Published in final edited form as:

Am J Ind Med. 2013 January ; 56(1): 58–64. doi:10.1002/ajim.22046.

Prevalence of Measles, Mumps, Rubella and Varicella Susceptibility among Health Science Students in a University in India

G Arunkumar, PhD¹, K E Vandana, MD², and Nalini Sathiakumar, MD, DrPH³

¹Manipal Centre for Virus Research (ICMR Virology Network Laboratory- Grade-I), Manipal University, Manipal – 576 104 Karnataka State, INDIA

²Kasturba Medical College, Manipal University, Manipal – 576 104 Karnataka State, INDIA

³Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, 1665 University Blvd. RPHB 523D, Birmingham, AL 35294-0022 USA

Abstract

Background—Health science students (HSS) are at increased risk of contracting and transmitting viral disease such as measles, mumps, rubella and varicella (chickenpox). This study was undertaken to determine the prevalence of susceptibility of HSS to these infections.

Methods—Using a cross-sectional design, 790 HSS of Manipal University, Manipal, India, answered a questionnaire and provided a blood sample which was tested for specific IgG antibodies to measles, mumps, rubella and varicella by ELISA (Enzygnost®).

Results—The study group was comprised of medical (53.9%), nursing (16.6%) and allied health (29.5%) students. Among the overall group (n=790), the prevalence of serological susceptibility to measles, mumps, rubella and varicella were 9.5%, 32.0%, 16.6%, and 25.8%, respectively. Among the subgroup of vaccinated subjects, susceptibility to measles, mumps, rubella and varicella were 7.9%, 34.7%, 10.7% and 35.2%, respectively.

Conclusion—HSS susceptible to measles, mumps, rubella and/or varicella are at risk of acquiring these diseases during their training period. In addition, they may be a potential source for nosocomial transmission posing a risk to immunocompromised patients. Hence, in the Indian setting, HSS should be immunized against measles, mumps, rubella and varicella at the time of joining the medical school.

Keywords

Susceptibility; Measles; Mumps; Rubella; Varicella

INTRODUCTION

Health Science Students (HSS) are exposed to various infectious diseases during their training, and vaccine preventable airborne viral infections (VPAVI) are a major occupational risk for these students[Skull, et al. 2001]. There are several reports of outbreaks of measles, mumps, rubella and chickenpox among health sciences university

Corresponding Author: G Arunkumar, PhD, Associate Professor and Head, Manipal Centre for Virus Research, (ICMR Virology Network Laboratory- Grade-I), Manipal University, Manipal – 576 104, Karnataka State, INDIA, arun.kumar@manipal.edu, Tele Fax: 0091 0820 2922718.

Conflict of interest: The authors declare no conflict of interest

students and health care workers from both developed and developing countries [Apisarnthanarak, et al. 2007, Christmas, et al. 1998, MMWR 1985, MMWR 1985a, Wharton, et al. 1990]. In India, the Expanded Program of Immunization (EPI) introduced measles immunization in 1985–1986 [WHO 1994]. Even after more than 20 years of introduction of measles vaccine in the national program, the average national measles vaccine coverage in India remains below 60% [NFHS-3 2007]. In general, although these diseases have an uncomplicated course in childhood, these often result in severe complications in adults. Measles in adults is frequently associated with impairment of liver function [Gavish, et al. 1983, Tishler and Abramov 1983] and may cause renal failure as well as encephalitis [Wairagkar, et al. 1999, Wairagkar, et al. 2000]. Mumps in adults may be complicated with orchitis, meningoencephalitis, encephalitis and acute demyelinating encephalomyelitis. Rubella in young adults may be associated with severe arthralgia and varicella may cause more frequent central nervous system involvement in adults as well as pneumonia which can be devastating in pregnant woman. Unlike community settings, a very high level of immunity (>98%) is required to prevent measles outbreak in university campuses where there is a conglomeration of susceptible individuals in a closed environment [Allen, et al. 1993]. Serosurveillance studies conducted in various parts of the world indicate that 3–25% of health care workers are susceptible to mumps, measles, rubella and varicella [Almuneef, et al. 2006, Amela, et al. 2003, Kukino, et al. 2004, Mossong, et al. 2004, Pavlopoulou, et al. 2009, Vyse, et al. 2006, Ziegler, et al. 2003]. A study from a medical school in South India report attack rates of chickenpox among staff and student nurses as 0.78 and 1.54 per 100 person-years, respectively [Richard, et al. 2001]. Thus, HSS are at high risk of acquiring these infections from patients or visitors during their training. Further, susceptible HSS may contribute to outbreaks of these diseases within healthcare facilities which may be potential sources of nosocomial infections especially among immunocompromised patients. Immunity to these infections is determined by seroprevalence studies by detecting IgG antibodies against the specific infectious agent. Therefore, we undertook a study to determine the prevalence of HSS susceptible to measles, mumps, rubella and varicella in a University setting in India.

