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Epidemiological Features and Sero-Susceptibility of Measles among Foreign Workers Screened for Employment in Qatar

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Abstract

Background: The epidemiological features and sero-susceptibility of measles will help health authorities establishing evidence-based vaccination and control strategies. Objectives: were to measure the sero-susceptibility of measles and determine the possible associated epidemiological features with sero-susceptibility among workers. **Method:** A cross-sectional study was used. Four hundred twenty-two workers attending the Medical Commission (MC) were studied. An interview administered questionnaire, socioeconomic status score, and anti-measles IgG test were the data collection tools. **Results:** Measles sero-susceptibility was (5.7%) among the studied participants. It was significantly associated with those being (Less than 25 years, single, and not living with children). Sero-susceptibility was more common among those who are:(Males, from Sri Lanka, Egypt or Nepal, illiterate or holding primary education, seeking office jobs, having income meet routine expenses, ranked in the low or middle socioeconomic status score, and living with (>1) person/room crowding index. **Conclusion:** It is not recommended to start screening against measles as a part of the routine testing in the MC. Vaccinating foreign workers before their arrival is not a priority, as measles sero-susceptibility among them is limited. Encouraging the continuation of strict active surveillance for measles, including case detection, contact protection, and control to approach elimination.

Keywords: Epidemiological features; Measles; Screening; Seropositivity; Measles IgM antibodies; Qatar

Abbreviations: ELISA: Enzyme-Linked Immuno-Sorbent Assay; GCC: Gulf Council of Countries; HMC: Hamad Medical Corporation; IgM: Immunoglobulins M; IRB: Institutional Review Board; MC: Medical Commission; MoPH: Ministry of Public Health; PHCC: Primary Health Care Corporation; PI: Principle Investigator; PRNT: Plaque Reduction Neutralization Test; RT-PCR: Real-Time Polymerase Chain Reaction; SD: Standard Deviation; SES: Socioeconomic Status Score; UAE: United Arab Emirates; WHO: World Health Organization

Introduction

In 2012, the World Health Organization (WHO) launched the Global Measles and Rubella Strategic Plan [1]. It aimed to provide control and elimination of both measles and rubella between 2012 to 2020. Outbreaks continue to happen due to high measles communicability, countries, where indigenous transmission was eliminated, remain vulnerable to occasional outbreaks due to importation. Ever since the adoption of the measles vaccine, its coverage remained inconsistent around the world; and as a result, measles continues to pose a significant threat to children's lives and subsequently, their families around the globe [2,3]. Part of the major global burden of measles is from South East Asia, where the vaccination and preventive programs are under-optimized [4].

Qatar is a rapidly developing Arabic country with a total population of (2,675,000) as of April, 2017 [5]. A very considerable portion of them came originally from South East Asia for working in the country and referred to as foreign workers. Their contribution to the outbreaks in Qatar is extremely high. Considering some of their original countries are known to contribute greatly to the global measles burden [6,7].

In Qatar, it is mandatory to have a medical examination before getting a work permit and residency. Such an examination is done to the Medical Commission (MC) which is a validated center operated by Ministry of Public Health (MoPH).

The knowledge of the epidemiological features of the cases and assessment of sero-susceptibility is of great interest in Qatar health sector as they could help efficiently to eliminate measles. This is the first study in Qatar to assess the sero-susceptibility of measles among the high-risk group of foreign workers.

Aim and Objective

This study is part of a project to assess sero-susceptibility and knowledge & awareness about measles among the workers in Qatar explained elsewhere [8]. Assessment of the epidemiological features of the cases and assessment of sero-susceptibility is vital to understand the frequent outbreaks in Qatar. Further, it will help health officials to develop preventive services to reach WHO elimination goals. Study objectives were first to measure the sero-susceptibility of measles, among foreign workers applying for work permit attending the MC in Qatar, during 2014. Second objective was to determine the possible associated epidemiological features including socioeconomic status and housing condition with measles sero-susceptibility among these workers applying for work permit attending the MC in Qatar, during 2014.

Methods

Study Settings and Design

The study setting was in the MC center during the period from November (2014) until the end of January (2015). A cross-sectional study design was done to recruit a total of (460) eligible participants.

Study Population

All the foreign workers attending MC for a medical examination before getting work permits and meet the eligibility criteria. Inclusion criteria were both genders, individuals between (18 and 60) years, and willing to participate in the study. The exclusion criteria were either applicants were coming to MC for other reasons rather than getting the work permit (e.g., study residency permit and extension of travel or visit visas) or declined participation.

Sample Size and Sampling Technique

The following equation was used [9]:

$$n= [Z^2\ 1\text{-}\alpha / 2 \times P \times (1\text{-}P)] / d^2$$

Where Z is Z statistic for an α error of (0.05) corresponding to a (95%) confidence level, P: the prevalence estimated for measles sero-susceptibility (50%), and the d: error rate of (0.05). For compensation of the non-response or any missing data, a (20%) new number was added, and the final total sample became (460) participants. Due to the lack of local or regional information about the extent of measles sero-susceptibility among foreign workers, and being a novel study in the region, the size was calculated using a (50%) measles sero-susceptibility, which is the maximum that the formula accommodates.

