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Patterns of diseases in health students abroad: A systematic review

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Summary

Background: Different health risks are associated with international electives among medical students, including the transmission of infectious diseases and non-communicable diseases. This review aims to summarise the evidence for illnesses associated with travel in medical students taking part in electives abroad.

Methods: Articles were identified through a literature search in two databases (until 30 July 2020) - PubMed and Web of Science.

Results: Sixteen articles were included in the systematic review. The results were classified into two broad categories: communicable diseases and non-communicable diseases. Gastrointestinal infections

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including travellers' diarrhoea were the most common infectious diseases reported by medical students abroad, followed by respiratory tract infections and skin infections. Blood-borne and sexually transmitted infection and systemic febrile infections due to vector-borne pathogens were rarely reported. Only six of the 16 studies addressed microbial carriage. The acquisition of resistant bacteria appeared to be frequent. Traffic accidents and mental health problems were also reported.

Conclusions: One of the lessons learned from this review is the requirement for large-scale epidemiological studies to evaluate the burden of infectious diseases such as gastrointestinal, respiratory and blood-borne infections with microbiological documentation. In particular, the emergence of the acquisition of resistant bacteria may lead to a theoretical risk of spread to the community and hospitals. Studies addressing mental health issues in the context of medical electives abroad are also needed.

Keywords*: communicable diseases, health students, travel, non-communicable diseases, health risk*

Introduction

International travellers are exposed to many travel-related health problems, including infectious diseases [1] with a potential risk to the community or the hospital population upon their return. The risk of travel-associated diseases may significantly vary according to age, destination, and conditions during travel, underlying medical conditions, the season and duration of travel, and adherence with preventive measures, among other factors [2]. The reason for travel is another key factor that influences the epidemiology of travel-associated diseases [3].

Every year, a significant proportion of medical students from high-income countries participate in clinical or non-clinical placements in low- and middle-income countries [4]. As well as receiving standard health advice before travel, there are usually a number of additional issues to consider, including occupational risks, professional standards, emotional well-being, and ethical challenges. Certain places and settings pose a higher risk and, as such, the health risks for medical students while on electives abroad need to be addressed in a specific way. A recent narrative literature review examined travel advice to medical students taking part in clinical electives in resource-poor settings with regards to potential risks of exposure to infectious illness, trauma, sexual health problems, excessive sun exposure, mental health issues and crime [5].

Travel advice to specific population of travellers should build upon evidence-based data on the prevalence of disease in this population. The purpose of this review is to summarise the evidence for illnesses associated with travel in medical students taking part in internships abroad.

Methods

Search strategy

The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (http://www.prisma-statement.org/) [6]. We searched all articles listed in the PubMed (https://pubmed.ncbi.nlm.nih.gov/) and Web of Science (http://www.webofknowledge.com/) databases, until 30 June 2020. Combinations of the following key words were used as search terms:

#1: “abroad” OR “travel”

#2: “medical students” OR “health students”

#3: “health risks” OR “diseases” OR “illness”

#4: #1 AND #2 AND #3

The selection was restricted to articles published in English. Meta-analysis and reviews were excluded but their references lists were screened to identify studies that might have been overlooked in the search. After manually removing duplicates that were found in the two databases, two authors independently scanned the abstracts of all articles, applying the inclusion and exclusion criteria. In addition, articles without an abstract were included for full-text screening and assessed at this stage. Only articles that were excluded by both authors during the abstract screening were eventually excluded from the full-text screening. After screening the abstracts, the full text of the articles was evaluated for eligibility by the same two authors and selected or rejected for inclusion in the review. Any discordant result was resolved through a consensus meeting. Studies were eligible for inclusion if they reported profiles of travel-related diseases and / or microbial carriage, including antibiotic resistant microorganisms in medical or health care students following their participation in electives abroad, and provided prevalence data. We excluded case reports, letters and studies describing only preventive measures.

Results

Study selection

The study selection flow-diagram (Figure 1) presents our results in detail. The search algorithm produced 322 articles from the PubMed and Web of Science databases. After removing duplicates, 230 articles were scanned, based on their title and abstract, and a total of 189 articles were processed for full text screening. After the full text screening, a total of 16 articles were included for data analyses (Figure 1) [7-22]. The results were classified into two broad categories: communicable diseases and non-communicable diseases.

