*Original Article*

# Seroprevalence of Measles, Mumps and Rubella Antibodies in Thai University Hospital Healthcare Workers

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***Background:*** Measles, mumps, and rubella are highly contagious respiratory viruses. Healthcare workers (HCWs) are at high risk for infection and transmission to other HCWs and patients.

***Objective:*** To study the seroprevalence of measles, mumps, and rubella antibodies in HCWs at Thammasat University Hospital, Thailand.

***Materials and Methods:*** This was a descriptive, cross-sectional study in 2017. IgG specific antibodies were measured in serum samples from HCWs: measles and mumps were assessed with an enzyme-linked immunosorbent assay kit, rubella using chemiluminescent microparticle immunoassay.

***Results:*** One hundred and forty HCWs participated: 21 doctors (15%), 73 nurses (52.14%) and 46 other employees (32.86%). The mean age was 29.2±6.36 years: range 20 to 57 years. The prevalence of immunity against measles was 129 (92.14%), rubella 126 (90%) and mumps 82 (58%). Older HCWs had significantly greater seroprevalence for measles ($p$ = 0.002) and mumps ($p$ = 0.033). Previous measles/measles-containing vaccines history had no statistical correlation with immunological status; 10/74 HCWs (13.51%) <29 years of age who had received 2 doses of measles/measles-containing vaccines in line with the EPI (Expanded Program on Immunization) and no later boosters showed no measles immunity.

***Conclusion:*** Mumps antibody seroprevalence was lower than that of measles and rubella. HCWs without immunity to measles and mumps were found in the younger cohort. Despite having previous measles/measles-containing vaccines, HCWs should receive a booster before employment.

***Keywords:*** Antibody, Measles, Rubella, Mumps, Healthcare workers

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Measles, mumps and rubella are transmitted by inhaling droplets or coming into contact with patient respiratory secretions. These infections remain contagious while patients are asymptomatic. Should medical personnel lacking antibodies come into contact with those infected, these workers will most likely contract the diseases and spread contagion to colleagues as well as other patients. Measles, in particular, is easily and quickly transmitted with occasional epidemics found among hospital staff in medical and public health education institutes.

Under the Expanded Program on Immunization (EPI), Thailand's Ministry of Public Health commenced measles vaccinations in 1984 for 9-month old children and provided a second set of vaccinations for Grade 1 students in 1996. In 1997, Grade 1 students were shifted to the measles-mumps-rubella (MMR) vaccine, then in 2010, children aged 9 to 12 months were switched to MMR vaccine as well. Rubella immunization was first provided to girl aged 12-year who were in Grade 6 students during 1986 to 1998 and later to all Grade 1 students during 1993 to 1996; this protocol was subsequently eliminated with the aforementioned MMR vaccine system of 1997[(1)]. Currently, 96% of the country is covered by first MMR vaccinations and 87% by the second set[(2)].

The National Advisory Committee on Immunization Practice in Thailand recommends 4 vaccines for healthcare workers (HCWs): hepatitis B, influenza, MMR, and varicella. Nonetheless, some HCWs remain unvaccinated or have incomplete vaccinations. Having adequate immunity to measles, mumps and rubella is a major part of infection control for HCWs, but few studies have been conducted on the prevalence of immunity to these infections among Thai HCWs.

Studies published between 1994 and 2013 regarding European HCWs reported a median of 6.0% (range 3.3% to 14%) as seronegative to measles, including those who had a history of measles vaccination and/or history of measles disease. The seronegative rate of measles antibody increased to 9.2% in the Middle East, 10% in Asia and the Western

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Pacific but was lower to 3.5% in a 1990 South African study[3]. In 2015, Finnish pediatric HCWs displayed detectable measles, mumps and rubella antibodies at 81.5%, 89.2% and 93%, respectively: poor correlation between reported vaccination history and detected antibody levels was noted[4]. In 152 primary healthcare centers in Greece, 25% of HCWs were susceptible to mumps[5]. Earlier studies in American HCWs also recorded mumps susceptibility rates of 8 to 13%[6,7]. Seroprevalence of rubella antibodies were 97.2% of HCWs. Workers aged <30 years were at high susceptibility[8].

We thus aimed to assess the seroprevalence of measles, mumps and rubella among HCWs at Thammasat University Hospital, Thailand, in hope of using this data to support appropriate planning for MMR immunization of our HCWs.