On average (2000-2500) applicants are screened per day. Determining the serum level of anti-measles IgG as a screening tool for measles virus immunity (or susceptibility) is not a routine MC duty. A systematic random sampling technique was employed to recruit study participants [10]. The Principal Investigator (PI) visited the MC daily for over one week to get a preliminary assessment of the average daily attendees being served. Participants were enrolled through communication with the authorized local administrator who provided lists of served applicants, which is routinely recorded. The first participant enrolled every day was chosen randomly, followed by the next one systematically every other (88) new applicants till the end of the working day. This systematic sequence was determined after calculating the required time to accomplish each interview, and subsequently, the number of interviews that can be accomplished during the working hours, taking into consideration the average daily applicants visiting the MC. Participants were enrolled until the fulfilment of the calculated sample size.

Research Instruments

In the current study, PI used newly developed questionnaire, lab tests to measure serum measles Immunoglobulins M (IgM) level and calculated Socioeconomic Status Score (SES) as research instruments. It included information about the followings:

Socio-demographic characteristics

Data including gender, age, nationality, marital status, educational, proposed job, and income in the home country.

Serum IgG level against the measles virus

It was measured using the Enzyme-Linked Immuno-Sorbent Assay (ELISA) test technique that includes a photometer microplate reaction reader of a wavelength that varies between (450 and 650) nm. The test was considered positive if the level of IgG serum antibodies exceeded the cut-off point (>0.200) mIU/ml, as interpreted by the ELISA reader; positive participants are considered immune against infection. If the level was below a cut-off point of (<0.100) mIU/ml, it was considered negative; these participants were regarded as potentially susceptible to infection. Between these two figures, results were considered equivocal, where the test was repeated as per manufacturer protocol. When collected blood samples were seen as grossly haemolytic, icteric, or lipemic, they were unable to be tested or incorporated in the study [11].

Housing Condition

The newly developed questionnaire also investigated the housing conditions of the participants. Where, living together with children & their numbers, type and size of their home dwelling were questioned. Further crowding index (person/room) was calculated.

The calculated Socioeconomic Status (SES)

The score used in the current study categorizes participants into three groups depending on location in the score range (between 1 and 24), low SES level with a calculated score from (1 to 8), middle (9-16), and high (17-24). The score was modified after the (2012) updated and revalidated Fahmy and El-Sherbini scale, the most commonly used scale for health research regionally [12].

The score is composed of five domains: (Education and culture, family and housing, occupation, regular health care provider, and economic domains). The score yields a calculated total score of (24), where the higher score indicates better SES. The [domains, their relevant questions, question score, and class levels] were modified to suit the situation of workers in Qatar after extensive discussion between three community medicine experts. Accordingly, the relative weight of each item and its allocation in each domain were defined. The SES scoring description was an integral part of the study interview administered questionnaire. It was calculated by the PI after completion of interviews by the end of each data collection day [13].

Research Approach

After interviewing the worker and filling the questionnaire, the PI or the data collector accompanied the interviewee to the phlebotomy room to collect the blood sample. Six ml of venous blood was drawn by trained laboratory personnel using the appropriate syringes under strict infection control measures as per MC policy. The sample was kept in a lab refrigerator (between +2° and +8° C) until the end of the working day. Then was taken in a biohazard bag to the virology lab, where the ELISA test was performed after collection of samples in one run. Results were accessed using the MC unique number given for each applicant through the electronic medical record.

Quality control measures

The questionnaire was developed by the research team, its content, and face validity were established by an extensive literature review, consultation of experts in the same field. The questionnaire was prepared in English and translated into Arabic with back translation at Hamad Medical Corporation (HMC) accredited translation center to ensure its validity and reliability.

All blood collection is done under high adherence to the blood extraction policy in MC, infection control instructions. Tests were conducted using the SIEMENS Enzygnost® Anti-Measles Virus/IgG, an enzyme immunoassay for the qualitative detection and quantitative measurement of the specific IgG antibodies against measles virus in human serum. The manufacturer of the test reported in the instruction manual that the test sensitivity is (99.6%) and specificity of (100%) [14].

Pilot testing of the questionnaire was done by utilizing a convenient sample of (50) workers to assess the clarity of questions, average time needed to accomplish each, and management of the whole administrative process. Refinements were made based on feedback from the pre-test. Those who participated in the pilot were later excluded from the main study.

The PI collected the data, and the four assigned MC officially certified data collectors to avoid interviewer bias. These data collectors are multi-lingual and were extensively trained before data collection, the study and the questionnaire were described to them; they shared in the pilot study, and all their inquiries were answered. A review of the completed questionnaires was done daily and prior to data entry to monitor for completeness and consistency and to detect any eccentric remarks early.

