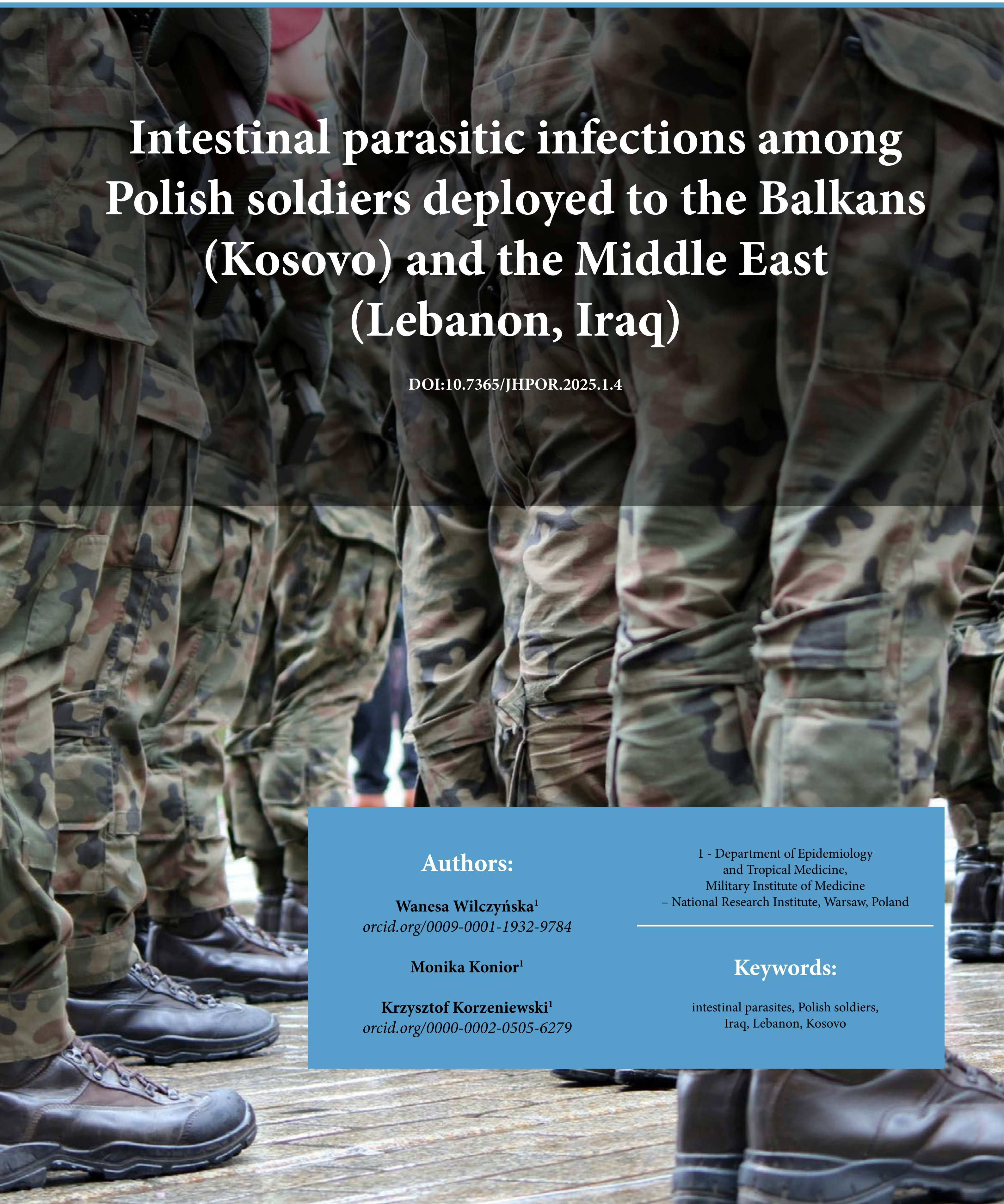
#01/2025
ISSN 2299-1247

JHPOR | Journal of Health Policy & Outcomes Research



Intestinal parasitic infections among Polish soldiers deployed to the Balkans (Kosovo) and the Middle East (Lebanon, Iraq)

DOI:10.7365/JHPOR.2025.1.4

Authors:

Wanesa Wilczyńska[1]
orcid.org/0009-0001-1932-9784

Monika Konior[1]

Krzysztof Korzeniewski[1]
orcid.org/0000-0002-0505-6279

1 - Department of Epidemiology and Tropical Medicine, Military Institute of Medicine – National Research Institute, Warsaw, Poland

Keywords:

intestinal parasites, Polish soldiers, Iraq, Lebanon, Kosovo

How to cite this article?
Wilczyńska W., Konior M., Korzeniewski K., Intestinal parasitic infections among Polish soldiers deployed to the Balkans (Kosovo) and the Middle East (Lebanon, Iraq) J Health Policy Outcomes Res [Internet]. 2025[cited YYYY Mon DD];. Available from: https://jhpor.com/article/2428-intestinal-parasitic-infections-among-polish-soldiers-deployed-to-the-balkans-kosovo-and-the-middle-east-lebanon-iraq

contributed: 2025-02-10
final review: 2025-03-17
published: 2025-03-25
Corresponding author:
Krzysztof Korzeniewski kkorzeniewski@wim.mil.pl

Abstract

Objective
Soldiers forming Polish Military Contingents (PMCs) serving outside of Poland are exposed to a number of risk factors, which increase the probability of contracting intestinal parasitic infections (IPIs). This is primarily associated with poor sanitation in most areas of troops deployment and also with the ease of transmission via the oral-faecal route. The aim of the present article was to discuss the prevalence of IPIs in Polish soldiers deployed to Kosovo (the Balkans), Lebanon and Iraq (the Middle East).

Methods
Parasitological exams were performed on stool samples collected from 2759 Polish soldiers who were serving in Iraq (n=766), Lebanon (n=970), and Kosovo (n=1023) between 2020 and 2023. Stool samples were transported to the Military Institute of Medicine – National Research Institute in Poland. Light microscopy examinations of the samples were performed using three different diagnostic methods (direct smear, decantation with distilled water, and Fülleborn's flotation).