Type of studies

Of the 16 publications included, three main types of studies were observed according to study design. Prospective cohort surveys were described in nine publications with the number of participants in each study varying from 12 to 597 [8,12,16-22]. Five retrospective surveys were identified with the number of individuals included in each study varying from 48 to 180 [9,11,13-15]. Two other studies were cross-sectional longitudinal surveys involving 71 and 85 individuals [7,10] (Table 1).

Demographics and travel characteristics (Table 1)

The majority of publications reported that more than 60% of students included in the studies were female. The median age ranged from 21 to 25 years old. Participants originated from different continents and countries (Europe, Asia, and America). Most students took part in clinical electives in hospital settings, or pre-clinical electives. Younger students also participated in humanitarian missions, volunteer work, research projects or international student exchange projects. Travel destinations were frequently in developing countries including South Asia, South East Asia, Africa and South and Central America. The duration of travel varied from 10 days to several weeks or months, up to one year.

Patterns of communicable diseases in health students abroad

Gastrointestinal infections

Gastrointestinal symptoms, including travellers' diarrhoea, were the most common health problem reported by medical students when abroad, affecting 31–73.9% of participants included in the reviewed publications [8,9,13,14,17,18,20]. One study investigated the carriage of gastrointestinal pathogens in French medical students who participated in internships abroad during the summer months. The acquisition of *Escherichia coli* was frequent, including Enteroaggregative *E. coli* (EAEC) and Enteropathogenic *E. coli* (EPEC) [22].

Respiratory tract infections

The prevalence of respiratory tract infection symptoms ranged from 1.8% to 38.8% among the medical students abroad included in the papers reviewed [8,9, 13,14,18,21]. In a study conducted on 134 French medical students travelling abroad in 2018, only 1.5% of students reported influenza-like illnesses (ILI) during travel and no case of confirmed influenza virus infection was reported upon return [21]. In another two-year cohort survey conducted on French medical students, the rate of acquisition of at least one respiratory virus was 17.8% [22], with rhinovirus being the most frequent (14.8%). In addition, 40.7% of participants acquired at least one respiratory bacterium, with *Staphylococcus aureus* (18.9%) and *Haemophilus influenzae* (17.1%) being the most frequent [22].

Tuberculosis (TB) transmission is another concern for medical students abroad, especially when they are staying for a long time in endemic countries, but no specific large-scale studies have been conducted to evaluate its prevalence among this population. A cohort study on 281 Dutch and Belgian medical students taking part in an elective in low- or middle-income countries showed that of the 50.5% of participants who visited endemic areas and were screened for TB upon their return, six (4%) had a positive test (four positives with tuberculin skin test (TST) and two positives with QuantiFERON

test). One was treated for latent TB [20]. In another study, a proportion of 2.4% of Dutch students (2/84) had a newly positive TST on returning from an elective in the tropics [14].

Blood- borne infectious diseases

Several studies showed that when travelling in areas with a high prevalence of HIV, notably during clinical electives, the risk of HIV, hepatitis B and hepatitis C transmission may be an underestimated potential health risk for medical students, who may suffer from needle stick injuries or exposure to blood or body fluids [11,12,15,20]. These studies observed that between 6.9% and 37% of students reported a significant exposure to potentially infective fluids. Another study showed that 67% carried out at least one type of procedure associated with an increased risk of exposure to blood-borne viral infections and 2.2% experienced percutaneous or mucosal exposure to potentially infectious body fluids [14].

Risk of sexually transmitted diseases

Although medical students have a certain knowledge in the field of sexual health, there have been cases of sexually transmitted diseases recorded in medical students when abroad [9,18]. Two of these studies showed that between 6% and 20% of healthy students had had sex with a new partner, including partners from the host country, while travelling abroad. A recent study by Vlot *et al.*, observed that 2.5% of students had had unprotected sex with a new partner while abroad [20]. A prospective survey conducted by Angelin *et al.* among Swedish health care and non-health care students studying abroad [18] reported that only 65% of students always used a condom during sexual intercourse while travelling, including 42% of health care students. This study also revealed that drinking alcohol was also associated with meeting a new sexual partner during travel. Confirmed cases of sexually transmitted diseases were rarely reported. One and two cases were respectively identified in the studies by Angelin *et al.*, and Inglis *et al.*, [9,18]. Studies investigating the carriage of vaginal pathogens by

French medical students who participated in an internship abroad during the summer months, reported acquisition rates of *Gardnerella vaginalis* and *Atopobium vaginae* of 12.9% and 13.9% in 2018 and 2019 respectively. A proportion of 4–5.1% of female students had molecular quantification criteria for bacterial vaginosis upon their return [21,22].

