Original Investigation / *Özgün Araştırma*

DOI: 10.5578/ced.20240401 • *J Pediatr Inf 2024;18(4):e209-e214*

Immunity to Vaccine-Preventable Diseases among Health Vocational High School Students

Sağlık Meslek Lisesi Öğrencilerinin Aşı ile Önlenebilir Hastalıklara Karşı Bağışıklık Durumu

Burcu Ceylan Cura Yayla[1](İD), Rukiye Saç[2](İD), Sıla Çamur[2](İD), Nermin Akbaş[3](İD), Medine Ayşin Taşar[4](İD)

[1] *Clinic of Pediatric Infection, University of Health Science Faculty of Medicine, Ankara Training and Research Hospital, Ankara, Türkiye*
[2] *Clinic of Pediatric, University of Health Science Faculty of Medicine, Ankara Training and Research Hospital, Ankara, Türkiye*
[3] *Clinic of Family Medicine, University of Health Science Faculty of Medicine, Ankara Training and Research Hospital, Ankara, Türkiye*
[4] *Clinic of Pediatric Emergency, University of Health Science Faculty of Medicine, Ankara Training and Research Hospital, Ankara, Türkiye*

Cite this article as: Cura Yayla BC, Saç R, Çamur S, Akbaş N, Ayşin Taşar M. Immunity to vaccine-preventable diseases among health vocational high school students. J Pediatr Inf 2024;18(4):e209-e214.

Abstract

Objective: Hospitals are a high-risk setting for vaccine-preventable diseases such as hepatitis A and B, mumps, measles, rubella (MMR), and chickenpox. Therefore, it is necessary to ensure the protection of seronegative adolescent students in health vocational high schools. This study aimed to determine the seroprevalence of hepatitis A, hepatitis B, MMR and chickenpox in health vocational high school students interning at a tertiary training and research hospital.

Material and Methods: Demographic characteristics and hepatitis B surface antibody (anti-HBs), hepatitis A immunoglobulin G (anti-HAV IgG), mumps IgG, measles IgG, rubella IgG, and varicella zoster virus (VZV) IgG levels of health vocational high school students who applied for or completed an internship in our hospital were analyzed retrospectively.

Results: Of 946 students with complete routine childhood vaccination (median age 17 years, range 15-18 years; 75.7% female), anti-HBs was positive in 82.6%, anti-HAV IgG in 14.7%, measles IgG in 76.2%, mumps IgG in 88%, rubella IgG in 96.8%, and VZV IgG in 91.7%. There was a statistically significant but negligible positive correlation between anti-HBs level and age (r= 0.072, p= 0.029). There was no difference in the seroprevalence of anti-HBs, anti-HAV, MMR, or VZV antibodies by gender (p> 0.05).

Conclusion: The seroprevalence of hepatitis A, measles, and hepatitis B antibodies was found to be low among the health vocational high school students in this study. It is important to determine students' immunity to vaccine-preventable diseases and take precautions before starting vocational high school.

Keywords: Vaccine-preventable diseases, adolescents, health vocational high school

Öz

Giriş: Hepatit A, hepatit B, kabakulak, kızamık, kızamıkçık (KKK), suçiçeği gibi aşı ile önlenebilir hastalıklar için hastaneler riskli bir ortamdır. Bu nedenle, staj yapan sağlık meslek lisesi öğrencilerinden seronegatif olanların korunması sağlanmalıdır. Çalışmamızda, üçüncü basamak bir eğitim ve araştırma hastanesine staja gelen sağlık meslek lisesi öğrencilerinin hepatit A, hepatit B, KKK ve suçiçeği gibi hastalıklara karşı seroprevalansının belirlenmesi amaçlanmıştır.

Gereç ve Yöntemler: Hastanemizde staj yapan veya staj yapmak için başvuran sağlık meslek lisesi öğrencilerinin demografik özellikleri, hepatit B yüzey antikoru (anti-HBs), hepatit A immünglobulin G (anti-HAV IgG), kabakulak IgG, kızamık IgG, kızamıkçık IgG ve varisella zoster virüs (VZV) IgG düzeyleri, otomasyon sisteminden geriye dönük olarak incelenmiştir.

