

Healthcare Workers' Preparedness: An Exploratory Study for Measles Control in a Middle-Income Country

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Background: Healthcare workers (HCWs) should have an active role in measles control. **Objective:** This study aimed to assess the HCWs' measles immune status and its influencing factors; to measure their knowledge, attitude, and practice toward measles infection/vaccination; and to identify factors predicting their vaccination status. **Methods:** Data were collected using a semi-tailored questionnaire. Immunoglobulin G against measles was measured. Regression analysis for measles vaccination was performed. **Results:** Approximately 97 HCWs (93.3%) were seropositive, 79 (76.0%) were vaccinated, 18 (17.3%) were previously infected, and 9 (8.7%) were both vaccinated and previously infected. One previously vaccinated participant was seronegative. The immune status was associated with marital status, residence, work duration, infection control training, and wearing personal protective equipment. Positive attitudes and practices were reported. Marital status and infection control training were predictors for measles vaccination. **Conclusion:** HCWs showed readiness to control the spread of measles. National policies for compulsory HCWs' vaccination and immune status check before training and employment are required. **Keywords:** measles, healthcare workers, vaccination, middle-income countries, infection control

Introduction

Healthcare workers (HCWs), by occupational exposure, have a higher risk of both acquiring and spreading serious vaccine-preventable diseases to vulnerable patients and colleagues. The World Health Organization (WHO) estimates that approximately 59 million HCWs worldwide are potentially exposed to hazardous biological agents every day.¹ When a disease can be transmitted through humans, as in the case of measles, vaccination is considered as the most important primary prevention strategy, with extended effect to HCWs' colleagues and patients.¹ Measles is a highly infectious disease that can transmit measles virus to 75–90% of susceptible contacts² with a reported higher risk among nonimmune HCWs compared to that of the general population.³ Recently, outbreak events were reported, in Egypt and worldwide, characterized by the nosocomial transmission of measles with subsequent infection of HCWs.^{4,5}

World Health Organization (WHO) defined measles elimination as the absence of endemic measles transmission in a defined geographical area for at least 12 months. Meanwhile, eradication is defined as the worldwide interruption of measles virus transmission in the presence of a surveillance system that has been verified to be

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performing well.⁶ In 2015, Egypt endorsed the 2016–2020 Eastern Mediterranean Vaccine Action Plan as a framework for the implementation of the Global Vaccine Action Plan in countries of the region. It included immediate measles elimination and interruption of endemic measles virus transmission, latest by 2020.⁶ Measures for measles containment action plan in hospital settings include early and accurate case diagnosis, prevention of infection transmission, and protection of HCWs and other hospital staff.⁷

Being the only reliable protection against the nosocomial spread of measles, especially for susceptible HCW, vaccination against measles is strongly recommended by international and national health authorities.⁴ Live attenuated measles vaccines, either monovalent vaccine or measles-containing vaccine in combination such as combined measles–rubella vaccine, measles–mumps–rubella (MMR) vaccine, or measles–mumps–rubella–varicella vaccine, induce lifelong immunity.⁸ At least 98% of those receiving two doses of MMR vaccine are protected against the disease.⁹ Vaccine-induced antibody concentrations decrease over time and may become undetectable. However, immunological memory persists and, following exposure to measles virus, most vaccinated people produce a protective immune response.⁸

Globally, measles immunization coverage has improved steadily since 1990, to reach 83% in 2008. The lowest rates were in the WHO South-East Asia (75%) and African (73%) regions.¹⁰ Low measles vaccination coverage was reported in several studies.^{8,9} The World Health Organization (WHO) recommends a threshold of 95% immunization coverage to achieve so-called “herd immunity.” However, by the end of 2018, the global coverage of the first dose of the measles vaccine was reported at 86%, the second dose is much lower, at 67%. In the past 8 years, over 20 million children worldwide missed out on measles vaccine annually, creating a pathway to current global outbreaks especially in low- and middle-income countries.¹¹

