets and the formation of a strong, harmonious physique. The analysis of body mass index showed that there was no significant difference between the indicators of all three groups in the first and second stages ($p>0.05$). However, in the process of training in Group 3, the index significantly deteriorated by 1.07 kg/m2 ($p<0.05$), and in Groups 1 and 2 it did not change significantly, which confirms the positive effect of sports on improving the physical development of cadets. Studying the strength index, we found that the indicators of cadets in Groups 1 and 2 improved during the period of their training in the HMEI, and in Group 3 there was a deterioration in the strength index. In the second stage of the research, Groups 1 and 2 showed significantly better strength indicators than Group 1, which confirms our previous findings.

The results of the study of indicators of the functional state of cadets in Groups 1, 2, and 3 are presented in Table 2. The analysis of resting heart rate showed that cadets of Groups 1 and 2 had a significant ($p<0.05$; $p<0.01$) improvement in heart rate during the period of their training in the HMEI, and the indicators did not change significantly ($p>0.05$) in Group

Table 1. The comparative characteristics of cadets' physical development indicators in the process of their training (n=145)

Stages of the research	Group 1 (n=29)	Group 2 (n=84)	Group 3 (n=32)	Significance of the difference		
				t_{1-2}	t_{2-3}	t_{1-3}
Height, cm						
First stage	176.3±0.84	176.6±0.41	177.0±0.75	0.32	0.47	0.62
Second stage	176.9±0.90	177.1±0.52	177.4±0.77	0.19	0.32	0.42
Body weight, kg						
First stage	72.4±0.77	72.8±0.56	72.1±0.69	0.42	0.79	0.29
Second stage	73.5±0.83	74.2±0.59	75.8±0.79**	0.69	2.04	2.09
Chest circumference, cm						
First stage	93.1±0.47	94.2±0.37	93.5±0.51	1.84	1.11	0.58
Second stage	95.6±0.49**	96.8±0.44***	95.1±0.53*	1.82	2.47	0.69
Hand dynamometry, kg						
First stage	40.4±0.88	41.1±0.59	40.6±0.84	0.66	0.16	0.49
Second stage	43.6±0.85*	45.2±0.71***	42.9±0.91	1.53	2.08	0.56
Bruksch index, sm						
First stage	528.1±1.76	532.4±1.53	527.9±1.71	1.84	1.96	0.08
Second stage	541.6±1.79***	546.6±1.47***	536.1±1.77**	2.16	4.56	2.18
Body mass index, kg/m^2						
First stage	23.34±0.32	23.48±0.23	23.04±0.29	0.36	1.19	0.69
Second stage	23.44±0.31	23.88±0.25	24.11±0.30*	1.10	0.59	1.55
Strength index, %						
First stage	58.10±1.19	58.50±0.52	58.15±0.98	0.31	0.32	0.03
Second stage	60.40±1.06	61.30±0.48**	57.09±1.03	0.77	3.7	2.24

Note: n: number of subjects; t_{1-2} (t_{2-3}, t_{1-3}) – the significance of the difference between the indicators of cadets of Groups 1 and 2 (2 and 3; 1 and 3) by the Student's t-test;
** – the significance of the difference between the indicators of first and second stages of the research at $p<0.05$; ** – $p<0.01$; *** – $p<0.001$.*

Table 2. The comparative characteristics of cadets' functional state indicators in the process of their training (n=145)

Stages of the research	Group 1 (n=29)	Group 2 (n=84)	Group 3 (n=32)	Significance of the difference		
				t_{1-2}	t_{2-3}	t_{1-3}
Heart rate, bpm^{-1}						
First stage	70.1±0.48	70.3±0.36	69.9±0.44	0.33	0.7	0.31
Second stage	68.7±0.45*	68.8±0.31**	70.6±0.46	0.18	2.88	2.67
Systolic blood pressure, mmHg						
First stage	120.3±0.71	120.6±0.52	120.2±0.66	0.34	0.48	0.10
Second stage	119.7±0.63	119.9±0.49	122.8±0.69	0.25	1.06	1.18
Diastolic blood pressure, mmHg						
First stage	72.0±0.65	72.1±0.53	71.9±0.61	0.12	0.25	0.11
Second stage	70.5±0.63	70.7±0.57	72.2±0.64	0.24	1.75	1.89
Ruffier index, c. u.						
First stage	6.23±0.12	6.17±0.07	6.31±0.10	0.43	1.15	0.51
Second stage	5.61±0.11**	5.84±0.09*	6.25±0.11	1.62	2.88	4.11
Robinson index, c. u.						
First stage	84.33±0.72	84.78±0.57	84.02±0.81	0.34	0.77	0.29
Second stage	82.26±0.68*	82.55±0.65*	85.84±0.84	0.31	3.10	3.31
Time to restore heart rate to baseline after standard exercise, s						
First stage	114.5±3.27	112.3±2.46	116.1±3.05	0.54	0.97	0.36
Second stage	96.3±3.13***	92.9±2.61***	102.7±2.98*	0.83	3.23	2.18
Vital capacity of the lung, l						
First stage	4.01±0.06	4.04±0.03	3.97±0.05	0.45	1.20	0.51
Second stage	4.36±0.05***	4.38±0.03***	4.15±0.06*	0.34	3.43	2.69
Vital index, ml/kg						
First stage	55.67±1.24	55.49±0.69	55.17±1.17	0.13	0.24	0.29
Second stage	59.34±1.15***	59.11±0.73***	55.09±1.21	0.17	2.84	2.55

*Note: n: number of subjects; t_{1-2} (t_{2-3}, t_{1-3}) – the significance of the difference between the indicators of cadets of Groups 1 and 2 (2 and 3; 1 and 3) by the Student's t-test; * – the significance of the difference between the indicators of first and second stages of the research at p<0.05; ** – p<0.01; *** – p<0.001.*

3. At the same time, in the second stage of the research, in the groups of cadets who were engaged in orienteering and other sports, the indicators were significantly (p<0.05) better than in cadets who were engaged in the traditional method of SMPA. This indicates that both orienteering and other military-applied sports have a positive effect on the functional state of the cadets' cardiovascular system. No significant difference was found between the groups in terms of blood pressure (p>0.05). The pressure indicators tended to improve in the process of training in the HMEI, which confirms the high level of the functional state of the cardiovascular system of cadets. The analysis of the Rufier index, which can be used to assess the reserve of the cardiovascular system of cadets, showed that in the second stage of the research, the indicators of cadets of Groups 1 and 2 were significantly (p<0.001; p<0.05) better than in Group 3. At the same time, the Rufier index in Groups 1 and 2 improved significantly (p<0.01; p<0.05) during their training in the HMEI, while in Group 3 there were no significant changes (p>0.05). In Groups 1 and 2, the Rufier index corresponded to a high level, which allows us to speak about the positive impact of orienteering and sports in general on the work of the cardiovascular system of cadets.

The study of the Robinson index showed that, as with the previous indices, the indicators of cadets of Groups 1 and 2 do not differ significantly (p>0.05) in the second stage of the research but were significantly (p<0.01) better than those of Group 3. During the training in the HMEI the indicators of the Robinson index significantly (p<0.05) improved in the groups of cadets who were engaged in orienteering by 2.07 c.u. and other sports – by 2.23 c.u., which indicates the positive influence of orienteering and other military applied sports on the improvement of the cardiovascular system of cadets. When studying the indicators of heart rate recovery time after a standard load (20 squats in 30 seconds), we found that the duration of heart rate recovery during the training period significantly improved

in cadets of all three study groups. Thus, in Group 1 the indicators improved by 18.2 s, and in Group 2 – by 19.4 s, in Group 3 – by 13.4 s. At the same time, the indicators in the second stage of the research in cadets of Groups 1 and 2, which do not differ significantly ($p>0.05$), were significantly better than in Group 3, by 6.4 s ($p<0.05$) and 9.8 s ($p<0.01$), respectively. This allows us to note once again the positive influence of orienteering training sessions on the functional capabilities of the cardiovascular system of the cadets' organism.

The most pronounced changes were observed in the indicators of the vital capacity of the lungs, which characterize the respiratory system of cadets. Thus, in the cadets of Groups 1 and 2, the indicators significantly ($p<0.001$) improved by 350 ml and 340 ml, respectively, and in Group 3 – by 180 ml ($p<0.05$). At the same time, in the second stage of the research, in Groups 1 and 2, the vital capacity of the lungs indicators was significantly ($p>0.05$) the same and significantly ($p<0.05$; $p<0.01$) better than in Group 3, which emphasizes the positive impact of orienteering and other sports on improving the respiratory system in cadets. The analysis of the vital index confirmed the previous findings and showed that in Groups 1 and 2, the indicators significantly ($p<0.001$) improved by 3.67 ml/kg and 3.62 ml/kg, respectively, and in Group 3 – did not significantly change ($p>0.05$). In the second stage of the research, the vital index values in Groups 1 and 2 were significantly ($p<0.05$) better than in Group 3, while they did not differ significantly ($p>0.05$).

The conducted research has shown a positive impact of different types of motor activity, in general, and orienteering, in particular, on the improvement of cadets' physical development and functional state indicators in the process of their training in the HMEI.

DISCUSSION

According to experts [14, 15], orienteering is an all-season sport that can be used as a means of health improvement and rehabilitation, as a means of physical education for youth and physical training of servicemen, and as a sport for improving the skills of athletes. Orienteering organically combines the development of both mental and physical qualities of athletes. Scientists [16] consider orienteering as a model of life, since all human activities take place in a mental and playful environment, solving various tasks: checking the map with the terrain, assessing changing situations, choosing ways of movement, measuring distances, determining azimuths, etc. Orienteering training sessions are held outdoors at any time of the year, mainly in forest or park areas, which helps to increase the body's resistance to various colds and infectious diseases, and improve physical development and functional state [17].

According to scientists [18], the strengths of orienteering are its accessibility and popularity, promotion of the development of basic motor and volitional qualities (purposefulness, determination, self-control, observation, resourcefulness), improvement of mental cognitive processes (memory, imagination, speed and logic of thinking, ability to quickly switch attention, sense of time and spatial orientation, etc.) At the same time, orienteering is a complex sport that requires mastery of many general and special knowledge, skills, and abilities necessary for servicemen in modern combat: the ability to quickly and accurately overcome unfamiliar terrain, the ability to move quickly over rough terrain, overcome natural and artificial obstacles, accurately determine one's location and follow a specific plan of action. These elements of orienteering are quite relevant for modern combat activities and are of an applied nature. Our research proves the positive impact of orienteering on the physical development and functional state of cadets in the process of their training in the HMEI. In addition, the results of our research complement the conclusions of many scientists about the effectiveness of military-applied sports in the formation of physical readiness of servicemen for professional and combat activities.

CONCLUSIONS

We found a more positive effect of orienteering training sessions, compared to the traditional method of SMPA, on the indicators of physical development and functional state of cadets. In the second stage of the research, Group 1 showed significantly ($p<0.05$-0.001) better indicators of body weight, resting heart rate, vital capacity of lungs, the Rufier index, vital index, and the Robinson index than Group 3. At the same time, no significant difference was found between Groups 1 and 2 ($p>0.05$). This indicates that both orienteering and other types of motor activity are more effective in improving the physical development and functional state of cadets during their training. A high level of these indicators of cadets will help to improve the effectiveness of their educational and future professional as well as combat activities.

Prospects for further research are to study the influence of different types of motor activity on indicators of physical and mental health of military personnel of different age and gender.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Kostiantyn Prontenko
S.P. Koroliov Zhytomyr Military Institute
22 Mira St., 10001 Zhytomyr, Ukraine
e-mail: prontenko-kostya@ukr.net

ORCID AND CONTRIBUTIONSHIP

Kostiantyn Prontenko: 0000-0002-0588-8753 A
Ivan M. Okhrimenko: 0000-0002-8813-5107 B D
Serhiy V. Cherednichenko: 0000-0002-4690-2371 D
Oleksandr A. Tomenko: 0000-0002-1097-965X C
Olha M. Pasko: 0000-0001-9555-1101 B D
Liudmyla M. Prudka: 0000-0001-5440-2361 E
Tetyana V. Matiienko: 0000-0001-9695-2222 F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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REVIEW ARTICLE

Herbal medicine in Poland and abroad: A narrative review of the current status and future directions

Miroslaw Kiedrowski[1,2]

[1]DEPARTMENT OF ONCOLOGY, NATIONAL MEDICAL INSTITUTE OF THE MINISTRY OF THE INTERIOR AND ADMINISTRATION, WARSAW, POLAND
[2]STATIONARY AND HOME HOSPICE, EWDOMED HOSPICE AND FOUNDATION, WARSAW, POLAND

ABSTRACT

The article reviews the current state of phytotherapy in Poland, considering various global trends. It highlights the issues, limitations, and challenges confronting this field and its numerous controversies. The significant problems hindering the development of phytotherapy are inconsistent legislation and a lack of strong scientific evidence that meets modern standards.