METHODS

Study design and study population

The study was cross-sectional in design. The study setting was the campus of Manipal University, Manipal, located in Udupi district along the west coast of Karnataka State, South India. Medical, dental, nursing or allied health sciences students from the Manipal campus were invited to participate in the study, which was conducted between November 2008 and August 2011. The study was announced through posters placed in notice boards at prominent places such as lecture theatres, library, hostel and dining hall. A total of 790 HSS who voluntarily participated during the enrollment period of November 2008 to August 2011 were recruited which represents nearly one third of the HSS in the Manipal campus of Manipal University. Each subject was briefed about the goals of the study and the potential benefits and risks of joining the study. A written informed consent was then obtained. Sociodemographic data, immunization history and disease occurrence history were obtained using a self-administered questionnaire. Confidentiality was ensured by coding the questionnaires and samples before data entry and analysis, and the identifying links were known only to the principal investigator and were used only to communicate back the study results to the subjects.

IgG testing

At enrollment, 5 ml of venous blood sample was collected from each study participant. Measles-, mumps-, rubella- and varicella-specific IgG antibodies in the serum sample were

determined using Enzygnost® anti-measles virus-IgG ELISA, Enzygnost® anti-parotitis (mumps) virus-IgG ELISA, Enzygnost® anti-rubella virus-IgG ELISA and Enzygnost® anti-VZV-IgG ELISA (Dade Behring (now Siemens Healthcare Diagnostics Ltd), Germany) respectively. The test was performed and interpreted as directed by the manufacturer. For the qualitative result, an absorbance of 0.2 optical density was considered seropositive for measles, mumps, rubella and varicella. All study participants were informed of their test results and susceptible subjects were advised to take vaccination in consultation with their physicians. Vaccines were available in the University teaching hospital.

Ethical approvals

Ethical approvals were obtained from both the Institutional Ethics Committee of Manipal University, Manipal, India, and from the Institutional Review Board of University of Alabama at Birmingham, USA.

Analysis

Descriptive analysis of the study population including the demographic information, past history of infections and immunizations were conducted. Subjects' susceptibility to measles, mumps, rubella and varicella were defined as the absence of disease-specific IgG antibody. Prevalence of susceptibility was computed as the proportion of study group that were susceptible. Chi-square test was used to determine the statistical significance of difference in susceptibility among various categories and a p value of <0.05 was considered significant.

RESULTS

Table I provides the demographic data, past history of the infections of interest and immunization. Study subjects were young adults with a mean age of 21.6 years (SD, 2.4). Of the 790 HSS who participated in the study, 296 were males (37.5%) and 494 (62.5%), females. The study group was comprised of medical (53.9%), nursing (16.6%) and allied health (29.5%) students. By birth, 27.0% study subjects belonged to Karnataka state, 16.6% to Kerala State and 42.7 to remaining states of India, while 13.8% were born outside India. History suggestive of measles/rubella (fever with maculopapular rash), mumps (fever with painful swelling of parotid) and varicella (fever with vesicular rash) was given by 14.2%, 9.4% and 25.9% of participants, respectively. Measles, rubella, MMR and varicella immunization history was reported in 12.8%, 5.6%, 42.7% and 6.8% of subjects, respectively.

Serological susceptibilities of HSS to measles, mumps, rubella and varicella were 9.5%, 32.0%, 16.6%, and 25.8%, respectively (Table II).

Age-stratified analysis clearly indicates higher susceptibility at 18 years of age and a gradual decrease in susceptibility to measles, and varicella with increasing age (Figure 1). However, susceptibility to mumps is uniformly high (around 30%) across age groups, while susceptibility to rubella remains in the vicinity of 20% across age groups.

