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Enteric pathogens in German police officers after predominantly tropical deployments – A retrospective assessment over 5 years


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ABSTRACT

Introduction: The study was performed to assess the infection risk of German police officers on predominantly tropical deployments, mostly United Nations missions, with gastrointestinal pathogens. **Methods:** Police officers were offered PCR-based screening for gastrointestinal pathogens before and after deployment. The screening panel comprised enteroinvasive bacteria (*Salmonella* spp., *Shigella* spp./enteroinvasive *Escherichia coli*, *Campylobacter jejuni*, and *Yersinia* spp.), enteropathogenic protozoa (*Entamoeba histolytica*, *Giardia duodenalis*, *Cryptosporidium* spp., and *Cyclospora cayentanensis*), as well as enteric helminths (*Ancylostoma* spp., *Ascaris lumbricoides*, *Enterobius vermicularis*, *Hymenolepis nana*, *Necator americanus*, African *Schistosoma* spp., *Strongyloides stercoralis*, *Taenia saginata*, *Taenia solium*, and *Trichuris trichiura*). **Results:** *G. duodenalis* ($n = 3$), *C. jejuni* ($n = 2$), *Salmonella* spp. ($n = 1$), *Shigella* spp./enteroinvasive *E. coli* ($n = 3$), and *S. stercoralis* ($n = 3$) were detected in 12 out of 133 (9.0%) police officers. The majority had shown gastrointestinal symptoms on deployment and all were asymptomatic at the time of medical assessment. The major infection sites were Sub-Saharan Africa followed by Northern Africa and the Middle East. **Conclusions:** Deployment of police officers to tropical deployment sites on United Nations missions is associated with a considerable acquisition risk of gastrointestinal pathogens in a quantitatively relevant minority. Post-deployment screening is advisable to facilitate therapeutic and hygiene-related consequences.

KEYWORDS

police, deployment, infectious disease, tropics, epidemiology, United Nations

BACKGROUND

Nearly a decade before, increased likelihood of enteric carriage with the intestinal protozoan *Giardia duodenalis* was demonstrated for German soldiers after deployment on a United Nations (UN) mission in tropical Sudan [1]. On this deployment, soldiers operating as UN observers lived outside traditional military field camp infrastructure, implying the need for buying food and beverages on local markets or for eating and drinking in local restaurants. These particular risks were identified to most likely account for the higher colonization or infection rate.

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Several reports on infectious disease-associated health risks on military UN missions can be found in international medical literature. Following the riots associated with the independence of the Democratic Republic of the Congo in 1960, an Austrian military medical team on a UN mission reported on relatively mild cases of malaria, severe amebic dysentery, and mild enteric helminth infections with *Ascaris lumbricoides* [2].

More recently, UN forces on a peace-keeping mission in Haiti reported infectious diseases predominantly associated with antimicrobial drug-resistant *Enterobacteriaceae* and with dengue fever virus in the late 1990s, while detected *Plasmodium* spp. were still susceptible to chloroquine at this time [3, 4].

Gastroenteritis on UN missions is of public health importance as demonstrated by a limited outbreak in Irish forces operating in South Eastern Chad from 2008 till 2010 [5] or frequent cases in British soldiers on a mission in South Sudan in 2017 as reported by the military medical surveillance software EPINATO 2 [6]. Of note, the British forces reported likely adaptation processes in the soldiers' gut, resulting in 3 times higher proportions of gastroenteritis in the first half of the operation compared with the second one [6]. In parallel, frequency of bites and stings was reduced to 50% as well, but while this phenomenon most likely resulted from experience and associated avoidance strategies, this is less likely for invisible risks like contamination due to diarrheagenic microorganisms. But also, complications like liver failure due to viral hepatitis A have to be considered as reported for a UN peacekeeper in South Sudan [7], stressing the importance of adequate vaccine protection.

