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Short Communication

Infectious disease risks among refugees from North Korea

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ABSTRACT

Objectives: The characteristics of disease in North Korea, including severe malnutrition and infectious disease risks, have not been openly and widely analyzed. This study was performed to estimate the risks of infectious diseases among refugees from North Korea.
Methods: A literature review of clinical studies among North Korean defectors was conducted to statistically estimate the risks of infectious diseases among North Korean subjects.
Results: A total of six groups of data from five publications covering the years 2004 to 2014 were identified. Tuberculosis and viral hepatitis appeared to be the two most common infectious diseases, especially among adult refugees. When comparing the risks of infectious diseases between North Korean and Syrian refugees, it is critical to remember that *Plasmodium vivax* malaria has been endemic in North Korea, while cutaneous leishmaniasis has frequently been seen among Syrian migrants.
Conclusions: Valuable datasets from health surveys of defectors were reviewed. In addition to tuberculosis and viral hepatitis, which were found to be the two most common infectious diseases, a special characteristic of North Korean defectors was *Plasmodium vivax* malaria. This needs to be added to the list of differential diagnoses for pyretic patients.
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Introduction

With its intensifying military exercise and nuclear programs, the political climate in North Korea has become unstable. Considering the possibility of refugees in this region in the future, preparedness for a sudden change is required, along with an appropriate risk assessment (Stares and Wit, 2009). In particular, it is critical to anticipate the infectious disease risks triggered by sudden and large-scale human migration events. However, the characteristics of disease in North Korea, including severe malnutrition, have not been openly and widely analyzed, and disease structures are likely to be rather different from those of surrounding countries (Lee et al., 2013).

The most pressing public health questions may be: (1) For what infectious diseases are the risks high? (2) How does the composition of diseases compare to those of other humanitarian crisis events?

The present study was performed to estimate risks of infectious diseases among refugees from North Korea by means of a literature review.

Materials and methods

While epidemiological datasets from the North Korea population have not been openly shared with other countries, the current risks of infectious diseases in North Korea can be inferred from the health status of defectors, i.e., North Korean individuals who have managed to defect for political, ideological, or other reasons and relocate to South Korea or elsewhere. As of July 2017, a total of 8891 male and 21,914 female defectors had entered South Korea, with more than 90% of these defections having occurred since 2002 (Ministry of Unification, Korea, 2017). The average age of male and female defectors has been 30.2 years and 33.6 years, respectively, with 25.1% of male defectors and 11.9% of female defectors being minors aged <20 years (Ministry of Unification, Korea, 2017).

In this study, all publications reporting infectious disease risk estimates for North Korea, i.e., estimates of incidence or prevalence for different infectious diseases, were identified and analyzed. Many of the publications reporting infectious diseases in North

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Korea have been written in Korean and have not been published as original research articles, thus the present study was not able to follow a formal method of systematic search using MEDLINE or other databases. References cited by specialized articles on North Korea (Stares and Wit, 2009; Lee et al., 2013) and published reports on North Korean defectors since 2002 were first tracked (Kim, 2010). Their reference lists were subsequently investigated further to search for potentially useful articles. This search was repeated as many times as necessary until no further references were identified. The publications obtained were limited by the following inclusion criteria: the publication must (1) report the risks of two or more infectious diseases as statistical estimates, (2) clarify the time and subject of the study, and (3) explicitly document a survey method by which the clinical diagnosis was made. Information with respect to the year of the survey, number and characteristics of subjects, and the survey method was retrieved from each selected study.

Although not specific to North Korea, contemporary understanding of the infectious disease risks among refugee populations in general is currently well-documented (European Centers for Disease Prevention and Control (ECDC), 2009). In particular, due to the ongoing civil war in Syria, which began in around 2011, European countries have already accepted a large number of Syrian refugees and have experience of exposures to a number of imported infectious diseases (Petersen et al., 2013). Using the GeoSentinel surveillance results for Syrian refugees that were collected from several European countries (Mockenhaupt et al., 2016), it was sought to identify any special infectious disease risks that could characterize the health of North Korean defectors.

Results

A total of six groups of data from five publications covering the years 2004–2014 were identified (Table 1), including five survey results and one governmental report dataset (Lee et al., 2013; Ministry of Unification, Korea, 2017; Yoon and Kim, 2005; Hwang et al., 2012; Dorman et al., 2017). Among the five survey studies, four had included defectors in South Korea as the source of information (and defectors were interviewed about themselves and their household members in North Korea), while the remaining one study had implemented a laboratory examination of defectors attending a clinic in Toronto. With the exception of the Toronto study, which collected data based on medical attendance, all of the other surveys were based on cross-sectional interviews of defectors including healthy individuals. While early studies in 2004 and 2004–2007 included healthy individuals ($n = 306$ and $n = 6087$ persons, respectively) and examined the yearly incidence, a later study covering the years 2008–2010 and a Toronto study for the years 2011–2014 examined only those who had at least one medical complaint ($n = 524$ children and $n = 583$ adults according to a survey of 345 defectors in South Korea and 117 persons in Toronto, respectively). The Toronto study relied on laboratory