KEY WORDS: herbalism, herbal medicine, phytotherapy, legislation, ethics.

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INTRODUCTION

Herbalism is the study and practice of using medicinal plants for various purposes, including breeding, cultivation, harvesting, drying, packaging, and storage. Herbs can be grown in gardens or on specialized plantations and harvested from their natural habitats. In this sense, herbalism can be considered a branch of agriculture and horticulture, closely related to forestry, environmental protection, and ecology. Herbalism provides raw materials for herbal medicine.

Herbal medicine involves creating herbal remedies using natural or processed materials from medicinal plants for treatment and prevention. In academic circles, this practice is more widely referred to as phytotherapy. This term helps lend a more scientific framework to the discipline while moving away from the superstitions and traditions frequently associated with folk herbalism. Phytotherapy seeks to validate the effectiveness of herbal treatments while honoring a long-standing tradition of herbalism. It utilizes the benefits of plant medicine through a scientific lens. Although the traditional terms "herbalism" and "herbal medicine" may seem to conflict with academic medicine, until the 19th century and even into the mid-20th century, academic medicine heavily relied on herbal medicine, which remains an integral part of its foundation.

AIM

This study evaluates the current state of phytotherapy in Poland, considering various global trends. Numerous issues, limitations, challenges confronting this field, and significant problems hindering the development of phytotherapy are discussed.

REVIEW AND DISCUSSION

The distinction between food and medicine was not apparent in ancient times. Hippocrates, often called the father of medicine, is famously quoted as saying, "Let food be thy medicine, and medicine be thy food". Although there is no conclusive evidence that he authored this phrase, it reflects a fundamental idea of the era [1]. Some herbs, such as garlic (*Allium* L.), serve dual roles as spices and vegetables. While certain plants have beneficial properties, they can also be harmful if consumed excessively, as with coffee (*Coffea* L.). Consequently, herbal medicine is closely intertwined with medical science, dietetics, bromatology, and food and nutrition technology.

When exploring definitions in popular sources, including Wikipedia, one is often surprised by the poor quality of the articles on the subject. Many citations need more specificity, be updated, or are inappropriate, as they do not refer to direct sources. Repeated warnings have urged verifying the provided information and supplementing the footnotes. The term "herbal medicine" appears there as identical to "herbalism," "phytomedicine," and "phytotherapy."

Zick et al. state that herbal medicine presents "its own set of methodological and philosophical research issues that extend beyond those encountered in other systems" [2]. They highlight the accomplishments of an international workshop organized by the International Society for Complementary Medicine Research (ISCMR) in Germany in 2007. This workshop focused on several key issues, including:

– defining herbalists as professionals and establishing herbalism as a recognized discipline;

– examining the role of the industry in herbal research;
– designing methodologically sound studies, including those with placebo controls, and basing active herbal therapies on scientific principles;
– investigating herbs as plant organisms;
– developing and studying multicomponent herbal therapies through appropriate methodologies.

Despite thousands of years of using herbs, in the 21st century, clearly defining herbalism and herbal medicine is a challenge. The question of who the herbalist /phytotherapist is (or should be) is even more complex [3, 4]. Herbalism and herbal medicine primarily stem from centuries of observations, often influenced by irrational beliefs and various cultural and religious factors [5]. Only a small portion of herbal medicine is based on studies that adhere to rigorous scientific standards. This limitation place herbalism on the fringes of modern medicine. Nevertheless, contemporary humans continue seeking a hint of magic in their lives [6]. Physicians deeply involved in herbal medicine often identify themselves as phytotherapists to distinguish their work from traditional herbalists. Still, some conventional herbalists also use the designation "phytotherapist." As a result, many medical doctors may integrate relevant aspects of herbal medicine into their practice without explicitly referencing it.

When evidence-based medicine began to gain traction in the 1970s, traditionally accepted methods - previously endorsed by customs and scientific authorities—were put through scientific scrutiny [7]. This process revealed that many of established methods were ineffective, and some even caused harm. The trend of moving away from ineffective medical practices continues today. Often, a lack of scientific evidence is mistakenly interpreted as a lack of effectiveness. It is misleading, as later research sometimes confirms traditional observations.

Nevertheless, modern phytotherapy acknowledges the need for scientific validation but still needs progress in this area, as much of its scientific foundation needs more quality [8]. If herbal medications underwent extensive testing, the results could challenge the use of several herbal drugs. It has already occurred in various cases. For instance, Echinacea purpurea was thought to boost immunity by enhancing phagocytosis, increasing NK cell activity, improving the cytokine profile, and reducing inflammation. It was expected to be effective in treating common colds; however, most clinical trials have shown it to be ineffective or only minimally effective. Conversely, studies - often of limited quality—report its efficacy in certain other conditions. For example, initial reports suggest it may be effective in managing low-activity autoimmune uveitis and could play a role in the remission of low-grade cervical intraepithelial neoplasia (L-SIL) [9-12]. Moreover, it is important to note that there is a risk of misinterpretation when analyzing studies utilizing different types of extracts from the same plant. The effectiveness of herbal medicine can be influenced by several factors, including the kind of preparation, the technology used, the part of the plant utilized, the type of extract, its strength (DER; drug extract ratio), and the extraction solvent. As a result, making a definitive statement regarding the therapeutic effect of a plant requires more complex studies compared to those for simple synthetic drugs. For instance, the composition and effects of water, ethanol, and oil extracts of St. John's Wort can vary significantly. Aqueous solutions from St. John's wort containing mainly hydrophilic components are used in gastrointestinal diseases. On the other hand, ethanolic extracts containing hypericin and hyperforin affect the central nervous system and are indicated for the treatment of episodes of mild depressive disorders [13]. According to a recent meta-analysis by Zhao et al., which covered fourteen clinical trials involving a total of 2,270 patients suffering from depression, St John's Wort extracts demonstrate efficacy comparable to selective serotonin reuptake inhibitors, but with fewer side effects [14].

Drugs derived from plants are rarely included in official treatment guidelines, as acknowledged by international scientific societies for specific medical conditions. Notable exceptions exist in oncology and hematology, where the alkaloids vincristine and vinblastine, extracted from the periwinkle plant (*Catharanthus roseus*), and paclitaxel, derived from the yew tree (*Taxus brevifolia* Nutt.), are commonly used in various effective treatment regimens [15]. These substances target microtubules, crucial components of the cytoskeleton during cell division. They have undergone extensive research, establishing their efficacy, safety, and toxicity profiles. Their use in specific cancers, including lymphomas, leukemia, plasmacytic myeloma, and various solid tumors, is outlined in the guidelines of scientific societies, e.g., NCCN and ESMO, which rely on high-quality clinical trials. While these drugs were initially derived from plants, they are currently produced through chemical synthesis, placing their use ultimately outside phytotherapy.

HISTORICAL OUTLINE

Evidence of the use of plant medicines can be found in some of the oldest historical documents, including:

- the Kahun Papyrus (c. 2000 BC; contains texts on gynecology and veterinary);
- Smith's Papyrus (c. 1600 BC; includes surgical texts);
- the Ebers Papyrus (c. 1550 BC; provides information on internal diseases);
- Hearst's Papyrus (c. 1500 BC; contains prescriptions);
- the Great Berlin Papyrus (c. 1300 BC; also contains prescriptions) [16, 17].

The Egyptian physicians we know of were primarily clerics, and it is believed there were no secular physicians until the 6th century BC. The tutelary god of sciences was Toth, credited with the authorship of fourty-two Hermetic books, with the last six focusing on medicine. When treatment was carried out following these sacred texts, the medic was protected from blame, regardless of the outcome. Any deviations from these texts were unacceptable. If a medic acted arbitrarily and the patient died, he could even face the death penalty.

The medical profession was highly regarded, with high-ranking clerics overseeing the maintenance of a high level of expertise.

Medicine was practiced by qualified physicians (members of *Sekhmet's clergy*) and sorcerers. Clerics managed botanical gardens where they cultivated various herbs. Pomegranate bark (*Cortex Punicae granati*) was used to treat worms. Sea onion (*Scilla maritima*) served as a remedy for vomiting, while opium was highly effective for pain relief. Remedies were administered in various forms, including solutions, ointments, patches, poultices, enemas, rinses, and fumes, and the method of prescribing was similar to the practices used today.

In contrast, ancient Chinese medicine was generally independent of religion and temples. According to tradition, the ancient Chinese emperor Shen-Nung, also known as the Red Emperor (around 2800 BC), is said to have dispatched expeditions around the world to collect plants and minerals. His research is believed to have led to the establishment of the oldest Chinese herbarium [17].

In Poland, herbal medicine began to develop as a medical field during the Middle Ages. Many medicinal plants were cultivated in monastery herbariums. Following Gutenberg's invention of the printing press, the first printed herbaria were published. These texts included healing, dyeing, cosmetics, and household use information.

The 16th century saw the publication of works such as Stefan Falimirz's "On Herbs and Their Power," which translated Latin texts and included woodcuts depicting various herbs. Another notable contribution was Marcin of Urzędów's "Herbarz Polski," published in 1595, which was entirely original. At the beginning of the 17th century, Szymon Syrenius produced an important herbarium documenting 765 plants, making it a significant work of its time. Syrenius translated herb names from Latin or German, borrowed from colloquial language, and even created original names, many of which remain in use today, such as thistle and hogweed.

Jerzy Andrzej Helwing's contributions to the late 17th and early 18th centuries included numerous herbariums, one of which is preserved in the National Library in Warsaw [17-19].

Regardless of the academic, there was also a folk trend of herbal medicine. Many plants were believed to possess supernatural properties, and various rules governing their collection and cultivation were obliged. In 19th-century Poland, gardens often featured mint, nettle, thyme, burdock, St. John's wort, and sage. Wild herbs were also gathered, with specific locations believed to enhance their effectiveness. For instance, herbs collected from balks, borders, and near fences and those found by shrines, saints' statues, and crosses were considered the most potent.

Conversely, it was deemed inappropriate to collect herbs from cemeteries or from others' fields (the latter risked accusations of witchcraft). Additionally, a gathering was advised to occur before sunrise or after sunset to avoid similar suspicions. The night before church holidays, such as St. John the Baptist's Day, the Assumption of the Blessed Virgin Mary, and Corpus Christi, was considered the optimal time to collect herbs, as they were believed to be most potent then.

The moon's phases were also significant in harvesting; it was best to gather herbs during the full moon or the first quarter and not recommended in the last quarter. As the saying went, they were collected "when the moon is rising, because then various things multiply, while when the moon is decreasing, then they diminish."

Ordination of herbs also held great importance, occurring twice a year – during the octave of Corpus Christi and on August 15, Our Lady of the Herbs feast. It was believed that only women should gather herbs, as those collected by men were thought to possess much less healing power. While many of these traditions may evoke a smile today, they were taken seriously in the past, influencing later perceptions of herbalism.

MODERN PERSPECTIVE

2019, the World Health Organization (WHO) published the "WHO Global Report on Traditional and Complementary Medicine." The report highlights the limited access to modern healthcare in many countries and the role of traditional medicine in such societies. It defines herbal medicines as consisting of herbs, raw materials, herbal preparations, and finished herbal products that contain parts of plants, other plant materials, or combinations of both as active ingredients. In some countries, traditional practices may also include natural, organic, or inorganic active ingredients not of plant origin, such as those derived from animals or minerals [20].