Considerably less information is available on infectious disease risks in nonmilitary personnel during UN missions. In an assessment on medical evacuation and fatalities among civilian UN employees, infectious diseases were identified as a leading cause with 17% of the registered evacuations. Among the fatalities, infections accounted for even 41% [8]. Further, a *Coxiella burnetii* induced outbreak was recorded during UN deployment of Argentinean police forces in Kosovo [9].

Beyond such impressive outbreak events [9], however, little is known on endemic infectious health risks for police forces on UN deployment. Therefore, we have performed a retrospective assessment specifically addressing this topic based on molecular diagnostic screening results for deployed German police officers.

PATIENTS AND METHODS

Population

Since 2015, German police officers deployed to tropical UN missions were invited to provide stool samples for molecular diagnostic assessment on a voluntary basis prior as well as 8–12 weeks after deployment. The deployment periods, mainly ranged between less than a year and more than a year, during which the police officers usually lived in guarded compounds with local water supply and consumed

food and beverages from local markets or in local restaurants. The screening was performed to provide both individual diagnostic results for therapeutic purposes and surveillance information for epidemiological risk assessments.

Clinical data provided on sample sheets of predeployment stool samples comprised age and sex of the patient as well as the history of previous deployments. Sample sheets of post deployment stool samples comprised data on age, sex, area, and duration of deployment, as well as more detailed information of gastrointestinal and febrile symptoms.

Samples

Voluntarily provided stool samples were sent by police physicians to the Department of Tropical Microbiology and Entomology of the Bundeswehr Hospital Hamburg, located at the Bernhard Nocht Institute for Tropical Medicine, Hamburg, which is the German National Reference Centre for Tropical Pathogens in Hamburg, Germany. As only DNA containing pathogens were assessed, sample storage and transport time of less than 6 weeks was still accepted, but usually the samples were transported within few days. Received stool samples were subjected to nucleic acid extraction using the QiaAMP DNA Stool Mini Kit (Qiagen, Hilden, Germany) as described by the manufacturer. Nucleic acid extractions were stored at -80°C prior to molecular assessment in batches once a month.

Molecular assessment

The nucleic acid extractions were subjected to in-house real-time multiplex PCR targeting enteroinvasive bacteria (*Salmonella* spp., *Shigella* spp./enteroinvasive *Escherichia coli* (EIEC), *Campylobacter jejuni*, and *Yersinia* spp.) [10], enteropathogenic protozoa (*Entamoeba histolytica*, *G. duodenalis*, *Cyclospora cayetanensis*, *Cryptosporidium* spp.) [11] as well as intestinal helminths (African *Schistosoma* spp., *Ancylostoma* spp., *A. lumbricoides*, *Enterobius vermicularis*, *Hymenolepis nana*, *Necator americanus*, *Strongyloides stercoralis*, *Taenia saginata*, *Taenia solium*, and *Trichuris trichiura*) [11]. PCR assay characteristics as calculated based on evaluation studies have been detailed elsewhere [10, 11].

Inclusion and exclusion criteria

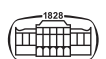
Each stool sample fulfilling the minimum preanalytic standards as described above was included in the assessment. Lacking provision of pre-deployment stool samples was no exclusion for the analysis of post-deployment samples and vice versa, making several data sets incomplete. Incompletely filled sample sheets were no exclusion criteria as well.

Statistics

Due to the low total number of samples and patients, statistics were restricted to descriptive analysis.

Ethics

Ethical clearance (WF-019/17) for anonymous retrospective assessment without informed consent was obtained from the