Ethical approvals

The study granted approvals from the Institutional Review Board (IRB) of HMC, and the MC management. The manager of the MC was contacted officially by the PI before data collection. He was informed about the objectives and importance of the study, and he aided and facilitated contact with the working team.

The PI trained four multi-lingual data collectors officially assigned by the MC management; all of them were MC staff. The management also assigned a devoted nurse to help in the logistic issues, including sampling technique application, to track blood sample collection and transportation.

The researchers followed all Helsinki Declaration recommendations with research on human subjects [15,16], as well as local safety and infection control guidelines for blood collection from human beings. Participants' data confidentiality was ensured as well as privacy was practiced during blood extraction.

Results

The final total number of participants enrolled in this study (who completed the interview and got an available valid blood test result) was (422) participants. Twenty-four participants (5.7%) were sero-susceptibility to measles based on the negative result of the anti-measles virus IgG blood test performed to all participants, as seen in Figure 1.

The majority of participants were male as they constituted (94.1%) of the sample. The mean age of participants was (31.35 years + 8.76 Standard Deviation (SD)). As regards nationalities encountered, more than one-third of the sample were from the Philippines (36.5%). Marital status categories were (single, married, widowed, and divorced), it was observed that (56.1%) of participants were married. Moreover, most of them have either a "secondary" or a "university or above" level of education constituting (43.9%) and (41.9%) respectively. While (55.5%) were currently seeking manual jobs. Around (42%) of them have a sufficient income to meet their routine expenses, as shown in Table 1.

Socio-demographic characteristics	Frequency (%)
Gender	
Male	397 (94.1)
Female	25 (5.9)
Age in completed years	
<25	95 (22.5)
25 - <35	196 (46.5)
35 - <45	100 9 (23.7)
≥45	31 (7.3)
Mean + SD (31.35 + 8.76) years	
Nationality	
Philippines	154 (36.5)
Sri Lanka	128 (30.3)
India	61 (14.4)
Egypt	37 (8.8)
Nepal	13 (3.1)
Other	29 (6.9)
Marital status	
Single	185 (43.9)
Married, widow or divorced	237 (56.1)
Educational level	
Illiterate	9 (2.1)
Primary	4 (1.0)
Preparatory	47 (11.1)
Secondary	185 (43.9)
University or above	177 (41.9)
Proposed job in Qatar	
Manual worker	234 (55.5)
Household worker	8 (1.9)
Technical worker	111 (26.3)
Office job	11 (2.6)
Professional	58 (13.7)
Income	
In debt	3 (0.7)
Just meet the routine expenses	177 (41.9)
Meet the routine and emergency expenses	107 (25.4)
Able to save or invest money	135 (32.0)

Table 1: Distribution of study participants according to their socio-demographic characteristics, Medical Commission, Qatar, 2014 (*n*=422).

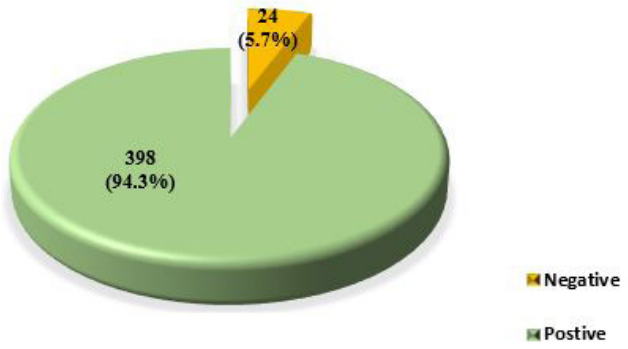

Figure 1: Distribution of study participants according to their measles sero-susceptibility status, Medical Commission, Qatar, 2014 (*n*=422).

All the participants were questioned about their housing conditions including calculation of crowding index (person/room) [17]. Table 2 shows the distribution of study participants according to their housing conditions. It was noted that more than half of the participants (53.6%) reported that they were not living together with children in the same household back home, followed by those living together with children (≥5) years of age (27%).

Housing conditions	Frequency (%)
Living together with children	
No	226 (53.6)
Yes, with children <5 years of age	82 (19.4)
Yes, with children ≥5 years of age	114 (27.0)
Type and size of their home dwelling	
Owned, with ≥4 rooms	101 (23.9)
Owned, with <4 rooms	266 (63.0)
Rented, with ≥4 rooms	5 (1.2)
Rented, with <4 rooms	50 (11.9)
Crowding index (person/room)	
≤1	141 (33.4)
>1	281 (66.6)

Table 2: Distribution of study participants according to their housing conditions, Medical Commission, Qatar, 2014 (*n*=422).

The majority of participants (63%) reported ownership of a dwelling with (<4) rooms in their home country, and only (1.2%) of them lived in a rented house with (≥4) rooms. When the crowding index was calculated, it was noted that those with a person/room ratio (>1) are around two thirds of the sample (66.6%).

Regarding distribution of the studied participants based on their calculated SES score, it was observed that more than half of them (57.6%) were in the middle socio-economic level category, while (42.2%) were categorized in the high socio-economic level category, as demonstrated in Figure 2.