Bulgular: Çocukluk çağı rutin aşılaması tam olan 946 öğrencinin (yaş ortancası 17 yıl, aralık: 15-18, %75.7 kız) anti-HBs %82.6, anti-HAV IgG %14.7, kızamık IgG %76.2, kabakulak IgG %88, kızamıkçık IgG %96.8 ve VZV IgG %91.7 pozitif bulunmuştur. Yaş ile anti-HBs pozitifliği arasında pozitif bir korelasyon saptanmıştır (p= 0.029, r= 0.072). Cinsiyete göre anti-HBs, anti-HAV, KKK ve VZV antikor seroprevalanslarında anlamlı bir fark bulunmamıştır (p> 0.05).

Sonuç: Çalışmamızda, sağlık meslek lisesi öğrencilerinin hepatit A, kızamık ve hepatit B'ye karşı seroprevalanslarının düşük olduğu saptanmıştır. Öğrencilerin sağlık meslek lisesine başlamadan önce aşıyla önlenebilir hastalıklara karşı bağışıklık durumlarının belirlenmesi ve gerekli önlemlerin alınması önemlidir.

Anahtar Kelimeler: Aşıyla önlenebilen hastalıklar, ergen, sağlık meslek lisesi

Correspondence Address/Yazışma Adresi

Burcu Ceylan Cura Yayla

Clinic of Pediatric Infection,
University of Health Science Faculty of Medicine,
Ankara Training and Research Hospital,
Ankara, Türkiye

E-mail: dr.bcc.83@gmail.com

Received: 24.06.2024 **Accepted:** 14.10.2024 **Available Online Date:** 13.12.2024

Introduction

Health care professionals are at risk of being exposed to serious and potentially fatal diseases due to contact with patients and infected materials (1). Measures to reduce this risk include ensuring hand hygiene, appropriate patient isolation, and up-to-date vaccination of health care professionals (2,3). In addition to measures implemented in the hospital setting, health workers maintaining their immunity against vaccine-preventable diseases such as hepatitis A, hepatitis B, measles, mumps, rubella (MMR), and chickenpox is important in preventing infections. Hepatitis A, hepatitis B, MMR, and varicella infections in the adolescence and adulthood have higher rates of morbidity and mortality than in the childhood (4). The risk of transmission of vaccine-preventable diseases is reported to be higher in pediatric and infectious disease wards (5). Vaccination is strongly recommended for all health care workers susceptible to measles, rubella, chickenpox, and hepatitis B (6). In addition, vaccination against hepatitis A is also recommended in Türkiye (7). Health care professionals should be screened for immunity against vaccine-preventable diseases and vaccinated accordingly before they have contact with patients (5,6).

Having not yet reached adulthood, adolescents may not have the awareness and maturity to protect themselves in the high occupational risk environment of the hospital. Therefore, it is especially important to determine the level of immunity against vaccine-preventable diseases in health vocational high school students participating in hospital internship programs and to ensure that seronegative students are protected. Students who are not immune must be encouraged to complete their vaccinations.

Measles and hepatitis B vaccines were included in the routine childhood vaccination program of Türkiye in 1970 and 1998, respectively. During the measles vaccination period in the years 2003-2005, children between the ages of nine months and 14 years received an additional dose of measles vaccine. In 2006, the MMR vaccine was added to the routine childhood vaccines administered at 12 months and in the first grade of elementary school. In 2006-2009, primary and secondary school cohorts were vaccinated against rubella. The hepatitis A vaccine was added to the national immunization program in October 2012 (two doses at 18 and 24 months for children born in or after March 2011), followed by the varicella zoster virus (VZV) vaccine in December 2013 (a single dose at 12 months for all children born in or after January 2012) (8,9).

The present study aimed to determine the seroprevalence and immune status against hepatitis A, hepatitis B, MMR, and chickenpox among health vocational high school students interning in our hospital. The secondary aim of the study was to facilitate the development of future vaccine programs in Türkiye based on seroprevalence data in children aged 15-18 years.

Materials and Methods

Our study is a retrospective cross-sectional study that included high school nursing students born between January 1, 1998, and December 31, 2004, who were referred to our hospital for internship during the periods of September 2014, to December 31, 2019, and September 1, 2021, to March 31, 2022. No new interns were accepted in our hospital between January 1, 2020 and August 31, 2021 because of COVID-19 measures. The students' demographic information, vaccination history, and levels of hepatitis B surface antibody (anti-HBs), hepatitis A immunoglobulin G (anti-HAV IgG), mumps IgG, measles IgG, rubella IgG, and VZV IgG, which are measured during the internship application process, were collected retrospectively from the hospital records system.