Table 1
Infectious disease risks among North Korean defectors.[a]

Year of survey	2004	2004–2007	2008–2010	2008–2010	2011	2011–2014
First author (Ref.)	Yoon (Yoon and Kim, 2005)	Police Science Institute (Ministry of Unification, Korea, 2017)	Hwang (Hwang et al., 2012)	Hwang (Hwang et al., 2012)	Lee (Lee et al., 2013)	Dorman (Dorman et al., 2017)
Sample size, *n*	306	6087	524	583	NA	117
Subjects	Defectors in SK	Defectors in SK and their family members	Symptomatic children	Symptomatic adults	Governmental report	Refugees in Canada
Method	Cross-sectional interview of defectors	Serial cross-sectional interviews of defectors	Cross-sectional survey of symptomatic subjects	Cross-sectional survey of symptomatic subjects	Latest governmental reports	Attendance at a clinic
Diseases/clinical syndromes						
Viral hepatitis	25 (8.2)	669 (11.0)	9 (1.7)	119 (20.4)	–	16 (14)
TB	19 (6.2)	130 (2.1)	22 (4.2)	172 (29.5)	345/100 000	–
Malaria	–	–	–	–	10 000 per year	–
STI	–	137 (2.3)	–	–	–	Chlamydia 10, syphilis 3
HIV	–	–	–	–	–	0
Acute gastroenteritis	35 (11.4)	–	44 (8.4)	16 (2.7)	–	–
Cholera	–	–	6 (1.1)	–	–	–
Typhoid fever	–	–	11 (2.1)	14 (2.4)	–	–
Paratyphoid	–	–	–	24 (4.1)	–	–
Intestinal parasites	–	–	–	–	–	11 (22)
Chickenpox	–	–	16 (3.1)	–	–	–
Measles	–	–	18 (3.4)	–	–	–
Influenza	–	–	–	20 (3.4)	–	–
Acute flaccid paralysis	–	–	15 (2.9)	–	–	–
Rickettsiosis	–	–	15 (2.9)	–	–	–
Sinusitis	11 (3.6)	–	–	–	–	–
Skin infections	11 (3.6)	–	–	–	–	–
Oral infectious diseases	9 (2.9)	–	–	–	–	–

NA, not applicable; SK, South Korea; TB, tuberculosis; STI, sexually transmitted infections.
[a] Data are presented as the number (percentage) among the total.

confirmation of a causative pathogen, but the diagnostic criteria of the other survey studies only relied on the individual knowledge of the respondents.

For all surveys, viral hepatitis appeared to be one of the most commonly identified diseases (Table 1). The prevalence among healthy individuals during 2004–2007 was estimated to be 11.0% (n = 669 infections among 6087 defectors). Whenever the causative virus of the hepatitis was identified, it was hepatitis B virus. Similarly, tuberculosis was common, with a documented incidence in 2011 of 345 cases per 100 000 people (Lee et al., 2013). The governmental estimate was about one-tenth of the reported estimate among defectors (Table 1). While these numbers are not directly comparable (e.g., defectors may not specifically count active tuberculosis only), the mismatch may imply underreporting in the governmental data. The high incidence of tuberculosis has already been recognized internationally (Perry et al., 2011), and the rise of drug-resistant tuberculosis remains a concern with regard to the anticipated future demand for the control of this disease in the Korean Peninsula (Seung and Linton, 2013). In addition to viral hepatitis and tuberculosis, the government of North Korea has acknowledged the presence of *Plasmodium vivax* malaria, which exhibits a relatively benign clinical presentation as compared with *Plasmodium falciparum*. The annual number of cases is estimated to be less than 10 000 persons (Lee et al., 2013), but it was not identified among defectors or their family members.

While sexually transmitted infections have been reported, none were reported to have been caused by HIV; rather, Chlamydia and syphilis cases were diagnosed among refugees in Toronto. Bacterial infections of the intestinal tract were common among both children and adults, and the presence of stool parasites was identified among the refugees in Toronto. Of note, typhoid fever and cholera were reported among children (Table 1), although the immunization coverage of vaccine-preventable diseases has been estimated to be >95% for a variety of vaccines including MCV1 (measles-containing vaccine first dose) and Pol3 (third dose of polio-containing vaccine) in recent decades. Nevertheless, this high coverage has not been methodologically verified, and in fact, measles, acute flaccid paralysis (AFP), and chickenpox were reported among ill children of defectors during the years 2008–2010. Rickettsiosis has also been reported among children.