Duration of stay in the campus- stratified analysis clearly indicates gradual reduction of susceptibility to measles as the duration of stay increases (Figure 2). Further, susceptibility to varicella sharply declines following one year of stay in the campus. However, susceptibility to rubella and mumps do not show any trend with duration of stay in the campus. Table III depicts the susceptibility of HSS to various combinations of VPAVI. While 42% (332/790) of the HSS were immune to all VPAVI (measles, mumps, rubella and varicella), 18.2% (144/790) were susceptible only to mumps. Only seven (0.9%) subjects were susceptible to all the viruses; 11.3% (89/790) subjects were susceptible only to varicella.

Gender-stratified analysis indicates a significantly higher susceptibility of females to rubella compared to male participants (Table IV).

Discipline-stratified analysis revealed that nursing students were significantly ($p < 0.00001$) more susceptible to measles (22.1%), rubella (25.2%) and varicella (55.7) than the medical and allied health science students (Table IV). However, susceptibility to mumps was uniformly higher (26–33.8%) among all the disciplines. Analysis with respect to place of birth indicates a significantly higher susceptibility in HSS born in Kerala State, India.

Table IV further presents the susceptibility of study subjects who had history of immunization or past infections. While 7.9% of MMR recipients were susceptible to measles versus 10.6% of unvaccinated subjects, susceptibility to mumps was 34.7% (35.3% among unvaccinated) and to rubella was 10.7% (28.2% among unvaccinated). Only a single subject out of 44 who had received monovalent rubella vaccine was susceptible. However, 35.2% of subjects who had varicella vaccine did not have detectable levels of immunity versus 33.2% among unimmunized subjects. Susceptibility to measles and rubella among those who reported a clinical history suggestive of measles/rubella was 6.3% and 18.8%, respectively. While 17.6% subjects who had fever with swollen parotid glands suggestive of mumps did not have immunity to mumps, only 4.9% participants who had chickenpox remained susceptible.

DISCUSSION

Our study showed that the overall susceptibility of HSS to measles, mumps, rubella and varicella was very high. At 18 years of age, nearly one-third of HSS were susceptible to measles, mumps and rubella and about 50% to varicella. The high susceptibility of HSS to measles, mumps and rubella is consistent with reports from Australia [Torda 2008]. However, data from other countries such as Japan [Yoshida, et al. 2007], Slovenia [Socan and Berginc 2008] and Greece [Pavlopoulou, et al. 2009] indicate a lower susceptibility of HSS to these diseases (range, 0.7% to 14.3%). Our finding of about 50% of HSS susceptible to varicella is comparable to reports from Sri Lanka [Agampodi, et al. 2010, Kurukulasooriya, et al. 2010], but not with other countries such as Australia [Torda 2008], Greece [Pavlopoulou, et al. 2009], Japan [Yoshida, et al. 2007], Slovenia [Socan and Berginc 2008] and Thailand [Bhattarakosol, et al. 1996], which report a much lower susceptibility (range, 2.4 % to 25.7%). The susceptibility of HSS to these diseases is dependent on the immunization policy practiced in each country. In India, only the measles vaccine is part of the EPI and was introduced in 1985–1986 and the overall coverage is less than optimal.

There may be several reasons as to why these young adults are susceptible to these childhood viral diseases. The epidemiological transition subsequent to the economic growth-related improvements in the standard of living and changes in socializing patterns of upper and middle class people in India has led to a significant reduction in the incidence of natural childhood vaccine preventable airborne viral infections among children in urban areas over the years. This might have contributed to accumulation of a high proportion of susceptible young adults who either escaped a natural infection or missed childhood vaccination.

In our study, susceptibility to measles, rubella and varicella showed an inverse relationship with age. Possible cumulative exposure and subsequent seroconversion over several years may explain this pattern. Further, susceptibility to measles and varicella showed significant inverse relationship with length of stay of HSS in the campus reiterating evidence of HSS acquiring these diseases during their training. However, susceptibility to mumps was not age-dependant as one-third of study subjects at all age groups were susceptible. Higher

susceptibility of young women in reproductive age to rubella requires special attention as rubella can be transmitted transplacentally and cause congenital defects in the foetus.