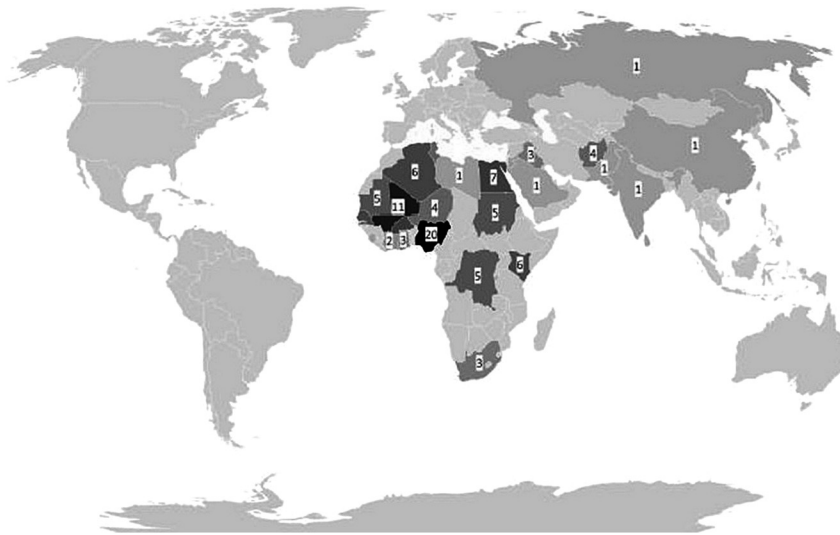


Fig. 1. Reported deployment sites of the police officers assessed in this study

Ethics Committee of the Medical Association of Hamburg, Germany, in line with German National Laws.

RESULTS

Study population

Between 2015 and 2020, a total of 133 deployed German police officers was included in the assessment. The mean age (\pm standard deviation (SD)) was 43.1 ± 8.6 , the median age was 45.0 in a right-shifted distribution. The male:female ratio was 12.3:1 ($n = 123$ males, $n = 10$ females). Thereby, 62 (46.6%) police officers provided pre-deployment stool samples, 71 (53.4%) provided post-deployment stool samples. At total of 59 (44.4%) provided both pre and post-deployment samples. The total number of assessed samples was 192 with 111 samples (57.8%) provided after deployment. This higher number of samples compared with the number of assessed police officers results from multiple deployments of the same individuals. From the 62 officers who provided pre-deployment stool samples, 50 individuals (80.6%) had reported previous deployments.

Associated with the 111 stool samples provided by police officers post-deployment, reported sites of deployment were Algeria ($n = 6$, 5.4%), Afghanistan ($n = 4$, 3.6%), Burkina Faso ($n = 7$, 6.3%), Burundi ($n = 1$, 0.9%), the Democratic Republic of the Congo ($n = 5$, 4.5%), Egypt ($n = 7$, 6.3%), Ghana ($n = 2$, 1.8%), Iraq ($n = 3$, 2.7%), Ivory Coast ($n = 2$, 1.8%), Jordan ($n = 1$, 0.9%), Kenya ($n = 6$, 5.4%), Lebanon ($n = 1$, 0.9%), Mali ($n = 11$, 9.9%), Mauretania ($n = 5$, 4.5%), Niger ($n = 3$, 2.7%), Nigeria ($n = 19$, 17.1%), Northern Africa (not further specified, $n = 1$, 0.9%), Pakistan ($n = 1$, 0.9%), Russia ($n = 1$, 0.9%), Saudi Arabia (1, 0.9%), Senegal (6, 5.4%), Sierra Leone ($n = 1$, 0.9%), South Africa ($n = 3$, 2.7%), Sudan ($n = 5$, 4.5%), Tunisia ($n = 3$, 2.7%), or multiple countries ($n = 3$, 2.7%; case 1: Libya, Niger, and Tunisia; case 2: China, India, and Sri Lanka; case

3: Ghana, and Nigeria), while no sites of deployment were reported in 3 instances. A visualization of the sites of deployment is shown in Fig. 1.