Anti-HBs antibody was quantified using the enzyme-linked immunosorbent assay (ELISA) method (Abbott, Axsym, Germany). Anti-HAV IgG was measured using the chemiluminescence microparticle enzyme immunoassay method (Abbott, Architect, Germany). Measles IgG, rubella IgG, mumps IgG, and VZV IgG were quantified by micro-ELISA (RADIM®, Italy) in an automated system (Alisei Quality System, SEAC, Italy). An anti-HBs level ≥10 mIU/mL was considered positive. For anti-HAV IgG, mumps IgG, measles IgG, rubella IgG, and VZV IgG assays, the results were evaluated according to the manufacturer's instructions and interpreted as positive or negative. Due to the intermittent availability of test kits in the hospital and other technical problems, not all tests could be performed for all the nursing student interns.

The student interns included in the present study were born between 1998 and 2004, and according to their records, all were vaccinated in accordance with the national vaccination schedule of the Turkish Ministry of Health. Those born in 1998 received two doses of separated measles vaccine and one dose of separated rubella vaccine, while those born between 1999 and 2004 received two doses of measles vaccine and one dose of MMR vaccine. None of the student interns had received hepatitis A or VZV vaccines.

This study was reviewed and approved by the research ethics committee of the Ankara Training and Research Hospital (No: E22-953).

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics 25.0 for Windows (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk and Kolmogorov-Smirnov were used to analyze the normal distribution characteristics of numerical variables. Descriptive statistics were expressed as median with minimum-maximum values in the case of continuous variables without normal distribution, and as numbers and percent-

age values were in the case of categorical variables. The Pearson's chi-square and Fisher-Freeman-Halton tests were used to compare the differences between the groups in terms of categorical variables. In order to compare non-parametric data, the Mann-Whitney U test were used. Spearman test was performed for correlation analysis. A p value <0.05 at the 95% confidence level was considered statistically significant.

Results

The study included a total of 946 nursing students [716 (75.7%) female and 230 (24.3%) male] with a median age of 17 years (range: 15-18). The students' seroprevalence status against vaccine-preventable infections is shown in Table 1 and Table 2.

Of the students tested for anti-HBs (n= 913), 82.6% (n= 754) were seropositive and 17.4% (n= 159) were seronegative. The rate of anti-HBs positivity was 82.8% (n= 571) for girls and 82.1% (n= 183) for boys, with no statistical relationship between sex and anti-HBs positivity (p= 0.813). The median age of anti-HBs-positive students was 17 years (range: 15-18), and the median anti-HBs level was 145.3 mIU/mL (range: 0-1000). There was a statistically significant but negligible correlation between anti-HBs level and age (r= 0.072, p= 0.029). There was no significant relationship between age and anti-HBs positivity (p= 0.299).

Among the students tested for anti-HAV IgG (n= 538), 14.7% (n= 79) were seropositive and 85.3% (n= 459) were seronegative. Anti-HAV IgG positivity was not associated with gender (p= 0.888), with rates of 14.5% in girls and 15.2% in boys. The median age of the anti-HAV IgG-positive students was 17 years (range: 15-18), and the median anti-HAV IgG level was 0.2 mIU/mL (range: 0-60). There was a very weak negative correlation between age and anti-HAV level (r= -0.120, p= 0.005). However, there was no significant relationship between age and anti-HAV positivity (p= 0.679).

Table 1. IgG serology of hepatitis B, hepatitis A, measles, mumps, rubella and varicella in students

	n	%
Anti-HBs (n= 913)		
Positive	754	82.6
Negative	159	17.4
Anti-HAV IgG (n= 538)		
Positive	79	14.7
Negative	459	85.3
Anti-HAV IgG (n= 538)		
Positive	231	76.2
Negative	72	23.8
Mumps IgG (n= 299)		
Positive	263	88
Negative	36	12
Rubella IgG (n= 281)		
Positive	272	96.8
Negative	9	3.2
VZV IgG (n= 289)		
Positive	265	91.7
Negative	24	8.3

Anti-HBs: Hepatitis B surface antibody, Anti-HAV IgG: Hepatitis A immunoglobulin G, IgG: Immunoglobulin, VZV: Varicella zoster virus.

