Ann Med Res

Current issue list available at Ann Med Res

Annals of Medical Research

journal page: annalsmedres.org

HBV immunity gaps in older adults undergoing cataract surgery: Opportunistic screening and linkage to care

Ezgi Karatas[a], *, Seher Koksaldi[a], Mustafa Kayabasi[b], Yavuz Oruc[a]

[a]Ağrı İbrahim Çeçen University, Faculty of Medicine, Department of Ophthalmology, Ağrı, Türkiye
[b]Muş State Hospital, Clinic of Ophthalmology, Muş, Türkiye
*Corresponding author: e.karatas.2015@gmail.com (Ezgi Karatas)

MAIN POINTS

- Nearly half (47.0%) of cataract surgery candidates had non-protective anti-HBs (<10 mIU/mL), and two-thirds (67.7%) had levels ≤100 mIU/mL, indicating substantial immunity gaps.
- HBsAg positivity was 4.4%, highlighting silent carriers identified at preoperative screening with infection-control implications.
- Female sex was independently associated with non-protective titers (aOR 1.49, 95% CI 1.04–2.13).
- Pragmatic contribution: routine preoperative serology in ophthalmology functions as an opportunistic public-health checkpoint to trigger booster vaccination and linkage-to-care.

Cite this article as: Karatas E, Koksaldi S, Kayabasi M, Oruc Y. HBV immunity gaps in older adults undergoing cataract surgery: Opportunistic screening and linkage to care. *Ann Med Res*. 2026;33(6):292–299. doi: 10.5455/annalsmedres.2025.10.328.

ABSTRACT

Aim: To assess whether routine preoperative testing in cataract surgery candidates can serve as a practical public health checkpoint for detecting waning hepatitis B immunity and initiating booster-based protection pathways.

Materials and Methods: In this descriptive cross-sectional study, preoperative anti-HBs, HBsAg, anti-HCV, and anti-HIV serologies were evaluated in 430 patients (January 2023 -- December 2024) who underwent cataract surgery. Anti-HBs levels were classified as non-protective (<10 mIU/mL), low-protective (10–<100 mIU/mL), or highly protective (≥100 mIU/mL). Chi-square tests and logistic regression were used to analyze immunity levels and associated risk factors.

Results: Among 430 patients (mean age 67.4 ± 9.6 years; 47.4% women), anti-HBs titers were <10 mIU/mL in 47.0% (202/430), 10–<100 mIU/mL in 20.7% (89/430), and ≥100 mIU/mL in 32.3% (139/430). Women had higher odds of non-protective titers (<10 mIU/mL) than men (OR 1.52, 95% CI 1.04–2.23; P=0.031), which persisted after adjustment for age and comorbidity (aOR 1.49, 95% CI 1.04–2.13; P=0.028). HBsAg positivity was 4.4% (19/430); anti-HCV was 2.1% (9/430) and HIV was 0%. Across major comorbidity groups, anti-HBs distributions were broadly similar.

Conclusion: A substantial proportion of patients undergoing cataract surgery lack adequate HBV immunity, emphasizing the need for routine preoperative serological screening and booster vaccination. This pioneering study from Türkiye provides valuable insights into infection control strategies for ophthalmic surgery.

Keywords: Cataract surgery, Hepatitis B virus, Hepatitis B virus antibodies, Infection control, Vaccination

Received: Nov 03, 2025 **Accepted:** Jan 29, 2026 **Available Online:** Jun 25, 2026

INTRODUCTION

Cataract surgery is minimally invasive and involves minimal blood loss. Although the risk of blood-borne infection transmission is infrequent, universal precautions and preoperative screening protocols are essential to ensure the safety of both patients and staff. The incidence of needlestick (sharps) injuries in ophthalmic practice has been reported to be 0.06–0.08 per 1,000 procedures; although low, this risk cannot be dismissed given the potential severity of HBV and other blood-borne infections [1]. Asymptomatic seropositive individuals, who are often unaware of their infection status, present unique challenges in perioperative settings, necessitating stringent infection control protocols [2].