The paper emphasizes significant progress in registering and regulating herbal medicines across all six WHO regions in recent years, with the African region showing the weakest progress. The report emphasizes the importance of integrating traditional methods into healthcare. It states, "Before herbal medicines can be made accessible to the general public, they must be proven safe, effective, and of good quality." In certain countries, such as New Zealand, the regulations governing herbal medicines fall under dietary supplement laws. Conversely, specific legislation for herbal medicines is absent in southern African countries or Mexico.

National pharmacopeias and monographs on herbal medicines have gained recognition in various countries. Some nations maintain more than one record, although these records are not necessarily legally binding. For instance, Ghana has established the "Ghana Herbal Pharmacopoeia" (2nd ed., 2007) as its national pharmacopeia [21]. In addition, there is a national monograph titled "Ethnobotanical and Floristic Studies in Ghana," along with several other African pharmacopeias [22]. However, none of these documents have legal status, and as of 2012, 120 national monographs detailing Ghana's medicinal plants have been published.

European countries utilize the European Pharmacopoeia (Ph. Eur.), prepared by the European Pharmacopoeia Commission [23]. This effort aims to standardize the quality requirements and testing methods for medicines across Europe, as guided by the Convention on the Preparation of the European Pharmacopoeia.

The European Pharmacopoeia Commission operates under a treaty of the Council of Europe and is part of the European Directorate for the Quality of Medicines and HealthCare (EDQM) in Strasbourg.

The European Pharmacopoeia includes numerous monographs on plant raw materials and their preparations. Some examples include:

– radix *Echinaceae angustifoliae* (root of *Echinacea angustifolia*)
– *herba Thyme* (*thyme herb*) and *Thymi aetheroleum* (thyme essential oil)
– *folium Salviae officinalis* (*sage leaf*) and *tinctura Salviae* (*sage tincture*)
– *fructus Anisi* (*anise fruit*) and *Anisi etheroleum* (*anise essential oil*)

The eleventh edition of the European Pharmacopoeia is in effect as of January 2023. It is available in printed and electronic formats, with supplements and a search engine [23, 24].

Several countries include herbal medicines in their National Essential Medicines Lists (NEMLs). However, these medicines are not widely represented in countries with well-developed modern healthcare systems. In the WHO European Region, which includes many Asian countries, only Armenia, Kazakhstan, the Republic of Moldova, the Russian Federation, Tajikistan, Ukraine, and Uzbekistan have added herbal medicines to their NEMLs [25, 26].

THE PROFESSION OF HERBALIST-PHYTOTHERAPIST, ITS COMPETENCIES, LEGAL AND ORGANIZATIONAL ASPECTS

A contemporary herbalist-phytotherapist holds a somewhat ambiguous status. In the Polish classification of professions and specialties, this role falls under group 32 (medium health personnel) and specifically under 3230 (practitioners of unconventional or complementary therapies), indexed as number 323012 [27]. According to the accompanying description, a herbalist-phytotherapist performs various functions, including obtaining, storing, and selling herbs, herbal and cosmetic products, and dietary supplements. They work alongside pharmacists and physicians to explore and understand the properties of medicinal plants, determining the appropriate dosages, side effects, and interactions with synthetic drugs. Additionally, they advise on and use herbs in unconventional (natural) medicine for therapeutic purposes, engaging in alternative therapies.

The professional tasks of a herbalist-phytotherapist include:
– sourcing herbs, medicinal spices, and oil plants from growers and wild gatherers, including tree buds and bark, roots, flowers, and leaves of various plants;
– evaluating the quality and properties of raw materials for cosmetics, herbal medicine, and food and dietary supplements;
– supervising the drying process of herbs and medicinal plants while ensuring compliance with established standards for raw materials (known as standardization of plant material);
– determining active substances in analytical laboratories under a pharmacist's or physician's guidance (e.g., alkaloids, saponins, essential oils, mustards, tannins, mucilages, and flavonoids);
– acting as an intermediary in the sale of herbal products and ensuring adherence to standards and expiration dates at wholesalers and retail stores;
– advising customers on the purchase of herbal products, cosmetics, and dietary supplements based on the information provided in the product leaflets;
– continuously improving their knowledge and skills regarding the properties of herbs and medicinal plants by participating in training courses, seminars, and conferences;
– promoting awareness about the properties of herbs and medicinal plants through media channels and conducting training sessions, workshops, and seminars in unconventional medicine;
– collaborating with companies involved in the cultivation and processing of herbs and medicinal plants, as well as with pharmaceutical companies and healthcare professionals;
– engaging with health services and representatives of traditional medicine.

Many of the provisions regarding the profession of "herbalist-phytotherapist" (spelled with a dash) are controversial. Formal qualifications in this field can be obtained through postgraduate studies, which do not adequately prepare individuals for laboratory work, nor do they equip them with the necessary skills or verify their proficiency. It raises questions about how a herbalist-phytotherapist, not previously trained in chemistry, pharmacy, and analytics, could accurately determine the content of active substances in analytical laboratories. Furthermore, it is still being determined how to do so, even under a pharmacist's or physician's guidance, without violating applicable laws or compromising patient safety.

Additionally, the professional tasks associated with this classification include:
– operating a drugstore and herbal medicine shop and selling herbal products;
– certifying herbal products in analytical and quality control laboratories;
– conduct independent business and practice phytotherapy within the framework of unconventional therapies;
– participating in the production process of macerates, extracts, decoctions, aromatic waters, medicinal oils, tinctures, and other preparations;
– determining the dosage of prepared remedies, identifying side effects, and understanding interactions with synthetic drugs.

In November 2022, a position paper released by the Phytotherapy Section of the Polish Medical Association, along with the Committee on Therapeutics and Drug Sciences of the Polish Academy of Sciences, the Polish Pharmacological Society, and the Polish Council of Plant Medicine, raised the following accusations:

1. There was an incorrect classification and a lack of justification for combining the terms "herbalist" and "phytotherapist" within the professional title. The authors argued that "herbalist" should be categorized with specialists in biological sciences and related fields, specifically under classifications 213 and 2132, which pertain to specialists in agriculture, forestry,

and related areas (e.g., herbarium engineer – at the time, three universities offered adequate engineering programs).

2. The paper pointed out the inadequate training of herbalists for the activities outlined in their classification. It noted that, in practice, a herbalist could achieve formal competence through postgraduate studies without any prior specialized education. In extreme cases, obtaining a herbalist certification could require only the completion of courses that do not even mandate a high school diploma [28].

Phytotherapy is a branch of medicine. Prescribing herbal treatments – essentially, treating people - requires adequate medical training. Opening such a sensitive area for people with undemanding formal qualifications exposes patients to irresponsible practices and legitimizes them.

Despite the previously mentioned concerns (balancing patient safety with the risk of stifling economic freedom and over-regulating the occupation), the herbalist-phytotherapist profession is acknowledged within the Polish classification system. The question of how much further regulation this profession should undergo remains a topic of debate.

There are likely knowledgeable herbalists who, despite lacking formal medical training, understand the limitations of phytotherapy. They do not have the skills to diagnose diseases but possess extensive knowledge about herbs' properties and are passionate about using their expertise to benefit patients. However, some individuals mistakenly believe that all ailments can be addressed solely through herbal remedies. In extreme cases, this can discourage patients from pursuing proven medical treatments. Such behavior fundamentally contradicts the evolving ethical principles and deontology of herbal practice [29-31].

In Western countries, a herbalist who is not a licensed physician cannot "treat" patients or provide pharmaceutical services unless they are a pharmacist. However, like any individual, herbalists can offer their knowledge and guidance to people seeking help. Unlike regulated medical professionals, herbalists are not legally responsible for their practices. This lack of accountability does not build the prestige of the profession. Still, it does not deter people from seeking their assistance.

ETHICAL ASPECTS OF PRACTICING THE PROFESSION OF HERBALIST-PHYTOTHERAPIST

According to a survey by the Central Statistical Office, 66% of Poles consider health the most essential value in their lives [32]. Similarly to other countries, society expects medical professionals to possess high substantive competence and follow ethical standards. This expectation is reflected in a specific legal concept known as "public trust professions," as outlined in Article 17.1 of the Constitution of the Republic of Poland. Twenty-four laws have established the legal framework for seventeen professional self-governments related to nineteen public trust professions. In alphabetical order, these professions include lawyer, architect, auditor, laboratory diagnostician, tax advisor, pharmacist, physiotherapist, civil engineer, bailiff, physician, dentist, veterinarian, notary public, nurse, midwife, psychologist, legal counselor, paramedic, and patent agent. Only regulated professions can be classified as public trust professions. Notably absent from this list is the profession of herbalist-phytotherapist, even though it deals with human health.

Although numerous concepts and positions exist, attempts are being made to develop a non-controversial code for herbalists. Various proposals exist in both Polish and international sources [33-37]. None of them, however, has achieved universally binding status. Still, recognizing the need for such recommendations is a positive development. All proposed codes emphasize the importance of respecting human rights and dignity, continuing one's education and expertise, collaborating with physicians, and practicing the profession with honesty and integrity while staying within one's scope of competence.

STORAGE AND MARKETING OF MEDICINAL PRODUCTS IN POLAND REGARDING HERBALISM

The Pharmaceutical Law of September 6, 2001, as amended, regulates the marketing of medicinal products in Poland. A drug is a substance or a mixture of substances that can prevent or treat diseases in humans or animals. It may also be used for diagnostic purposes or to restore, improve, or modify the body's physiological functions through pharmacological, immunological, or metabolic actions.

According to Article 71.1, non-pharmacy outlets, including but not limited to herbal and medical stores, may conduct retail sales of products dispensed without a physician's prescription, excluding veterinary medicinal products. These stores can be managed by a pharmacist, a pharmaceutical technician, a graduate of a second-level course in herbal merchandising, or entrepreneurs who employ such individuals as managers.

The law defines several terms:

- herbal medicinal product: A medicinal product containing as active ingredients one or more herbal substances, one or more herbal preparations, or a combination of both;
- plant substance: This includes mainly whole, divided, or cut plants, parts of plants, algae, fungi, and lichens, whether unprocessed, dried, or fresh. Some secretions without specific processing can also be considered plant substances. These are defined in detail by the part of the plant used and its botanical name;
- plant preparation: This refers to products obtained by subjecting plant substances to extraction, distillation, pressing, fractionation, purification, concentration, and fermentation. It includes, in particular, crushed or powdered plant substances, tinctures, extracts, oils, and juices.

The law specifies the procedure for processing applications for marketing medicinal products through what is known as the mutual recognition procedure and the decentralized procedure in Article 19a, paragraph 3. However, it excludes traditional herbal medicinal products for which a Community monograph has not been created. Additionally, it excludes traditional herbal medicinal products that do not consist of

herbal substances or preparations listed in the Community directive on traditional herbal medicinal products.

Article 20.1, paragraph 2 states that an application for marketing plant raw material in the comminuted form must include the name of the medicinal product, the name of the active substance, a statement of the pharmaceutical form, the method of application, the dosage, and, if applicable, the package size along with the name and permanent address of the responsible entity applying, or the manufacturers.

Article 20a further defines traditional herbal medicinal products as those that:

- have indications appropriate solely for traditional herbal use and can be used without medical supervision, with a composition suitable for a medicinal product dispensed without a doctor's prescription;
- are intended for use in specific strengths and dosage methods for oral, external, or inhalation use only;
- have a history of traditional use with sufficient data to support safety. Their pharmacological effects and efficacy must be established based on long-term use and therapeutic experience.

All of the above criteria must be met simultaneously. Traditional herbal medicinal products can also contain added vitamins or minerals as long as their effects complement those of the primary product. Notably, the criteria for these products are significantly more liberal compared to synthetic drugs. Although the law requires that applications for the authorization of traditional herbal medicinal products include data from literature, including scientific literature, it also allows for "expert opinions" to suffice, which would not be acceptable for synthetic drugs. The criterion is that the herbal medicinal product or its equivalent must have been used for therapeutic purposes for at least 30 years before the application date, including at least 15 years in a member state of the European Union or the European Free Trade Association (EFTA). In uncertain situations, the President of the Authority may request an opinion from the Committee for Plant Medicinal Products of the European Medicines Agency regarding the submitted documentation.