Results
16.2% of the examined soldiers were infected with at least one species of intestinal parasites (16.0% in Kosovo, 15.3% in Lebanon, 17.6% in Iraq). The examinations found only two cases of helminthic infections and three cases of infections with the pathogenic Giardia intestinalis protozoa. Most of the identified IPIs were potentially pathogenic Blastocystis spp. stramenopiles (12.0%). Conclusions: The results showed a low prevalence of IPIs among the study participants, despite harsh environmental conditions in all three areas of deployment (the Balkans and the Middle East). Low rates of IPIs suggest compliance with food and drinking water precautions and good hygiene practices of the soldiers involved in the study.

Introduction

Soldiers serving on military operations abroad can be classified as long-term travellers, and as such they are at a particularly high risk of exposure to infectious agents.[1] The key factors responsible for the spread of infectious diseases among military personnel include poor standards of sanitation as well as limited access to safe food and uncontaminated drinking water sources. However, regular contact with local residents and the consumption of locally produced food also play a significant role in infectious diseases transmission.[2] Although soldiers deployed on military operations to lower-income countries are generally in good physical condition, a sudden exposure to infectious agents can seriously affect their health, because, unlike local residents, they lack naturally acquired immunity to locally occurring pathogens. In addition, strenuous physical work, sleep deprivation and exposure to extreme stress can compromise their immune system making them even more susceptible to infections.[2, 3] There have been many case reports in the literature focusing on the prevalence of infectious diseases among deployed military personnel. According to the reports, tropical and parasitic diseases, such as malaria[4, 5], leishmaniasis[6-8], filariasis[9], schistosomiasis[10] and intestinal parasitic infections are an important cause of morbidity in soldiers. In fact, gastrointestinal infections were found to be one of the most common health problems in soldiers serving on military operations abroad. The studies demonstrate that the prevalence of diarrhoeas among deployed military personnel is 5-7% per 100 person per month.[14] Although most cases of diarrheal diseases are caused by bacteria[15], diarrhoeas can also be caused by intestinal parasites, especially in countries with poor sanitation and inadequate food and drinking water safety. Intestinal parasitic infections (IPIs) have a worldwide distribution and pose a significant health threat to all international travellers, including deployed military personnel. IPIs are easily transmitted via the oral-faecal route; they often have an asymptomatic course and if left untreated they can progress into a chronic condition. These factors make the diagnosis difficult and increase the risk of transmitting IPIs to contacts living in Poland.[16] Regular screening for intestinal parasites and an early diagnosis of IPIs are a crucial part of maintaining good health for all soldiers deployed overseas, but these measures can also improve combat readiness of troops. In 2010, Polish authorities introduced a special prevention program aimed to control the spread of IPIs among military personnel deployed on operations abroad[17], the program has been continued uninterrupted until today. The aim of the article was to present the prevalence of IPI cases among soldiers forming the Polish Military Contingents deployed to Kosovo (the Balkans), Lebanon and Iraq (the Middle East).

Material and Methods

Study population

The study, which was conducted between 2020 and 2023 involved a total of 2759 Polish soldiers relocated to Iraq (n=766), Lebanon (n=970) and Kosovo (n=1023). Stool samples for parasitological exams were collected inside the areas of deployment. The collected samples were fixed with SAF fixative and transported by air to a laboratory in Poland for further diagnostics. The study participants were required to provide three stool samples; the samples were collected a few weeks before the end of their tour of duty in the theatre of operations. The examinations were performed in 2020, 2021, 2022, 2023 (members of the PMC Iraq could not be tested in 2022 due to pandemic restrictions which were binding at the time). In terms of the demographic variables, 93.6% of the soldiers involved in the study were men; 48.9% of the soldiers were aged between 30 and 40 years old; 35.9% were privates and 33.5% were non-commissioned officers.

Areas of deployment

Modern military operations are often conducted in lower-income countries. These countries often face a number of socio-economic challenges; they have poor infrastructure, ineffective sewerage systems, an insufficient number of wastewater treatment plants and inadequate food and water safety regulations. Lack of education and poor personal hygiene practices of the local residents are yet another problem in many developing countries. For these reasons, it is extremely difficult to maintain hygiene and sanitation in the areas of troops deployment. Sanitary inspectors who are responsible for food, water and accommodation safety inside of military bases have no authority outside the bases. Yet, regular contact with people from local communities can increase the risk of infectious diseases transmission among military personnel.[18] Members of the Polish Military Contingents deployed to Kosovo, Iraq and Lebanon serve under harsh climate conditions and in settings lacking adequate sanitation services.[19, 20]

Iraq, a country in the Middle East, has two climate zones: the subtropical climate is only seen in the north, while tropical climate prevails in the rest of the country.[19] The Polish Military Contingent Iraq is primarily responsible for training Iraqi troops and providing them with expert advice and guidance in their fight against the Islamic State in order to bring peace and political stability in the region.[21] The destruction of Iraq's water supply system and wastewater treatment infrastructure during the recent military conflict has strongly affected the country's epidemiological situation. It is estimated that more than 50% of Iraqi residents have no access to safe drinking water as rivers, which are the primary source of drinking water, have been contaminated with massive amounts of wastewater [19]

Lebanon is a country in the Middle East which has a Mediterranean-type climate. Polish soldiers deployed on a mission to Lebanon are primarily responsible for providing humanitarian assistance to local people who have been affected by the recent military conflict as well as for the monitoring and ensuring security on the Lebanese borders.[21] A high prevalence of infectious diseases among local people translates into a high risk of transmission of communicable diseases to foreign soldiers.[20, 22]

Kosovo is a landlocked country in the Balkans which has a warm continental climate.[23] Polish soldiers who have been relocated to Kosovo are responsible for providing support to local uniformed services, patrolling the border between Kosovo and Serbia, as well as monitoring the traffic across the border zone.[21] The nature of the tasks performed by Polish soldiers increases the risk of transmission of infectious diseases which are endemic in the country.