HSS belonging to the nursing discipline as well as those born in Kerala State, India were significantly susceptible to measles, rubella and varicella when compared to others. However, most of the HSS participated in the study were of 18 years old and were in the first year of their stay in the campus. Further, majority of the nursing students came from Kerala State while medical and allied health science students predominantly hailed from other states of the country. This overlap may further explain the observed increased susceptibility of nursing students hailing from Kerala State, India. Susceptibility to mumps did not show any association either with the discipline of the study or the place of birth.

Nearly one-fifth of subjects who self-reported clinical history suggestive of mumps were susceptible to mumps, while only a negligible proportion of those who self-reported clinical history suggestive of varicella was susceptible to varicella. It is possible that the recall history for varicella was better compared to mumps. Further, a significant fraction of the subjects who neither gave a history of immunization against VPAVIs nor suffered natural infection were immune to measles, mumps, rubella and varicella. This substantiates the need for laboratory testing to identify the susceptible subjects.

A high proportion of the subjects (one third) with history of immunization continue to remain susceptible to mumps and varicella while only one tenth of subjects were susceptible to measles and rubella. Use of only single dose of vaccine and probably inefficient cold chain maintenance in remote areas may be possible explanations. However, no firm conclusions can be drawn as the data are based on self-reports and not corroborated with immunization records.

A high proportion of susceptible population of HSS in a closed community such as a university campus poses serious threats of outbreaks. The threshold susceptibility level for disease outbreaks in these scenarios is far less than that in the community [Allen, et al. 1993]. HSS' susceptibility increases their risk of acquiring these diseases in hospital. In addition, susceptible HSS may be carriers of infection and be potential sources of nosocomial infections to immunocompromised patients.

Each year, we have noted several cases of measles and varicella among our students (unpublished data) substantiating the findings of this study. To the best of our knowledge, this is the first study from India addressing the susceptibility of HSS to measles, mumps, rubella and varicella.

While most of the immunization drives in developing countries are aimed at children, it is important to recognize and identify pockets of susceptible populations that could jeopardize the prevention and control of these vaccine preventable diseases. Interestingly, a significant fraction of the study participants with history of immunization continues to remain susceptible. There is no national vaccination drive or catch-up program to cover these pockets of susceptible population. In 1980s, a similar situation resulted in measles [Chretien and Garagusi 1980] and mumps outbreaks among university students in several states of United States [Sosin, et al. 1989]. Identifying the susceptible student population is an important step towards preventing and controlling outbreaks of measles, mumps, rubella and varicella among HSS and health care workers. Eliminating these pockets of susceptible young adults in the campuses would complement national efforts to control and eliminate these diseases in future.

Serological screening of HSS for proof of immunity and subsequent specific immunization is not an economically and logistically viable option in India due to the cost of the assays

and poor accessibility of laboratories which offer these assays. Instead, immunization of HSS against mumps, measles, rubella and varicella at the time of admission may be the best possible option in India to reduce the susceptible young adults in the campuses in general, and reduce the occupational risk of HSS in particular. However, due to epidemiological transition and increasing vaccination coverage against measles, natural exposure and boosting of immunity is declining in India. Hence, a second dose of vaccine may be required to achieve high level of immunity required to prevent outbreaks among HSS in campuses.

The study had several limitations. First, we did not use random sampling method to recruit study subjects. However, the large study size and uniformity of the sampling population may minimize selection bias. Second, the potential for recall bias of self-reported history of clinical disease and immunization may exist; our objective measurements of specific-IgG antibodies reduced this error. Thirdly, the recruitment of only HSS may limit the generalizability of the study to other university students in our campus. However, the study population comprises of nearly one-third of the HSS in the university campus it is representative of the HSS and the findings could be safely extrapolated to HSS in other university campuses in India.

CONCLUSIONS AND RECOMMENDATION

In conclusion, this study demonstrates that a high proportion of HSS in Manipal University are susceptible to measles, mumps, rubella and varicella and hence, are at risk of acquiring these diseases during their training period. In addition, they may be a potential source for nosocomial transmission posing a risk to immunocompromised patients. More importantly, these pockets of susceptible young adults pose serious threat to national efforts to contain diseases such as measles through routine immunization of children. Thus, immunization of HSS against mumps, measles, rubella and varicella at the time of admission may be the best possible option in India to reduce the susceptible young adults in the campuses in general, and reduce the occupational risk of HSS in particular.