Other infectious diseases

Reports of students acquiring malaria during their stay abroad are anecdotal [9,14,18,20]. The majority of students who visited areas that are endemic for malaria were prescribed appropriate chemoprophylaxis [13,14,18,20]. A proportion of 13–32% of students stopped using prophylaxis prematurely due to adverse effects or because they forgot to take the pills [18,20].

Three cases of arboviral infections with chikungunya, dengue fever and zika, were reported in a recent study on Dutch and Belgian medical students [20]. Two cases of post-travel dengue were also reported in a study on 180 Dutch health students following an elective abroad [14].

Schistosomiasis infection occurs through contact with freshwater. Because symptoms may take several months to develop, students may be unaware of the infection and not consult a doctor. Two studies conducted on Dutch medical students during an elective abroad revealed a schistosomiasis acquisition rate of 0.3% and 2.6% respectively among students who had swum or waded in freshwater in countries where schistosomiasis is prevalent [14,20].

Skin infections have also been described in medical students while abroad, with prevalence ranging from 2% to 29% [9,14,18,21]. One case of cutaneous larva migrans was reported in a recent study on Dutch and Belgian medical students [20].

Acquisition of antibiotic resistant bacteria

The significant increase in the S83L substitution in GyrA – one of the target proteins for quinolones – shows that the Escherichia communities residing in the intestines of the Swedish medical students were

modified during their stay in India, insofar as they was a higher resistance potential [16]. 35% of students acquired new Extended-Spectrum Beta-Lactamase bacterial strains, identified by culture in a cohort study on Swedish medical students abroad [19]. Twelve out of 18 Swedish health students visiting the Indian sub-continent acquired ESBL-*E.coli* [17]. Carriage of MRSA post-travel ranged from 0.5% to 3% in Dutch medical students returning from an elective abroad [14,20].

Patterns of non-communicable diseases in medical students abroad

Traffic accidents

Several studies reported a prevalence of traffic accidents among medical students while abroad ranging from 1–3% [9,14,18,20]. In a study conducted on medical students, 45.6% of participants considered themselves to be at risk of road accidents while abroad [12].

Mental health

Medical students abroad have to adapt to a new cultural environment in addition to the ongoing pressure of attending medical school. The main issues that students need to adapt to when abroad include issues such as the language barrier, accommodation, social relations, homesickness and bureaucracy [7,10,20]. Studies on American medical students in Israel showed that 10–12% of students needed psychological counselling [7,10]. These studies also reported that 28–30% of students used alcohol to relieve the stress encountered during their studies abroad.

Discussion

In this work, we were able to analyse pooled data about more than 2,600 medical students participating in an elective abroad, mostly in tropical settings. Most students travelled for about two months. As

expected, most individuals were young adults under the age of 25. The majority of these students were female, in line with data from the Association of American Medical Colleges [23]. The design of the studies included in this work (prospective or retrospective cohort studies and cross sectional longitudinal surveys) made it possible to evaluate the prevalence of diseases presented by medical students during their electives abroad, based on syndromic surveillance data. The two most frequent conditions by far were, travellers' diarrhoea and respiratory tract infection symptoms, in line with results obtained by EuroTravNet in large populations of ill travelers consulting at specialised facilities [24]. Overall, gastrointestinal and respiratory tract infections among medical students while abroad appeared to be mild and self-limited. Between one- and two-thirds of students included in this work reported suffering travellers' diarrhoea during their electives, although most of them had received pre-travel advice and were supposed to follow food and drink-related measures to prevent diarrhoea. This confirms that the prevention of travellers' diarrhoea by dietary avoidance measures is often not successful [25]. A single mono-centric study investigated the acquisition of gastrointestinal pathogens in a small cohort of French medical students abroad and showed that *E. coli* was the most common pathogen [21]. This finding is in line with results showing that this *E. coli* is the first cause of acute diarrhoea among international travellers [26,27]. Persistent diarrhoea due to *Giardia lamblia* was also reported in previously healthy medical students from Marseille (France) returning from humanitarian work in South India in the summer of 2018, including one case which was refractory to first line treatment [28]. In addition, the acquisition of antibiotic resistant bacteria has been described in Swedish medical students during an elective abroad, notably when travelling to South East Asia [19]. Similar results were found in French medical students [unpublished data]. This is particularly worrying given that medical students may be in contact with at-risk patients upon their return, when participating in medical electives in their country of residence. Reinforced hand hygiene should be promoted among students returning from electives in countries where antibiotic resistance is frequent.