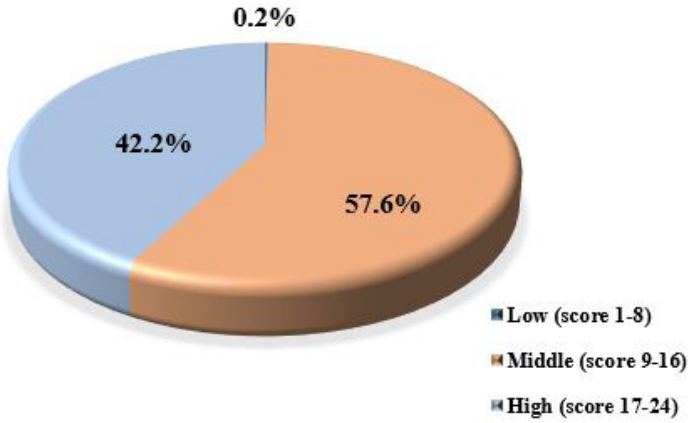

Figure 2: Distribution of study participants according to their calculated Socio-Economic Status (SES) score, Medical Commission, Qatar, 2014 (*n*=422).

Further assessing the relation between the sero-susceptibility for measles and epidemiological characteristics & housing conditions was carried out. Table 3 shows the relation between measles virus sero-susceptibility among the study participants and their socio-demographic characteristics and housing conditions.

Characteristic	Sero-susceptibility (n=422)		Total	χ^2	p value
	Yes (%)	No (%)			
Gender					
Male	23 (5.8)	374 (94.2)	397	0.14	0.576
Female	1 (4.0)	24 (96.0)	25		
Age					
<25	14 (14.7)	81 (85.3)	95		
25 - <35	10 (5.1)	186 (94.9)	196		
35 - <45	0 (0)	100 (100.0)	100	22.53	**0.000***
≥45	0(0)	31 (100.0)	31		
Nationality					
Philippines	3 (1.9)	151 (98.1)	154		
Sri Lanka	11 (8.6)	117 (91.4)	128		
India	3 (4.9)	58 (95.1)	61		
Egypt	3 (8.1)	34 (91.9)	37	7.77	0.169
Nepal	1(7.7)	12(92.3)	13		
Others	3 (10.3)	26 (89.7)	29		
Marital status					
Single	17 (9.2)	168 (90.8)	185	7.53	**0.006***
Married, widow or divorced	7 (3.0)	230 (97.0)	237		
Educational level					
Illiterate	1 (11.1)	8 (88.9)	9		
Primary	1 (25.0)	3 (75.0)	4		
Preparatory	3 (6.4)	44 (93.6)	47		
Secondary	11 (5.9)	174 (94.1)	185	3.79	0.435
University or above	8 (4.5)	169 (95.5)	177		
Proposed job (in Qatar)					
Manual worker	12 (5.1)	222 (94.9)	234		
Technical worker	7 (6.3)	104 (93.7)	111		
Household worker	0 (0)	8 (100.0)	8		
Office job / clerk /	2 (18.2)	9 (81.8)	11	3.93	0.416
Professional	3 (5.2)	55 (94.8)	58		
Income					
In debt	0 (0)	3 (100.0)	3		
Just meet routine	14 (7.9)	163 (92.1)	177		
Meet routine + emergency expenses	4 (3.7)	103 (96.3)	107	2.96	0.398
Able to save	6 (4.4)	129 (95.6)	135		
Calculated SES					
Low and Middle	14 (5.7)	230 (94.3)	244	0.00	0.958
High	10 (5.6)	168 (94.4)	178		
Living with children					
No	19 (8.4)	207 (91.6)	226		
Yes, children <5 years of age	5 (6.1)	77 (93.9)	82	10.01	**0.007***
Yes, children ≥5 years of age	0 (0)	114 (100)	114		
Crowding index (person/room)					
≤1	5 (3.5)	136 (96.5)	141	1.81	0.179
>1	19 (6.8)	262 (93.2)	281		
SES: Socioeconomic Status Score					

Table 3: Relation between measles sero-susceptibility among participants and their socio-demographic characteristics & housing conditions, Medical Commission, Qatar, 2014, (*n*=422).

Age, marital status, and living with children are statistically significant factors with the sero-susceptibility. While, nationality, education, calculated SES, and crowding index are not statistically significant to sero-susceptibility.

It was more common among males (5.8%) rather than females (4%), more common among those aged less than (25) years old (14.7%) compared to older age groups, and the difference between the groups was statistically significant (p=0.000).

Among the top five nationalities encountered in participants, the highest sero-susceptibility was in those from Sri Lanka (8.6%), Egypt (8.1%), and Nepal (7.7%). Under the category of "other nationalities," including (29) participants, there were only three sero-susceptible cases (one from each of Jordan, Morocco, & Tunisia), and the susceptibility for the whole group was (10.3%).