HBV remains a major global public health challenge, with an estimated 296 million people living with chronic HBV infection in 2019, resulting in approximately 820,000 deaths annually due to liver cirrhosis and hepatocellular carcinoma [3]. The World Health

Organization (WHO) classifies regions based on hepatitis B surface antigen (HBsAg) prevalence (<2%) [4]. In Türkiye, HBsAg prevalence has decreased from 12.3% in 2000 to 4–6% in recent years, largely due to the national HBV vaccination program initiated in 1998 [5]. However, regional dispari-

ties persist, with a higher prevalence (up to 10%) in Eastern Türkiye than in metropolitan areas [6]. Globally, approximately one-third of the population is exposed to HBV, underscoring the need for robust preventive strategies [7].

Vaccination has significantly reduced HBV incidence [8]. However, long-term immunity wanes in some individuals, particularly older adults who may not have been vaccinated during childhood [9]. Cataract surgery, one of the most common procedures globally, involves older adults who may have waning immunity due to incomplete vaccination coverage in earlier decades. Studies indicated that anti-HBs levels decline over time, with seroprotection rates ranging from 30% to 80% in adults, depending on age, vaccination history, and comorbidities [10].

In surgical settings, where the risk of HBV transmission is heightened owing to exposure to blood and bodily fluids, preoperative serological screening is increasingly recognized as essential [11]. While HBV screening is routine in high-risk surgeries, its application in

elective procedures, such as cataract surgery, remains underexplored, particularly in

intermediate-prevalence settings such as Türkiye.

This study aimed to characterize the preoperative HBV serological status of cataract surgery candidates by quantifying anti-HBs levels to identify individuals with inadequate immunity, guide targeted booster vaccination, and strengthen infection control practices in ophthalmic settings, thereby supporting the global HBV elimination goals for 2030 [12]. We defined seroprotection as anti-HBs ≥10 mIU/mL and, given blunted immune responses in certain high-risk settings (e.g., haemodialysis, profound immunosuppression), considered ≥100 mIU/mL a conservative benchmark cited in existing guidance [13]. Accordingly, we reported anti-HBs in three strata (<10, 10–<100, ≥100 mIU/mL) and evaluated factors associated with non-protection. Our objective was to characterize serological protection levels rather than the aetiology of immunity; accordingly, differentiation between vaccine- and infection-induced anti-HBs responses lay outside the study's predefined scope.

MATERIALS AND METHODS

This study was approved by the Ağrı İbrahim Çeçen University Scientific Research Ethics Committee (date: 26.12.2024, decision no: 500) and adhered to the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment. This cross-sectional study (January 2023–December 2024) was designed to quantify the degree and robustness of protective immunity against HBV—using anti-HBs titer strata (<10, 10–<100, ≥100 mIU/mL) in patients who underwent cataract surgery, based on blood samples obtained preoperatively. We also estimated the preoperative seroprevalence of HBV (HBsAg), HCV (anti-HCV), and HIV (anti-HIV). Inclusion required a clinical diagnosis of cataract and written informed consent; patients with incomplete serologic data were excluded. Before surgery, all participants underwent a standard ophthalmic examination. As part of the routine preoperative work-up, venous blood was collected before surgery for serologic testing (quantitative anti-HBs [mIU/mL], qualitative HBsAg, anti-HCV antibody, and HIV antibody) using chemiluminescent immunoassays according to manufacturers' instructions.

Demographic characteristics, medical history, and comorbidities were recorded. The results were categorized as follows:

- Non-protective: anti-HBs <10 mIU/mL
- Low protective: anti-HBs 10–<100 mIU/mL
- Highly protective: anti-HBs ≥100 mIU/mL [13].