Healthcare workers are often referred to be the most confident source of immunization-related data for their patients and associates. They are considered in the best position to understand hesitant patients and to find ways of explaining the benefits of vaccination. However, in some instances, healthcare workers themselves can be vaccine-hesitant, they even do not recommend the vaccine for their patients. Hence, HCWs should not only be vaccinated with a documented evidence of measles immunity, but they should also be encouraged to have an active role in measles control.¹²

Although the Expanded Program of Immunization (EPI) in Egypt has achieved several successes in controlling vaccine-preventable diseases with coverage of over 90%, challenges still exist with measles outbreaks occurring in 2013 and 2014, and the increasing need for continuous surveillance.¹³ This study aimed to assess the HCWs’ measles immune status and its influencing factors; to measure their knowledge, attitude, and practice toward measles infection, potential exposure, and vaccination; and to identify factors predicting the vaccination status of the HCWs.

Materials and Methods

Study Design and Settings

A cross-sectional study was conducted from October 10, 2018, to March 10, 2019, at the Pediatric Department of Zagazig University Hospital, Zagazig City, Egypt. Participants’ workup was performed at Medical Microbiology and Immunology Laboratories, Faculty of Medicine, Zagazig University.

Study Population and Sampling Technique

The HCWs of the Pediatric Department of Zagazig University Hospital were invited to participate in this study. The sample size was calculated to be 137 HCWs. Calculations have been performed using the sample size software online (available at <http://sampsizе.sourceforge.net/iface/#prev>) for prevalence studies.¹⁴ The total number of HCWs at the Pediatric Department was 260, assuming a seroprevalence of immunoglobulin G (IgG) against measles of 75%¹⁵ at a confidence interval of 95% and power of test of 80%. Sample selection was performed using a simple random sampling technique.

Announcement and invitation for participation in the study were sent via email and delivered at the workplace for all HCWs working at the Pediatric Department of Zagazig University Hospital. This was followed by another two reminders to increase the participants’ response rate.

Data Collection Tools

The data were collected by the researchers using a semi-tailored questionnaire adapted from previous similar studies.^{1,16,17}

The questionnaire was translated into Arabic by a bilingual coinvestigator and back-translated by another bilingual expert to ensure validity. Before the start of the study, the questionnaire has been tested on 10 HCWs to determine if there were any ambiguity or items leading to

misunderstanding in the questionnaire to reach its final form. The necessary corrections, modifications, and rewording after considering any minor differences and discrepancies have been performed to ensure clarity of all questions and ease of understanding. The reliability coefficient test (Cronbach's alpha) was >0.72 for all questions.

The questionnaire consisted of three parts:

First Part

Questions on sociodemographic and occupational information of the participants such as age, gender, marital status, having children, residence (eg, urban or rural), occupation (medical and paramedical personnel), and current job duration.

Second Part

Questions on the history of measles exposure, past infection, and vaccination.

Third Part

Questions on knowledge, attitude, and practice of participants toward measles infection and immunization.

Procedures

Immunological Investigations

To assess the immune status of the study participants against measles, IgG against measles was measured using Enzygnost[®] Anti-Measles Virus/IgG (Siemens Healthcare Diagnostics Products, Germany). A 2-mL blood was collected under complete aseptic conditions. All steps were performed according to the enzyme-linked immunosorbent assay kit protocol. Photometric evaluation of the samples was performed using a measuring wavelength of 450 nm with Enzygnost[®] Anti-Measles Virus/IgG. Samples containing approximately 150 mIU/mL were found to be within the range of 0.100 to 0.200 ΔA . Anti-Measles Virus/IgG negative $\Delta A < 0:100$ (cutoff value). Anti-MeaslesVirus/IgGpositive $\Delta A > 0:200$. HCWs with negative measles IgG were informed about the results and were offered immunization with either a measles vaccine or MMR vaccine according to the availability of the vaccine and the HCWs' sex (MMR vaccines were used for women).