Susceptibility was more common among single workers (9.2%) compared to those married, divorced, or widowed (3%), and the difference found to be statistically significant (p=0.006). Additionally, more common among those having primary education (25%) and least among university education participants (4.5%).

Other socio-demographic features did not show statistical significance between groups. On the other hand, when studying some of the housing conditions of participants, it was found that those not living with young children in their home country were more immune-susceptible, and the difference was found to be statistically significant (p=0.007).

Discussion

The current study aimed to assess sero-susceptibility and epidemiological features of measles among foreign workers applying; that could help the local health authority in establishing evidence-based vaccination and control strategies, setting a target population priority, and facilitate entry into the elimination phase.

The current study revealed that among the four hundred twenty-two (422) studied foreign workers applying for the MC, measles sero-susceptibility was encountered in (5.7%) of them, and those who are confirmed to be immune (i.e., positive anti-measles IgG test), were (398) participants (94.3%) as seen in Figure 1.

A similar rate was seen in a study done during (2011) in one of Switzerland's largest prisons, where (116) inmate migrants from different countries were serologically screened against measles to implement preventive measures. They found (6%) to be sero-susceptible, all of them below the age of (30) years and concluded that susceptibility to measles was fairly low in this ethnically diverse population [18].

But in another study done in Izmir (Turkey), where a community-based serosurvey was performed including (595) participants of different age groups in (2001), the revealed sero-susceptibility was (3%) among adults of the age group (20-29) years, and higher levels of susceptibility was seen among the younger age groups. They recommended out of their results to devote more effort and resources to increase the vaccination coverage above the level of (90%) [19].

The comparable low sero-susceptibility rate was seen in a study conducted among healthcare workers in the United Kingdom during (2003), where (218) Addenbrooke's hospital employees were tested using two different techniques to detect measles IgG both from serum and oral fluid, they found (3.3%) to be non-immune. The study concluded that; although the prevalence of measles sero-susceptibility was low, with the fall in Measles Mumps and Rubella vaccine uptake and the increased likelihood of outbreaks, it is important to identify individuals at risk IgG detection through ELISA serum test is superior to the oral saliva test [20].

Regarding the relation between measles sero-susceptibility and gender, the current study showed that susceptibility is more common among males, but the relation was statistically insignificant, as seen in Table 3. A similar finding was noted in the study performed in Izmir (Turkey), where gender, as an independent characteristic, was not seen by analysis to be significantly associated with measles seronegativity [18]. In a population-based seroepidemiologic survey study in Germany (2011), males were associated with a higher but insignificant level of susceptibility [18]. In a population-based sero-epidemiologic survey study done in Germany (2011), males were associated with a higher but insignificant level of susceptibility [21]. Males were also seen as more sero-susceptible in other studies done among adults in Israel, and adolescents in Egypt [22,23]. The explanation for male predominance was not elucidated in these studies, as it cannot be attributed to a six difference or the utilization of vaccination services.

On the other hand, in a study published during (2007) in Canada (1480), adult immigrants and refugees of different ethnic backgrounds were recruited and serologically tested against measles, mumps, and rubella, their mean age±SD was (32.3±9) years. They found through a multivariable analysis adjusted for demographic and socioeconomic covariates that females were significantly more likely than males to be sero-susceptible to measles (odds ratio=2.1, 95% confidence interval=1.2-3.8). They attributed this gender inequality to what is known about females being disadvantaged concerning vaccination changes in their country of origin belonging to the developing world compared to their male counterparts [24].

In another study published in (2007) from Urmia (Iran), where the researchers used the ELISA test to examine sera of (835) subjects aged (5-25) years for detection of anti-measles IgG antibodies. They found that in the age group (21-25) years; female had higher levels of sero-susceptibility compared to males (28.3%

vs. 21%) respectively, but the difference was not statistically significant. They attributed these high levels of susceptibility in both genders to vaccine failure encountered in the local immunization programs [25].

In respect to the age of participants included in the current study and its relation to sero-susceptibility, it was seen that the younger the age group, the higher is the sero-susceptibility. Those aged (<25) years showed the highest sero-susceptibility (14.7%), and the difference between the age groups was statistically significant, as seen in Table 3. A similar significant relation was also documented between age and measles seronegativity in the study from Izmir (Turkey). Likewise, in the study from Urmia (Iran), they found that the mean of anti-measles antibody titer is significantly increasing with age, especially among those who were more than (16) years of age (i.e., susceptibility to measles decreases with age). They attributed that change to the boosting effect from repeated exposure to the wild circulation virus resulting in unapparent sub-clinical re-infection.

Alike; In a study published in (2011) from Lebanon; (502) junior medical and paramedical university students were assessed serologically for the immunity against measles; (14%) of them proved to be sero-susceptible, a rate closely similar to the current study participants < (25) years who are in the same age group as those studied in Lebanon [26].

Lower sero-susceptibility levels were reported in a study from Italy in (2007), were researchers tested (1106) health care workers and published that (8%) of them, aged < (36) years were seronegative to the anti-measles IgG by the ELISA test [27].