PHYTOTHERAPY PERSPECTIVES

Modern phytotherapy maintains its naturalistic roots while drawing upon rational and practical elements. It combines knowledge from various medical sciences, including pharmaceuticals, nutrition, chemistry, biology, and agricultural and forestry. While it is not a mainstream part of medical science, phytotherapy undeniably contributes to it and can benefit patients across most fields of clinical medicine.

Various Polish scientific journals focusing on phytotherapy can be found, including "Postępy Fitoterapii,""Herba Polonica," and "Etnobiologia Polska." They are indexed in various bibliographic databases, but none is indexed in Medline /Pubmed, and none has an official Impact factor.

Phytotherapy can be applied to patients of all ages for various conditions. Unlike synthetic drugs targeting a specific molecule, phytotherapy involves a more complex approach. The therapeutic effects are sometimes believed to arise from the interactions between different components of plant-based treatments alongside numerous factors that can be challenging to assess objectively.

Medicinal plants sometimes help with lifestyle-related diseases. Phytotherapy should not replace medical interventions of proven efficacy. Still, herbal remedies can be effective for common ailments if used reasonably. For instance, the leaf of specific Senna species can be used short-term for constipation, and tablets standardized for sennoside B are available.

Many herbal medicines come in convenient forms from specialized companies, which ensure the quality of the raw materials used. The use of medicinal plants is also being recognized in functional foods and as adaptogens, exemplified by popular extracts from Panax ginseng, *Eleutherococcus senticosus, Rhaponticum carthamoides, Rhodiola rosea,* and *Schisandra chinensis* [38].

Herbal medicines, like all active drugs, carry the risk of side effects. While these side effects are numerous and not as well understood as those of synthetic drugs, they are essential to consider. Herbal medicines can trigger hypersensitivity reactions. For instance, St. John's wort (*Hypericum L.*) is known to cause photosensitivity in some individuals. Additionally, many herbs can interact with essential synthetic medications. For example, green tea can affect the cytochrome CYP3A4 enzyme, which may reduce the effectiveness of sorafenib, a drug used to treat hepatocellular carcinoma and kidney cancer [39]. However, herbs are generally considered safe and rarely cause issues when used as directed in daily life.

Herbal medicine is widespread in developing societies and is the foundation of traditional medicine in nearly all cultures worldwide. It also plays a vital role in Western societies. In Poland, pharmacy and medical students are educated on the fundamental aspects of phytotherapy. For illustration, pharmacy students explore these topics in pharmacognosy courses, while medical students learn to compose prescriptions containing herbal medicines at the beginning of pharmacology classes. Also, clinical medicine and toxicology courses occasionally raise herbal medicine issues.

CONCLUSIONS

The potential of phytotherapy is increasingly recognized in the 21st century, making it an intriguing area for research. However, its ambiguous status and the perception as either legitimate or fraudulent impede its progress.

Another area for improvement is a conflict between the evidence-based approach and phytotherapy. Relying on less proven methods always raises doubts. Thus, it should be discussed comprehensively and reported in the patient's record.

Current legislation allows only licensed physicians to treat using herbal medicines, while others may offer support based on ordinary interpersonal contact. Consistent legal regulations are required to support the development of phytotherapy and to ensure the efficacy, quality, and safety of herbal treatments.

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CONFLICT OF INTEREST
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CORRESPONDING AUTHOR
Miroslaw Kiedrowski
Clinical Department of Oncology
National Medical Institute of the Ministry
of the Interior and Administration, Warsaw, Poland
137 Wołoska St., 02-507, Warsaw, Poland
e-mail: mkiedrow@mp.pl

ORCID AND CONTRIBUTIONSHIP
Miroslaw Kiedrowski: 0000-0003-1361-9286 A B C D E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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REVIEW ARTICLE

Provision of medical services for Ukrainians in the system of temporary protection in Poland and Germany

Vitalii M. Pashkov[1], Marianna I. Liubchenko[2], Oleksii O. Liubchenko[2]

[1]ACADEMICIAN STASHIS SCIENTIFIC RESEARCH INSTITUTE FOR THE STUDY OF CRIME PROBLEMS, KHARKIV, UKRAINE
[2]YAROSLAV MUDRIY NATIONAL LAW UNIVERSITY, UKRAINE

ABSTRACT

Aim: The aim of the work is to study the access of Ukrainians using temporary protection to medical care in different healthcare systems using the example of Poland and Germany.

Materials and Methods: Scientific databases Scopus and ResearchBib were used. International law and national legislation of Poland and Germany were analyzed. Surveys were conducted among 1,180 respondents to identify the problem of long waiting times for receiving medical care in the specified countries.

Conclusions: Access to medical care for persons from Ukraine using temporary protection is significantly simplified. Polish and German national legislation is loyal to the beneficiaries of temporary protection. Despite the serious distinctions between different healthcare systems in Europe, this does not create significant obstacles for access to medicine. However, unfortunately, there are cases of bureaucracy and bureaucratic barriers in providing such access. In our opinion, such a phenomenon should be reduced to a minimum, while Ukrainians should be provided with the opportunity to receive timely medical assistance in the host country, without creating situations when a person must return to Ukraine solely to receive more prompt medical assistance.

KEY WORDS: Access to HealthCare, Temporary Migration, Displaced Persons, Health Legislation, International Law

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INTRODUCTION

Every person in need of medical care, according to the European Charter of Patients' Rights [1], is guaranteed the right to access such care, regardless of factors such as place of residence**,** which is extremely important in the context of this topic. The Charter is one of the main foundations of medical law in Europe. It is based on the Charter of Fundamental Rights of the European Union [2], and, in our opinion, is one of the main "bricks" of European law. Its norms were developed in the Directive 2011/24/EU [3], which specified the rights of patients in the context of cross-border treatment. The right to receive medical care for beneficiaries of temporary protection was enshrined in Directive 2001/55/EC [4], which states the obligation of member states to provide such persons with at least emergency medical care and necessary treatment in case of illness. In addition, the detailing of the right to medical assistance was further developed in the context of the national legislation of the EU countries.

In the context of access to healthcare, the inadmissibility of discrimination is important, because any person, regardless of his characteristics, has equal rights and opportunities to realize them. Thus, the World Health Organization, as part of the "Health - 2020" program, adopted the framework of the European healthcare policy since social values and rights are decisive in the field of healthcare [5].

The principle of non-discrimination is enshrined in several documents: in the documents of the World Health Organization [6], in the Universal Declaration of Human Rights [7], and in the United Nations International Covenant on Economic, Social and Cultural Rights [8].

The European Court of Human Rights has repeatedly emphasized that although the European Convention on Human Rights does not enshrine the right to political asylum, states must prevent the application of inhuman treatment to such persons in the context of Article 3 of the Convention. The Court in "CASE OF N.H. AND OTHERS v. FRANCE", emphasized that the inadequate living conditions, the lack of resources to meet basic needs, including access to medicine, constitutes a violation of Article 3 of the Convention, as the applicants were dependent on the refugee assistance provided for by national legislation [9].

According to Eurostat, as of July 31, 2024, about 4 million people benefit from temporary protection in the countries of the European Union because of Russian aggression against Ukraine [10]. The largest number of such persons is registered in Germany, Poland, and the Czech Republic (Fig . 1).

AIM

The purpose of the work is to study access to medical care for beneficiaries of temporary protection from Ukraine in various healthcare systems using the example of Poland and Germany.

Fig. 1. Non-EU citizens who fled Ukraine and were under temporary protection at the end of July 2024 according to Eurostat data.

MATERIALS AND METHODS

To achieve the goals of the study, international agreements and legal acts of the Republic of Poland and the Federal Republic of Germany were analyzed. Also, statistical studies of state and non-governmental organizations, including international ones, were used. Scientific articles from scientometric databases such as: Scopus and ResearchBib were researched.

Also, surveys were conducted among persons who in one way or another encountered the Polish or German healthcare system. Surveys were conducted in Google Forms in 2024 and were anonymous. In addition, the surveys were also shared on social media so that everyone could leave their views on the problem. 660 respondents took part in the survey for Poland, and 520 respondents for Germany. All of them were over 18 years old. Informed consent was obtained from the participants.

Surveys were conducted according to the authors' questionnaire and included a separate question for Poland, as well as a separate question for Germany, related to access and waiting time for receiving medical care in the specified countries with four options for answering them: 1) Yes, the problem of long waiting times (3-4 weeks) exists and is significant; 2) 50/50, the problem depends on the region and the availability of medical specialists; 3) no, access to medical care is prompt and does not require long waiting times; 4) I cannot say, I do not have enough information.

For full understanding of the question-and-answer options, they were written in English and Ukrainian. The purpose of this survey was to identify the problem of long waiting times for receiving medical care in Germany and Poland.

The main methods of this research were as follows: the system analysis method by which the legislation was analyzed as a whole and its effectiveness was evaluated, the dialectical method, which was used to identify discrepancies between established legal norms and their actual implementation, statistical (processing of survey data, statistical sources), graphical method (visual presentation of survey data through a visual demonstration), a comparative survey method for comparing the availability of medical care in different countries, which was used as surveys of respondents who encountered the healthcare system of Germany or Poland.

REVIEW AND DISCUSSION

The Republic of Poland is a state supporting Ukraine throughout the full-scale invasion. Medical assistance to beneficiaries of temporary protection was not an exception. Thus, on March 12, 2022, Poland adopted the Law "On assistance to citizens of Ukraine in connection with the armed conflict on the territory of this state" [11], which defines a set of measures to support persons from Ukraine. Article 37 of this Law enshrines the right of citizens of Ukraine to free medical care to the same extent as citizens of Poland, with few exceptions. Thus, a wide list of medical services is conducted in Poland, including vaccination, special medical transportation, oncology treatment, etc. [24].

It is worth emphasizing that the healthcare system in Poland closely resembles that of Ukraine, which makes it much easier for beneficiaries of temporary protection to go to a healthcare facility. By analogy with Ukrainian legislation, in Poland there is a Law dated August 27, 2004 "On healthcare services financed from public funds" [12], which is the main legal act that defines the general norms for the provision of medical care and introduces the term *primary care physician*. The Law of October 27, 2017 "On primary medical care" details the rights and obligations of such a doctor [13]. Article 6 of that Law specifies that a primary care physician is essentially an analogue of a Ukrainian primary care physician (family physician). A citizen of Ukraine who is legally staying in Poland has the right to contact a primary care doctor for medical assistance, referral to a highly specialized doctor, preventive care, etc.

It should be noted that the term "citizen of Ukraine" in this case is used not only for actual citizens of Ukraine, but also for stateless persons who are the husband, wife, child or child of the other spouse of a citizen of Ukraine, provided that they arrived in Poland in connection with hostilities on the territory of Ukraine and are not citizens of Poland or other member states of the European Union.

In our opinion, the implementation of norms related to the healthcare of beneficiaries of temporary protection in Poland into the national legislation is quite successful.

The Statistical Office in Rzeszów, which monitors the state of health among people from Ukraine in Poland, displays current statistics in the database "Refugee Health in Poland" [14]. These studies are supported by the World Health Organization. Regardless of the name, the information displayed in the database applies not only to refugees, but in general to all Ukrainians who received medical care in Poland, including those receiving temporary protection. Therefore, we can claim that the specified source is appropriate to use for assessing access to medicine within the scope of the subject of this article.

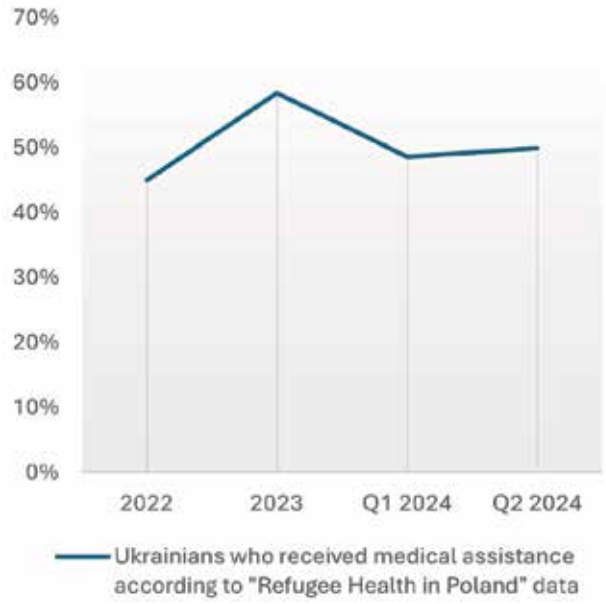

Fig. 2. Ukrainians who received medical assistance according to "Refugee Health in Poland" data.