Data Management

Data were coded, entered, and analyzed using the Statistical Package for the Social Sciences (SPSS) version 21.0 (SPSS, Chicago, IL, USA). Quantitative data were represented as a mean and standard deviation (SD), and qualitative data were represented as frequencies and percentages. The

independent Student's *t*-test was used to determine the significance of differences between the two continuous variables, and the chi-squared test was used to assess for differences in the categorical variables. Logistic regression analysis was performed to determine the factors predicting the measles vaccination of the participants. The test results were considered significant when *p*-value <0.05 .

Ethical Considerations

This study was approved by the Zagazig University's Institutional Review Board No: 5518-9-9-2019. Participation was voluntary, and written informed consent was obtained from all the participants after describing the aim of the study. Privacy and confidentiality were assured.

Results

Out of the 137 selected HCWs, 104 participated in the study with a response rate of 75.9%. The age of the participants ranged from 19 to 52 years old with a mean \pm SD of 33.8 ± 10.79 . More than three-quarters of HCWs were female (82.7%), married (76.9%), had children (73.1%), and lived in urban areas (76.9%). Regarding the occupational data, more than half of HCWs (56.7%) were nurses, 35.6% were physicians, and the rest of them (7.7%) were paramedical personnel (technician/nonmedical staff). Most of the HCWs were working for more than 10 years (79.8%) and only 20.2% for less than 10 years.

Regarding the history of measles exposure, infection, and vaccination of the participants, approximately 26% of HCWs had a history of measles infection, 76.9% were vaccinated, 93.8% were vaccinated for >10 years, and all of their children had received measles vaccine. Only 5.8% had clinically managed a measles patient recently, and 11.5% had increased temperature or reported skin rash over the past week.

Out of the total 104 HCWs, 97 (93.3%) were seropositive and 7 (6.7%) were seronegative for measles. The seropositive HCWs were distributed either as vaccinated only (79/76.0%), previously infected only (18/17.3%), or both vaccinated and previously infected (9/8.7%). Among the previously vaccinated ($n=80$) HCWs, there was one participant who showed a seronegative status for measles (Figure 1).

Table 1 demonstrates a statistically significant difference between seropositive and seronegative HCWs in the following factors: marital status, residence, work duration, previous infection control training courses, and wearing personal protective equipment (PPE), specifically mask N95, while dealing with measles patients.

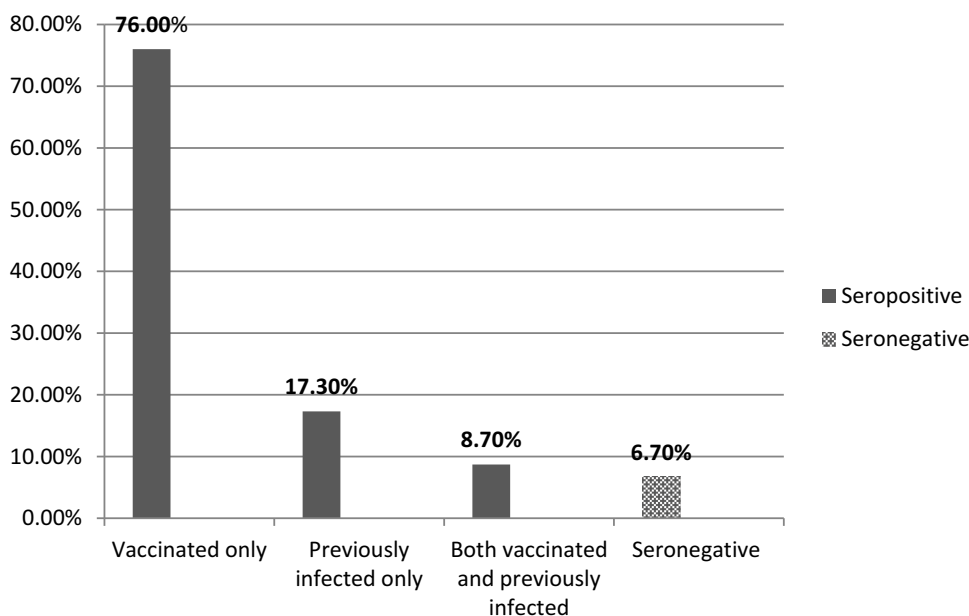


Figure 1 Seroprevalence of IgG against measles among HCWs.