Acknowledgments

The present work was supported by the University of Alabama at Birmingham International Training and Research in Environmental and Occupational Health program, Grant Number 5 D43 TW05750, from the National Institutes of Health-Fogarty International Center (NIH-FIC). The content is solely the responsibility of the authors and do not necessarily represent the official views of the NIH-FIC.

Funding:

Grant Sponsor: The National Institutes of Health-Fogarty International Center (NIH-FIC)

Grant Number - 5 D43 TW05750

REFERENCES

1. Skull SA, Andrews RM, Gorrie GJ, Riddell MA, Street AC. Healthcare workers continue to be at risk of measles: a case for better vaccination coverage. *Med J Aust.* 2001; 174:662–663. [PubMed: 11480693]
2. Apisarnthanarak A, Kitphati R, Tawatsupha P, Thongphubeth K, Apisarnthanarak P, Mundy LM. Outbreak of varicella-zoster virus infection among Thai healthcare workers. *Infect Control Hosp Epidemiol.* 2007; 28:430–434. [PubMed: 17385149]
3. Christmas WA, Mamolen M, James FE. Measles outbreak at a university without a two-dose immunization requirement. *West J Med.* 1998; 168:534–537. [PubMed: 9656005]
4. MMWR. Leads from the MMWR-Measles on college campuses- United States. *JAMA.* 1985; 254:1296–1297. [PubMed: 4021003]

5. MMWR. Leads from the MMWR-Rubella in colleges- United states. JAMA. 1985a; 253:2820–2827.
6. Wharton M, Cochi SL, Hutcheson RH, Schaffner W. Mumps transmission in hospitals. Arch Intern Med. 1990; 150:47–49. [PubMed: 2297298]
7. WHO. Expanded Programme on Immunization. Measles Control, India Weekly Epid Rec. 1994; 69:368–370.
8. NFHS-3. [accessed on 25 May 2011] National Family Health Survey (NFHS-3), Key Indicators for India 2005-06, India. 2007. <http://www.nfhsindia.org/pdf/India.pdf>
9. Gavish D, Kleinman Y, Morag A, Chajek-Shaul T. Hepatitis and jaundice associated with measles in young adults. An analysis of 65 cases. Arch Intern Med. 1983; 143:674–677. [PubMed: 6838292]
10. Tishler M, Abramov AL. Liver involvement in measles infection of young adults. Isr J Med Sci. 1983; 19:791–793. [PubMed: 6643015]
11. Wairagkar NS, Gandhi BV, Katrak SM, Shaikh NJ, Parikh PR, Wadia NH, Gadkari DA. Acute renal failure with neurological involvement in adults associated with measles virus isolation. Lancet. 1999; 354:992–995. [PubMed: 10501362]
12. Wairagkar NS, Kakrani AL, Shaikh NJ, Bapat VM, Gadkari DA. Renal failure, encephalitis and measles in a young woman. J Assoc Physicians India. 2000; 48:528–529. [PubMed: 11273150]
13. Allen LJ, Lewis T, Martin CF, Jones MA, Lo CK, Stamp M, Mundel G, Way AB. Analysis of a measles epidemic. Stat Med. 1993; 12:229–239. [PubMed: 8456208]
14. Almuneef MA, Memish ZA, Balkhy HH, Otaibi B, Helmi M. Seroprevalence survey of varicella, measles, rubella, and hepatitis A and B viruses in a multinational healthcare workforce in Saudi Arabia. Infect Control Hosp Epidemiol. 2006; 27:1178–1183. [PubMed: 17080374]
15. Amela C, Pachon I, de Ory F. Evaluation of the measles, mumps and rubella immunisation programme in Spain by using a sero-epidemiological survey. Eur J Epidemiol. 2003; 18:71–79. [PubMed: 12705626]
16. Kukino J, Naito T, Mitsuhashi K, Oshima H, Sekiya S, Isonuma H, Watanabe K, Dambara T, Hayashida Y. Susceptibility of medical students to vaccine-preventable viral diseases: a serological study. J Infect Chemother. 2004; 10:335–337. [PubMed: 15614457]
17. Mossong J, Putz L, Schneider F. Seroprevalence of measles, mumps and rubella antibodies in Luxembourg: results from a national cross-sectional study. Epidemiol Infect. 2004; 132:11–18. [PubMed: 14979584]
18. Pavlopoulou ID, Daikos GL, Tzivaras A, Bozas E, Kosmidis C, Tsoumakas C, Theodoridou M. Medical and nursing students with suboptimal protective immunity against vaccine-preventable diseases. Infect Control Hosp Epidemiol. 2009; 30:1006–1011. [PubMed: 19708792]
19. Vyse AJ, Gay NJ, Hesketh LM, Pebody R, Morgan-Capner P, Miller E. Interpreting serological surveys using mixture models: the seroepidemiology of measles, mumps and rubella in England and Wales at the beginning of the 21st century. Epidemiol Infect. 2006; 134:1303–1312. [PubMed: 16650326]
20. Ziegler E, Roth C, Wreghitt T. 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 (Lond). 2003; 53:398–402. [PubMed: 14514907]
21. Richard VS, John TJ, Kenneth J, Ramaprabha P, Kuruvilla PJ, Chandy GM. Should health care workers in the tropics be immunized against varicella? J Hosp Infect. 2001; 47:243–245. [PubMed: 11247687]
22. Torda AJ. Vaccination and screening of medical students: results of a student health initiative. Med J Aust. 2008; 189:484–486. [PubMed: 18976187]
23. Yoshida N, Tsumura N, Toyomasu K, Sagawa K. Antibody titers against measles, rubella, mumps and varicella-zoster viruses in medical students. Sangyo Eiseigaku Zasshi. 2007; 49:21–26. [PubMed: 17303935]
24. Socan M, Berginc N. High seroprevalence of varicella, measles, mumps, rubella and pertussis antibodies in first-grade medical students. Wien Klin Wochenschr. 2008; 120:422–426. [PubMed: 18726668]
25. Agampodi SB, Dharmaratne SD, Thevanesam V, Dassanayake S, Kumarihamy P, Ratnayake A. Incidence and effects of Varicella Zoster Virus infection on academic activities of medical