Parasitological examinations by light microscopy

Each soldier involved in the study was required to provide three stool samples collected at 2-3-day intervals. The faecal samples were collected into stool specimen containers pre-filled with SAF-fixative (sodium acetate-acetic acid-formalin). Fixed samples were transported (first by air and next by land) to the Department of Epidemiology and Tropical Medicine at the Military Medical Institute - National Research Institute in Poland where they were examined by three different light microscopy methods: examination of a direct smear prepared by mixing a fixed stool specimen with Lugol's iodine, examination of preparations from decantation with distilled water, and examination of preparations from Fülleborn's flotation method.[24] In total, 24,831 microscopic slides were prepared and examined. Due to certain limitations of the microscopic-based methods, molecular tests were used to differentiate between the pathogenic Entamoeba histolytica and non-pathogenic Entamoeba dispar species, whenever Entamoeba histolytica/dispar was detected by microscopic methods. Before performing molecular tests, SAF-fixed samples were rinsed five times with distilled water to remove the fixative from the sample. Extraction was then carried out using a commercial Genomic Mini AX Stool DNA isolation kit (A&A Biotechnology, Poland) in line with the manufacturer's instructions. Following the extraction of samples, an inhibitor removal kit (A&A Biotechnology, Poland) was used and next a real-time PCR reaction was performed using a commercial E. histolytica/dispar differentiation kit (Amplicon sp. z o. o., Poland) following the thermal cycling profile recommended by the manufacturer; the test results were interpreted in accordance with the manufacturer's instructions.

Statistical assessment

All statistical calculations were performed using Stat Soft Inc. (2014) STATISTICA version 12.0 (www.statsoft.com) and an Excel spreadsheet. Quantitative variables were characterized by the arithmetic mean. The variables of the qualitative type were presented in terms of counts and percentages. Chi-squared tests were applied to assess the independence of qualitative variables. In all calculations, the level of statistical significance was set at p = 0,05.

Ethical considerations

Each participant was required to provide informed consent to participate in the study and to fill in a patient information form. The Military Institute of Medicine, an institution responsible for carrying out the study, provided the information clause on the processing of personal information by the Polish Ministry of Defence in accordance with Article 14 (1) and (2) of the Regulation 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, hereinafter referred to as the GDPR. The legal basis for the processing of personal data is defined in Article 6 (1) (e) of the GDPR, which stipulates that the processing of personal data is necessary to perform tasks carried out in the public interest. Moreover, the Bioethics Committee at the Military Institute of Medicine gave a positive opinion for the execution of a research project aimed to assess the prevalence of intestinal parasitic infections in the general Polish population on the example of selected military contingents by adopting Resolution no. 53/WIM/2019 of 18 December 2019, under the Declaration of Helsinki of 1996 and the EU guidelines 'Good clinical practice for trials on medical products in the European Community' ratified by the Polish Ethics Committee and legally binding since 01 January 1993.

Results

A total of 2759 Polish soldiers forming three separate military contingents, i.e.: PMC Iraq (n=766), PMC Lebanon (n=970) and PMC Kosovo (n=1023) were involved in this study. The study found that 16.2% of all the examined soldiers were infected with at least one species of intestinal parasites. The examinations found two cases of helminthic infections (Ascaris lumbricoides, Enterobius vermicularis; which accounted for 0.5% of all the identified infections) and three cases of infections caused by pathogenic Giardia intestinalis protozoa (0.7%). Most of the identified infections were caused by potentially pathogenic Blastocystis spp. and Dientamoeba fragilis, these infections were found in 13.7% of the examined soldiers. Another 2.8% of the study participants were found to be carriers of non-pathogenic protozoa. Polyparasitism was seen in 9.8% of the soldiers involved in the study (with Blastocystis spp. and Dientamoeba fragilis coinfections being predominant). A vast majority of the study participants (83.3%) had no parasitic infections. The overall prevalence of IPIs in the soldiers tested is shown in Table 1.

Table 1. Intestinal parasitic infections in tested soldiers deployed to Iraq, Lebanon, and Kosovo (n = 2759) in years 2020-2023

Intestinal parasites	Infections n (%)	Tested soldiers (%)
Helminths	2 (0.4)	0.1
Ascaris lumbricoides	1 (0.2)	0.0
Enterobius vermicularis	1 (0.2)	0.0
Pathogenic protozoa	3 (0.7)	0.1
Giardia intestinalis	3 (0.7)	0.1
Potentially pathogenic stramenopiles	378 (84.6)	13.7
Blastocystis spp.	330 (73.8)	12.0
Dientamoeba fragilis	48 (10.7)	1.7
Non-pathogenic protozoa	78 (17.4)	2.8
Entamoeba dispar	5 (1.1)	0.2
Endolimax nana	23 (5.1)	0.8
Entameoba coli	46 (10.3)	1.7
Entamoeba hartmanii	2 (0.4)	0.1
Chilomastix mesnili	2 (0.4)	0.1
Poliparasitism	44 (9.8)	1.6
Blastocystis spp. + *Dientamoeba fragilis*	16 (3.6)	0.6
Blastocystis spp. + *Endolimax nana*	8 (1.8)	0.3
Entamoeba coli + Entamoeba hartmanii	1 (0.2)	0.0
Blastocystis spp. + Entamoeba coli	9 (2.0)	0.3
Blastocystis spp. + *Entamoeba histolytica/dispar*	2 (0.4)	0.1
Blastocystis spp. + *Chilomastix mesnili*	1 (0.2)	0.0
Dientamoeba fragilis + *Entamoeba coli* + *Endolimax nana*	1 (0.2)	0.0
Dientamoeba fragilis + *Blastocystis* spp. + *Entamoeba coli* + *Endolimax nana*	1 (0.2)	0.0
Dientamoeba fragilis + *Blastocystis* spp. + *Entamoeba coli*	1 (0.2)	0.0
Blastocystis spp. + *Entamoeba coli* + *Endolimax nana*	1 (0.2)	0.0
Blastocystis spp. + *Entamoeba coli* + *Entamoeba histolytica/dispar*	1 (0.2)	0.0
Entamoeba coli + Endolimax nana	1 (0.2)	0.0
Entamoeba hartmanii + *Entamoeba histolytica/dispar*	1 (0.2)	0.0

In total, 10 distinct species of intestinal parasites were identified. Examinations by light microscopy methods identified 5 infections with Entamoeba histolytica/dispar species, however, further molecular tests performed on those samples confirmed that the infections were caused by non-pathogenic Entamoeba dispar. The prevalence of infections caused by potentially pathogenic parasites was slightly higher in women (17.4%) compared to men (12.8%), but it was not statistically significant (p-value = 0.0915). However, it is important to remember that women only accounted for 6.4% of the study group, and therefore the analysis of the distribution of infections by sex may not be reliable. Most IPIs (nearly 50%) were seen in soldiers aged 30-40 years old, however, this particular age group was the largest age group in the study and accounted for 48.9% of all the participants. 13% of the studied soldiers reported gastrointestinal symptoms within three months prior to sample collection (one of those soldiers was found to have a helminthic infection, while 9.9% of the group were infected with potentially pathogenic parasites). However, the occurrence of symptoms in people infected with intestinal parasites was not statistically significant (p-value = 0.2145). The study demonstrated that the overall prevalence of IPIs in Polish soldiers deployed to Iraq, Lebanon and Kosovo was 17.6%, 15.3% and 16.0%, respectively. The data on intestinal parasitic infections in each of the contingents is shown in Table 2.