Participants were asked about measles infection, transmission, and vaccination (Table 2). A significant variation was observed among HCWs about the mode of transmission. Although all of them were aware that measles is a contagious disease, the virus can spread from children to HCWs, can cause complications, and can be prevented by administering the vaccine, only 7.7% of HCWs were aware that measles virus could not be transmitted by food. Regarding the infectivity period, 69.2% of them thought the measles patient to be a source of infection of the offenders before the onset of rash, and 15.4% of HCWs considered the measles patient as not a source of infection for the offenders only after the emergence of skin rash.

Table 3 describes the participants' attitude and practice toward measles infection and vaccination. A high percentage of positive attitudes and practices was reported such as the following: advising the mothers of children to take the measles vaccine and take a complementary dose; believing that measles vaccine should be compulsory for the HCWs; believing that measles vaccine has to be taken even if infection control measures are followed; wearing PPE, specifically mask N95, while dealing with patients; taking infection control training course in hospitals for measles prevention; and readiness in taking training course for those who were not trained (92.3%, 86.5%, 81.7%, 73.1%, 73.1%, and 71.4%, respectively). More than two-thirds of the participants (67.3%) agreed that it is

important to check their immune status against measles and (60.6%) to isolate measles patient in a single room in the hospital.

Table 4 shows that marital status and taking infection control training courses are statistically significant predicting factors influencing the measles vaccination status among the investigated HCWs ($p < 0.05$).

Discussion

Measles vaccination of healthcare workers is an efficient mean of prevention of nosocomial measles outbreaks and could contribute to eliminate measles in the general population. Adults over 20 years old have a higher risk of severe or fatal measles than adults less than 20 years old.¹⁸ HCWs' vaccination recommendations work better if they are focused on specific HCWs' groups and appropriate diseases such as measles.¹⁹ As measles is a common childhood illness, the current study targeted HCWs at the pediatric hospital, the place where measles-infected children visit very frequently.

The measles vaccine is fundamental for susceptible HCWs as in recent years the epidemiology of these diseases has changed, involving a significant number of adults and elderly individuals instead of children.²⁰ Little attention is paid by HCWs to the importance of receiving vaccination against measles. This was evident in a previous Egyptian study (32.8%).¹⁷ In a previous report, about 61.6% of Italian HCWs do not believe that the measles vaccine should be

Table 1 Factors Affecting the Immune Status of the Study Participants Against Measles

Characteristics	Immune Status Against Measles				Test of Sig.	P-value
	Seropositive (n=97)		Seronegative (n=7)			
Age (years): Mean ± SD	34.19±10.89		28.4±8.01		t=1.37	0.17
Gender	No	%	No	%	$\chi^2=0.66$	0.41
Male	16	16.5	2	28.6		
Female	81	83.5	5	71.4		
Marital Status:					$\chi^2=9.8$	0.002*
Unmarried	19	22.7	2	28.6		
Married	78	77.3	5	71.4		
Residence:					$\chi^2=4.91$	0.03*
Rural	20	20.6	4	57.1		
Urban	77	79.4	3	42.9		
Job:					$\chi^2=0.79$	0.67
Physicians	34	35.1	3	42.9		
Nurses	56	57.7	3	42.9		
Paramedical personnel	7	7.2	1	14.3		
Current job duration:					$\chi^2=6.36$	0.01*
<10ys	17	17.5	4	57.1		
≥10ys	80	82.5	3	42.9		
Take infection control training courses					$\chi^2=7.56$	0.006*
Yes	74	76.3	2	28.6		
No	23	23.7	5	71.4		
Wear PPE (especially mask N95) while dealing with measles patients?					$\chi^2=14.17$	0.001*
Yes	75	77.3	1	14.3		
No	14	14.4	3	42.9		
Sometimes	8	8.2	3	42.9		

Note: *Significant value= $p<0.05$.