Among the students tested for measles IgG (n= 303), mumps IgG (n= 299), and rubella IgG (n= 281), the rates of seropositivity were 76.2%, 88%, and 96.8%, respectively. The rates of positivity in girls and boys respectively were 77.6% and 71% for measles IgG, 89.5% and 82.3% for mumps IgG, and 96.9% and 96.6% for rubella IgG. There were no statistical differences according to gender (p= 0.31, p= 0.128, and p= 1.00, respectively).

Of the students tested for VZV IgG (n= 289), 91.7% (n= 265) were seropositive. There was no difference in VZV IgG seroprevalence according to gender (p= 0.606), with positivity rates of 92.1% in girls and 90.2% in boys.

Discussion

Our results demonstrate that the health vocational high school students in this study had low seroprevalence rates of hepatitis A, measles, and hepatitis B antibodies. It is known that the antibody response after vaccination may decrease over the years, but this does not always mean that the vaccine is no longer protective. But still, these people without protective levels of antibodies may still carry risk especially in countries with frequent epidemics like our (10).

Infections are the leading causes of occupational disease and mortality for health care professionals. Of the nursing students in this study, 17.4% were found to be susceptible to hepatitis B, 85.3% to hepatitis A, 23.8% to measles, 12% to mumps, 3.2% to rubella, and 8.3% to VZV.

Saç et al. have reported no association between sex and seroprevalence of hepatitis A, hepatitis B, measles, rubella, mumps, varicella zoster (11). Similarly, our study did not find any association between gender and seroprevalence status against vaccine-preventable infections.

The Centers for Disease Prevention and Control (CDC) report that the rate of a protective anti-HBs antibody response (≥10 mIU/mL) is 92% in health workers under 40 years of age, while this rate is 95% in children (12). Açıkgöz et al. have observed 93.7% anti-HBs positivity in health care workers (13). Rates of anti-HBs positivity have been reported as 87.5% in a study conducted with students in a dentistry faculty in Türkiye and 89.4% in a study conducted with nursing students (14,15).

Although all students in our study group received three doses of hepatitis B virus vaccine the anti-HBs titer was >10 mIU/mL in only 82.6% of them and anti-HBs antibody was lower than in other studies and CDC recommendations. We attribute the low seroprevalence of anti-HBs antibody in the students in our study group to the long time since they received

Table 2. Distribution of hepatitis B, hepatitis A, measles, mumps, rubella and varicella IgG serology of students according to sex

	Girl n (%)	Boy n (%)	p
Anti-HBs (n= 913)			
Positive	571 (82.8)	183 (82.1)	0.813
Negative	119 (17.2)	40 (17.9)	
Anti-HAV (n= 538)			
Positive	59 (14.5)	20 (15.2)	0.888
Negative	347 (85.5)	112 (84.8)	
Measles IgG (n= 303)			
Positive	187 (77.6)	44 (71)	0.31
Negative	54 (22.4)	18 (29)	
Mumps IgG (n= 299)			
Positive	212 (89.5)	51 (82.3)	0.128
Negative	25 (10.5)	11 (17.7)	
Rubella IgG (n= 281)			
Positive	216 (96.9)	56 (96.6)	1
Negative	7 (3.1)	2 (3.4)	
VZV IgG (n= 289)			
Positive	210 (92.1)	55 (90.2)	0.606
Negative	18 (7.9)	6 (9.8)	

Anti-HBs: Hepatitis B surface antibody, Anti-HAV IgG: Hepatitis A immunoglobulin G, IgG: Immunoglobulin, VZV: Varicella zoster virus.

the vaccine. Therefore, health vocational high school students should be tested for hepatitis B antibody before starting an internship and vaccinated if their level is <10 mIU/mL.

As part of the extended vaccination program in our country, hepatitis A vaccination is routinely performed for children born in or after March 2011 (8). None of the students in our study were vaccinated against hepatitis A. Therefore, the rate of hepatitis A seronegativity was quite high (85.3%). Similarly, a study conducted in Türkiye revealed the rate of hepatitis A seronegativity to be 91.6% (16). Considering that our country is moderate endemic for HAV, and the hepatitis vaccine is cost-effective in adults in high and moderate HAV endemic areas for pre-vaccination serological tests, we think that it would be cost-effective to immunize health vocational high school students who are not vaccinated against hepatitis A without considering pre-vaccination serology (5).