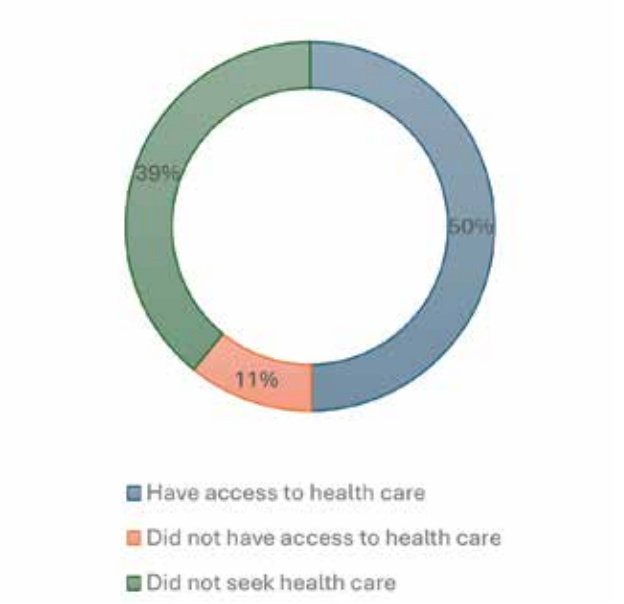

Fig. 3. Access to healthcare according to "Refugee Health in Poland" data.

According to the data of the platform "Refugee Health in Poland" [14], as of the first quarter of 2024, there were approximately 957,000 Ukrainians in Poland. 48.6% of them turned to healthcare institutions for medical help (Fig. 2).

For comparison, according to Opendatabot data, in Ukraine, as of January-April 2023, 15.6 million people consulted doctors providing primary medical care [15]. According to United Nations Population Fund as of 2023, approximately 36.7 million people lived in Ukraine [16]. Therefore, as of January-April 2023, almost 43% of the population turned to doctors, which is even less than the relative number of Ukrainians' applications during the first quarter of 2024 in Poland, which generally indicates the availability of medicine for beneficiaries of temporary protection and the successful implementation of international law and national legislation in Poland.

Despite this, we believe that it is worth strengthening control over the provision of medical care in Poland, because, according to the International Rescue Committee, as of 2023, about half of the surveyed people who received medical care faced difficulties in accessing it. A quarter of the interviewed participants returned to Ukraine to receive medical assistance [17].

In addition, according to Refugee Health in Poland [14], as of the second quarter of 2024, 100,079 Ukrainians (about 11% of all Ukrainians in Poland) did not receive medical assistance at all (Fig. 3). Approximately 50% of them did not receive medical assistance due to the long waiting time.

To assess the effectiveness of the existing means for obtaining access to medical services for persons using temporary protection, we conducted a survey among Ukrainians who used the healthcare system in Poland. 660 respondents took part in the survey. 14 respondents did not have information on this issue, so they are not considered in further statistics.

646 people took part in the subsequent survey (Fig. 4). According to the survey, 44 people believe that the problem with waiting time is serious, which is 6.8%. 333 people believe that the problem exists, but it depends on the region of Poland and its material support, which is 51.5%. 269 people indicated the absence of a problem, which is 41.7%.

Regarding the dependence of the problem of a long wait for medical care on the region and material support, it should be noted that in some cases, due to insufficient personnel, a primary care physician may refer to a highly specialized secondary care physician in a nearby city or even region.

Therefore, regardless of the relative availability of medical care in Poland, in our opinion, it is necessary to improve the Polish healthcare system, namely:

Reduce the waiting time for receiving medical services, by increasing the number of scarce medical specialties, encouraging society to study and find employment in such specialties;

Make the Affordable Medicines program more accessible to those who need it;

Overcome information barriers by conducting campaigns aimed at increasing the awareness of Ukrainian citizens about the healthcare system in Poland.

Therefore, although the access to medicine of the persons using temporary protection is not questioned, the simplification of such access is necessary and needs to be solved.

In contrast to Poland, obtaining medical assistance in Germany is more complex. Thus, the status of a person who applied for asylum in Germany is regulated by the «Asylbewerberleistungsgesetz»[18]. For such persons, a specific mechanism for obtaining medical assistance is

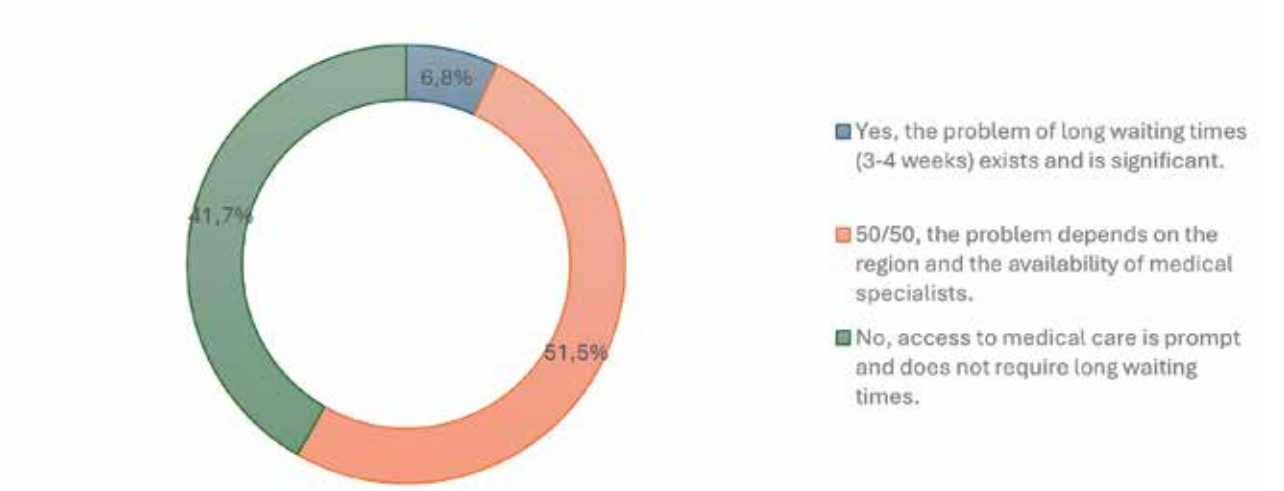

Fig. 4. Is there a problem in Poland with long waiting times (3-4 weeks) for beneficiaries of temporary protection from Ukraine to receive medical assistance?

defined, which is different from beneficiaries of temporary protection. This article examines the right to receive medical care specifically for beneficiaries of temporary protection. A scientific understanding of the procedure for accessing medical care *before* obtaining that status is beyond the scope of this study, so it should be bypassed.

In Germany, medical care is not free. However, access to it for a Ukrainian is the same as for a German citizen. According to § 5 of the Fifth Book of the Social Code of the Federal Republic of Germany of December 20, 1988, foreign citizens who have received a residence permit are subject to mandatory insurance [19]. The norms of the Second Book of the Social Code of the Federal Republic of Germany establish the right to receive assistance from the state for persons who cannot provide for their basic needs on their own, including beneficiaries of temporary protection [20]. Support within the framework of civil assistance covers the costs of public health insurance. Moreover, it is currently impossible to get such care without choosing health insurance. If a person does not receive such assistance, he or she may voluntarily choose health insurance within six months of receiving temporary protection status. Otherwise, if the person is not insured within six months, the Employment Center will automatically insure such a person. In the case of employment of a person, health insurance is a mandatory condition, and such an employee is paid after deducting the cost of insurance.

According to § 11 of the Fifth Book of the Social Code of the Federal Republic of Germany, insured persons are entitled to benefits that fully or almost completely cover the cost of medical care, including treatment of illness, prevention of diseases, pregnancy, maternity, preventive examination, etc. [19]. In addition, the Federal Office for Migration and Refugees has created an Internet resource "germany4ukraine.de" [20], which provides recommendations, including on obtaining medical care in Ukrainian, Russian, English, and German, which greatly simplifies the integration of Ukrainians into German society.

Asylum Information Database (AIDA), managed by the European Council for Refugees and Exiles (ECRE), regularly conducts statistical studies on the status of beneficiaries of temporary protection access to healthcare. As of 2023, 33% of Ukrainians face problems accessing medical care.

We conducted a survey among people who had one way, or another encountered the German healthcare system. 520 respondents took part in the survey. Only 25 respondents did not have information on this issue, so they are not included in further statistics.

Thus, 495 people took part in the subsequent survey (Fig. 5). According to the survey, 140 people believe that the problem with waiting times is serious, which is 28.3%. 305 people believe that the problem exists, but it depends on the region of Germany and its material support, which is 61.6%. Only 50 people indicated the absence of a problem (10.1%).

The results of the survey indicate that, although access to medicine for persons under temporary protection is not in doubt, the problem of long waiting times for obtaining such access is urgent and needs to be solved.

In our opinion, such a problem is one of the main reasons for returning to Ukraine for the purpose of receiving medical assistance, since in this case, you can usually get help on the day of application, with some exceptions, when you need to wait no more than two days. However, in general, the quality of medicine in Germany is much higher than in Ukraine.

However, the positive dynamics of the health status of beneficiaries of temporary protection are being monitored [22]. Thus, only 10% of respondents consider their health to be poor, and 5% indicated they need medical assistance. Such statistics indicate a sufficient level of state provision

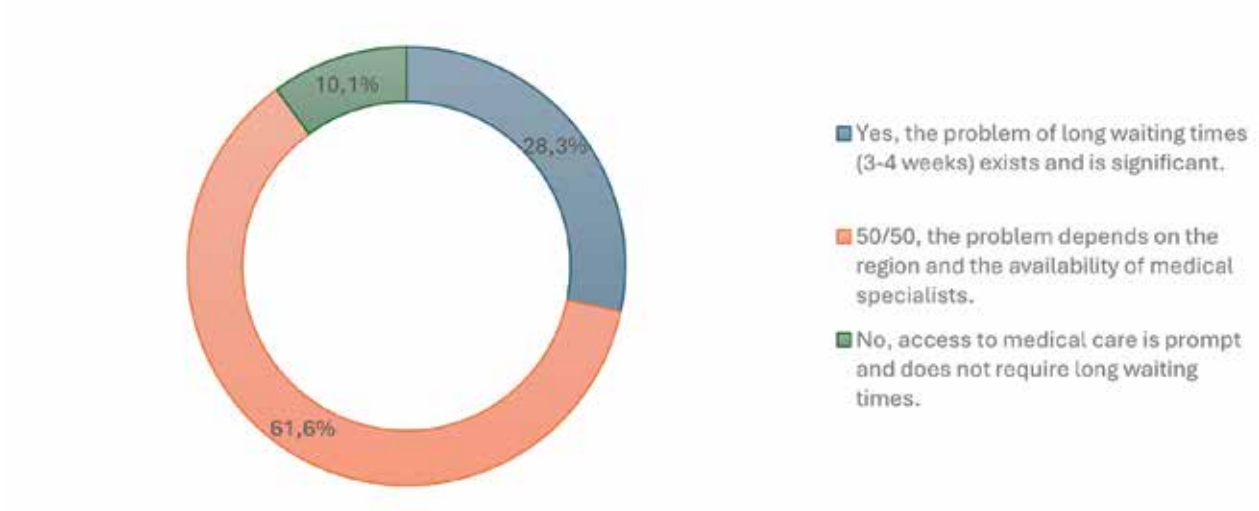

Fig. 5. Is there a problem in Germany with long waiting times (3-4 weeks) for beneficiaries of temporary protection from Ukraine to receive medical assistance?

of access to medical care. But, of course, there is no limit to improvement, so we believe that, along with the existing measures, it is necessary to strengthen the control of access to medicine, by reporting and recording Ukrainians who have received medical assistance in Germany, and by publishing general information in open databases to strengthen control by the public.

CONCLUSIONS

The findings of this study demonstrate that access to healthcare for Ukrainians under temporary protection in Poland and Germany is generally well-established, supported by both countries' accommodating policies and comprehensive legal frameworks. Specifically, survey data shows that 48.6% of Ukrainians in Poland and 67% in Germany successfully accessed medical services, though notable challenges remain.

