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Vaccination coverage, seroprotection, and perceived immunity to hepatitis B among medical students in Brazil: implications for occupational safety in medical education

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Abstract

Background

Hepatitis B remains an important occupational health concern for healthcare workers and medical students due to the risk of exposure to blood and body fluids during clinical training. Medical students begin clinical activities early in their training, which may increase exposure to biological risks, including infection with the hepatitis B virus (HBV). This study aimed to analyze vaccination status and immunological protection against hepatitis B among medical students from two universities in Fortaleza, Ceará, Brazil, as well as their perception of immunity and the performance of post-vaccination serological testing.

Methods

A cross-sectional study was conducted with 163 medical students from two universities in Fortaleza, Ceará, Brazil. Data were collected using a structured questionnaire including information on vaccination history, perception of immunity, and post-vaccination serological testing. Descriptive statistics were used to calculate absolute and relative frequencies. Associations between variables were assessed using Pearson's chi-square test or Fisher's exact test. Prevalence ratios (PR) with 95% confidence intervals were also calculated.

Results

Complete hepatitis B vaccination coverage (three doses) was reported by 81% of participants. Although 91% of students believed they were immune, only 23% reported having undergone post-vaccination serological testing. Among the 38 students who performed serology, 38% of fully vaccinated individuals had reactive anti-HBs results. A statistically significant association was observed between perceived immunity and performance of serological testing.

Conclusions

A relevant discrepancy was observed between self-reported vaccination coverage, perceived immunity, and effective serological protection among medical students. These findings highlight the importance of implementing institutional protocols for serological verification and integrating vaccination monitoring and biosafety education into undergraduate medical training.

Background

Hepatitis B remains an important occupational health concern for healthcare professionals and students due to the risk of exposure to blood and other body fluids during clinical activities. Medical students

begin clinical training during the early years of their education, which may increase exposure to biological risks, including infection with the hepatitis B virus (HBV) [1, 2].

HBV infection represents one of the major global public health challenges. It is estimated that approximately 296 million people live with chronic infection, with about 1.2 million new infections and approximately 820,000 deaths annually related to its complications [3, 4]. In Brazil, despite the implementation of the National Immunization Program (PNI) and universal hepatitis B vaccination since 1998, the disease remains a relevant concern, particularly among healthcare workers and students [5].

HBV transmission occurs primarily through vertical transmission (from mother to child during childbirth) and through contact with infected blood or body fluids. Additionally, HBV maintains significant infectivity on dry surfaces, especially in the presence of blood or body fluids, and may remain detectable for several days. Reports indicate persistence of HBsAg antigen and viral DNA for extended periods under laboratory conditions. This high environmental stability is recognized in the medical literature as an important factor in nosocomial and occupational transmission [6, 7, 8].

In the context of medical education, this scenario becomes particularly relevant. During undergraduate training, students attend clinical environments and perform procedures such as blood collection, venipuncture, insertion of intravenous catheters, and suturing of minor wounds. These activities may expose students to potentially contaminated biological material. Needlestick injuries and exposure to sharp instruments remain one of the main routes of occupational exposure to HBV among students and healthcare professionals in training, especially during the early stages of clinical practice [2, 9, 10, 11].

Hepatitis B vaccination is considered the most effective preventive measure against the virus and shows high rates of seroconversion in the general population [12, 13]. However, the immune response may vary between individuals, and antibody levels may decline over time [14, 15]. Therefore, evaluation of vaccine-induced immunity becomes particularly relevant in populations exposed to occupational risks. Some authors recommend serological testing 5 to 10 years after vaccination, as well as booster vaccination for individuals without adequate protection [14].

In this context, assessing vaccination status and immunological protection among medical students is essential for preventing occupational infections and monitoring adherence to vaccination strategies in this population undergoing healthcare training [1, 2].

Thus, the present study aimed to analyze vaccination status and immunological protection against hepatitis B among medical students from two universities in Fortaleza, Ceará, Brazil, as well as to evaluate perceived immunity and the performance of post-vaccination serological testing in this population.

Methods

Study design

This was a cross-sectional, descriptive, and analytical study conducted with medical students from two higher education institutions located in Fortaleza, Ceará, Brazil.

Study population

Students regularly enrolled in the medical course and aged 18 years or older were eligible to participate in the study. Participation was voluntary and required the signing of an informed consent form.

Data collection

Data were collected using a structured self-administered questionnaire containing information on age, sex, hepatitis B vaccination history, perceived immunity, and performance of anti-HBs serological testing. The questionnaire was developed by the authors specifically for this study (see Supplementary File 1 – Questionnaire for the full version).

Variables

The dependent variable analyzed was serological immunity status (reactive or non-reactive anti-HBs result). Independent variables included age, sex, completeness of the vaccination schedule, and perceived immunity.