Duration of stay ranged from <1 week ($n = 1$, 0.9%) about 1–4 weeks-intervals ($n = 1$, 0.9%) up to longer deployments >4 weeks ($n = 107$, 96.4%), while no data were provided in two instances ($n = 2$, 1.8%). Occurrences of gastrointestinal symptoms on deployment were reported by 40 (36.0%) of the police officers, after deployment by 0 (0%) and not at all by 62 (55.9%), while 9 individuals (8.1%) did not answer this question. Reported stool frequency was once or twice a day in 36 (32.4%) cases and ≥ 3 times a day (in line with standard definitions of diarrhea and associated with unformed stool) in 19 (17.1%) cases. Details on reported symptoms comprised visible blood in stool in 0 (0%) cases, stomach ache in 15 (13.5%) cases, nausea and vomiting in 14 (12.6%) cases, cramps in 6 (5.4%) cases, severe flatulence in 12 (10.8%) cases, and fever defined as body temperature ≥ 38.5 °C (degree centigrade) in 11 (9.9%) cases. Reported duration of gastrointestinal symptoms ranged from ≤ 1 week in 25 (22.5%) cases to more than a week in 10 (9.0%) cases. In spite of diarrhea, none of the policemen consulted a physician on deployment. Also, the police officers did not report any medication at the time of the stool analysis.

Detected pathogens

The following pathogens were detected by PCR in the stool of the assessed police officers: *G. duodenalis* ($n = 3$), *C. jejuni* ($n = 2$), *Salmonella* spp. ($n = 1$), *Shigella* spp./enteroinvasive *E. coli* ($n = 3$), and *S. stercoralis* ($n = 3$). With the exception of one case with *S. stercoralis* in a pre-deployment assessment of a police officer with previous deployments to not-reported deployment sites, all other pathogens were detected in post-deployment assessments.

In total, 12 out of 133 police officers (9.0%) were affected by a pathogen, while abundance of multiple pathogens was not observed. The geographical distribution of pathogen

acquisition is shown in Table 1, indicating local predominance of infection events in Sub-Saharan Africa followed by North Africa and the Middle East. Focusing on the reported symptoms, the association between pathogens and symptoms is presented in Table 2. As shown in this table, mild to moderate gastrointestinal symptoms on deployment were frequently but not always reported by police officers with proven gastrointestinal pathogens. Of note, these symptoms never facilitated consultations of a physician for diagnostic work-up or therapeutic intervention.

DISCUSSION

Dominance of gastrointestinal infections among infectious diseases observed on tropical deployments is well known from military operations [12–14]. For civilian Western travelers, a similar importance of enteric pathogens has been demonstrated by assessments of the GEOSENTINEL database [15]. Not surprisingly, deployed police officers are no exception as shown by a considerable enteric infection and infestation rate in this study.

Regarding the predominantly identified pathogens, bacteria dominated followed by enteric parasites, which is perfectly in line with previous reports on infectious gastroenteritis in the Sub-Saharan tropics associated with living under hygiene-restricted, local conditions [16, 17]. In particular, the abundance of *G. duodenalis* matches similar

previous experience with German soldiers on United Nations missions quite well [1].

Focusing on the observed symptoms, the most affected police officers had reported any gastrointestinal symptoms on deployment; however, those were nonspecific and had spontaneously vanished after deployment. No-one reported any consultations of physicians due to gastrointestinal symptoms. In line with this, the pathogen detections would highly likely have been missed without the police officers' voluntary participation in the screening. This may be acceptable in case of bacterial infections, in case of which spontaneous decolonization can be awaited in asymptomatic patients if there are no hygiene-related contraindications. In support of this assumption, previous studies have shown high rates of spontaneous clearance of enteric colonization with multidrug-resistant bacteria which were acquired on travel abroad after the return [18, 19]. However, at least counseling on appropriate hygiene strategies for the prevention of the fecal-oral spread between the family members at home is advisable in such situations. In case of the detected enteric protozoa, however, antimicrobial therapy should be performed. Further, in line with the German Infection Prevention Act (Infektionsschutzgesetz, IfSG), with the exception of *S. stercoralis*, all detected pathogens from this study were notifiable to the local health authority due to hygiene considerations.