The comparative analysis of waiting times revealed significant disparities between countries: in Poland, only 6.8% of respondents reported serious problems with waiting times, while in Germany this figure reached 28.3%. Additionally, 51.5% of respondents in Poland and 61.6% in Germany indicated that access challenges vary by region, highlighting the need for standardized service delivery.

Despite the serious differences between the various healthcare systems in Europe, in particular the system of financing medical care from the state budget and the system of universal health insurance, this does not create significant obstacles for access to medicine.

European countries have undertaken to ensure the rights and freedoms of persons enjoying temporary protection. However, each country implements this obligation in national legislation differently. Thus, Poland adopted the Law "On assistance to citizens of Ukraine in connection with the armed conflict on the territory of this state", which establishes guarantees for Ukrainians' access to medical care. Germany, in turn, ensures such rights by using the existing legislation, which applies not only to citizens of Ukraine.

At the same time, such implementation is not always successful and effective. Thus, there are cases of bureaucratization and excessive formalism in providing access to medicine. As the research showed, there are not isolated cases of long waiting for medical care both in Poland and in Germany. In our opinion, to improve access to medical care, it is necessary to:

1. To reduce the waiting time by increasing the number of specialists. This may include measures such as encouraging the local population to obtain medical education, simplifying employment for foreign doctors, creating more attractive working conditions, etc.
2. Minimize excessive formalism by reducing the number of mandatory documents, simplifying the procedure for their consideration and receipt.
3. Strengthen public oversight, which may involve the creation of regular reporting mechanisms, the publication of statistics on the provision of medical care on waiting times and quality of services. Thus, public coverage of problems will contribute to transparency and increase pressure on competent public authorities to improve the efficiency of service provision.
4. Improve information accessibility. Thus, the activation of information companies, along with existing ones, will contribute to faster integration and understanding of local features of the healthcare system.
5. Study limitations and future directions.

STUDY LIMITATIONS

- The survey sample (660 respondents for Poland and 520 for Germany) may not fully represent all temporary protection beneficiaries.
- Regional variations within each country require more detailed investigation.

– The study focused primarily on waiting times and did not extensively examine other potential barriers to healthcare access

FUTURE RESEARCH DIRECTIONS

– Longitudinal studies tracking changes in healthcare access patterns over time
– Comparative analysis with healthcare access in other EU countries hosting. Ukrainian temporary protection beneficiaries.
– In-depth examination of regional disparities in healthcare service delivery.
– Assessment of the effectiveness of different information support systems for temporary protection beneficiaries

PRACTICAL IMPLEMENTATION STEPS

Short-term actions (0-6 months):

– Establish monitoring systems for healthcare waiting times.
– Create multilingual information resources about healthcare access.
– Implement feedback mechanisms for service users.
– Medium-term actions (6-18 months):
– Develop regional capacity-building programs for healthcare providers.
– Establish cross-border coordination mechanisms for medical service delivery.
– Create standardized procedures for healthcare access across regions.
– Long-term actions (18+ months):
– Integrate temporary protection healthcare access into permanent national healthcare frameworks.
– Develop sustainable funding mechanisms for expanded healthcare services.
– Create permanent support structures for temporary protection beneficiaries.
– The implementation of these recommendations would significantly enhance healthcare accessibility and service delivery quality for temporary protection beneficiaries, which will allow Ukrainians under temporary protection to receive high-quality medical services in full.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Vitalii M. Pashkov
National academy of the law Sciences of Ukraine
70 Hryhoriia Skovorody St., 61000 Kharkiv, Ukraine
e-mail: v.pashkov26.06@ukr.net

ORCID AND CONTRIBUTIONSHIP

Vitalii M. Pashkov: 0000-0001-9489-7768 A B D - F
Marianna I. Liubchenko: 0000-0001-7090-2403 A B D - F
Oleksii O. Liubchenko: 0000-0002-8068-5665 A B D - F

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REVIEW ARTICLE

Embryological Significance of Glial cells in the Central Nervous System

Ewa Alicja Ogłodek, Anna Grzesińska, Barbara Paraniak-Gieszczyk, Izabela Woźny-Rasała

DEPARTMENT OF MEDICAL SCIENCES, DR. W. BIEGANSKI COLLEGIUM MEDICUM, JAN DLUGOSZ UNIVERSITY IN CZESTOCHOWA, CZESTOCHOWA, POLAND

ABSTRACT

Glial cells are essential for the proper functioning of the nervous system, categorized into two groups: macroglial and microglia. Traditionally viewed as passive entities involved in nutrition, support, and insulation, recent insights reveal their crucial role in brain function and plasticity. They serve as key regulators of synaptic activity, influencing information transmission between neurons and impacting processes like learning. Glial cells are vital for maintaining neuronal network integrity and functionality; disruptions in their function can lead to neuronal dysfunction and death. Our review aims to underscore the embryological importance of glial cells in nervous system function. Systematic searches of major electronic medical databases were conducted, including PubMed, Web of Science, Scopus, and Google Scholar, up to February 15, 2024. Our findings indicate that abnormalities in glial cell function contribute to various human conditions such as Alzheimer's disease, depression, generalized anxiety disorder, panic disorders, fibromyalgia, and schizophrenia.

KEY WORDS: astrocytes, glial, oligodendrocytes, central nervous system

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INTRODUCTION

Glial cells, credited to pathologist Rudolf Virchow as their discoverer, are vital components of the nervous system that facilitate the functions of neurons. The term "glial cells" originates from the Greek word "glia," meaning glue, highlighting their initial role in binding nerve cells together [1]. Initially, glial cells were primarily thought to serve this adhesive function. However, subsequent research has revealed their significant regulatory roles in information flow between neurons, participation in synaptic plasticity, and overall neuronal function [2]. Gliogenesis leads to the formation of macroglia within the central nervous system (CNS), which includes astrocytes, oligodendrocytes, ependymal cells, Bergmann and Müller cells, as well as microglia cells derived from the mesoderm. These cells originate from ectodermal neural stem cells [3].

AIM

Our article aims to underscore the embryological importance of glial cells in nervous system function.

MATERIALS AND METHODS

Systematic searches of major electronic medical databases were conducted, including PubMed, Web of Science, Scopus, and Google Scholar, up to February 15, 2024.

REVIEW AND DISCUSSION

GLIOGENESIS IN FETAL LIFE

The development of the nervous system begins with the formation of the neural plate, which arises from the embryonic ectoderm approximately two weeks after fertilization. This neural plate then undergoes a series of transformations, giving rise to structures such as the neural tube, nerve folds, and neural crest. The neural tube, a critical developmental structure, contributes to the formation of important anatomical features like the spinal cord. Within the neural tube, the lateral walls undergo a process of transformation, forming the median canal. The walls of the neural tube are composed of a multi-layered, cylindrical epithelium called neuroepithelium [4, 5].

From approximately the fifth week of fetal development, neuroepithelial cells begin the process of constructing the nervous system, serving as the foundational cells for the brain and spinal cord. It is at this stage that various types of nerves and cells constituting the central nervous system start to form from stem cells through gliogenesis [6]. Neuroepithelial cells, forming the lining layer, give rise to neurons and macroglia cells like astrocytes and oligodendrocytes within the spinal cord, alongside highly proliferative intermediate progenitor cells. As the marginal zone, comprising the outer regions of neuroepithelial cells, undergoes differentiation, some neuroepithelial cells within the lining layer differentiate into neuroblasts [7]. These neuroblasts form an intermediate zone situated between the lining layer and the marginal layer and possess the potential to develop into neurons upon the formation of cytoplasmic protrusions. Primary supporting cells, termed glioblasts or spongioblasts, also originate from neuroepithelial cells. Some glioblasts differentiate into astroblasts, subsequently giving rise to astrocytes, while others differentiate into oligodendroblasts, which later mature into oligodendrocytes. Following the emergence of neuroblasts and glioblasts, ependymal cells arise [8]. Microglia cells, dispersed throughout the gray and white

matter, derive from mesenchymal cells. The production of myelin sheaths around nerve fibers in the spinal cord begins late in fetal life. In the peripheral nervous system, myelin sheaths are generated by the cell membranes of Schwann cells [9, 10]. The transition from neurogenesis to gliogenesis is facilitated by the expression of neurogenic factors such as members of the neural BMP (bone morphogenetic protein) family (e.g., BMP 4, BMP 7), Wnt, FGF (fibroblast growth factor), Patched1, and hox (homeobox) proteins [11, 12]. The SHH (sonic hedgehog homolog) protein, pivotal in establishing an opposing concentration gradient of glio- and neurogenic factors, plays a significant role in initiating gliogenesis by undergoing autoproteolysis and modifications leading to pathway activation [13, 14]. Following this, neural tube compartmentalization ensues, accompanied by the expression of transcription factors, after extracting genes such as p2 (PAX6, pO, reelin), p1(reelin, pAX6), p3 (Nkx.6.1, SLIT1) and (Nkx.6.1, SLIT1), which drive astrogliogenesis and the formation of oligodendrocyte progenitor cells (OPCs) within the pMN domain [15].

MACROGLIA (ASTROCYTES, OLIGODENDROCYTES, EPENDYMAL CELLS, RADIAL GLIAL CELLS) AND GLIOGENESIS

In the scientific literature, the earliest investigations into glial function within the nervous system primarily focused on astrocytes. These cells, ranging from 8 to 12 μm in size, are the largest among glial cells. They possess numerous protrusions that establish connections with neuronal cell bodies and protrusions, as well as with capillary blood vessels and other astrocytes. This intricate network facilitates an active exchange of ions and substances through gap junctions, regulated by neurotransmitters and the cytokine system. Additionally, astrocytes exhibit anti-inflammatory properties and protect neurons from oxidative stress [16]. They also secrete growth factors such as brain growth factor (BGF), nerve growth factor (NGF), and fibroblast growth factor (bFGF), which are crucial for neuronal growth and repair processes [17]. Research on astrocyte function expanded significantly following the discovery of receptors for gamma-aminobutyric acid (GABA) and glutamate on oligodendrocytes and astrocytes by Harold Kimelberg and Helmut Kettenmann. Subsequent studies revealed that astrocytes respond to stimulation by increasing intracellular calcium ion (Ca2+) concentration [18]. Puebla M. et al. observed a surge in calcium upon astrocyte stimulation in culture [19]. This process involves an elevation in calcium ion levels across interconnected astrocyte networks, indicating the presence of glutamate ion channels in astrocytes. Activation of these channels leads to a calcium signal within the cell network through the influx of Ca2+ ions into astrocytes [20]. Further investigations have suggested that astrocytes may play a role in modulating synaptic transmission, leading to their designation as modulators of fundamental processes within the central nervous system [21]. Subsequent studies on receptor expression in astrocytes have highlighted their ability to produce various receptors and influence the expression of diverse membrane channels. Additionally, astrocytic extrasynaptic transmission has been demonstrated to play a pivotal role in regulating neuronal activity [22].

The formation of astrocytes is facilitated by gliogenic cytokines such as Interleukin-6 (IL-6), cardiotrophin-1 (CT1), and ciliary neurotrophic factor (CNTF). These cytokines activate the gp130-JAK-STAT signaling pathway, leading to the phosphorylation of STAT (signal transducer and activator of transcription) proteins [23]. STAT proteins play a crucial role in the transcription of astrocytic genes. Additionally, the BMP2 protein contributes to astrocyte differentiation by forming CREB-STAT complexes [24]. Astrogliogenesis is regulated by various factors, including the methylation status of cytosines within promoter sections of astrocytic genes. During early fetal life, these promoter regions contain methylated cytosines, preventing transcription factors from binding. Consequently, neural stem cells can only differentiate into neurons during this period [25]. In the developing brain, processes unfold in a specific sequence. Initially, progenitor cells are formed from cells expressing the Nkx2.1 factor. Subsequently, the Gsx2 factor becomes involved, followed by the expression of the Emx1 factor in the third stage. This ordered progression is critical for the proper development and differentiation of neural cells, including astrocytes [26].