On the contrary; higher sero-susceptibility levels were reported from the United States; in a study conducted among adolescent and adult recruits affiliated to the United States military and published in (2008), measles seronegativity was reported to be as high as (15.4%), and they attributed that to either being not vaccinated due to vaccine rejection by their parents or to weaning of the antibody level [28]. Even higher levels of sero-susceptibility were reported among Emirati medical students attending the college of medicine and health sciences at the United Arab Emirates (UAE) University and published in (2012). Their work revealed that among the (180) junior students they serologically examined, (50) (27.8%) were sero-susceptible. They mentioned in their study that the UAE was the first among the Gulf Council of Countries (GCC) to adopt the WHO expanded program of immunization, including the measles vaccine in (1980), and accordingly childhood vaccine-preventable diseases have almost been eliminated. They attributed the high sero-susceptibility rates to possible weaning of immunity in the absence of a circulating wild virus. They offered revaccination to their students and recommended policy enforcement of measles screening to all students before joining the university and vaccination accordingly [29].

Considering the relation between measles sero-susceptibility and the marital status of participants in the current study, it was seen that susceptibility was significantly higher among those who are single (9.2%) compared to other groups, as seen in Table 3. This observation may be simply explained that singles are usually younger in age compared to those who are tied with marriage relation, including those who are currently widowed or divorced. Also, could be clarified by the possible explanation that those who are married and have children may possibly acquire measles infection from their own offspring or from their peers of the same age if parents continue to be sero-susceptible. In Table 3 it was demonstrated that those who are not living together with children in the same household were more sero-susceptible (8.4%), compared to those living with young children (<5) years (6.1%) or older children (0%), and the relation was statistically significant. This finding was inconsistent with what researchers from Izmir (Turkey) founded; as they showed in their work no statistical relation between measles sero-negativity and the marital status [18]. The possible explanation is that their study included younger adults, only up to the age of (29) years, who are more likely to be sero-susceptible compared to older adults.

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In respect to the nationality of the current study participants, there was no statistically significant relation with measles sero-susceptibility. Nevertheless, sero-susceptibility among the major nationality groups was more prominent in those from Sri Lanka (8.6%), Egypt (8.1%), and Nepal (7.7%), as seen in Table 3. In the study from Switzerland published (2011), they revealed that among the multi-nationality young cosmopolitan prison population they

examined, those from Western Europe showed the highest sero-susceptibility (25%), followed by those from North Africa (21%) and those from Eastern Europe (16%). However, none among those who came from Sub-Saharan Africa had sero-susceptibility to measles [17]. They attributed this difference to be coherent with the expected impact of vaccination campaigns and the resultant percent of vaccination coverage according to the world's region, which was published by the 63rd World Health Assembly during (2010) [30].

In comparison with the encountered world regions mentioned in the Swiss study; it is noted that in the current study there are (5) cases constituting (20.8%) of the sero-susceptible participants were from North African countries, (3) from Egypt and one from each of Morocco and Tunisia.

In the current study, as regards the high susceptibility rates seen among participants who came from Sri Lanka, the possible explanation may be related to lower rates of vaccination coverage in their home country. Which, is related to healthcare infra-structure disruption as a result of long-standing civil conflicts in the Northern and Eastern parts of Sri Lanka, described as one of the most brutal in South-East Asia and/or explained by the inappropriate low age of immunization. In Sri Lanka, the mono-measles vaccine is given at the age of (9) months, and a combined Measles-Rubella vaccine is given at the age of (3) years [31].

The high sero-susceptibility seen in the current study among Egypt participants could be attributed to either vaccine failure or low rate of second dose intake in some areas. In Egypt, the mono-measles vaccine is given at the age of (9) months, and the Measles Mumps and Rubella vaccine are given at one year of age. Nevertheless; reports from Nepal reveal rather an achieved substantial reduction in reported measles incidence and the number of confirmed measles outbreaks, with an adopted measles control strategy consisted of strengthening routine childhood immunization programs and providing a second opportunity for measles vaccination. However, outbreaks continue to occur in Nepal, and one report documented the presence of overseas cases traced back by measles viral gene-typing to returning travellers came from Nepal, causing an incidence of nine cases in western Sydney-Australia [32,33].

In respect of other socioeconomic determinants studied among foreign workers in the current study (i.e., their educational level, occupation, income, and socioeconomic status level), all were seen to be statistically insignificant with measles sero-susceptibility. A similar finding was seen in the study done in Izmir (Turley), where they found by the logistic regression analysis that only age was a significant predictor of measles among all the studied independent variables sero-susceptibility. [18] A similar result was seen in the study from Lebanon, where there was no relation between the economic status and measles sero-susceptibility [25].