The results of the studies into the prevalence of intestinal parasitic infections conduced in Iraq, Lebanon and Kosovo between 2020 and 2023 demonstrated that the prevalence of IPIs in Polish soldiers ranged from 12.4% (Lebanon, 2022) to 18.2% (Iraq, 2020) (Table 3). We have observed a slight reduction in the number of IPIs in soldiers relocated to Iraq and Kosovo in 2021 and also in the military personnel serving in Lebanon in 2022, which might have been associated with the introduction of Covid-19 restrictions and an improvement in compliance with personal hygiene guidelines. The results demonstrated that the prevalence of non-pathogenic, potentially pathogenic or pathogenic IPIs in members of the Polish Military Contingents exceeded 10%, which highlights the need for continuous surveillance of IPI cases among personnel forming Polish military contingents and warrants the continuation of the IPI surveillance and prevention program in the coming years.

Table 2. Intestinal parasitic infections in soldiers deployed to Iraq, Lebanon, and Kosovo in years 2020-2023

Contingents	Iraq (n=766)		Lebanon (n=970)		Kosovo (n=1023)		*p*-value (Chi-squared)
Intestinal parasites	Infections n (%)	Tested soldiers (%)	Infections n (%)	Tested soldiers (%)	Infections n (%)	Tested soldiers (%)	
Helminths	2 (1.5)	0.3	0.0 (0.0)	0.0	0.0 (0.0)	0.0	0.0740
Ascaris lumbricoides	1 (0.7)	0.1	0.0 (0.0)	0.0	0.0 (0.0)	0.0	
Enterobius vermicularis	1 (0.7)	0.1	0.0 (0.0)	0.0	0.0 (0.0)	0.0	
Pathogenic protozoa	1 (0.7)	0.1	0.0 (0.0)	0.0	2 (1.2)	0.2	0.4069
Giardia intestinalis	1 (0.7)	0.1	0.0 (0.0)	0.0	2 (1.2)	0.2	
Potentially pathogenic stramenopiles	106 (78.5)	13.8	122 (82.4)	12.6	150 (91.5)	14.7	0.3969
Blastocystis spp.	86 (63.7)	11.2	106 (71.6)	10.9	138 (84.2)	13.5	
Dientamoeba fragilis	20 (14.8)	2.6	16 (10.8)	1.7	12 (7.3)	1.2	
Non-pathogenic protozoa	26 (19.25)	3.4	26 (17.6)	2.7	26 (15.9)	2.54	0.5282
Entamoeba dispar	1 (0.7)	0.1	3 (2.0)	0.3	1 (0.6)	0.1	
Endolimax nana	10 (7.4)	1.3	5 (3.4)	0.5	8 (4.9)	0.8	
Entameoba coli	13 (9.6)	1.7	17 (11.5)	1.8	16 (9.8)	1.6	
Entamoeba hartmanii	1 (0.7)	0.1	1 (0.7)	0.1	0.0 (0.0)	0.0	
Chilomastix mesnili	1 (0.7)	0.1	0.0 (0.0)	0.0	1 (0.6)	0.1	
Poliparasitism	20 (14.8)	2.6	11 (7.4)	1.1	13 (7.9)	1.3	
Positive results (+)	135	17.6	148	15.3	164	16.0	0.4066

Table 3. Intestinal parasitic infections in soldiers deployed to Iraq (n = 766), Lebanon (n=970), and Kosovo (n=1023) in years 2020-2023

Polish Military Contingent	Iraq			Lebanon				Kosovo				Iraq			Lebanon				Kosovo			
Year	2020	2021	2023	2020	2021	2022	2023	2020	2021	2022	2023	2020	2021	2023	2020	2021	2022	2023	2020	2021	2022	2023
Soldiers (n)	176	197	393	163	184	202	421	215	178	205	425	176	197	393	163	184	202	421	215	178	205	425
Intestinal parasites	Infections n (%)											Percentage of tested soldiers										
Helminths	1 (3.1)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ascaris lumbricoides	1 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Enterobius vermicularis	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pathogenic protozoa	1 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.3)	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Giardia intestinalis	1 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.3)	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Pothentially pathogenic stramenopiles	24 (75.0)	26 (81.3)	56 (78.9)	20 (83.3)	24 (72.7)	22 (88.0)	56 (84.8)	27 (75.0)	22 (88.0)	29 (93.6)	72 (83.7)	13.6	13.2	14.3	12.3	13.0	10.9	13.3	12.6	12.4	14.2	16.9
Blastocystis spp.	19 (59.4)	21 (65.6)	46 (64.8)	18 (75.0)	21 (63.6)	17 (68.0)	50 (75.8)	26 (72.2)	20 (80.0)	22 (71.0)	70 (81.4)	10.8	10.7	11.7	11.0	11.4	8.4	11.9	12.1	11.2	10.7	16.5
Dientamoeba fragilis	5 (15.6)	5 (15.6)	10 (14.1)	2 (8.3)	3 (9.1)	5 (20.0)	6 (9.1)	1 (2.8)	2 (8.0)	7 (22.6)	2 (2.3)	2.8	2.5	2.5	1.2	1.6	2.5	1.4	0.5	1.1	3.4	0.5
Non pathogenic protozoa	6 (18.8)	1 (18.8)	14 (19.7)	4 (16.7)	9 (27.3)	3 (13.0)	10 (15.2)	9 (25.0)	3 (12.0)	2 (6.5)	12 (14.0)	3.4	3.1	3.6	2.5	4.9	1.5	2.4	4.2	1.7	1.0	2.8
Entamoeba dispar	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	1 (4.0)	1 (3.0)	1 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0	0.3	0.0	0.0	0.5	0.5	0.5	0.0	0.0	0.0
Endolimax nana	2 (6.3)	1 (3.1)	7 (9.9)	2 (8.3)	1 (3.0)	0 (0.0)	2 (3.0)	0 (0.0)	2 (8.0)	0 (0.0)	6 (7.0)	1.1	0.5	1.8	1.2	0.5	0.0	0.5	0.0	1.1	0.0	1.4
Entameoba coli	4 (12.5)	4 (12.5)	5 (7.0)	5 (8.3)	2 (24.2)	5 (8.0)	7.6	5 (22.2)	8 (4.0)	1 (6.5)	2 (5.8)	2.3	2.0	1.3	1.2	4.4	1.0	1.2	3.7	0.6	1.0	1.2
Entamoeba hartmanii	0 (0.0)	1 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.5	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Chilomastix mesnili	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.2)	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Poliparasitism	5 (15.6)	5 (15.6)	10 (14.1)	3 (12.5)	2 (6.1)	2 (8.0)	4 (6.1)	5 (13.9)	2 (8.0)	2 (6.5)	4 (5.6)	2.8	2.5	2.5	1.8	1.1	1.0	1.0	2.3	1.1	1.0	0.9
Total	32	32	71	24	33	25	66	36	25	31	72	18.2	16.2	18.1	14.7	17.9	12.4	15.7	16.7	14.0	15.1	16.9
Negative (-)	151	170	332	146	153	179	361	184	155	177	358	85.8	86.3	84.5	87.7	83.2	88.6	85.8	85.6	87.1	86.3	81.4