Statistical analysis

Statistical analysis included descriptive and inferential statistics, with calculation of absolute and relative frequencies. Associations between variables were evaluated using Pearson's chi-square test or Fisher's exact test when appropriate. Prevalence ratios with 95% confidence intervals were also calculated. A significance level of 5% was adopted.

Ethical approval

The study was conducted in accordance with the principles of the Declaration of Helsinki and Brazilian Resolution 466/2012 of the National Health Council. The research was approved by the Research Ethics Committee of the University of Fortaleza under protocol number 6.689.258.

Results

A total of 163 medical students participated in the study, with a mean age of 21.4 years. A predominance of male participants was observed (61.3%).

Vaccination status and perceived immunity

Regarding hepatitis B vaccination status, 132 students (81.0%) reported having received the complete three-dose schedule, whereas 31 (19.0%) reported not completing the vaccination schedule.

Concerning perceived immunity, 149 participants (91.0%) believed they were protected after vaccination, while 14 (9.0%) did not consider themselves immune.

Performance of anti-HBs serology

Only 38 students (23.3%) reported having undergone serological testing for detection of anti-HBs antibodies, while 125 (76.7%) had never performed the test.

Association between vaccination schedule and serological result

Among the 38 students who performed serological testing, 26 (68.4%) had received the complete three-dose vaccination schedule. Of these, 10 (38.5%) had reactive results, 15 (57.7%) had non-reactive results, and one participant (6.9%) did not know the result.

Among the 12 students with incomplete vaccination who underwent serology, 5 (41.7%) had reactive results and 7 (58.3%) had non-reactive results.

No statistically significant association was observed between complete vaccination and reactive serological results ($\chi^2 = 0.00$; $p = 1.00$). Fisher's exact test confirmed this result ($p = 1.00$). The prevalence ratio was 0.92 (95% CI: 0.41–2.10).

Association between perceived immunity and serological testing

A statistically significant association was observed between perceived immunity and performance of anti-HBs serology ($\chi^2 = 6.06$; $p = 0.0138$). Fisher's exact test confirmed the statistical significance ($p = 0.0087$).

Among students who believed they were immune, 34.2% had undergone serological testing, whereas among those who did not consider themselves protected, 71.4% had performed the test.

The prevalence ratio was 0.48 (95% CI: 0.32–0.71), indicating that students with perceived immunity were less likely to undergo serological testing.

Discussion

The results of this study reveal an important discrepancy between self-reported vaccination coverage, perceived immunity, and effective serological protection among medical students from two universities in Fortaleza, Ceará, Brazil. Although most participants reported complete vaccination schedules, the low rate of post-vaccination serological testing revealed significant gaps in immunity monitoring among this population undergoing medical training and exposed to occupational risk during clinical practice.

The vaccination coverage of 81% for the complete three-dose schedule observed in this study is similar to that reported in other studies involving healthcare students. International studies have also demonstrated high hepatitis B vaccination coverage among healthcare students, although gaps remain

in monitoring immunity and performing post-vaccination serological testing[1,2,16,17]. However, the finding that 91% of medical students believe they are immune, while only 23% underwent confirmatory serological testing, suggests a possible false sense of security. This misperception may compromise the adoption of appropriate preventive measures, such as repeating the vaccination schedule when necessary, and reinforces the importance of objectively verifying immunity through laboratory testing.

This finding becomes even more relevant when considering that medical students are progressively exposed to occupational risks throughout their training. Studies have demonstrated a high frequency of occupational exposure to blood and body fluids during clinical education, often associated with incomplete vaccination coverage and low rates of post-vaccination serological testing [1,9]. The insertion of students into clinical environments, where they perform invasive procedures and have direct contact with blood and body fluids, increases the risk of exposure to bloodborne pathogens, including HBV. Studies also indicate that needlestick injuries remain relatively frequent among students and healthcare professionals in training, particularly during the early stages of clinical practice, when technical skills are still being developed [9,11,17].

In the Brazilian context, research conducted in different regions has demonstrated considerable variation in vaccination coverage and seroconversion rates among medical students [5,9, 10,19]. Studies conducted in southeastern and southern regions of the country report seropositivity rates between 65% and 85%, values significantly higher than those observed in the present study [10]. Although methodological differences between studies should be considered, this discrepancy may reflect factors such as differences in access to serological testing, variations in institutional vaccination monitoring policies, population characteristics, or the time elapsed since vaccination [4, 12, 14, 16].

Fortaleza represents an important center for medical education in northeastern Brazil, concentrating several higher education institutions that receive students from diverse socioeconomic and epidemiological backgrounds. In this context, understanding the immunization profile against hepatitis B among medical students becomes essential for supporting more effective institutional occupational health policies [5,9,19].