## Materials and Methods

This was a descriptive cross-sectional hospital-based study conducted among 140 volunteers HCWs at Thammasat University Hospital during 2017. Volunteers had blood samples taken to measure measles IgG antibodies by the ELISA method CHORUS® MEASLES IgG kit, sensitivity 100% and specificity 86%. Mumps IgG antibodies were tested by the ELISA method CHORUS® MUMPS IgG kit, sensitivity 98% and specificity 67%. Rubella IgG antibodies were measured by chemiluminescent microparticle immunoassay ARCHITECT® Rubella IgG kit, sensitivity 98.4% and specificity 99%.

Results for measles and mumps were classified as seropositive if the optical density (OD) was >1.2 and negative if <0.9; equivocal OD values between 0.9 and 1.2 were also considered negative. The seropositive cutoff value for rubella was ≥10.0 IU/mL and negative at 0.0 to 4.9 IU/mL; equivocal values between 5.0 and 9.9 IU/mL were also considered negative. The study protocol was approved by the Ethics Review Committee of the Faculty of Medicine, Thammasat University.

### *Statistical analysis*

Results were displayed as percentages of seroprevalence for measles, mumps and rubella antibodies, with relationships between measles, mumps and rubella antibodies and age, vaccination history and duration of work in hospitals described. Relationships between factors were examined using Chi-square test: results were considered significant when $p<0.05$.

## Results

Data was collected from 140 volunteers: 128 women (91.43%) and 12 men (8.57%). HCWs were aged 20 to 57 years: mean 29.2 ± 6.36. There were 21 doctors (15%), 73 nurses (52.14%) and 46 other workers (32.86%). Fifty-seven HCWs worked in the Outpatient Department (40.71%) and 83 in Inpatient (59.29%). Most, 100 HCWs (71.43%), had worked at the hospital for less than 6 years, 23 (16.43%) for 6 to10 years, and 17 (12.14%) for 10 years or more. Eight workers (5.71%) self-reported they had been ill with mumps, 1 (0.71%) had rubella, while none stated they ever had measles (Table 1). In our study, 129 HCWs were found to have measles antibodies (92.14%), 82 had mumps antibodies (58%), and 126 had rubella antibodies (90%).

For Outpatient Department HCWs, 51 (89.47%) exhibited measles, 37 (64.91%) mumps, and 53 (92.98%) rubella antibodies. In our Inpatient Department 78 (93.98%), 45 (54.22%) and 73 (87.95%) of HCWs had measles, mumps and rubella antibodies, respectively. No differences in seroprevalence of antibodies were seen between departments (Table 2).

Within the 100 HCWs who had worked for less than 6 years, 90 (90%) displayed measles, 53 (53%) mumps, and 86 (86%) rubella antibodies. For the 23 HCWs who worked for 6 to 10 years, 22 (95.65%) were found to have measles, 16 (69.57%) mumps, and all 23 had (100%) rubella antibodies; of those 17 who worked for >10 years, all 17 (100%) had measles, 13 (76.47%) mumps, and all 17 (100%) displayed rubella antibodies. In sum, HCWs who had been employed at our institution longer showed higher trends of

**Table 1.** Demographic data of healthcare workers

| Characteristic | n = 140 (percent) |
|---|---|
| Gender | |
| Male | 12 (8.57) |
| Female | 128 (91.43) |
| Age (years) | |
| <26 | 45 (32.14) |
| 26 to 30 | 46 (32.86) |
| 31 to 35 | 24 (17.14) |
| 36 to 40 | 18 (12.86) |
| >40 | 7 (5.00) |
| Department | |
| Outpatient | 57 (40.71) |
| Inpatient | 83 (59.29) |
| Work duration at hospital | |
| <6 years | 100 (71.43) |
| 6 to 10 years | 23 (16.43) |
| >10 years | 17 (12.14) |
| Infection history | |
| Measles | 0 (0) |
| Mumps | 8 (5.71) |
| Rubella | 1 (0.71) |

**Table 2.** Seroprevalence of measles, mumps and rubella antibodies in healthcare workers by department

| Department | Rate of healthcare workers with antibodies | | |
|---|---|---|---|
| | Measles n (%) | Mumps n (%) | Rubella n (%) |
| Outpatient (n = 57) | 51 (89.47) | 37 (64.91) | 53 (92.98) |
| Inpatient (n = 83) | 78 (93.98) | 45 (54.22) | 73 (87.95) |
| *p*-value | 0.355 | 0.226 | 0.400 |

measles, mumps and rubella antibodies: duration of work was significantly related to rubella ($p$ = 0.049) and mumps (0.019) antibodies (Table 3).