About 20% of students included in this study, reported suffering from the symptoms of a respiratory tract infection during their elective. Exposure to tuberculosis (as assessed by a TST and QuantiFERON test) was observed in 2–4% students in two surveys [14,20]. In another mono-centric, small-sized survey, the most frequent respiratory pathogens acquired by French students were cosmopolitan viruses such as rhinovirus [21].

Despite the fact that frequent exposure to potentially infectious body fluids was reported in several studies reviewed here (about 40% of students), due to activities conducted in hospital settings, the actual prevalence of blood-borne infections among medical student abroad was very low. Similarly, despite at-risk sexual behaviour being commonplace among medical students while travelling abroad [5], sexually transmitted diseases were very rarely reported in the studies included in the present review. Changes in the vaginal flora may be more frequent during travel and may trigger vaginosis in a minority of female students. With the exception of skin infections that may affect 15–30% of students in some surveys, other infections and, notably, systemic febrile illness due to mosquito-borne infections including malaria and arboviruses, appeared to be rare among medical students.

Non-infectious health risks including traffic accidents and mental health problems, although less frequently studied were also reported among health students abroad. The risk of transport-related injuries while travelling, although much less frequent than common infectious diseases (about 1–4% students) is one of the most frequent causes of death during electives abroad. In contrast, mental health problems (about 10%) and alcohol consumption (about 30%), frequently give rise to problems among medical students abroad. Despite the fact that travel destination and travel duration were not associated with increased alcohol consumption [18], research involving a large number of international medical students abroad is needed to better investigate the mental health issues related to travel.

Conclusion

Medical students traveling abroad face a wide range of travel-related health risks including infectious and non-communicable diseases. One of the lessons learned from this review is the need for large-scale epidemiological studies to evaluate the burden of infectious diseases such as gastrointestinal, respiratory and blood-borne infections with microbiological documentation. In particular, the emergence of the acquisition of resistant bacteria may lead to a theoretical risk of spread to communities and hospitals. Studies addressing mental health issues in the context of medical electives abroad are also needed.

References

1. Korzeniewski K. Post-travel screening of symptomatic and asymptomatic travelers. Int Marit Health. 2020;71(2):129-139.
2. Steffen R, deBernardis C, Baños A. Travel epidemiology—a global perspective. International Journal of Antimicrobial Agents 2003;21:89–95.
3. Fenner L, Weber R, Steffen R, Schlagenhauf P. Imported Infectious Disease and Purpose of Travel, Switzerland. Emerg Infect Dis 2007;13:217–22.
4. Watson DA, Cooling N, Woolley IJ. Healthy, safe and effective international medical student electives: a systematic review and recommendations for program coordinators. Trop Dis Travel Med Vaccines. 2019;5: 4.
5. Johnston N, Sandys N, Geoghegan R, O'Donovan D, Flaherty G. Protecting the health of medical students on international electives in low-resource settings. J Travel Med 2018;25.

6. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS Med. 2009 Jul 21;6(7):e1000100.
7. Schreier AR, Abramovitch H. American medical students in Israel: stress and coping. Med Educ. 1996;30(6):445-452.
8. Cossar JH, Allardice GM, Whiting B. Health Surveillance of Glasgow Medical Undergraduates Pursuing Elective Studies Abroad (1992–1998). J Travel Med 2000;7:314–8.
9. Inglis TJJ. Travel-Associated Health Risks of Singaporean Medical Students. J Travel Med 1996;3:80–2.
10. Abramovitch H, Schreier A, Koren N. American medical students in Israel: stress and coping--a follow-up study. Med Educ 2000;34:890–6.
11. Gamester CF, Tilzey AJ, Banatvala JE. Medical students' risk of infection with bloodborne viruses at home and abroad: questionnaire survey. BMJ 1999;318:158–60.
12. Franklin GF, Gray K, Nathwani D. Provision of drugs for post-exposure prophylaxis of HIV for medical students on overseas electives. J Infect 2001;43:191–4.
13. Goldsmid JM, Sharples N, Bettiol SS. A Preliminary Study on Travel Health Issues of Medical Students Undertaking Electives. J Travel Med 2003;10:160–3.
14. Sharafeldin E, Soonawala D, Vandenbroucke JP, Hack E, Visser LG. Health risks encountered by Dutch medical students during an elective in the tropics and the quality and comprehensiveness of pre-and post-travel care. BMC Med Educ 2010;10:89.
15. Merlin JS, Morrison G, Gluckman S, Lipschik G, Linkin DR, Lyon S, et al. Blood and body fluid exposures among US medical students in Botswana. J Gen Intern Med 2011;26:561–4.