Health care professionals have a higher risk of exposure to measles than in the general population which is a highly contagious disease that can lead to serious complications and death (6). According to the CDC, one dose of the MMR vaccine is 93% effective against measles, while two doses are 97% effective (17). Measles Ig G seropositivity rates are between 70%-82.8% in different reports from our country (11,18,19). In the present study, 76.2% of the students were positive for measles IgG.

If health workers have insufficient immunity for measles, they may act as reservoirs in their health care institutions and infect patients. Contagion by health workers was primarily responsible for the spread of the 2017-2018 measles outbreak in Europe. There should be a mandatory immunization policy for health vocational high school students against vaccine-preventable diseases that cause significant morbidity and mortality and can be spread by health workers (20). In the present study, approximately one-quarter of the students were found to be negative for measles IgG.

When considering rubella, there is no data showing the higher risk in health workers compared to other professions (6). One dose of MMR vaccine is approximately 97% effective in preventing rubella (21). Ödemiş et al. have reported 94.5% seropositivity against rubella in their study (22). In another study conducted on nursing students, there was 98.3% seropositivity against rubella (18). Similar to the literature, rubella IgG was detected in 96.8% of the students in our study.

Mumps infections are rarely associated with health care (23). The MMR vaccine is very safe and effective. Two doses of MMR vaccine are approximately 88% (range: 32-95%) effective against mumps, while a single dose is approximately 78% effective (range: 49-92%) (24). Mumps vaccine is less immunogenic, and immunity gradually decreases after vaccination (25). In one study, the seroprevalence of mumps was found to be 92.3% (16). We determined the rate of mumps IgG positivity to be 88% in the present study. Although not as contagious as measles; mumps and rubella can still cause outbreaks and nosocomial transmission (26,27). Therefore, anyone working in health care settings should have immunity to mumps as well as measles and rubella infection documented by adequate immunization records or laboratory evidence of immunity (27,28). The MMR vaccine is the most effective way to protect health care professionals from contracting these infections (29).

Chickenpox is another highly contagious infectious disease and health workers, patients, and visitors are among the sources of nosocomial transmission in hospital environments (30). An estimated 14-40% of health care providers are susceptible to VZV. Although 97-99% of those with a positive history of chickenpox are seropositive, the rate of seropositivity is variable among those with a negative or uncertain history of chickenpox (31). Health workers should be screened for VZV immunity and those who are seronegative should be vaccinated with two doses of VZV vaccine at least four weeks apart (6).

In a study among Japanese health students, the seroprevalence rate of VZV has been reported as 92-98% (32). In a study conducted in Türkiye, the seroprevalence of VZV has been found to be 88.5% (16). In the present study, 91.7% of health vocational high school students tested positive for VZV IgG. The high seroprevalence observed in our study is likely attributable to natural infection as none of the students were vaccinated against VZV.

The results of this study once again demonstrate the importance of screening nursing students for vaccine-preventable diseases and vaccinating susceptible individuals before starting a hospital internship. In addition, it reveals the antibody seroprevalence in children aged 15-18 years in Türkiye.

Conclusion

This study examined immunity to important childhood infectious diseases in high school nursing students and revealed low seroprevalence of antibodies against hepatitis A, measles, and hepatitis B.

By sharing the results of this study, we want to emphasize that nursing students should be screened for vaccine-preventable diseases and those who are susceptible should be vaccinated before participating in internships. Our study demonstrates the seroprevalence of antibodies among adolescents in our region.

Among other measures, increasing seroprevalence against vaccine-preventable diseases is necessary to protect adolescent health workers against occupational diseases. The present study provides important evidence of the need to update the national vaccine program for children in Türkiye with additional vaccinations for adolescents.

Limitations

This study has certain limitations. First, there was the possibility of selection bias. As the study was carried out in a single hospital, generalization of the results to other hospitals or regions may be limited. The vaccination cards of the students could not be accessed which caused vaccination information to be based only on verbal declaration. This is another limitation for this study. In addition, it is not known whether the students have had the diseases or if there is a breakthrough infection. The study also did not include a control group.

Ethics Committe Approval: Ethics committee approval for the study was obtained from the Clinical Research Ethics Committee of Ankara Training and Research Hospital (Decision no: 953/2022, Date: 20.04.2022).

Peer-review: Externally peer-reviewed.