Older HCWs were more likely to have measles, mumps and rubella antibodies than younger ones. Significantly larger numbers of older HCWs were found to have measles ($p$ = 0.002) and mumps (0.033) antibodies versus younger HCWs; in addition, a greater amount of older HCWs showed rubella antibodies ($p$ = 0.155) but not statistical significant (Table 4).

Table 5 displays measles, mumps and rubella antibodies from HCWs categorized by history of measles/measles-containing vaccines according to the EPI and subsequent booster vaccinations. A history of measles/measles-containing vaccines was not statistically related to measles, mumps and rubella antibodies. Ten older HCWs (aged 34 to 44 years) with no history of any measles/measles-containing vaccines had 100% immunity against measles, 100% against rubella and 80% against mumps.

Thirty-two HCWs were born prior to 1984, before measles/measles-containing vaccinations were introduced into the EPI. In this group, there are 22 HCWs (68.75%) who received 1 to 2 booster doses of measles/measles-containing vacciness later. The study found that all HCWs >33 years old have immunity against measles. There were 28 HCWs between the ages of 29 to 33 years; this is the age of receiving 1 dose of measles/measles-containing vaccines in the EPI. Three of these HCWs reported receiving measles/measles-containing vaccines boosters later; 1 worker in this age group had no immunity to measles and had not received a booster. Finally, our last cohort grouped by age received 2 doses of measles/measles-containing vaccines as directed by the EPI, as they were under 29 years old. Of the 79 HCWs in this set, 5 received measles/measles-containing vaccines boosters later. The remaining 74 HCWs did not have boosters, and 10 (13.51%) were found to have no immunity against measles.

**Table 3.** Measles, mumps and rubella antibodies of healthcare workers by employment duration

| Employment duration | Rate of healthcare workers with antibodies | | |
|---|---|---|---|
| | Measles n (%) | Mumps n (%) | Rubella n (%) |
| <6 years (n = 100) | 90 (90) | 53 (53) | 86 (86) |
| 6 to 10 years (n = 23) | 22 (95.65) | 16 (69.57) | 23 (100) |
| >10 years (n = 17) | 17 (100) | 13 (76.47) | 17 (100) |
| $p$-value | 0.463 | 0.019 | 0.049 |

**Table 4.** Measles, mumps and rubella antibodies of healthcare workers by age

| Age | Rate of healthcare workers with antibodies | | |
|---|---|---|---|
| | Measles n (%) | Mumps n (%) | Rubella n (%) |
| <26 years (n = 45) | 36 (80) | 22 (48.89) | 39 (86.67) |
| 26 to 35 years (n = 70) | 68 (97.14) | 40 (57.14) | 62 (88.57) |
| >35 years (n = 25) | 25 (100) | 20 (80) | 25 (100) |
| $p$-value | 0.002 | 0.033 | 0.155 |

**Table 5.** Measles, mumps and rubella antibodies of healthcare workers by history of measles/measles containing vaccination

| History of measles/measles containing vaccination | Rate of healthcare workers with antibodies | | |
|---|---|---|---|
| | Measles n (%) | Mumps n (%) | Rubella n (%) |
| None (n = 10) | 10 (100) | 8 (80) | 10 (100) |
| 1 dose (n = 47) | 46 (97.87) | 31 (65.96) | 44 (93.62) |
| 2 doses (n = 78) | 68 (87.18) | 40 (51.28) | 68 (87.18) |
| 3 doses (n = 5) | 5 (100) | 3 (60) | 4 (80) |
| $p$-value | 0.168 | 0.198 | 0.340 |

## Discussion

HCWs are at greater risk for measles, mumps and rubella than the general population, particularly for measles with its facile airborne transmission. In countries with measles epidemics, HCWs were 19 times more likely to be infected with measles than ordinary people[9], and often these HCWs do not have measles vaccinations[10]. For our HCWs, mumps antibody levels were the lowest (58.57%), compared to measles (92.14%) and rubella (90%). Previous studies show MMR vaccines create mumps antibodies the least coupled with lowest efficacy in mumps prevention.