One of the most concerning findings of this study was the low proportion of reactive serology among fully vaccinated students who underwent testing. Only 38% of students with a complete vaccination schedule had reactive anti-HBs results, a value lower than expected according to international literature, which reports seroconversion rates ranging from 90% to 95% in immunocompetent individuals after the full vaccination schedule. This result suggests that a significant proportion of students may not have detectable antibody levels at the time of serological assessment [4,9,12,13,15].

Several factors may influence the immune response to hepatitis B vaccination. Studies have demonstrated that seroconversion may be affected by individual characteristics such as age at the time of vaccination, sex, body mass index, smoking status, comorbidities, and genetic factors related to immune response [4,13,14,18]. In addition, the progressive decline of antibody levels over time is a widely documented phenomenon [12,13]. Although cellular immune memory may persist even in the

absence of detectable antibodies, the lack of confirmatory serological testing makes it difficult to identify individuals who may remain susceptible to infection [14].

Another relevant finding observed in this study was the similarity between seropositivity rates among students with a complete vaccination schedule (38%) and those with incomplete vaccination (42%). Although the number of participants who performed serological testing was relatively small, this result suggests that self-reported vaccination alone may not guarantee effective immunological protection. This finding reinforces the importance of post-vaccination serological verification, particularly among populations at higher occupational risk [4,11].

The additional analysis conducted in this study also demonstrated a statistically significant association between perceived immunity and the performance of serological testing. Students who believed they were immune were less likely to undergo serological testing compared with those who did not consider themselves protected. This result suggests that subjective perception of immunity may reduce the search for laboratory confirmation, contributing to gaps in knowledge about the true immunological status of students.

From an occupational health perspective, this finding is particularly relevant. Occupational exposure to the hepatitis B virus in academic environments represents not only an individual risk but also a concern for patient safety and the broader academic community [1,11]. Students susceptible to infection may acquire the virus during clinical activities and potentially contribute to transmission in healthcare environments.

Given these findings, it becomes essential for medical schools to implement systematic strategies to monitor the vaccination and serological status of students. Verification of hepatitis B immunity before the beginning of clinical training should be considered a fundamental biosafety measure. Institutional protocols including post-vaccination serological testing, identification of non-responders, and provision of revaccination strategies may significantly reduce occupational risk.

Studies have demonstrated that additional vaccine doses may restore immunity in a large proportion of individuals initially classified as non-responders [11,18]. Therefore, early identification of students who fail to achieve seroconversion allows preventive measures to be implemented before occupational exposure occurs.

In addition to immunological monitoring strategies, health education plays a central role in preventing hepatitis B in academic environments. Educational interventions have been shown to significantly improve knowledge regarding hepatitis B and preventive measures among healthcare students and professionals [2,9,11].

This study has some limitations that should be considered when interpreting the results. The sample consisted of students from two institutions located in the same city, which may limit the generalization of the findings to other regions of the country. Furthermore, the low proportion of students who

underwent serological testing may have introduced selection bias, as individuals who chose to perform the test may differ from those who did not. Finally, the cross-sectional design does not allow evaluation of temporal changes in antibody levels or the long-term durability of vaccine-induced immunity.

Despite these limitations, the findings of this study contribute to expanding knowledge about hepatitis B immunization profiles among medical students in northeastern Brazil and reinforce the importance of implementing institutional policies for vaccination and serological monitoring.

Future research should consider multicenter studies that allow comparison across different institutional and regional contexts, as well as investigations into factors associated with lack of vaccine response and evaluation of revaccination and serological monitoring strategies among medical students.

Conclusions

This study demonstrated a relevant discrepancy between self-reported hepatitis B vaccination coverage, perceived immunity, and effective serological protection among medical students from two universities in Fortaleza, Ceará, Brazil. Although most participants reported having completed the vaccination schedule and believed they were protected, the low rate of post-vaccination serological testing revealed an important gap in immunity monitoring within this population.

The findings reinforce the need to implement institutional protocols for serological verification, adopt revaccination strategies when necessary, and strengthen biosafety education throughout medical training.

These measures may contribute to reducing occupational risk, protecting students, and strengthening a culture of safety in academic healthcare environments.

Abbreviations

HBV
Hepatitis B virus
anti
HBs—Antibody to hepatitis B surface antigen
PNI
National Immunization Program

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki. The research protocol was approved by the Research Ethics Committee of the University of Fortaleza,

Ceará, Brazil, under approval number 6.689.258. All participants were informed about the objectives of the study and voluntarily agreed to participate by signing an informed consent form.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. The questionnaire used in this study is included as “Supplementary File 1 – Questionnaire”.

Competing interests

The authors declare that they have no competing interests related to this study.

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Authors’ contributions

YFB, ISO, LCC, and JAB were responsible for data collection.
SLS and SFRS performed the statistical analysis and supervised the study.
All authors contributed to the study design, critically revised the manuscript, and approved the final version.

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Supplementary Files

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- SupplementaryFile1Questionnaire.docx