Regarding the reported areas of presumed infection, the deployment sites were predominantly located in Sub-Saharan Africa, followed by Northern Africa and the Middle East. Again, the pathogen spectrum matches the results from previous studies in Sub-Saharan Africa well [16, 17]. Just in one instance of a *S. stercoralis* infestation, the likely area of infection on a previous deployment could not be retrospectively identified.

Asymptomatic infections and infestations may occur as observed in this study as well, making it challenging to distinguish colonization from infection events [20]. This phenomenon is especially pronounced for local inhabitants of resource-limited tropical areas [16], making the development of some sort of semi-immunity likely in the course of long-term stays on such deployments. Previous reports on reduced frequencies of gastrointestinal disease in later stages of deployments are likely to support this hypothesis [6] and match well with the observation from our study that gastrointestinal symptoms were not observed after

Table 1. Presumed sites of pathogen acquisition on deployment

Pathogen (number <i>n</i>)	Area of deployment (number <i>n</i> , % of all returnees from the respective area of deployment)
<i>Campylobacter jejuni</i> (<i>n</i> = 2)	Afghanistan (2/4, 50.0%)
<i>Giardia duodenalis</i> (<i>n</i> = 3)	Burkina Faso (1/7, 14.3%); Kenya (1/6, 16.7%); Nigeria (1/19, 5.3%)
<i>Salmonella</i> spp. (<i>n</i> = 1)	Egypt (1/7, 14.3%)
<i>Shigella</i> spp./enteroinvasive <i>Escherichia coli</i> (<i>n</i> = 3)	Mali (3/11, 27.3%)
<i>Strongyloides stercoralis</i> (<i>n</i> = 3)	Iraq (1/3, 33.3%), Nigeria (1/19, 5.3%), pre-deployment (1/81, 1.2%)

Table 2. Association between pathogens and symptoms

Pathogen (number <i>n</i>)	Any symptoms reported (percentage)	Details of reported symptoms (including fever)	Consultation of a physician and/or medical treatment due to gastroenteritis (number <i>n</i>)
<i>Campylobacter jejuni</i> (<i>n</i> = 2)	1/2 (50%)	Cramps	0 (0.0%)
<i>Giardia duodenalis</i> (<i>n</i> = 3)	2/3 (66.7%)	Diarrhea, abdominal pain, nausea, fever, cramps	0 (0.0%)
<i>Salmonella</i> spp. (<i>n</i> = 1)	0/1 (0.0%)	Not applicable	0 (0.0%)
<i>Shigella</i> spp./enteroinvasive <i>Escherichia coli</i> (<i>n</i> = 3)	2/3 (66.7%)	Diarrhea, abdominal pain, nausea, cramps	0 (0.0%)
<i>Strongyloides stercoralis</i> (<i>n</i> = 3)	1/3 (33.3%)	Diarrhea	0 (0.0%)

deployment in the police officers in spite of pathogen detections by PCR.

The study has some undeniable limitations. First, the number of assessed police officers over 5 years is still low and only a minor proportion provided both pre-deployment and post-deployment stool samples. Secondly, the assessment is retrospective, further limiting its interpretability. Thirdly, the information on the sample sheets was in part incomplete. Taking those limitations together, the results of the study have to be considered as preliminary and hypothesis-forming. Future prospective studies are desirable to further assess specific health risks for police officers on tropical deployments.

CONCLUSIONS

In spite of the limitations mentioned above, the study indicates a quantitatively relevant minority of infected and infested police officers after tropical deployments. Targeted screening for tropical infectious diseases is therefore advisable as a routine procedure. Further, prospective epidemiological research on police officers on deployment in resource-limited tropical areas with restricted hygiene conditions may provide better understanding of specific health risks associated with such deployments. In addition, the results suggest a need for compensating the risk for enteric infections due to exposition in endemic regions by specific training and education of the risk personnel concerning hygiene measures and basics of infectious diseases.

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Authors' contribution: MH, UM, RMH and HF jointly planned the study. MH assessed the data and prepared the manuscript. All authors have jointly optimized and reviewed the manuscript.

Conflict of interest: Nothing to declare.

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