Providing 2 doses of MMR vaccinations revealed an efficacy for mumps prevention of 31 to 95%[11-13]. In the UK, 1 MMR vaccine dose prevented mumps at 85% efficacy and 2 doses at 95%. Vaccination efficacy decreases with time, and waning immunity was frequently found in older children and adolescents[14]. Children with a history of receiving 1 dose of mumps vaccinations were noted to have 96% mumps efficacy at 2 years of age which decreased to 66% by the time these children were 11 to 12 years old. Children with a history of receiving 2 doses of vaccinations had 99% efficacy at 2 years of age decreasing to 86% when they were 11 to 12 years old. There have also been MMR vaccine shortages, which has led to use of measles combined with rubella (MR) vaccines. HCWs who have been boosted with MR will lack antibody stimulation to mumps. In January 2018, the US Advisory Committee on Immunization Practices recommended an additional third dose of vaccinations containing mumps for persons at risk during epidemics[15].

Our HCWs who were employed longer tended to have higher seroprevalence of measles, mumps and rubella antibodies; these older HCWs also had higher seroprevalence than their younger colleagues. In a study from Spain, the

overall prevalence of susceptibility to mumps was 12.5%, with the highest proportion of susceptible HCWs (23.6%) in theage group <27 years[16]. Higher seroprevalence was found in the older age group, born before vaccination was introduced; this was likely the result of natural infection or receiving a booster later. Low seroprevalence of measles antibodies in the younger group may have been from inadequate vaccine coverage, vaccination failure, or waning immunity.

Although our younger HCWs received measles/measles-containing vaccines due to the EPI implementation in Thailand, poor responses may have occurred due to maternal antibodies interfering with the creation of vaccine antibodies and humoral immune responses to vaccinations in small children[17]. Thai health authorities advise administering the first measles/measles-containing vaccines in children from the age of 9 months because epidemics often take place in children under 1 year of age. A study conducted among Thai children found measles/measles-containing vaccines at the age of 9 months to have created measles antibodies at a rate of 85 to 95%, rubella at 96 to 99%, and mumps at 63 to 95%[18]. Seronegative results may be due to waning immunity[19] and lower chances of natural measles antibodies. A 2004 paper on MMR IgG antibodies among the Thai population found seroprotective antibody levels in measles to be 81%, rubella 89%, and mumps 82%. For measles, 73% seroprotective rates among children, aged 8 to 14 years, who should have received 2 doses of measles/measles-containing vaccines, were lower than expected[20]. In Taiwan, measles vaccinations began to be administered nationwide in 1978. From 2004 to 2009, antibodies were measured among hospital HCWs and found measles antibodies at 81.1% with waning immunity among HCWs who had received measles vaccinations, particularly in those less than 25 years old[21]. Currently, Thailand recommends MMR vaccinations as 1 subcutaneous injection for all HCWs when they begin work, at the earliest possible time, if they will come into contact with patients. This is unless HCWs have blood tests showing antibodies, evidence of 2 vaccine doses, or past infections tested in a medical facility. Nonetheless, our study found that 10/74 HCWs (13.51%), who had received the 2 doses of measles/measles-containing vaccines as mandated by the EPI with no later booster, did not potentially have measles immunity. Therefore, vaccination history should not be used as a single factor for assessing measles, mumps and rubella antibodies.

Measles, mumps and rubella antibodies clearly prevent infections, and vaccinations easily reduce the number of HCWs without antibodies, limiting the risk of spreading infections to colleagues and patients. Although HCWs may have evidence of 2 vaccine doses, 1 MMR dose prior to commencing work for all HCWs would, of course, increase antibodies in HCWs. As noted above, a vaccine history of even 2 doses has not shown to be any guarantee of antibodies for measles, mumps or rubella.

Guidelines for antibody screening before preventive vaccinations, particularly for measles, rubella and mumps, are crucial; however, the vaccine is less expensive compared to the cost of the antibody screening. There is no harm in giving the MMR vaccine to a person who may already be immune to one or more of the vaccine viruses as immunity needs to be raised in all 3 diseases.

Our limitations include being restricted to a single site and time period for sample collection in a set population of Thai university hospital HCWs. Lack of immunization records on individual childhood measles diseases, as well as measles/measles containing vaccination history, may also have been imperfect as it was self-reported.

## Conclusion

Seroprevalence of mumps antibodies was lower than that of measles and rubella. HCWs without immunity to measles and mumps were found in the younger cohort. Despite having previous measles/measles-containing vaccines, HCWs should receive this booster before employment. Blood tests for antibodies screening in all HCWs before vaccinations would require further studies on cost effectiveness.

## What is already known on this topic?

MMR Vaccination efficacy decreases with time, and waning immunity. Mumps antibody levels and efficacy were the lowest, compared to measles and rubella. There was differences in seroprevalence according to age.