- undergraduates--a five-year follow-up study from Sri Lanka. *BMC Infect Dis.* 2010; 10:117. [PubMed: 20465846]
26. Kurukulasooriya GM, Thevanesam V, Agampodi SB, Abeykoon AM, Amarasiri SP, Goonasekera KP. Susceptibility of New Entrant University students in Sri Lanka to varicella zoster infection. *Asia Pac J Public Health.* 2010; 22:219–224. [PubMed: 19411280]
27. Bhattarakosol P, Chantarabul S, Pittayathikhun K, Mung-mee V, Punnarugsa V. Prevalence of anti-varicella zoster IgG antibody in undergraduate students. *Asian Pac J Allergy Immunol.* 1996; 14:129–131. [PubMed: 9177828]
28. Chretien JH, Garagusi VF. Epidemic measles in college students. *J Am Coll Health Assoc.* 1980; 28:254–256. [PubMed: 7365151]
29. Sosin DM, Cochi SL, Gunn RA, Jennings CE, Preblud SR. Changing epidemiology of mumps and its impact on university campuses. *Pediatrics.* 1989; 84:779–784. [PubMed: 2797973]

Figure 1.
Susceptibility of HSS to measles, mumps, rubella and varicella according to age in years

Figure 2.
Susceptibility of HSS to measles, mumps, rubella and varicella according to their length of stay in the campus in years

Table I

Demographic characteristics, past history of infections and immunizations among study participants, Health Science Students, India (n=790)

Characteristic/history	N	(%)
Age in years (n= 778) *		
Mean (SD)	21.55 (2.4)	
Median (IQR)	21 (20–23)	
Mode	21	
Sex		
Male	296	(37.5)
Female	494	(62.5)
Discipline of study		
Medical (MBBS)	426	(53.9)
Nursing	131	(16.6)
Other (Allied Health Sciences)	233	(29.5)
Place of birth (state/country)		
Karnataka/India	213	(27.0)
Kerala/India	131	(16.6)
Other States/India	337	(42.7)
Outside India	109	(13.8)
History of fever with maculopapular rash	112	(14.2)
History of fever with painful swelling of parotid(s)	74	(9.4)
History of fever with vesicular rash	205	(25.9)
History of immunization		
Measles	101	(12.8)
Rubella	44	(5.6)
Measles-mumps-rubella(MMR)	337	(42.7)
Varicella (Chicken pox)	54	(6.8)