In the study from Canada among refugees, their participants were well-educated (mean years of education±SD=13.9+4 years), university education was reported by (47%) and were of relatively high socioeconomic class. However, these factors were not associated with sero-susceptibility to measles [23]. The picture of these participants from Canada is similar to the characteristics of the workers studied in the current research, were (43.9%) of them got a secondary level of education, (41.9%) got a university degree or above, (57.6%) scored in the middle SES level and (42.2%) in the high. However, neither the educational level nor the SES level showed a significant relation with measles sero-susceptibility, as seen in Table 3. Calculation of the SES score was based on a scale after the (2012) updating and revalidation of the commonly used Fahmy and El Sherbini scale for health research that was initially published in (1983).

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As sero-susceptibility to measles revealed by this study is somewhat limited (5.7%) the study recommends not to screen or to vaccinate foreign new workers, and if the local health authority chooses to vaccinate any way, priority will be to those most in need i.e., males, singles, (<25) years, and is from Sri Lanka, Egypt or Nepal.

We should consider that serological testing of workers before vaccination to decide those in need requires blood drawing, waiting for results, extra cost, logistic complexity, and extra medical visits. So, this strategy would be practical only if the sero-susceptibility is high enough, and the cost of sero-testing is low enough compared with that of the vaccine, to make testing cost-effective.

Additionally, immunization with excess or unnecessary vaccines may result in an increased cost, increased potential for adverse events, and considerable inconvenience for those foreign

workers who were trying to settle down in Qatar [35].

This study was a trial to provide the national health authorities with evidence-based data that can enable them to develop vaccination and other control strategies, to set target population priorities, facilitating entry into the measles elimination phase.

Study limitations: this cross-sectional design limits the ability to document temporal relation between sero-susceptibility and the proposed determinants; it was based on an interview questionnaire where recall bias is foreseeable. Data were collected from foreign workers, but if their dependents were included (especially children below the age of (5) years), the picture would be more revealing. Sero-susceptibility was detected using the standard screening ELISA test, which still got limitations regarding its sensitivity in comparison with the Plaque Reduction Neutralization Test (PRNT) or Real-Time Polymerase Chain Reaction (RT-PCR).

Conclusion

Measles sero-susceptibility among the studied (422) foreign workers attending the MC was as low as (5.7%), generally lower than what is seen in similar studies. Sero-susceptibility was significantly higher among those who are (singles, less than (25) years, and not living together with children. Sero-susceptibility was more common among those who are (males, came from Sri Lanka, Egypt or Nepal, having primary level of education or illiterate, seeking an office/clerk/administrative job in Qatar, with home income just meets their routine expenses, belonging to low and middle socioeconomic class, living in housing condition with (>1) person/room crowding index, Screening routinely for measles in the MC is not recommended for foreign workers applying for a work permit. Vaccinating foreign workers before their arrival is not a priority, as measles sero-susceptibility among them is limited.

If it is later seen as a priority, those most in need are (males, singles, less than (25) years, and being from Sri Lanka, Egypt or Nepal). Most of them will accept vaccination when offered-encouraging the continuation of strict active surveillance for measles, including case detection, contact protection, and control to approach elimination.

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References

1. World Health Organization (2012) Global Measles and Rubella Strategic Plan: 2012.
2. van den Hof S, Meffre CM, Spaendonck MAC, Woonink F, de Melker HE, et al. (2001) Measles outbreak in a community with very low vaccine coverage, the Netherlands. Emerg Infect Dis 7: 593-597.
3. Bester JC (2016) Measles and Measles Vaccination: A Review. JAMA Pediatr 170: 1209-1215.
4. Durrheim DN, Crowcroft NS, Strebel PM (2014) Measles-The epidemiology of elimination. Vaccine 32: 6880-6883.
5. Qatar Ministry of Development Planning and Statistics (2017) Qatar Statistical Authority, Monthly Statistics: Population and Social Statistics.
6. Qatar Ministry of Public Health (MOPH) (2014) Qatar National Health Accounts Report 2014: A Baseline Analysis of Health Expenditure and Utilization.
7. Qatar Ministry of Public Health (MOPH) (2013) Notified Infectious Diseases Report-2013. Communicable Diseases Control and Health Protection (CDC&HP) Division, Department of Public Health.
8. Al-zoqari FA, A Alyafei, Omar SR, Selim NA, Singh R (2020) Knowledge & Awareness of Measles among Foreign Workers Screened for Employment in Qatar. J Community Med Public Health 4: 185.
9. Kirkwood BR, Sterne JAC (2010) Essential Medical Statistics. John Wiley & Sons.
10. Sharma G (2017) Pros and Cons of Different Sampling Techniques. Int J Appl Res 3: 749-752.
11. Siemens Healthcare Diagnostics (2012) Enzygnost® Anti-Measles Virus/Igg. Enzyme Immunoassay for the Qualitative Detection and Quantitative Determination of Specific Ig Antibodies to Measles Virus in Human Serum and Plasma. Marburg/Germany.
12. El-Gilany A, El-Wehady A, El-Wasify M (2012) Updating and Validation of the Socioeconomic Status Scale for Health Research in Egypt. East Mediterr Health 18: 962-968.
13. Fahmy SI, Nofal LM, Shehata SF, El Kady HM, Ibrahim HK (2015) Updating Indicators for Scaling the Socioeconomic Level of Families for Health Research. J Egypt Public Health Assoc 90: 1-7.
14. IBL International (2012) Anti-Measles Virus/IgG. Enzyme immunoassay for the qualitative detection and quantitative determination of specific Ig antibodies to measles virus in human serum and plasma [pamphlet]. Marburg/Germany: Siemens healthcare diagnostics products GmbH.
15. World Medical Association (1976) Declaration of Helsinki. Recommendations guiding medical doctors in biomedical research involving human subjects. Ugeskr Laeger 138: 399-400.
16. Human D, Fluss SS (2001) Declaration of Helsinki: Historical and Contemporary Perspectives. World Medical Association.
17. Nagar D, Paulus PB (1997) Residential crowding experience scale-assessment and validation. J Commun Appl Soc Psychol 7: 303-319.
18. Getaz L, Rieder JP, Siegrist CA, Kramer MC, Stoll B, et al. (2011) Improvement of measles immunity among migrant populations: lessons learned from a prevalence study in a Swiss prison. Swiss Med Wkly 141: w13215.