Table 2 shows the results of a qualitative comparison between refugees from North Korea and refugees from Syria. In line with contemporary understanding of infectious diseases among international migrants (European Centers for Disease Prevention and Control (ECDC), 2009; Cookson et al., 1998), viral hepatitis and tuberculosis are likely to be the most commonly seen, especially among adults. With regard to parasitic diseases in these countries, it is critical to remember that *P. vivax* malaria has been endemic in North Korea, while cutaneous leishmaniasis has frequently been seen among Syrian migrants. Vaccine-preventable diseases including AFP, as well as intestinal parasitic infections, have often been seen among children. Recurrent epidemics of rickettsiosis have been observed in the Korean Peninsula, while a certain number of schistosomiasis cases have been reported in Syrian migrants.

Table 2
Qualitative comparisons of infectious disease risks between North Korean and Syrian refugees.[a]

	Adults		Minors	
	North Korean	Syrian	North Korean	Syrian
Viral hepatitis	+	+		
Tuberculosis	+	+		
Malaria	+			
Cutaneous leishmaniasis		+		
Vaccine-preventable diseases			+	+
Intestinal parasites			+	+
Dental problems			+	+
Rickettsiosis			+	
Schistosomiasis				+

+ indicates the presence of the corresponding disease.
[a] The presence of infectious diseases among Syrian refugees was determined from the analysis of GeoSentinel data in Europe (Mockenhaupt et al., 2016).

Discussion

This study appears to be the first to have estimated the probable infectious disease risks among refugees from North Korea using quantifiable sources of information. To quantify what has perhaps been believed to be almost unquantifiable, valuable datasets from health surveys of defectors were collected and reviewed. As already well documented (European Centers for Disease Prevention and Control (ECDC), 2009; Cookson et al., 1998), tuberculosis and viral hepatitis appeared to be two most common infectious diseases, especially among adult refugees. In addition, a special characteristic of North Korea is *P. vivax* malaria, which needs to be added to the list of differential diagnoses for pyretic patients. The importance of *P. vivax* malaria is not an original finding, as this has been recognized to be present in the southern provinces, especially from March to December (Centers for Disease Control and Prevention (CDC), 2017). Although immunization coverage in recent decades has been estimated at >95% for a variety of vaccines (Yoon and Kim, 2005), vaccine-preventable diseases among children of defectors were recorded in cross-sectional interviews with the parents. Rickettsiosis, a recurrent disease in the Korean Peninsula, should also be included in the differential diagnosis for febrile patients. Infections of the intestinal tract, including typhoid fever and cholera, were considered as present among children. The comparison of diseases between North Korean and Syrian refugees revealed differences in the types of parasitic and recurrent endemic diseases.

Two critical take-home messages should be emphasized from this identification of commonly seen infectious diseases. First, as the risks of tuberculosis and malaria are considered substantial, neighboring countries would need to improve their diagnostic and treatment capacities to prepare for any massive inflow of refugees. Many of the countries surrounding North Korea have been recognized as successful in controlling these diseases, and there has been a decline in the number of experts and research studies on tuberculosis and malaria in such countries. Such a trend is not only the case for neighboring areas, but also in many other industrialized countries, and proper diagnosis, laboratory testing, and treatment of malaria and tuberculosis have been difficult, except in urban areas with capacity in travel clinics or infectious disease departments. Substantial geographic gaps in disease structure have been maintained between North Korea and other countries, thus diagnostic and treatment capacity for a plausible spectrum of diseases should be secured to account for such gaps. Second, the immune landscape of North Korea could potentially be highly different from that of other countries, and the mobility of refugees may change the state of progress towards controlling vaccine-preventable diseases. It should be noted that AFP has been observed among both North Korean and Syrian migrants, although there are several causes of AFP other than poliovirus infection (e.g., botulism, acute myelopathy, and other neurotropic viruses including enteroviruses and herpesviruses).

Three limitations must be noted. First, many of the surveys of defectors relied only on interviews and the resulting frequency of disease did not adhere to the objective diagnostic criteria. As such, the observed frequency of disease is likely biased and it is expected that a certain number of misclassifications have occurred. Second, defectors from North Korea may not represent a random sample; they may instead represent the healthier fraction of the

population, as expected from their successful defection. However, defectors may also mainly arise from the poor fraction of the population in rural areas; in such an instance, the 'healthier' fraction is not guaranteed. Third, while risks were compared based on different sources in the literature, the survey methods differed (e.g., targeting healthy persons or recruiting only symptomatic individuals); thus, the disease structure may differ according to the recruitment method. For instance, diseases in Syrian migrants based on GeoSentinel in Europe may represent a symptomatically more severe fraction of infections among refugees compared with those based on interviews of all defectors including healthy individuals. Despite these important sources of error, the present study was conducted because an understanding of the background rate of infectious diseases is of the utmost importance for preparedness, and even a qualitative assessment (e.g., the presence or absence of a disease) may be regarded as beneficial information as part of a risk assessment.

Refugees are not necessarily an immediate threat with respect to communicable diseases, but the influx of a vulnerable group would inevitably put pressure on public health systems. Although not immediately, medical and public health experts in other countries will also face a need to accept refugees from North Korea. Given possible forthcoming needs, it is believed that the study reported here will help not only risk assessment, but also preparedness for surveillance, differential diagnosis, and appropriate treatment.

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