Disruption of the delicate balance between pro-oxidant and antioxidant mechanisms can lead to cellular damage and even cell death due to the accumulation of reactive oxygen species (ROS). Astrocytes play a pivotal role in safeguarding the nervous system by secreting and storing antioxidant compounds such as glutathione and ascorbate, contributing to protection against oxidative stress [27]. Moreover, astrocytes regulate glutamate levels at synapses, further enhancing their protective function. In response to exposure to toxins, astrocytes undergo mobilization, exhibiting increased proliferation and hypertrophy of their cell bodies, nuclei, and protrusions [28]. Additionally, upon stimulation, astrocytes release neuroprotective substances including nerve growth factor (NGF), brain-derived neurotrophic factor (BDNF), glial-derived neurotrophic factor (GDNF), fibroblast growth factor 2 (FGF2), erythropoietin, plasminogen activator inhibitor, and numerous other proteins [29, 30]. These actions underscore the protective role of astrocytes in mitigating damage to the nervous system. However, it's important to note that astrocytes can also produce pro-inflammatory cytokines, including IL-1beta, IL-6, transforming growth factor beta (TGFβ), and tumor necrosis factor alpha (TNFα) [31]. Following peripheral nerve damage, activation of astrocytes and the release of cytokines such as TNFalpha, IL-1beta, and nitric oxide have been observed. Dysfunction of astrocytes has been associated with the development of various neurological and psychiatric disorders. Pathological alterations and atrophy of astrocytes in the cortex have been reported in patients with major depression, bipolar affective disorder, and schizophrenia. Additionally, in depression, an increase in the S100B protein in serum correlates positively with the severity of depressive symptoms and is inhibited by

antidepressants, suggesting astrocyte involvement in the pathophysiology of depression [32].

Other glial cells originating from the neural crest and found within the peripheral nervous system include oligodendrocytes, also referred to as Schwann cells or lemmocytes. These cells are present in both the grey and white matter of the brain, and a single oligodendrocyte can ensheath multiple neuronal processes. They constitute the sparse glial population, with their processes encircling axons and forming myelin sheaths. Additionally, they accompany neuronal cell bodies, forming satellite oligodendrocytes. Myelin sheaths play a crucial role in the rapid and efficient conduction of nerve impulses within the nervous system [33].

Schwann cells play a crucial role in the peripheral nervous system by producing myelin sheaths around nerve fibers and possessing phagocytosis abilities, allowing them to remove unwanted substances. On the other hand, satellite cells are small glial cells that surround nerve cells and are components of ganglia in the sympathetic, parasympathetic, and somatic nervous systems. They contribute to signal transduction and nociception processes, which are essential for maintaining the body's homeostasis. Their role becomes particularly significant in conditions like neuropathic pain and inflammation of peripheral nerves. During these processes, there's an expression of intermediate filaments, acidic filamentous protein (GFAP), and the release of pro-inflammatory cytokines. In the nociception process, satellite cells release pro-inflammatory cytokines in the dorsal root ganglia and stimulate nerve endings in the dorsal horns of the spinal cord. Additionally, they are responsible for the fluctuating release of potassium and glutamate during the pain process associated with neurodegenerative and autoimmune diseases [34].

Genetic factors play a critical role in initiating oligogliogenesis. Key signaling pathways involved in this process include Wnt, BMP, or Notch. Transcriptional proteins such as P-catenin, Smad, or NICD are activated to inhibit genes associated with myelogenesis and oligodendrocyte differentiation. During oligodendrogenesis, the expression of inhibitors of myelin gene transcription is suppressed through the activation of histone deacetylase HDAC1/2 and corepressors Gro/TLE and SMRT. Oligodendrocyte maturation is facilitated by transcription factors like bHLH, Sox 10, YY1, Zfg488 [35]. In the context of nerve fiber damage, Schwann cells become activated and play a critical role in nerve regeneration processes. They regain their proliferative capacity, leading to nerve regeneration. Diseases such as multiple sclerosis, hereditary leukodystrophies, Guillain-Barre syndrome, Charcot-Marie-Tooth disease, chronic inflammatory demyelinating polyneuropathy, as well as tumors of glial origin like astrocytomas, gliomas, oligodendromas, or ependymomas, result in the loss of integrity of the myelin sheath [36, 37].

Ependymal cells, also known as lining glial cells, form a single layer of epithelium that lines the ventricles of the brain and the central canal of the spinal cord. Microglial cells are characterized by sparse protuberances with blocky branches and possess the ability to move and phagocytose. They are distributed in the spinal cord and the ventricular system of the brain and play a role in the production and secretion of cerebrospinal fluid. Radial glial cells, on the other hand, are progenitor cells capable of giving rise to astrocytes, oligodendrocytes, and sometimes neurons. Collectively, all the aforementioned types of glial cells are referred to as macroglia.

MICROGLIA

Microglia are also present in the central nervous system, comprising specialized macrophages derived from monocytes. They possess the capability to phagocytose, effectively removing foreign antigens from the central nervous system and mitigating oxidative stress-induced cell damage. Upon activation by various factors such as pro-inflammatory cytokines, growth factors, complement proteins, free radicals, neurotoxins, nitric oxide, prostaglandins, ATP, and excitatory amino acids, microglia migrate to the site of damage and release pro-inflammatory mediators. This process leads to neuronal depolarization. Microglial cells play a vital role in maintaining homeostasis by ensuring the survival of neurons within the central nervous system [38,39]. Studies indicate that following neural tissue damage, microglia undergo activation and orchestrate a series of processes aimed at both protecting against damaging factors and repairing resulting tissue damage.

In summary, microglia play a crucial role in maintaining homeostasis in the central nervous system, influencing its normal development and differentiation, secreting neuroprotective factors, and modulating neuronal plasticity. However, in various pathological conditions, active microglia can produce pro-inflammatory cytokines that contribute to cell death and exacerbate damage in the central nervous system. It's worth noting that complete elimination of microglia can have adverse effects since some of their functions are essential for protective and repair processes. Microglia are implicated in numerous neurodegenerative disorders like Alzheimer's disease, psychiatric conditions such as schizophrenia, and autoimmune diseases [40].

CONCLUSIONS

In conclusion, the significance of glial cells for the proper functioning of nerve cells cannot be overstated. Glial cells, including astrocytes, play crucial roles such as providing nutrients to neurons and removing unnecessary metabolites from them. They are also responsible for eliminating abnormal cells in the nervous system and contribute to the circulation and removal of various neurotransmitters. Additionally, glial cells produce myelin sheaths, essential for facilitating impulse transmission in the nervous system. During adolescence, glial cells support the development of neuronal function and synaptic connections. Moreover, in cases of peripheral nervous system fiber damage, Schwann cells, a type of glial cell, participate in the regeneration of these structures. Thus, the intricate functions of glial cells are indispensable for the proper functioning and maintenance of the nervous system.

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CONFLICT OF INTEREST
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CORRESPONDING AUTHOR
Ewa Alicja Ogłodek
Department of Medical Sciences, Dr. W. Biegański Collegium Medicum,
Jan Długosz University in Częstochowa
ul. Waszyngtona 4/8, 42-200, Częstochowa, Poland
e-mail: eoglodek@gmail.com

ORCID AND CONTRIBUTIONSHIP
Ewa Alicja Ogłodek: 0000-0001-5425-6210 (A B D-F)
Anna Grzesińska: 0009-0009-6444-4747 (B D)
Barbara Paraniak-Gieszczyk 0009-0002-5518-9931 (B D)
Izabela Woźny-Rasała: 0009-0005-7051-3092 (B D)

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REVIEW ARTICLE

Unfair criminalization as a threat to epidemic safety

Nataliya Gutorova[1], Oleksii Soloviov[2], Yevhen Gnedik[3]

[1]YAROSLAV MUDRYI NATIONAL LAW UNIVERSITY, KHARKIV, UKRAINE
[2]ACADEMY OF PERSONNEL MANAGEMENT , KYIV, UKRAINE
[3]ACADEMICIAN STASHIS SCIENTIFIC RESEARCH INSTITUTE FOR THE STUDY OF CRIME PROBLEMS OF THE NATIONAL ACADEMY OF LAW SCIENCES OF UKRAINE, KHARKIV, UKRAINE

ABSTRACT

Aim: This article aims to raise awareness and stimulate serious discussion of the negative impact of criminal law regulation on the prevention and treatment of infectious diseases, including HIV/AIDS, tuberculosis, and sexually transmitted diseases.

Materials and Methods: The study was conducted in 2024 and based on the empirical and analytical data of the Joint United Nations Programme on HIV/AIDS, the World Health Organization, the legal positions of the ECHR, legal practice and statistics of Ukraine, legal acts of the Ukraine, Germany, Estonia, Lithuania, and Poland. In total, 21 laws, drafts of laws, other documents, and 26 court decisions were analysed. Analytical, comparative, synthetic, systemic, sociological, induction, and deduction research methods were applied.

Conclusions: Criminal law should consider the latest medical research results when determining the boundaries of criminal law regulation. It is necessary to proceed from the principle of necessity in a democratic society when deciding on the criminalization of the transmission of HIV, tuberculosis, sexually transmitted diseases, COVID-19, and other infectious diseases. Based on this principle, decriminalization is necessary: a) infection with a disease that does not pose a serious danger; b) placing a person in danger of being infected with an infectious disease if such consequences did not occur and the person did not intend to become infected with such a disease.

KEY WORDS: public health, criminal law, HIV-criminalization, sexually transmitted diseases, human rights, stigmatization

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INTRODUCTION

Criminalization of acts, i.e., recognition of them as criminally punishable, entails severe restrictions of human rights and freedoms as consequences. Such a restriction is always associated with causing suffering to the person who committed an act harmful to society and with many so-called side effects. We are talking about significant expenditures of taxpayers' funds, which are spent on the criminal justice system, suffering that may be experienced by the families of convicted persons, the need for subsequent resocialization of persons who have been sentenced to isolation from society, deterioration of their health, the effect of so-called criminal infection, in which random offenders in the process of serving their sentence acquire connections in the criminal world and skills to commit crimes. These and other side effects of criminalization are well known; therefore, criminal law in a democratic society is considered an extreme, last resort, ultima ratio.

Unfortunately, politicians often use criminal law measures to show their voters their determination to combat negative social phenomena. Decisions on criminalization are often made spontaneously without conducting the necessary scientific research, making them frequently ineffective and unfair.

Analyzing the situation in the field of epidemic safety, specialists in the field of prevention and treatment of infectious diseases insist that, in many cases, criminalization not only does not contribute to the fight against epidemics but also has the opposite effect. The consequence of such measures is an increase in new infection cases. This criminalization hinders medical professionals' efforts to contain epidemics. This is, in particular, about the criminalization of placing a person in danger of being infected with the human immunodeficiency virus (hereinafter - HIV), as well as behavior that is not dangerous to society but is commonplace for groups of people with a high risk of HIV infection. [1].

The situation in which criminalization of acts negatively affects epidemic safety is unacceptable, while individual politicians and lawyers continue to defend the need for appropriate criminal law norms. Unfortunately, the findings of medical science remain unheeded. This demonstrates the need to conduct criminal law studies on this issue.

AIM

This article aims to raise awareness and stimulate serious discussion of the negative impact of criminal law regulation on the prevention and treatment of infectious diseases, including HIV/AIDS, tuberculosis, and sexually transmitted diseases.

MATERIALS AND METHODS

The study was conducted in 2024 and based on the empirical and analytical data of the Joint United Nations Programme on HIV/AIDS, the World Health Organization, the legal positions of the ECHR, Ukrainian legal practice and statistics, and the legal acts of Ukraine, Germany, Estonia, Lithuania, and Poland. In total, 21 laws, drafts of laws, other documents, and 26 court decisions were analyzed.

In the first stage, using analytical, synthetic, and systemic methods, Poland and Ukraine's criminal legislation on placing a person in danger of contracting an infectious disease was studied. In the future, the similarities and differences between these regulations and criminal law regulations in contracting a contagious disease in Germany, Lithuania, and Estonia were identified using a comparative method.