16. Johnning A, Kristiansson E, Angelin M, Marathe N, Shouche YS, Johansson A, et al. Quinolone resistance mutations in the faecal microbiota of Swedish travellers to India. BMC Microbiology 2015;15:235.
17. Bengtsson-Palme J, Angelin M, Huss M, Kjellqvist S, Kristiansson E, Palmgren H, et al. The Human Gut Microbiome as a Transporter of Antibiotic Resistance Genes between Continents. Antimicrob Agents Chemother 2015;59:6551–60.
18. Angelin M, Evengård B, Palmgren H. Illness and risk behaviour in health care students studying abroad. Med Educ 2015;49:684–91.
19. Angelin M, Forsell J, Granlund M, Evengård B, Palmgren H, Johansson A. Risk factors for colonization with extended-spectrum beta-lactamase producing Enterobacteriaceae in healthcare students on clinical assignment abroad: A prospective study. Travel Med Infect Dis 2015;13:223–9.
20. Vlot JA, Blanter AI, Jonker EFF, Korse NS, Hack E, Visser LG, et al. Travel preparation and health risks in Dutch and Belgian medical students during an elective in low- or middle-income countries: A prospective self-reporting cohort study. Travel Medicine and Infectious Disease 2020;37:101779.
21. Dao TL, Hoang VT, Ly TDA, Magmoun A, Canard N, Drali T, et al. Infectious disease symptoms and microbial carriage among French medical students travelling abroad: A prospective study. Travel Medicine and Infectious Disease 2020;34:101548.
22. Dao TL, Canard N , Hoang VT, Ly TDA , Drali T, Ninove L, et al. Risk factors for symptoms of infection and microbial carriage among French medical students abroad. Int J Infect Dis. 2020. https://doi.org/10.1016/j.ijid.2020.08.075

23. AAMC. The Majority of U.S. Medical Students Are Women, New Data Show. Available at: https://www.aamc.org/news-insights/press-releases/majority-us-medical-students-are-women-new-data-show
24. Schlagenhauf P, Weld L, Goorhuis A, Gautret P, Weber R, von Sonnenburg F, et al. Travel-associated infection presenting in Europe (2008-12): an analysis of EuroTravNet longitudinal, surveillance data, and evaluation of the effect of the pre-travel consultation. Lancet Infect Dis. 2015;15:55-64.
25. Steffen R, Hill DR, DuPont HL. Traveler's diarrhea: a clinical review. JAMA. 2015;313(1):71-80.
26. Giddings SL, Stevens AM, Leung DT. Traveler's diarrhea. Med Clin North Am 2016;100:317–30.
27. Leung AKC, Leung AAM, Wong AHC, Hon KL. Travelers' Diarrhea: A Clinical Review. Recent Pat Inflamm Allergy Drug Discov 2019;13:38–48.
28. Dao TL, Sevestre J, Hoang VT, Ly TDA, Ranqu S, Parola P, et al. Refractory giardiasis in medical students returning from humanitarian work abroad. Travel Med Infect Dis 2019:101469.

Table 1: Communicable diseases and non-communicable diseases among medical students abroad

Date of study	Clinical setting/ Place of study	Number of participants, age, sex	Country of origin	Travel destinations	Purpose of travel	Duration of stay	Clinical findings	Microbiological findings	Reference
12/1989 and 1/1990	Cross-sectional cohort study conducted on first and third year medical students from New York, California, other US states and Canada. Students were recruited during a mandatory lecture.	85, mean age 25.8 years (range 21–37), female (33.3%).	USA	Israel	First and third year medical students	Not available	Problems with money (59%), depression (12%), alcohol use (31%), regular cigarette smoking (7%).	-	7
1992 - 1998	Prospective cohort study conducted on medical undergraduates from Glasgow. Student were recruited pre-travel and invited to self-complete a questionnaire to be returned in a prepaid envelope.	597, range aged 20–32 years, female (64%).	UK	72 different foreign countries with USA, Australia, Malaysia, Canada, India and Singapore the most frequent.	Medical elective.	Mean 52 days, range (14–110).	Any symptoms (45%), gastrointestinal symptoms (34.7%), non-specific symptoms (30.2%) (fever, headache, dizziness), respiratory symptoms (1.8%).	-	8
Not documented	Retrospective cohort study conducted on medical students from Singapore.	114, age and gender not documented	Singapore	South-East Asia (94.7%).	Microbiology course	Not documented	Any symptoms (37.7%), gastrointestinal infections (26.3%),	-	9