Sample size calculation

Based on previous reports indicating that the prevalence of non-protective anti-HBs levels in older adults ranges between 40% and 50%, a prevalence estimate of p = 0.47 was assumed. With a 95% confidence level (Z = 1.96) and a margin of error of ±5% (d = 0.05), the minimum required sample size was calculated as 383 patients [14,15].

Statistical analysis

Analyses were performed using IBM SPSS Statistics, version 26 (IBM Corp., Armonk, NY). Descriptive statistics summarized demographics and serologic measures. Normality of continuous variables was assessed using the Shapiro–Wilk test and visual inspection of histograms and Q–Q plots. Normally distributed variables were presented as means ± standard deviations (SD) and compared using Student's t tests, whereas non-normally distributed variables were summarized as median (interquartile range, IQR) and compared using the Mann–Whitney U test. Comparisons across anti-HBs categories (<10, 10-<100, and ≥100 mIU/mL) were performed using one-way ANOVA for normally distributed variables or the Kruskal–Wallis test for non-normally distributed variables. For variables showing overall significance, post hoc pairwise comparisons were conducted with Bonferroni adjustment. Categorical variables were expressed as counts and percentages and compared using χ^2 tests or Fisher's exact test, as appropriate. Multivariable logistic regression analysis was performed to identify independent factors associated with non-protective anti-HBs status (<10 mIU/mL), and results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Two-sided P values < 0.05 were considered statistically significant.

RESULTS

Among 430 patients (67.4 ± 9.6 years; 204/430 [47.4%] women), anti-HBs titers were <10 mIU/mL in 202 (47.0%), 10–<100 mIU/mL in 89 (20.7%), and ≥100 mIU/mL in 139 (32.3%). Women were more likely than men to have non-protective titers <10 mIU/mL (107/204 [52.5%] vs 95/226

https://doi.org/10.5455/annalsmedres.2025.10.328

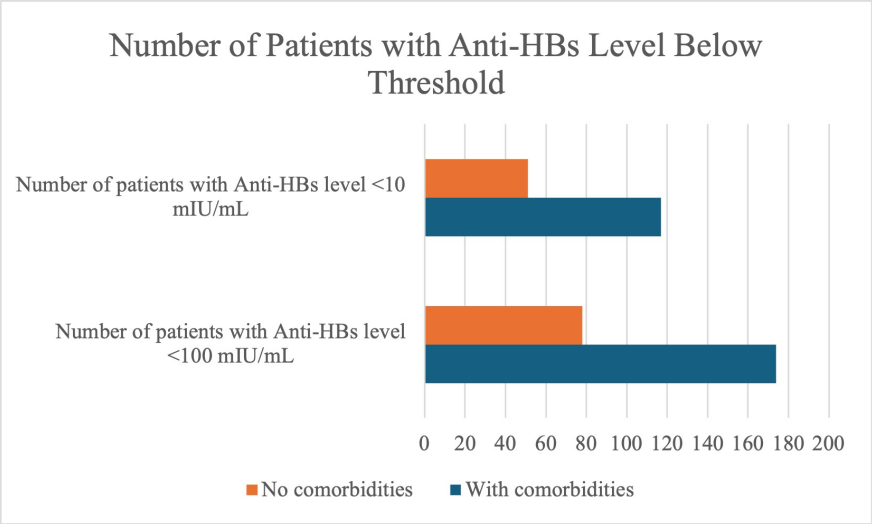

Figure 1. Represents the number of cataract surgery patients with anti-HBs levels below the immunity thresholds (<10 mIU/mL and <100 mIU/mL), categorized by the presence or absence of comorbidities. [Grouped bar chart showing hepatitis B surface antibody (anti-HBs) categories (<10, 10-<100, ≥100 mIU/mL) by comorbidity status (none vs ≥1 chronic disease). Distributions are broadly similar between groups; no significant global difference is observed. The largest category overall is anti-HBs <10 mIU/mL (202/430; 47.0%), followed by 10-<100 mIU/mL (89/430; 20.7%) and ≥100 mIU/mL (139/430; 32.3%). This figure emphasizes the sizeable proportion with non-protective titers, supporting preoperative screening and linkage to booster vaccination].