In the next stage, using sociological, analytical, and systemic methods, judicial statistics, and judicial practice of Ukraine on the application of criminal punishment for infection with the human immunodeficiency virus and other incurable infectious diseases, as well as for contracting a venereal disease, as well as WHO statistics on the number of new cases of HIV infection in Ukraine and other European countries were studied. Subsequently, the obtained results of the study of criminal legislation, statistical information, and judicial practice using analytical, synthetic, systemic methods, induction, and deduction methods were compared with analytical documents of the Joint United Nations Programme on HIV/AIDS, as well as research in the field of medicine on the impact of criminalization on the prevention and treatment of infectious diseases.

These data made it possible to analyze the validity of criminalizing the act of putting a person in danger of being infected with a contagious disease based on the international standard of the legitimacy of restricting human rights and freedoms in a democratic society formulated in the decisions of the European Court of Human Rights.

REVIEW AND DISCUSSION

Infection of a person with an infectious disease that is dangerous to his life, or transmission of the virus of such a disease, is essentially causing serious bodily harm to the victim. Since causing serious bodily harm in criminal law is considered a criminally punishable act, it is logical that causing serious bodily harm by infecting with a particularly dangerous infectious disease or transmitting the virus of such a disease is also such an act.

At the same time, in many countries, criminal laws have criminalized not only causing serious bodily harm but also the very fact of placing a person in danger of being infected or contracting an infectious disease, regardless of the actual consequences.

Thus, Article 130 of the Criminal Code of Ukraine [2] criminalizes, in Part 1, placing of a person in danger of being infected, in Part 2 – reckless infection, in Part 3 – reckless infection of two or more persons or a minor, in Part 4 – intentional infection with HIV or another incurable infectious disease that is dangerous to human life. Article 133 of the Criminal Code of Ukraine criminalizes infection with a venereal disease, which can be committed both intentionally and recklessly; placing a person in danger of being infected with a venereal disease, according to the legislation of Ukraine, is criminally punishable only in the event of an attempt to commit this crime, which, under Article 15 of the Criminal Code of Ukraine, is possible only if the perpetrator acted with direct intent, wanting to infect the victim with a venereal disease.

Part 1 of Article 161 of the Penal Code of Poland criminalizes directly exposing a person to the risk of infection from HIV, a sexually transmitted disease, or a serious, incurable, or life-threatening infectious disease [3]. The Act of 7 July 2022 abolished the previously existing differentiation in criminal punishment between exposing a person to the risk of infection from HIV and exposing a person to the risk of infection from a sexually transmitted disease or another incurable or life-threatening disease [4]. Such changes were justified by the need to consider medical progress in the treatment of people infected with HIV, which means that the disease caused by this virus is no more dangerous than other particularly dangerous diseases, and a more severe punishment for exposing a person to the risk of contracting HIV unreasonably increases the stigmatization of people living with HIV [5].

A comparison of the criminal legislation of Ukraine and Poland in terms of criminalization of infection with an infectious disease shows that the scope of criminalization in this area in Poland is significantly larger. Unlike Ukraine, criminally punishable offenses include placing a risk of infection with a venereal disease, as well as posing a risk of infection and infection not only with HIV but also with another life-threatening disease. In this sense, Article 161 of the Penal Code of Poland could have been applied to infection with the SARS-CoV-2 viral infection at the initial stages of the pandemic. However, the validity of such a decision was questioned [6].

Notably, the terminology used by Ukrainian and Polish legislators when formulating the legal norms under consideration in criminal law is incorrect. The WHO International Statistical Classification of Diseases and Related Health Problems (ICD) [7] does not use the term "venereal disease". This term is outdated, and diseases that were previously called venereal are included in a relatively broad list of diseases that are predominantly sexually transmitted (A50-A64). Therefore, the health legislation of both Poland and Ukraine does not provide for a list of venereal diseases. As a result, in Ukraine, over the past 10 years, Article 133 of the Criminal Code, "Infection with a venereal disease," has not been applied; during this period, not a single criminal case was sent to the court with an indictment under this article [8]. In the criminal legislation of Poland, Part 1 of Article 161 of the Penal Code (before amendments were made in 2022 – Part 2 of this Code) provides for the alternative of infection with either a venereal or infectious disease. Therefore, after the term "venereal disease" ceased to be used in medical legislation, this did not affect the scope of criminalization since "infectious disease" is broader and covers diseases previously defined as venereal. At the

same time, researchers note that this part of Article 161 of the Criminal Code of Poland requires improvement [9]. The term "incurable disease" used in the criminal laws of Ukraine and Poland is also problematic since neither WHO documents nor the healthcare legislation of these countries use such a term [10, p. 159, 160].

A different approach to the criminalization of infection with a life-threatening infectious disease is taken by countries whose criminal laws do not provide for separate articles describing such an act. Infection with a contagious disease, if necessary, can be considered as causing serious bodily harm or violating epidemic safety rules [11]. Examples of such countries include Germany [12], Estonia [13], and Lithuania [14].

An analysis of statistical information from Ukraine on the application of Article 130 of the Criminal Code of Ukraine, "Infection with HIV or any other incurable contagious diseases," over the past 10 years from 2014 to 2023, shows that 71 such offenses were registered during this period, while only 21 cases were sent to the court with a guilty verdict [8]. According to WHO, 139,393 new cases of HIV infection were identified in Ukraine from 2012 to 2021, while before the start of the full-scale war in 2021, Ukraine ranked second after the Russian Federation in the European region in terms of the number of new cases of HIV infection (37.1 per 100,000 population) [15].

As part of the study, an analysis of all sentences of Ukrainian courts posted in the Unified State Register of Court Decisions showed that under Article 130 of the Criminal Code of Ukraine from 2006 to September 2024. Of the 23 court sentences under this article, three sentences involved the transmission of HIV through negligence to 4 victims, and 17 sentences involved placing a person in danger of being infected with HIV infection. As for placing a person in danger of being infected with HIV, in most cases, the methods of committing the acts not only did not lead to, but either could not lead to, HIV transmission at all, or the probability of such transmission was close to zero [11].

A comparison of the number of people in Ukraine brought to trial under Article 130 of the Criminal Code of Ukraine for transmitting HIV to another person with the number of new cases of HIV during this period shows that criminal justice is purely selective. (4 victims since 2006). It does not and cannot have a restraining effect on the spread of the epidemic.

An analysis of scientific literature devoted to the issues of criminalization of exposing a person to the risk of infection with an infectious disease, including those transmitted sexually, as well as HIV transmission, shows significant differences in the approaches of representatives of legal and medical sciences.

In states where criminal law provides for the infection of another person with an infectious disease in special norms, legal researchers mainly analyze the legal features of the corresponding criminal offenses. At the same time, the issue of the validity of criminalization of placing at risk of infection with an infectious disease and the impact of such criminalization on epidemic safety is mainly not considered. In this aspect, it is worth noting the scientific research of Polish scientists Rafał Kubiak [6,] and Adam Wróbel [9], as well as Ukrainian scientists Kateryna Yanishevska [16], and Oksana Starko [17]. It can be assumed that posing a risk of bodily harm is a priori considered a basis for criminalization. Medical research in this area, which allows assessing the likelihood of infection transmission and its danger to human health, taking into account modern achievements of medical science and the impact of such criminalization on the fight against epidemics, is not analyzed in the works of these authors.

Representatives of medical science, considering the specified problem, focus on the groundlessness and inappropriateness of using criminal law in the fight against the spread of infectious diseases. They argue that criminal legislation on placing a risk of infection with a contagious disease, including HIV, COVID-19, and others, is a serious obstacle to the prevention and treatment of infectious diseases and containing the epidemic [1; 18]. Due to the fear of criminal liability, people living with HIV, as well as suffering from infectious diseases, in many cases refuse to be tested for infections, do not consult a doctor, but self-medicate, which contributes to the spread of epidemics. In addition, researchers are sure that such criminalization leads to the violation of human rights [19; 20; 21]. Scientists also note the lack of understanding of legal science and legislation of the current state of medicine in preventing and treating infectious diseases [18; 22].

Criminalization, i.e., defining an act as criminally punishable in criminal law, always entails restricting human rights and freedoms. In a democratic state governed by the rule of law, such restrictions cannot be established without justification and arbitrariness. When establishing and applying restrictions on exercising human rights and freedoms, international human rights standards oblige the state to be guided by their compliance with the criterion of "necessity in a democratic society," the so-called three-pronged test of legitimacy. The content of this test was formulated in the decisions of the European Court of Human Rights, which determined that the test of "necessity in a democratic society" requires determining: 1) whether the "interference" complained of corresponded to a "pressing social need," 2) whether it was proportionate to the legitimate aim pursued and 3) whether the reasons given by the national authorities to justify it are relevant and sufficient [23; 24].

Based on this test, the need to criminalize placing a person in danger of being infected with an infectious disease or transmitting an infectious disease virus is possible only if such criminalization corresponds to the "pressing social need." Such a social need could prevent the spread of especially dangerous infectious diseases and the effective fight against epidemics, which will make it possible to preserve the life and health of people as the highest social values in a democratic society. Guided by this principle, it is necessary to highlight the problems that exist in the criminalization of placing a person in danger of being infected with an infectious disease.

First, it should be emphasized that criminal punishability of actions assessed by the courts as placing a person in

danger of being infected with an infectious disease, but that did not lead to and could not lead to the transmission of the infection violates human rights.

In addition, the criminal punishability of infection with an infectious disease is legitimate only if the disease poses a serious threat to the life or health of the victim. Criminalizing the method of transmission of the infection, namely sexual transmission, provided that the infection cannot cause serious harm to health, excludes the legitimacy of such a decision.

When deciding whether to criminalize infection with a particularly dangerous infectious disease, one should rely on modern achievements of medical science. Authoritative medical professionals from around the world involved in the prevention and treatment of infectious diseases, including HIV/AIDS and COVID-19, insist on the need to decriminalize exposing someone to the risk of infection with an infectious disease in the absence of intent to transmit the infection. As stated above, in their opinion, the criminalization of exposing someone to the risk of infection with an infectious disease has a negative impact on the epidemiological situation. It leads to an increase in the number of new cases of infection. Medical professionals argue that criminalization of exposing someone to the risk of infection with an infectious disease results in a significant number of potential carriers refusing to undergo testing, which leads to an increase in new cases of infection. All this seriously calls into question the validity of the opinion of lawyers who, without any compelling arguments, defend the need to preserve such norms. In addition, when formulating criminal law norms, only those terms provided for by legislation in the healthcare field should be used. The use of the terms "venereal disease" and "incurable disease" in the criminal laws of Ukraine and Poland is a serious shortcoming of these laws.

CONCLUSIONS

Criminal law must consider the latest medical research results when determining the boundaries of its regulation. Medical science's understanding of the nature of infectious diseases, their transmission routes, prevention, and treatment methods is constantly improving. Therefore, regulation in this area, in terms of establishing and applying criminal law norms, must be carried out in constant contact with medical professionals and correspond to the current state of medical science. In this regard, criminal punishment for human behavior that not only did not lead to the infection of another person with an infectious disease or the transmission of its virus but also objectively could not lead to such consequences is absolutely unacceptable.

It is necessary to proceed from the principle of necessity in a democratic society when deciding on the criminalization of the transmission of HIV, tuberculosis, sexually transmitted diseases, COVID-19, and other infectious diseases. Such criminalization can only be justified if the infectious disease poses a serious threat to human life or health. In this regard, it is not consistent with the principle of necessity in a democratic society to criminalize the transmission of infectious diseases, including those transmitted primarily through sexual contact, if such diseases do not pose a serious threat to the life or health of the victim. Based on the findings of scientists specializing in the prevention and treatment of infectious diseases, including HIV/AIDS, it is necessary to decriminalize in the criminal law the placing of a person in danger of being infected with an infectious disease or transmitting the virus of such a disease if such actions are committed in the absence of intent for such consequences to occur. Such a decision will improve the effectiveness of the prevention and treatment of infectious diseases, help reduce the stigmatization of people living with HIV and suffering from infectious diseases, and help protect their rights and legitimate interests.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Nataliya Gutorova
Yaroslav Mudriy National Law University, Kharkiv, Ukraine
e-mail: natalygutorova@gmail.com

ORCID AND CONTRIBUTIONSHIP

Nataliya Gutorova: 0000-0003-2485-0651 A B D E F
Oleksii Soloviov: 0000-0002-6615-4868 A B D E
Yevhen Gnedik: 0000-0003-3005-3624 B C D E

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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