	Students were recruited during a teaching seminar.						respiratory infections (14.9%), skin infections (7.9%), Acute mountain sickness (1.8%), sexually transmitted diseases (1.8%), amoebic dysentery (0.9%), malaria (0.9%). Road traffic accident (0.9%)		
5/1997	Cross-sectional cohort study conducted on first-year medical students from New York and California. Students were recruited during a mandatory lecture.	71, mean age 25.8 years (range 23–37), female (30.4%).	USA	Israel	First year of medical studies.	Not documented	Consultation for psychological counselling (10.8%), alcohol use (27.9%), smoking (19.7%).	-	10
1997 - 1998	Retrospective cohort study conducted on post-travel medical students from London.	148, age and gender not documented	UK	South Africa, Nigeria, Sri Lanka, Kenya. 44% visited areas with a relatively high prevalence of HIV infection.	Medical elective.	Not documented	Percutaneous or mucosal exposure to potentially infectious body fluids (30%).	-	11

2000	Prospective cohort study conducted on medical students from Dundee. Students were enrolled at a pre-travel advice consultation.	103, age and gender not documented	UK	Overseas (no details provided)	Medical elective	Not documented	Exposure-prone procedures (74%), exposition to potentially infective fluids (37%).	-	12
Not documented	Retrospective cohort study conducted in medical students from Hobart.	48, age and gender not documented	Australia	Overseas (73%), Australia (27%), Pacific (22%), Europe (16%).	Medical elective	Not documented	Any symptoms (64%), travellers' diarrhoea or food poisoning (40%), URTI (12.5%), skin rashes (6.3%), cellulitis due to *Staphylococcus aureus* (2.1%), leptospirosis (2.1%), paratyphoid (2.1%), chickenpox (2.1%), pityriasis versicolor (2.1%), toe abscess (2.1%). Needle-stick injuries (4.2%), accidents (4.2%), assaults (4.2%). Insect-borne diseases (0%). Sexually transmitted diseases (0%).	-	13

7/2006-12/2008	Retrospective cohort study conducted on medical students from Leiden. Students were recruited when they registered at the international office of the university for electives abroad and were invited to participate by e-mail.	180, mean age 23 (range 19–38), female (78%).	The Netherlands	Africa (42%), Latin America (37%), Asia (18%), Middle East (3%), Europe (1%).	Clinical elective (47%), pre-clinical elective (16%), volunteer work (37%).	Mean of 74 days, median of 69 days, range (10–224).	Diarrhoea (65%), constipation (33%), skin infections (29%), upper respiratory tract infection (11%), fever shortly after travel (4%), traffic accident (1.1%), dengue post-travel (1.1%), any type of procedure associated with an increased risk of exposure to blood-borne viral infections (67%), mucosal or percutaneous exposure to potentially infectious body fluids (2.2%).	MRSA carriers post-travel (3%), seroconversion for anti-schistosomal antibodies post-travel (2.6%).	14
7/ 2007 - 2/2010	Retrospective cohort study conducted on medical students from Philadelphia. Students were recruited when they registered at the international office of the university	67, age and gender not documented.	USA	Botswana	Clinical elective in the hospital.	6–7 weeks	Exposure to blood or body fluids (25.4%), needle-stick injuries (11.9%), splashes (13.4%).	-	15

	for electives abroad and were invited to participate online.								
2010 - 2013	Prospective cohort study conducted on medical students from universities in Umea, Stockholm and Gothenburg, travelling to India. Students were enrolled at a pre-travel advice consultation.	12, age range: 20–30 years, female (75%).	Sweden	India	Internship or study at hospitals.	Mean 63.6 days, range (28–106).	Not documented	GyrA mutation (S83L) coding for resistance to quinolone in *E. coli* pre-travel (44%), post-travel 72%)	16
04/2010 - 05/2013	Prospective cohort survey conducted on health care students from Swedish universities in Umea, Stockholm and Gothenburg. Students were enrolled at a pre-travel advice consultation.	35, median age of 25 (range 23–28), female (74%).	Sweden	Central Africa (49%) and Indian peninsula (51%).	Pre-clinical and clinical courses.	Median 34 days, range (14-150).	Travellers' diarrhoea (69%).	Positive for ESBL-E pre-travel (3%), post-travel (34%, all following travel to India). The relative abundance of antibiotic resistance genes increased post-travel, most prominently for genes encoding	17