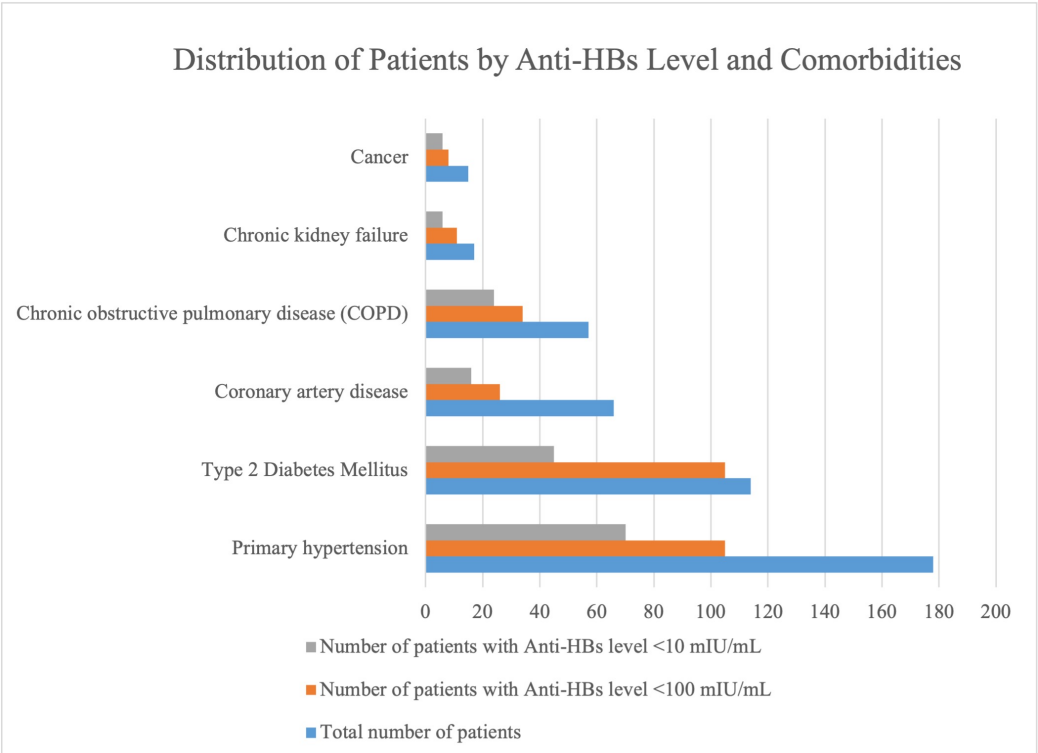

Figure 2. Depicts patient distribution according to Anti-HBs levels and comorbid conditions. [Bar chart comparing hepatitis B surface antibody (anti-HBs) categories (<10, 10-<100, ≥100mIU/mL) across multiple chronic conditions: primary hypertension, type 2 diabetes mellitus, coronary arterydisease, chronic obstructive pulmonary disease, chronic kidney disease, and a no-comorbidity referencegroup. Each condition displays three bars reflecting the distribution of anti-HBs categories. Overall patternsare broadly similar across conditions; in most groups, <10 mIU/mL (non-protective) constitutes the largestshare, while ≥100 mIU/mL indicates a smaller, long-term immunity subgroup. A modest tilt toward ≥100mIU/mL is observable in the coronary artery disease group, whereas hypertension and diabetes approximatecohort averages. The figure underscores that non-protective titers are prevalent across comorbidity profiles, reinforcing the rationale for preoperative screening and linkage to booster vaccination].