19. Egemen A, Aksit S, Ozacar T, Kurugol Z, Keskinoglu P, et al. (2001) Measles seroprevalence in Izmir with special emphasis on measles vaccination policy for Turkey. Pediatr Int 43: 379-384.

20. Ziegler E, Roth C, Wreghitt T (2003) Prevalence of measles susceptibility among health care workers in a UK hospital. Does the UK need to introduce a measles policy for its health care workers? Occup Med 53: 398-402.

21. Poethko-Müller C, Mankertz A (2011) Sero-epidemiology of measles-specific IgG antibodies and predictive factors for low or missing titres in a German population-based cross-sectional study in children and adolescents (KiGGS). Vaccine 29: 7949-7959.

22. Gdalevich M, Robin G, Mimouni D, Grotto I, Shpilberg O, et al. (2002) Measles antibody prevalence rates among young adults in Israel. Am J Infect Control 30: 165-169.

23. Tayil SE, El Shazly MK, El Amrawy SM, Ghouneim FM, Abou Khatwa SA, et al. (1998) Sero-epidemiological study of measles after 15 years of compulsory vaccination in Alexandria, Egypt. EMHJ-Eastern Mediterranean Health Journal 4: 437-447.

24. Greenaway C, Dongier P, Boivin JF, Tapiero B, Miller M, et al. (2007) Susceptibility to measles, mumps, and rubella in newly arrived adult immigrants and refugees. Ann Intern Med 146: 20-24.

25. Yekta Z, Porali R, Taravati MR, Salary Sh, Khalily F, et al. (2007) Measles IgG sero-prevalence and its attributable factors in 5–25-year-old cases prior mass vaccination campaign in Urmia, northeastern Iran. Iranian Red Crescent Medical Journal 9.

26. Chamat S, Salameh P, Haddad N, Berry A, Chedid P, et al. (2011) Protection of medical and paramedical university students in Lebanon against measles, mumps, rubella and varicella: active measures are needed. J Infect Public Health 4: 125-134.

27. Porru S, Campagna M, Arici C, Carta A, Placidi D, et al. (2007) Susceptibility to varicella-zoster, measles, rosacea and mumps among health care workers in a Northern Italy hospital. G Ital Med Lav Ergon 29: 407-409.

28. Eick AA, Hu Z, Wang Z, Nevin RL (2008) Incidence of mumps and immunity to measles, mumps and rubella among US military recruits, 2000-2004. Vaccine 26: 494-501.

29. Sheek-Hussein M, Hashmey R, Alsuwaidi AR, Al Maskari F, Amiri L, et al. (2012) Seroprevalence of measles, mumps, rubella, varicella-zoster and hepatitis A-C in Emirati medical students. BMC Public Health 12: 1047.

30. World Health Organization (2010) Global Eradication of Measles: Report by the Secretariat. Geneva, Switzerland.

31. Parameswaran A, Wijesinghe PR (2012) Was there a disparity in age appropriate infant immunization uptake in the theatre of war in the North of Sri Lanka at the height of the hostilities?: a cross-sectional study in resettled areas in the Kilinochchi district. BMC Int Health Hum Rights 12: 26.

32. Yadav DK, Shukla GS, Shrestha N, Gupta N, Dayal A, et al. (2018) Child Health Policy, Program and Gaps in Nepal.

33. Weston KM, Dwyer DE, Ratnamohan M, McPhie K, Chan SW, et al. (2006) Nosocomial and Community Transmission of Measles Virus Genotype D8 Imported by a Returning Traveller from Nepal. Commun Dis Intell Q Rep 30: 358-365.

34. Fahmy SI, El Sherbini AF (1983) Determining Simple Parameters for Social Classifications for Health Research. Bull High Inst Public Health 13: 95-108.

35. Feikema SM, Klevens RM, Washington ML, Barker L (2000) Extraimmunization among US children. JAMA 283: 1311-1317.