Abbreviation: PPE, personal protective equipment.

mandatory to HCWs. Fortunately, this study showed a significantly higher vaccination rate (76.9%). This might be attributed to the target group in the current study who works at the pediatric hospital with more readiness to protect themselves from measles infection; a prevalent disease among children.

Susceptible HCWs who work in patient care are at high risk of becoming a source for disease transmission among

patients.¹⁸ In the present study, testing seroprevalence IgG against measles among HCWs revealed that 6.7% were seronegative and hence were susceptible to measles infection. Measles vaccine unresponsiveness could be explained by host or vaccine-related factors. Actually, 2–10% of individuals fail to raise antibody levels to routine vaccines. Immune and health status as well as genetic factors are important key players. Vaccine-related ones include inadequate attenuation, wrong route or interrupted schedule and interruption of cold chain.^{21–24} In Egypt, measles vaccine was introduced as a compulsory vaccine to children at the age of 9 months, in which the vaccine might interfere with maternal Abs. In response, this time has been changed later to be at 12 months.^{22–24} In the current study, only one participant showed a seronegative response, despite being vaccinated. When interviewed, he stated that he only received one dose of the vaccine and forgot the second one.

Disseminating data about the current vaccine non-responsiveness status supports the importance of complying with the recent Centers for Disease Control and Prevention recommendation; the use of N95 or equivalent respirator for suspected measles cases regardless of the immunity status. This is because, in several instances, HCWs may be unaware of their immune status. Thus, they expose themselves to significant risk, and they mostly have a false sense of security when they deal with a suspected case.²⁵

Comparing the characteristics of nonimmune HCWs with that of immune ones, the results showed that most of them, excluding medical doctors, are nonimmune. The junior ones and those who did not take measles prevention and control course showed the highest percentages of non-immunity. This could be significantly helpful for hospital managers to select the target groups for any proposed vaccination campaigns. It emphasizes the importance of a preemployment and training assessment of immune status against measles. In 2019, the World Health Organization (WHO) reports confirmed that proof/documentation of HCWs' immunity or immunization to measles should be required as a pretraining and employment requirement.²⁶

Good knowledge is associated with a positive attitude, which was evident in the present study. Participants' knowledge about the routes of transmission is still insufficient, which was reflected in the improper practice and attitude toward patient isolation and protective clothing. All of the HCWs are well aware of the significance and effects of measles and the possible risk of acquiring the infection from their patients and vice versa. A finding was confirmed regarding their willingness to take training

Table 2 Knowledge of HCWs Regarding Measles Infection and Vaccination

Variables* (The Correct Answer)	Frequency (n=104)	%
Measles is a contagious disease? (Yes)	104	100.0
Measles is caused by a virus? (Yes)	84	80.8
Measles virus transmitted from one patient to another through the airborne route? (Yes)	80	76.9
Measles virus can be transmitted by food? (No)	8	7.7
Measles virus can be transmitted by contact or by using the patient's instruments? (Yes)	84	80.8
Measles virus can be transmitted from mother to fetus? (Yes)	60	57.7
Measles virus can be transmitted from the doctor/nurse to the children? (Yes)	100	96.2
Measles virus spread from children to health workers? (Yes)	104	100.0
High fever and rash are of the measles symptoms? (Yes)	100	96.2
Measles can cause complications and health problems? (Yes)	104	100.0
Measles can be prevented by giving the vaccine? (Yes)	104	100.0
Measles vaccine is one of the WHO recommended vaccinations for HCWs? (Yes)	86	82.7
Measles vaccine can give lifelong immunity? (Yes)	64	61.5
Pregnant woman can take measles vaccine? (No)	76	73.1
Measles outbreak/epidemic can occur? (Yes)	92	88.5
Is there a cure for measles? (Yes)	88	84.6
Is the measles patient a source of infection of the offenders before the onset of rash? (Yes)	72	69.2
Is the measles patient a source of infection for the offenders only after the emergence of skin rash? (No)	16	15.4

Note: *Proportions of HCWs answered correctly statements regarding measles infection and vaccination were calculated.