								resistance to sulphonamide (2.6-fold increase), trimethoprim (7.7-fold), and beta-lactams (2.6-fold).	
04/2010 - 01/2014	Prospective cohort survey conducted on health care and non-health care students from Swedish universities in Umea, Stockholm and Gothenburg. Students were enrolled at a pre-travel advice consultation.	185 health care students (HCSs), median age 25, female (75%). 150 other students.	Sweden	Sub-Saharan Africa (29%), South Asia (28%).	Pre-clinical and clinical courses.	Median 61 days.	Any symptoms (52% of all students), travellers' diarrhoea (31%), respiratory tract infection (26%), urinary tract infection (3%), skin infection (2%), sexually transmitted disease (0.5%), malaria (0.5%). Theft (7%), traffic accidents (3%). Note: clinical finding for HCS only are not available from the article)	-	18

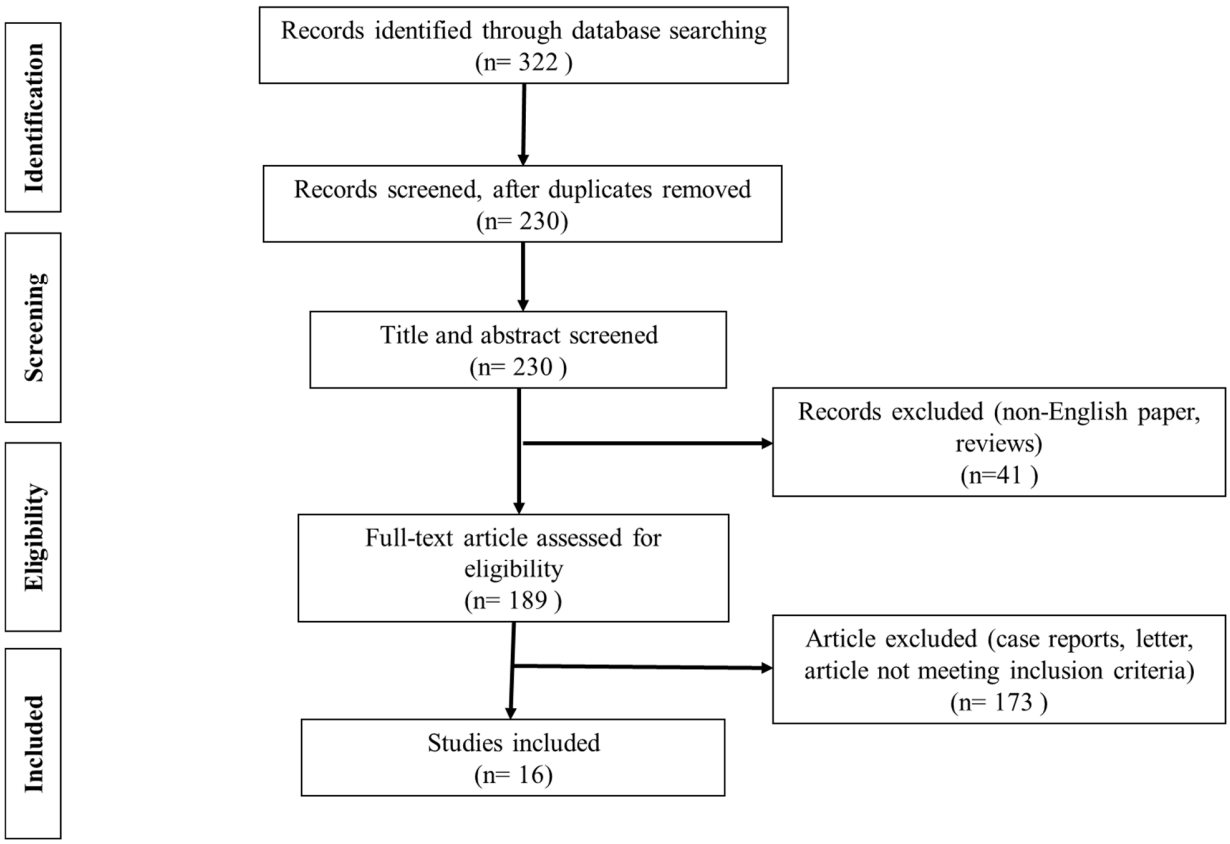
04/2010 - 01/2014	Prospective cohort survey conducted on health care students from Swedish universities in Umea, Stockholm and Gothenburg. Students were enrolled at a pre-travel advice consultation.	98, median age 25 (range 20–51), female (78%).	Sweden	South-East Asia (48%), Africa (40%). India (30%), Cameroon (22%), Nepal (8%), Vietnam (7%), Tanzania (5%), Rwanda (4%)	Pre-clinical and clinical courses.	Median 45 days (range 13–365).	Travellers' diarrhoea (69%).	Positive for ESBL-E pre-travel (7%), post-travel (36%), acquisition rate (35%). No CPE was found.	19
06/2010 - 12/2016	Prospective cohort study conducted on medical students from Leiden, Amsterdam, Groningen, Leuven and Ghent, travelling abroad. Students were recruited when they registered at the international office of the university for electives abroad and were invited to participate by e-mail.	479, median age of 24 (range 23–25), female (76%).	The Netherlands and Belgium	South America (38.4%), Africa (37.9%), Asia (17.7%), Central America (4.5%), Middle East (1.5%).	Clinical and pre-clinical elective.	Median 67 days, range (24–234).	Travellers' diarrhoea (46%), cutaneous larva migrans (0.7%). Schistosomiasis (0.3%), malaria (0.2%), chikungunya (0.2%), dengue fever (0.2%), zika (0.2%). Traffic accident (3%), needle-stick or splash injury (6.9%), unprotected sex with a new partner (2.5%), difficulty in adapting to the local culture (50%), homesickness	Positive for tuberculosis skin test post-travel (6/142, 4%). Positive for Methicillin-resistant *Staphylococcus aureus* post-travel (1/ 214).	20