## What this study adds?

The seroprevalence of measles, mumps and rubella antibodies in healthcare workers in were 92%, 58% and 90%, respectively. Older HCWs also had higher seroprevalence than their younger colleagues. Previous measles/measles-containing vaccines history had no statistical correlation with immunological status. Approximately thirteen percent of HCWs who had received the 2 doses of measles/measles-containing vaccines as mandated by the EPI with no later booster, did not have measles immunity. Therefore, vaccination history should not be used as a single factor for assessing measles, mumps and rubella antibodies.

## Acknowledgements

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## Potential conflicts of interest

The authors declare no conflicts of interest.

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## สภาวะภูมิคุ้มกันต่อโรคหัด หัดเยอรมัน คางทูม ในบุคลากรทางการแพทย์ของโรงพยาบาลมหาวิทยาลัยในประเทศไทย

อัจฉรา ตั้งสถาพรพงษ์, ธิดารัตน์ แก้วเงิน, สิรินพร สาจักร, พรอำภา บรรจงมณี

***ภูมิหลัง:*** โรคหัด คางทูม หัดเยอรมัน เป็นโรคที่ติดต่อได้ง่าย โดยการสูดดมละอองฝอยหรือสัมผัสสารคัดหลั่งระบบทางเดินหายใจของผู้ป่วย บุคลากรทางการแพทย์ที่ไม่มีภูมิคุ้มกันต่อเชื้อนี้หากคลุกคลีสัมผัสกับผู้ติดเชื้อจะป่วยเป็นโรคดังกล่าว และสามารถแพร่กระจายเชื้อต่อไปยังผู้ร่วมงานอื่นรวมทั้งผู้ป่วยอื่นได้

***วัตถุประสงค์:*** เพื่อศึกษาความชุกของการมีภูมิคุ้มกันต่อโรคหัด คางทูม และหัดเยอรมันในบุคลากรทางการแพทย์ โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ

***วัสดุและวิธีการ:*** เป็นการศึกษาตรวจวัดระดับภูมิคุ้มกันชนิดอิมมูโนโกลบุลินจี ต่อเชื้อหัด คางทูม และหัดเยอรมันในบุคลากรในโรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติช่วงปี พ.ศ. 2560

***ผลการศึกษา:*** อาสาสมัครทั้งหมด 140 ราย เป็นแพทย์ 21 ราย (ร้อยละ 15) พยาบาล 73 ราย (ร้อยละ 52.14) และบุคลากรอื่นๆ 46 ราย (ร้อยละ 32.86) มีอายุระหว่าง 20 ถึง 57 ปี อายุเฉลี่ย 29.2±6.36 ปี พบอัตราความชุกของภูมิคุ้มกันต่อโรคหัด หัดเยอรมัน และคางทูม คิดเป็นจำนวน 129 ราย (ร้อยละ 92.14) 126 ราย (ร้อยละ 90) และ 82 ราย (ร้อยละ 58) ตามลำดับ บุคลากรที่อายุมากมีภูมิคุ้มกันต่อหัด และคางทูม มากกว่าบุคลากรที่อายุน้อยอย่างมีนัยสำคัญ ($p$ = 0.002 และ 0.033 ตามลำดับ) ประวัติเคยได้รับวัคซีนหัด/ที่มีหัดเป็นส่วนประกอบไม่มีความสัมพันธ์ทางสถิติกับสภาวะภูมิคุ้มกันต่อโรคหัด คางทูม และหัดเยอรมัน โดย 10 ใน 74 ราย (ร้อยละ 13.51) ของกลุ่มที่มีอายุ <29 ปี ที่ได้วัคซีนหัด/ที่มีส่วนประกอบของหัดใน Expanded Program on Immunization (EPI) 2 โด๊ส และไม่เคยได้วัคซีนกระตุ้น พบไม่มีภูมิคุ้มกันต่อหัด

***สรุป:*** บุคลากรมีความชุกของการมีภูมิคุ้มกันต่อคางทูมต่ำกว่าหัด และหัดเยอรมัน บุคลากรที่ไม่มีภูมิคุ้มกันต่อโรคหัด และคางทูม พบในกลุ่มอายุน้อยมากกว่า แม้ว่ามีประวัติเคยได้รับวัคซีนหัด/ที่มีหัดเป็นส่วนประกอบใน EPI มาก่อน จึงควรมีการให้วัคซีนรวมป้องกันหัด คางทูม หัดเยอรมันกระตุ้นก่อนเริ่มปฏิบัติงาน