Table 3 Attitude and Practice of HCWs Regarding Measles Infection and Vaccination (N=104)

Questions	Agree/Done	
	No	%
Do you advise the mothers of children to take the measles vaccine and take a complementary dose?	96	92.3
Do you think it should be a compulsory vaccine for HCWs?	90	86.5
Do you believe that vaccine have to be taken even if infection control measures are followed?	85	81.7
Do you wear personal protective clothing while dealing with patients (especially mask N95)?	76	73.1
Did you take the infection control training course in hospitals for measles prevention?	76	73.1
For not trained (Are you ready to take this training course? (n=28))	20	71.4
Do you think it is important to check for immune status against measles?	70	67.3
Do you isolate measles patient in a single room?	63	60.6

courses about prevention (61.0% are already trained, and the majority of the untrained HCWs are ready to take training courses). However, HCWs have insufficient knowledge regarding the infectivity period (15.4% only knows the right answer); hence, this should be taken into consideration in future training and educational session.

All participants are aware that the vaccine prevents measles; however, 82.7% know that it is recommended by the WHO for HCWs, and 61.5% only knows that it gives lifelong immunity. Approximately 86.5% have a positive attitude toward a compulsory vaccine for HCWs. Similar results were reported from other studies.^{1,17,27} A previous study reported low immunization coverage among HCWs and attributed this finding to personal decisions and not immunization strategies.¹⁹ Vaccine hesitancy to measles

vaccine could be related to false beliefs about the vaccine; some accused it of causing autism, measles and even death. An important other factor is the lack of knowledge and awareness of vaccine role in preventing measles outbreaks. Previous vaccination side effect (bad experience) is also considered another contributor to vaccine hesitancy. Most successful interventions are based on education and improving knowledge about vaccine safety, effectiveness, or the need for vaccines.²⁸⁻³⁰ Logistic regression analysis demonstrated that marital status and taking infection control training courses are statistically significant predicting factors influencing the measles vaccination status among the investigated HCWs.

Indeed, changing the vaccine safety message directed to HCWs to highlight the benefits they will gain from being

Table 4 Regression Analysis for Predicting Factors Affecting Measles Vaccination Among the Investigated HCWs

Variables	OR (95% CI)
Age	0.959 (0.880–1.046)
Gender	0.492 (0.081–3.001)
Residence	0.353 (0.072–1.730)
Marital status	0.025 (0.003–0.215)*
Job	1.77 (0.620–5.092)
Current job duration	0.343 (0.062–1.899)
Taking infection control training courses	0.182 (0.046–0.726)*
Wearing PPE (especially mask N95) while dealing with measles patients	0.664 (0.280–1.571)

Note: * $p < 0.05$: Statistically significant.

Abbreviations: OR, odds ratio; CI, confidence interval.

vaccinated is urgently required to ensure a better vaccination rate in the near future. Although vaccination without screening is cost-effective, the costs should not be solely calculated upon the direct costs of vaccination procedure (vaccine price and administration cost). There are other aspects regarding the indirect costs of vaccination associated with lost work time and potential side effects of the vaccine and their consequent costs (medical care costs including healthcare provider visits, investigations and treatment).^{31–33} This could be helpful for the healthcare authorities to promote another appropriate message for the selected target groups, so they could achieve a better coverage for vaccination campaigns.

Conclusion

Good vaccination rate, good knowledge level, and positive attitude and practice are evident among HCWs with readiness to control measles spread in their hospital. However, collaborative efforts should be exerted to fill in the insufficient knowledge reflected on negative attitudes toward vaccine and control measures. A new articulated vaccine safety message should be directed to HCWs. National policies should be formulated to support the compulsory vaccination and immune status check before HCWs' training and employment in healthcare facilities. Different HCWs' groups should be targeted by future studies on a wider scale.

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Disclosure

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