Discussion

The prevalence of IPIs in deployed military personnel is strictly correlated with the epidemiological situation in a given country as well as hygiene and sanitation standards in a given area of operations. Many countries in the Middle East, e.g. Iraq and Lebanon, have serious problems with access to clean drinking water. In addition, poor infrastructure, limited access to sanitary facilities and a rapid population growth facilitate the spread of parasitic infections. Climate (hot temperatures and heavy rains) is yet another important factor affecting the transmission of parasites in those countries.[25] According to the studies, the prevalence of IPIs in the Middle East varies between 15.5 and 59%, depending on the population studied and the area where an individual study was conducted.[26-31] The prevalence of IPIs in Lebanon was found to range from 7.5% to as much as 57.8%, with the highest rates being observed in the paediatric population, which can be explained by the fact that children have a higher likelihood of acquiring a parasitic infection due to their underdeveloped personal hygiene habits.[32-36] The results of the present study demonstrated that 15.3% of the Polish military personnel deployed to Lebanon were found to be carriers of at least one non-pathogenic intestinal parasite. It needs to be emphasized that there were no cases of infections caused by pathogenic species in this group, which proves compliance with food and drinking water precautions and good hygiene practices of the soldiers studied. A study by Buczyński et al.[37], which was carried on a sample of military personnel serving in Lebanon between 1993 and 2000 (on the same operation as the one in which the participants of this study were involved), demonstrated that 3.8% of the deployed multinational military personnel required hospitalization due to infections caused by Ancylostoma duodenale, Ascaris lumbricoides, Trichuris trichiura or Giardia intestinalis. Parasitological examinations carried out by Saheb[38] and Al-Saqur et al.[39] in Iraq in 2015, showed a high prevalence of IPI infections among local residents, with infections caused by pathogenic protozoa (Entamoeba histolytica, Giardia intestinalis) and helminths (Enterobius vermicularis) being the most prevalent among the study participants. The studies which were conducted by the authors of the present article on a sample of 766 Polish soldiers between 2020 and 2021 and again in 2023 demonstrated that only two of the infections by intestinal parasites were caused by pathogenic agents (a protozoan infection with Giardia intestinalis, and a helminthic infection with Enterobius vermicularis). A study by Kosik-Bogacka et al.[40] into a group of Polish soldiers to be relocated to Lebanon and Iraq showed no cases of parasitic infections pre-deployment, however, when the same group of soldiers were tested several months into deployment, the examinations showed single cases of infections caused by intestinal parasites, which suggests that soldiers contracted the infection while serving on a mission abroad. According to the literature, Blastocystis spp. stramenopiles are the most common intestinal parasites in the Middle East[41-45], this fact has been confirmed by the results of the present study as well.

Diarrhoeas are a common health problem in Polish soldiers deployed to the Middle East. This fact was confirmed by a study which involved a group of military personnel stationed in Iraq between 2003 and 2004, the results showed that as much as 76% of the personnel involved in the study reported episodes of diarrhoea.[46] Gastrointestinal disorders are most commonly caused by bacteria or viruses, but can also be caused by intestinal protozoa, including those which were detected in soldiers deployed to the Middle East.[47] It needs to be emphasised that the longer the deployment, the higher the likelihood of acquiring a protozoan infection. As protozoan infections may lead to gastrointestinal disorders, they can cause a reduction in combat effectiveness of the whole troops.[48]

As for the contingent in Kosovo, the study showed no cases of helminthiases, but the prevalence of infections caused by pathogenic Giardia intestinalis and potentially pathogenic Blastocystis spp. was found to be the highest of all the contingents studied. This may have been associated with the fact that Kosovo is one of the poorest countries in Europe. That destruction of water supply and sewerage infrastructure during long lasting military conflicts has contributed to a wide spread of food and waterborne infections in the country. There are few reports in the literature regarding the prevalence of IPIs among adult Kosovars, but studies into the paediatric population showed high rates of Giardia intestinalis infection.[49, 50] Studies into the prevalence of Blastocystis spp. among Polish military personnel deployed to Kosovo which were conducted by Pietrzak-Mykała et al.[51] demonstrated a 5-fold increase in these infections four months post-deployment to the Balkans. The nature of the tasks performed by Polish soldiers requires regular contact with people from local communities, which significantly increases the risk of IPIs transmission. Despite a high epidemiological risk in all three areas of deployment, the overall prevalence of IPIs among the study participants was low, especially if we compare the data with the results obtained in previous years. For comparison, studies with the participation of Polish soldiers serving in Africa and in Asia between 2009 and 2014 demonstrated much higher rates of infections caused by pathogenic intestinal parasites. As an example, a study which involved a group of Polish soldiers deployed to Chad showed that over 20% of the soldiers examined were infected with Giardia intestinalis.[52] Another study which involved a group of Polish soldiers deployed to Afghanistan showed that more than 4% of the study participants were infected with pathogenic parasites, including Ascaris lumbricoides, Hymenolepis nana and Giardia intestinalis.[53]