* Age was available only for 778 cases

Table II

Susceptibility of HSS to measles, mumps, rubella and varicella at Manipal University campus, Health Science Students, India (n=790)

Disease	Number of seronegative subjects	Prevalence of susceptibility(%)	95% CI*
Measles	75	9.5	7.6–11.7
Mumps	253	32.0	28.9–35.4
Rubella	131	16.6	14.2–19.3
Varicella (Chickenpox)	204	25.8	22.9–29.0

*
CI= confidence interval

Table III

Susceptibility of HSS to various combinations of measles, mumps, rubella and varicella at Manipal University campus (n=790)

Disease(s)	Number of Seronegative subjects	Prevalence of Susceptibility(%)	95% CI
Measles, mumps, rubella and varicella	7	0.9	0.4–1.8
Measles, mumps and rubella	5	0.6	0.3–1.4
Measles, rubella and varicella	4	0.8	0.2–1.3
Measles, mumps and varicella	6	0.8	0.4–1.7
Mumps, rubella and varicella	12	1.6	1.0–2.8
Measles and Mumps	12	1.6	0.9–2.6
Measles and rubella	4	0.5	0.2–1.3
Measles and varicella	20	2.5	1.6–3.9
Mumps and rubella	27	3.4	2.4–4.9
Mumps and varicella	39	4.9	3.6–6.7
Rubella and varicella	26	3.3	2.2–4.8
Measles only	17	2.1	1.4–3.4
Mumps only	144	18.2	15.7–21.1
Rubella only	45	5.7	4.3–7.5
Varicella only	89	11.3	9.3–13.7

Table IV

Susceptibility of HSS to measles, mumps, rubella and varicella according to sex, discipline of study, place of birth, past immunization and past infection histories, Health Sciences Students, India

	Prevalence of Susceptibility in % (N)			
	Measles	Mumps	Rubella	Varicella
Sex				
Male (n=296)	9.1 (27)	34.1 (101)	12.5 (37)	22.6 (67)
Female (n=494)	9.7(48)	30.8 (152)	19.0 (94)\$	27.7 (137)
Discipline of study				
Medical (MBBS)(n=426)	6.6 (28)	33.8(144)	12 (51)	16.4 (70)
Nursing (n=131)	22.1(29)#	26 (34)	25.2 (33)#	55.7 (73)#
Other (Allied Health Sciences)(n=233)	7.7 (18)	32.2 (75)	20.2 (47)	26.2 (61)
Place of birth (State/Country)				
Karnataka/India(n=213)	7.5(16)	31 (66)	20.2 (43)	19.2 (41)
Kerala/India (n=131)	21.4(28)#	31.3 (41)	25.2 (33) @	61.8 (81)#
Other States/India(n=337)	7.7 (26)	35.0 (118)	13.9 (47)	21.4(72)
Outside India(n=109)	4.6 (5)	25.7 (28)	7.3 (8)	9.2 (10)
History of immunization				
Measles				
Yes(n=101)	10.9 (11)	.*	-	-
No (n=119)	9.2 (11)	-	-	-
Rubella				
Yes(n=44)	-	-	2.3 (1)	-
No (n=118)	-	-	23.7 (28)	-
MMR				
Yes (n=337)	7.9 (25)	34.7 (117)	10.7 (36)	-
No (n=85)	10.6(9)	35.3 (30)	28.2 (24)	-
Varicella				
Yes(n=54)	-	-	-	35.2 (19)
No (n=208)	-	-	-	33.2 (69)
History of fever with maculopapular rash				

Prevalence of Susceptibility in % (N)				
	Measles	Mumps	Rubella	Varicella
Yes(n=112)	6.3(7)	-	18.8(21)	-
No (n=263)	12.5 (33)	-	18.2 (48)	-
History of fever with painful swelling of Parotid(s)				
Yes(n=74)	-	17.6 (13)	-	-
No (n=332)	-	34.3 (13) @	-	-
History of fever with vesicular rash				
Yes(n=205)	-	-	-	4.9 (10)
No (n=255)	-	-	-	48.2 (123) #

* Not applicable.

Chi-square, Statistically Significant difference(p= <0.0001);

\$ p=0.018;

@ p=0.001