Author Contributions: Concept- BCCY, RS, MAT; Design- BCCY, RS; Supervision- BCCY, RS, MAT; Resource- BCCY, SÇ; Data Collection and/or Processing- BCCY, SÇ, NA; Analysis and/or Interpretation- MAT; Literature Search- BCCY, SÇ, RS, NA; Writing- BCCY, RS, SÇ; Critical review- BCCY, RS, MAT.

Conflict of Interest: All authors declare that they have no conflicts of interest or funding to disclose.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. *Centers for disease control and prevention (CDC). Vaccines and immunizations: For healthcare professionals. Available from: https://www.cdc.gov/vaccines/hcp/index.html (Accessed date: 07.03.2024).*
2. *Garner JS. Guideline for isolation precautions in hospitals. The hospital infection control practices advisory committee. Infect Control Hosp Epidemiol 1996;17(1):53-80. https://doi.org/10.2307/30142367*
3. *Larson EL. APIC guideline for handwashing and hand antisepsis in health care settings. Am J Infect Control 1995;23(4):251-69. https://doi.org/10.1016/0196-6553(95)90070-5*
4. *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(11):1178-83. https://doi.org/10.1086/508826*
5. *American Academy of Pediatrics. Immunization in Health Care Personnel. In: Kimberlin DW, Barnett ED, Lynfield R, Sawyer MH, eds. Red Book: 2021 Report of the Committee on Infectious Diseases. Itasca, IL: American Academy of Pediatrics: 2021;92-5.*
6. *Advisory committee on immunization practices, centers for disease control and prevention (CDC). Immunization of health-care personnel: Recommendations of the advisory committee on immunization practices (ACIP). MMWR Recomm Rep Morb Mortal Wkly Rep Recomm Rep 2011;60(RR-7):1-45.*
7. *Halk Sağlığı Genel Müdürlüğü. Sağlık çalışanları aşılama. Available from: https://hsgm.saglik.gov.tr/tr/saglik-calisanlari-asilama.html (Accessed date: 02.02.2024).*
8. *Çocuk sağlığı ve hastalıklarında tanı ve tedavi kılavuzları 2014. Available from: https://millipediatri.org.tr/Custom/Upload/files/kilavuzlar/kilavuz-2.pdf/ (Accessed date: 21.02.2024).*
9. *Türkiye'de bağışıklama programı. Available from: https://covid19asi.saglik.gov.tr/TR-77802/turkiyede-bagisiklama-programi.html (Accessed date: 02.06.2024).*
10. *American Academy of Pediatrics. Immunization in Health Care Personnel. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, eds. Red Book: 2018 Report of the Committee on Infectious Diseases. 31st ed. Itasca, IL: American Academy of Pediatrics; 2018:97-100.*
11. *Saç R, Taşar MA, Yalaki Z, Guneylioglu MM, Ozsoy G, Karadagli S et al. Hepatitis A, hepatitis B, measles, mumps, rubella and varicella seroprevalence in Turkish adolescent nursing students. Nobel Med 2019;15(1):33-40.*