In contrast, the studies conducted between 2020 and 2023 demonstrated that the prevalence of infections caused by pathogenic species was only 0.2% and that most infections were caused by potentially pathogenic Blastocystis spp. A high prevalence of Blastocystis spp. among the study participants is not surprising considering the ease of transmission of this pathogen and a high distribution of the species globally (including in Poland).[54, 55] In fact, the prevalence of Blastocystis spp. infections can reach up to 100% in some lower-income countries.[54, 55] The pathogenic nature of Blastocystis spp. is controversial. There are many factors responsible for the presence or absence of symptoms including the intensity of an infection, the immune response of a human host, or the presence of any comorbidities. Blastocystis spp. infections often co-occur with other parasitic invasions, so it is difficult to determine whether Blastocystis spp. is a truly pathogenic microorganism.[56] However, there have been reports of symptomatic Blastocystis spp. cases in the literature, which suggests that it is necessary to monitor the prevalence of the parasite in humans in order to prevent possible complications. Little is known of the actual prevalence of IPIs in Poland as most parasitic diseases are not notifiable, i.e. they are not required by law to be reported to competent authorities since 2008, i.e. since the Act on preventing and combating infections and infectious diseases in humans was introduced in Poland. There are few publications on the prevalence of IPIs in Poland, and the reports, which are available in the literature either focus on the paediatric populations or were conducted 10-20 years ago. A study by Kowalewska et al.[57] of 2013 remains one of the major sources of knowledge about the prevalence of intestinal parasites in Poland. The study covered the period of 30 years (until 2010) and involved a group of 52,000 patients treated on an out-patient basis at the Institute of Maritime and Tropical Medicine in Gdynia. The results of the study demonstrated a reduction in the number of IPIs (apart from Blastocystis spp. infections) from 17.4% to 7.9% over the 30-year-long study period. At the end of the 20th century, many laboratories in Poland did not perform parasitological tests for Blastocystis spp. and the stramenopile was not reportable. However, since the authorities started monitoring Blastocystis spp. cases in Poland, an upward trend in the prevalence of Blastocystis spp. has been observed. Currently, an estimated prevalence of Blastocystis spp. infections in Poland ranges from 0.14 to 23.6%, however, these data may be underestimated due to a reduction in the number of patients referred for parasitological tests.[57, 58] One of the most recent studies into the prevalence of IPIs in Poland was carried out in 2023. It involved a group of 427 Border Guard officers tasked with securing the east border of Poland. The prevalence of IPIs among the study participants was found to be 6.8%, with infections caused by potentially pathogenic Blastocystis spp. and Dientamoeba fragilis being predominant (similarly as in the present study involving military personnel deployed on operations abroad).[59] The presence of single cases of infections caused by pathogenic parasites as well as higher rates of infections with potentially pathogenic stramenopiles may suggest that some IPIs which have been identified may have been acquired during deployment abroad through direct contact with local residents or the consumption of local food or water. Korzeniewski et al. [60, 61] reported similar findings. He studied a group of Polish soldiers deployed on a mission to Afghanistan and found that Polish soldiers were infected with the same species of intestinal parasites as the ones found in local residents, which strongly suggests that the infections were contracted during deployment. However, we cannot rule out the possibility that transmission occurred pre-deployment as evidenced by a study conducted by Korzeniewski[62], which not only involved soldiers to be deployed on a mission abroad but also the soldiers' wives and children. The study found IPIs in both groups, which suggests that soldiers could have contracted an IPI in Poland and not on a mission abroad. According to Frickman[16], it is possible to keep the incidence of intestinal parasites low among soldiers to be deployed on overseas operations if standard precautions and hygiene measures for food and drinking water are implemented and conscientiously followed. The results of the present study support these findings.

Conclusions

The study showed a low prevalence of infections caused by IPIs in the group of soldiers forming Polish Military Contingents deployed to Kosovo, Lebanon and Iraq despite poor standards of sanitation in all areas of operations. Low rates of IPIs among the study participants are attributable to observance of food and water precautions and good hygiene practices of the soldiers involved in the study. Regular screening and treatment of all positive cases in the area of deployment, before they could come back home, helped to reduce the risk of transmitting the infections to contacts in Poland. The results of the present study suggest that prevention program aimed to control the spread of IPIs among Polish military personnel needs to be continued because of the dynamically changing situation in the world, a growing number of conflicts and increasing migration, which all contribute to the spread of parasitic diseases across the whole world.

Conflict of Interest
There are no conflicts of interest.

Funding
None.