							(5%), injury during leisure activities (18%), threat or physical violence (5%).		
06/2018 - 08/2018	Prospective cohort study conducted on medical students from Marseille, travelling abroad. Students were enrolled at a pre-travel advice consultation.	134, median age21 (range 19–23), female (75%).	France	South East Asia (30.6%), South America (25.4%), Africa (21.6%), South Asia (20.2%) and North America (0.8%).	Non-medical humanitarian mission (74.6%) and clinical training at hospitals (25.4%).	Mean 44.7 days, range (27–65).	Abdominal pain (53.7%), diarrhoea (52.2%), respiratory infection (38.8%), vaginal symptoms (for female students) (5%), skin infections (3%), urinary tract infections (2.2%). Scratching (1.5%), allergy (1.5%), cervical lymphadenopathy (0.7%), altitude sickness (0.7%), otitis (0.7%), chalazion (0.7%), migraine (0.7%), and palpebral oedema (0.7%).	Acquisition rate for at least one respiratory virus (9.2%), acquisition rate for at least one respiratory bacteria (15%), acquisition of Enteroaggregative *Escherichia coli* (EAEC) (53%), acquisition of Enteropathogenic *E. coli* (EPEC) (41%), acquisition of *Gardnerella*	21

								vaginalis (7.7%), acquisition of *Atopobium vaginae* (14.3%).	
06-08/2018 and 06-08/2019	Prospective cohort study conducted on medical students from Marseille, travelling abroad. Students were enrolled at a pre-travel advice consultation.	293, median age 21 (range 18–25), female (76.5%).	France	Africa (29%), South East Asia (27.7%), South America (21.8%), South Asia (18.8%).	Non-medical humanitarian mission (80.9%) and clinical training at hospitals (19.1%).	Mean 41 days, range (16–78).	Diarrhoea (48.1%), abdominal pain (46.4%), respiratory infection (35.8%), vaginal symptoms (for female students) (3.6%).	Acquisition rate for at least one respiratory virus (18.2%), acquisition rate for at least one respiratory bacteria (40.7%), acquisition of Enteroaggregative *Escherichia coli* (EAEC) (40.9%), acquisition of Enteropathogenic *E. coli* (EPEC) (18.6%), acquisition of	22

								Gardnerella vaginalis (12.9%), acquisition of *Atopobium vaginae* (13.9%).	

1 Figure 1: Flow-diagram of study selection



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