12. *Schillie S, Vellozzi C, Reingold A, Harris A, Haber P, Ward JW, et al. Prevention of hepatitis B virus infection in the United States: Recommendations of the advisory committee on immunization practices. MMWR Recomm Rep 2018;67(1):1-31. https://doi.org/10.15585/mmwr.rr6701a1*
13. *Acikgoz A, Cimrin D, Kizildag S, Esen N, Balci P, Sayiner AA. Hepatitis A, B and C seropositivity among first-year healthcare students in western Turkey: A seroprevalence study. BMC Infect Dis 2020;20(1):529. https://doi.org/10.1186/s12879-020-05247-5*
14. *Kutlu R, Terlemez A, Demirbaş N, Hatir AE. Diş hekimliği fakültesi öğrencileri ve personellerinde hepatit A ve hepatit B seroprevalansının değerlendirilmesi. Turk J Fam Med Prim Care 2020;14(2):246-51. https://doi.org/10.21763/tjfmpc.653932*
15. *Irmak Z, Ekinci B, Akgul AF. Hepatitis B and C seropositivity among nursing students at a Turkish university. Int Nurs Rev 2010;57(3):365-9. https://doi.org/10.1111/j.1466-7657.2010.00804.x*
16. *Uzun AK. Evaluation of hepatitis B, hepatitis A, measles, rubella, mumps and varicella antibody seroprevalences in vocational school of health students. J Contemp Med 2020;10(2):201-6. https://doi.org/10.16899/jcm.718639*
17. *CDC. Centers for Disease Control and Prevention. Measles, mumps, and rubella (MMR) vaccination. Available from: https://www.cdc.gov/vaccines/vpd/mmr/public/index.html (Accessed date: 18.06.2024).*
18. *Kader Ç, Erbay A, Akça NK, Polat MF, Polat S. Immunity of nursing students to measles, mumps, rubella, and varicella in Yozgat, Turkey. Am J Infect Control 2016;44(1):e5-7. https://doi.org/10.1016/j.ajic.2015.08.021*
19. *Yürüyen C, Yıldırım Tosun B, Aksaray S. İstanbul ili hizmet bölgemizde genç erişkin nüfusta kızamık seroprevalansının araştırılması. Türk Mikrobiyoloji Cemiy Derg 2022;52(2):131-4. https://doi.org/10.54453/TMCD.2022.53765*
20. *Maltezou HC, Theodoridou K, Ledda C, Rapisarda V, Theodoridou M. Vaccination of healthcare workers: Is mandatory vaccination needed? Expert Rev Vaccines 2019;18(1):5-13. https://doi.org/10.1080/14760584.2019.1552141*
21. *Rubella (German Measles). Available from: https://www.cdc.gov/rubella/index.html (Accessed date: 5.04.2024).*
22. *Ödemiş İ, Köse Ş, Akbulut İ, Albayrak H. Seroprevalence of measles, mumps, rubella, and varicella zoster virus antibodies among healthcare students: Analysis of vaccine efficacy and cost-effectiveness. Rev Esp Quimioter 2019;32(6):525-31.*
23. *McLean HQ, Fiebelkorn AP, Temte JL, Wallace GS. Prevention of measles, rubella, congenital rubella syndrome, and mumps, 2013: Summary recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2013;62(RR-04):1-34.*
24. *Centers for disease control and prevention (CDC). Mumps Vaccination. Available from: https://www.cdc.gov/vaccines/vpd/mumps/index.html (Accessed date: 21.04.2024).*
25. *Vygen S, Fischer A, Meurice L, Mounchetrou Njoya I, Gregoris M, Ndiaye B, et al. Waning immunity against mumps in vaccinated young adults, France 2013. Euro Surveill 2016;21(10):30156. https://doi.org/10.2807/1560-7917.ES.2016.21.10.30156*
26. *Wallin T, Holzschuh E, Kintner C. Notes from the Field: Rubella Infection in an Unvaccinated Pregnant Woman-Johnson County, Kansas, December 2017. MMWR Morb Mortal Wkly Rep 2018;67(40):1132-33. https://doi.org/10.15585/mmwr.mm6740a7*
27. *Bankamp B, Hickman C, Icenogle JP, Rota PA. Successes and challenges for preventing measles, mumps and rubella by vaccination. Curr Opin Virol 2019;34:110-16. https://doi.org/10.1016/j.coviro.2019.01.002*
28. *Lam E, Rosen JB, Zucker JR. Mumps: An update on outbreaks, vaccine efficacy, and genomic diversity. Clin Microbiol Rev 2020;33(2):e00151-19. https://doi.org/10.1128/CMR.00151-19*
29. *Weber DJ, Shenoy ES. Vaccine for health care personnel. In: Plotkin SA, Orenstein WA, O fit PA, Edwards KM (eds). Plotkin's Vaccines. Elsevier 2023;1469-88.*
30. *CDC. Centers for Disease Control and Prevention. Chickenpox for HCPs. Available from: https://www.cdc.gov/chickenpox/hcp/index.html (Accessed date: 04.04.2024).*
31. *Immunization of health-care workers:Recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Hospital Infection Control Practices Advisory Committee (HICPAC). MMWR Recomm Rep Morb Mortal Wkly Rep Recomm Rep 1997;46 (RR-18):1-42.*
32. *Kimura T, Tsunekawa K, Ogiwara T, Tokue Y, Nara M, Inoue T, et al. Seroprevalence of measles- and mumps-specific immunoglobulin G among Japanese healthcare students increased during 2007-2012. Jpn J Infect Dis 2013;66(5):411-5. https://doi.org/10.7883/yoken.66.411*