References

1. Vilkman K., Pakkanen S.H., Laaveri T., Siikamaki H., Kantele A. Travelers' health problems and behavior: prospective study with post-travel follow-up. BMC Infect. Dis. 2016;.16:.328.
2. Korzeniewski K., Nitsch-Osuch A., Chciałowski A., Korsak J. Environmental factors, immune changes and respiratory diseases in troops during military activities. Respir. Physiol. Neurobiol. 2013; 187(1): 118–122.
3. Connolly M.A., Heymann D.L. Deadly comrades: War and infectious diseases. Lancet. 2002; 360: S23–S24.
4. Hart T.A., Hardenbergh W.H. The southwest pacific area. Preventive medicine in world War II, Volume VI: communicable diseases: malaria. Chapter 10 [cited 13.08.2024]. Available from: http://history.amedd.army.mil/booksdocs/wwii/Malaria/tables/table79.pdf
5. Beadle C., Hoffman S.L. History of malaria in the United States naval forces at war: World War I through the Vietnam conflict. Clin. Infect .Dis. 1993; 16(2): 320–329.
6. Stahlman S., Williams V.F., Taubman S.B. Incident diagnoses of leishmaniasis, active and reserve components, U.S. Armed Forces, 2001-2016. MSMR. 2017; 24(2): 2–7.
7. Bailey M.S. Tropical skin diseases in British military personnel. J. R. Army Med. Corps. 2013; 159: 224–228.
8. Aronson N., Herwaldt B.L., Libman M. Diagnosis and treatment of Leishmaniasis: clinical practice guidelines by the Infectious Diseases Society of America (IDSA) and the American Society of Tropical Medicine and Hygiene (ASTMH). Clin. Infect. Dis. 2016; 63: e202–264.
9. Leggat P.A., Melrose W. Lymphatic filariasis: disease outbreaks in military deployments from World War II. Mil. Med. 2005; 170: 585–589.
10. Maluil S., Stevens R.A. Clinical report: schistosomiasis exposure in U.S. service personnel during whitewater rafting on the Nile River in Jinja, Uganda. Mil. Med. 2016; 181: e1495–1498.
11. Kasteler S.D. Diphyllobothriasis in a U.S military aviator. Aerosp. Med. Hum. Perform. 2018; 89: 473–477.
12. Genta R.M., Weesner R., Douce R.W., Huitger-O'Connor T., Walzer P.D. Strongyloidiasis in US veterans of the Vietnam and other wars. JAMA. 1987; 258: 49–52.
13. Lindrose A.R., Mitra I., Fraser J., Mitre E., Hickey P.W. Helminth infections in the US military: from strongyloidiasis to schistosomiasis. J. Travel Med. 2021; 28(6): taab004.
14. Connor P., Porter C.K., Swierczewski B. Diarrhoea during military deployment: current concepts and future directions. Curr. Opin. Infect. Dis. 2012; 25: 546–554.
15. Riddle M.S., Sanders J.W., Putnam S.D. Incidence, etiology, and impact of diarrhea among long-term travelers (US military and similar populations): a systematic review. Am. J. Trop. Med. Hyg. 2006; 74: 891–900.
16. Frickmann H., Schwarz N.G., Wiemer D.F., Fischer M., Tannich E., Scheid P.L., et al. Food and drinking water hygiene and intestinal protozoa in deployed German soldiers. Eur. J. Microbiol. Immunol. 2013; 3: 53–60.
17. Korzeniewski K. Prophylactic program of parasitic diseases of the digestive tract in the population of the Polish Armed Forces deployed overseas. Lek Wojsk. 2010; 88(1): 60–66 [in Polish].
18. Chomiczewski K., Gall W., Grzybowski J., Dęga K. Epidemiologia działań wojennych i katastrof. Alfa-medica press, Bielsko-Biała 2001 [in Polish].
19. Korzeniewski K. The epidemiological situation in Iraq. Przegl. Epidemiol. 2006; 60: 845–855.
20. Buczyński A., Korzeniewski K., Bzdega I., Jerominko A. Epidemiology of parasitic diseases in military personnel treated in the United Nations Interim Force hospital in Lebanon, from 1993 to 2000. Przegl Epidemiol. 2004; 58(2): 303–312.
21. Operational Command of the Armed Forces. PMC Kosovo [cited 13.08.2024]. Available from: https://www.do. wp.mil.pl/info/pkw-kosowo/
22. The United Nations Interim Force in Lebanon. History of UNIFIL: 1st August 2000-31st January 2001. UNIFIL 2001 [cited 14.08.2024]. Available from: https://unifil.unmissions.org/unifil-background
23. Encyklopedia PWN. Kosovo. Natural conditions [cited 13.08.2024]. Available from: https:// encyklopedia.pwn.pl /haslo/Kosowo-Warunki-naturalne;4958586.html
24. Garcia L.S., Procop G.W. Diagnostic medical parasitology. Manual of Commercial Methods in Clinical Microbiology. 2nd edition. John Wiley & Sons, Inc., New Jersey 2016; 284–308.
25. Abuseir S. A systematic review of frequency and geographic distribution of water-borne parasites in the

Middle East and North Africa. East. Mediterr. Health. J. 2023; 29(2): 151–161.

26. Şahin M., Ödemiş N., Yılmaz H., Beyhan Y.E. Investigation of Parasites in Food Handlers in Turkey. Foodborne Pathog. Dis. 2023; 20(9): 381–387.

27. Astal Z. Epidemiological survey of the prevalence of parasites among children in Khan Younis governorate, Palestine. Parasitol. Res. 2004; 94(6): 449–451.

28. Sharif M., Daryani A., Kia E., Rezaei F., Nasiri M., Nasrolahei M. Prevalence of intestinal parasites among food handlers of Sari, Northern Iran. Rev. Inst. Med. Trop. Sao Paulo. 2015; 57(2): 139–144.

29. Abu-Madi M.A., Behnke J.M., Ismail A. Patterns of infection with intestinal parasites in Qatar among food handlers and housemaids from different geographical regions of origin. Acta Trop. 2008; 106(3): 213–220.

30. Jaran A.S. Prevalence and seasonal variation of human intestinal parasites in patients attending hospital with abdominal symptoms in northern Jordan. East. Mediterr. Health J. 2017; 22(10): 756–760.

31. Mezeid N., Shaldoum F., Al-Hindi A.I., Mohamed F.S., Darwish Z.E. Prevalence of intestinal parasites among the population of the Gaza Strip, Palestine. Ann. Parasitol. 2014; 60(4): 281–289.

32. Hamzé M., Naja M., Mallat H. Biological analysis of workers in the food sector in north Lebanon. East. Mediterr. Health J. 2008; 14(6): 1425–1434.

33. Araj G.F., Musharrafieh U.M., Haydar A., Ghawi A., Itani R., Saliba R. Trends and prevalence of intestinal parasites at a tertiary care center in Lebanon over a decade. J. Med. Liban. 2011; 59(3): 143–148.

34. Saab B.R., Musharrafieh U., Nassar N.T., Khogali M., Araj G.F. Intestinal parasites among presumably healthy individuals in Lebanon. Saudi Med. J. 2004; 25(1): 34–37.

35. Osman M., El Safadi D., Cian A., Benamrouz S., Nourrisson C., Poirier P., et al. Prevalence and Risk Factors for Intestinal Protozoan Infections with Cryptosporidium, Giardia, Blastocystis and Dientamoeba among Schoolchildren in Tripoli, Lebanon. PLoS Negl. Trop. Dis. 2016; 10(3): e0004496.

36. El Achkar H., Ghandour L., Farran S., Araj G.F. Prevalence of intestinal parasites during pre- and post-COVID-19 pandemic at a tertiary care center in Lebanon. J. Infect. Dev. Ctries. 2023; 17(6): 826–831.

37. Buczynski A., Korzeniewski K., Bzdega I., Jerominko A. Choroby zakaźne wśród osób z rejonu objętego opieką szpitala Tymczasowych Sił Zbrojnych ONZ w Libanie w latach 1993–2000. Przegl. Epidemiol. 2004; 58: 303–312 [in Polish].

38. Saheb E.J. The prevalence of parasitic protozoan diseases in Iraq, 2016. Karbala International Journal of Modern Science. 2018; 4(1): 21–25.

39. Al-Saqur I.M., Al-Warid H.S., Al-Qaisi A.Q., Al-Bahadely H.S. Prevalence of gastrointestinal parasites in Iraq during 2015. In: AIP Conference Proceedings (Vol. 2290, No. 1). AIP Publishing, Baghdad 2020.

40. Kosik-Bogacka D.I., Korzeniewski K., Łanocha-Arendarczyk N., Korycińska J., Lepczyńska M., Dzika E., et al. Blastocystis spp. and Other Intestinal Parasites in Polish Soldiers Deployed to Lebanon and Iraq. Pathogens. 2024; 13(3): 271

41. Mohamed R.T., El-Bali M.A., Mohamed A.A., Abdel-Fatah M.A., El-Malky M.A., Mowafy N.M., et al. Subtyping of Blastocystis sp. isolated from symptomatic and asymptomatic individuals in Makkah, Saudi Arabia. Parasit. Vectors. 2017; 10: 174.

42. Badparva E., Sadraee J., Kheirandish F., Frouzandeh M. Genetic diversity of human Blastocystis isolates in Khorramabad, central Iran. Iran. J. Parasitol. 2014; 9: 44–49

43. Abu-Madi M., Aly M., Behnke J.M., Clark C.G., Balkhy H. The distribution of Blastocystis subtypes in isolates from Qatar. Parasit. Vectors. 2015; 8: 465.

44. Abu Odeh R., Ezzedine S., Samie A., Stensvold C.R., ElBakri A. Prevalence and subtype distribution of Blastocystis in healthy individuals in Sharjah, United Arab Emirates. Infect. Genet. Evol. 2016; 37: 158–162.

45. Khaled S., Gantois N., Ayoubi A., Even G., Sawant M., El Houmayraa J., et al. Blastocystis sp. Prevalence and Subtypes Distribution amongst Syrian Refugee Communities Living in North Lebanon. Microorganisms. 2021; 9(1): 184.

46. Brown J.A., Riddle M.S., Putnam S.D., Schlett C.D., Armstrong A.W., Jones J.J., et al. Outcomes of diarrhea management in operations Iraqi Freedom and Enduring Freedom. Travel Med. Infect. Dis. 2009; 7: 337–343.

47. Monteville M.R., Riddle M.S., Baht U., Putnam S.D., Frenck R.W., Brooks K., et al. Incidence, etiology, and impact of diarrhea among deployed US military personnel in support of Operation Iraqi Freedom and Operation Enduring Freedom. Am. J. Trop. Med. Hyg. 2006; 75: 762–767.

48. Downs J.W., Putnam S.D., Rockabrand D.M., El Okla G., Mostafa M., Monteville M.R., et al. A cross-sectional analysis of clinical presentations of and risk factors for enteric protozoan Infections in an Active Duty Population during Operation Iraqi Freedom.

Trop. Dis. Travel Med. Vaccines. 2015; 1: 2.

49. Korzeniewski K., Lass A., Augustynowicz A., Konior M. The Prevalence of Intestinal Parasitic Infections Among Kosovar and Serbian School-children in Kosovo. Helminthologia. 2020; 57(3): 276–279.

50. Quamilè I., Rogerie F., Grandadam M., Teyssou R., Nicand E., Koeck .JL., et al. Etude sur les diarrhées à Mitrovicè (Kosovo) en août 2001. Sante. 2010; 20(1): 9–14 [in French].

51. Pietrzak-Makyła B., Korzeniewski K., Gładysz P., Lass A. Detection and Molecular Characterization of Blastocystis Species in Polish Soldiers Stationed in the Republic of Kosovo. Int. J. Mol. Sci. 2023; 24(18): 14100.

52. Korzeniewski K., Skórczewski K. Health problems of peacekeepers carrying out mandatory tasks in Chad, Central Africa. Int. Marit. Health. 2011; 62: 37–40.

53. Korzeniewski K. Elimination of Intestinal Parasites among Polish Soldiers Deployed to Afghanistan, 2010–2014. Int. Rev. Armed Forces Med. Serv. 2016; 89(2): 42–50.

54. Stensvold C.R., Clark C.G. Current status of Blastocystis: A personal view. Parasitol. Int. 2016; 65: 763–771.

55. El Safadi D., Gaayeb L., Meloni D., Cian A., Poirier P., Wawrzyniak I., et al. Children of Senegal River basin show the highest prevalence of Blastocystis sp. Ever observed worldwide. BMC Infect. Dis. 2014; 14: 164.

56. Asghari A., Hassanipour S., Hatam G. Comparative molecular prevalence and subtypes distribution of Blastocystis sp. a potentially zoonotic infection isolated from symptomatic and asymptomatic patients in Iran: A systematic review and meta-analysis. Acta Parasitol. 2021; 66(3): 745–759.

57. Kowalewska B., Rudzińska M., Zarudzka D., Kotłowski A. Ocena częstości zarażeń pasożytami jelitowymi wśród pacjentów przychodni Instytutu Medycyny Morskiej i Tropikalnej w Gdyni w okresie ostatnich 30 lat. An evaluation of the intensity of intestinal parasitic infections among patients of out-patient division. Diagn. Lab. 2013; 49: 9–15 [in Polish].

58. Rudzińska M., Sikorska K. Epidemiology of Blastocystis Infection: A Review of Data from Poland in Relation to Other Reports. Pathogens. 2023; 12(8): 1050.

59. Korzeniewski K., Richert W. Intestinal parasitic infections in officers of the Border Guard in East Poland. Int. Marit. Health. 2023; 74(3): 175–79.

60. Korzeniewski K. Elimination of Intestinal Parasites among Polish Soldiers Deployed to Afghanistan, 2010–2014. Int. Rev. Armed Forces Med. Serv. 2016; 89(2): 42–50.

61. Korzeniewski K., Augustynowicz A., Lass A. Prevalence of intestinal parasites in Afghan community on the example of patients treated in Ghazni Provincial Hospital. Int. Marit. Health. 2014; 65(2): 68–72.

62. Korzeniewski K., Augustynowicz A., Lass A. Intestinal parasites in Polish community on the example of military environment. Int. Marit. Health. 2014; 65(4): 216–222.