[42.0%]; χ^2 test, P=0.031). In age-adjusted models (age and any comorbidity), female sex remained associated with anti-HBs <10 mIU/mL (aOR 1.49, 95% CI 1.04–2.13; P=0.028). The proportion with anti-HBs ≥100 mIU/mL was 32.3% (139/430), while 67.7% (291/430) had titers <100 mIU/mL (Table 1). HBsAg was positive in 19/430 (4.4%) patients;

https://doi.org/10.5455/annalsmedres.2025.10.328

Table 1. Demographic characteristics and anti-HBs* antibody concentrations of the patients.

Parameters	Female (n, %)	Male (n, %)	P-value
Number (n, percentage)	204 (47.4%)	226 (52.6%)	0.2
Age (mean ± SD)	68.21 ± 10.2	66.65 ± 8.8	0.09
Anti-HBs level (<10 mIU/mL)	107 (52.4%)	95 (44%)	0.03
Anti-HBs level (10-<100 mIU/mL)	31 (15.2%)	58 (25.6%)	0.00
Anti-HBs level (≥100 mIU/mL)	66 (47.4%)	73 (52.5%)	0.9

* Antibodies against Hepatitis B surface antigen.

Table 2. Distribution of patients according to systemic chronic diseases and gender.

Diseases	Female n (%)	Male n (%)	P-value
Primary hypertension	116 (56.9%)	62 (27.4%)	<0.001
Type 2 diabetes mellitus	72 (35.3%)	42 (18.6%)	<0.001
Coronary artery disease	31 (15.2%)	35 (15.5%)	1.0
Chronic obstructive pulmonary disease	23 (11.2%)	34 (15.0%)	0.25
Cancer	3 (1.5%)	12 (5.3%)	0.03
Chronic Hepatitis B	5 (2.5%)	7 (3.1%)	0.68
Chronic Hepatitis C	0 (0.0%)	2 (0.9%)	0.5
Other*	68 (33.0%)	54 (23.0%)	0.2

* Other diseases include aortic aneurysm, hydatid cyst, nephrectomy, ankylosing spondylitis, systemic lupus erythematosus, cirrhosis, polycythemia vera, psychosis, nephrotic syndrome, rheumatoid arthritis, bronchitis, hepatosteatosis, epilepsy, cerebrovascular occlusion, heart failure, chronic renal failure, and dermatomyositis.

12/19 (63.2%) met criteria for chronic hepatitis B, and the remainder represented previously undiagnosed current infection identified at preoperative screening. Results were unchanged after excluding HBsAg-positive cases (n=19) (all P>0.05).

Based on chronic disease status, 111 patients had no comorbidities, whereas 319 had ≥1 comorbidity. The most frequent conditions were hypertension (179/430, 41.6%), type 2 diabetes mellitus (116/430, 27.0%), coronary artery disease (66/430, 15.3%), and chronic obstructive pulmonary disease (59/430, 13.7%) (Table 2). Table 3 summarizes anti-HBs strata across comorbidity groups and specific diagnoses (HT, T2DM, CAD, COPD, CKD); Figure 1 and Figure 2 visualizes these patterns.

In multivariable logistic regression analysis (Table 4), female sex remained independently associated with non-protective anti-HBs status (≤10 mIU/mL) (adjusted OR [aOR] 1.74, 95% CI 1.14–2.63; P=0.010). Increasing age was associated with lower odds of non-protective titers (aOR 0.96 per 1-year increase, 95% CI 0.94–0.99; P=0.001). COPD was associated with increased odds of anti-HBs ≤10 mIU/mL (aOR 1.80, 95% CI 1.01–3.22; P=0.048), whereas diabetes mellitus, hypertension, and coronary artery disease were not significant predictors (all P>0.05).

DISCUSSION

This study evaluated the preoperative serological status of patients scheduled for cataract surgery by assessing markers of HBV, HCV, and HIV infection. Among 430 participants, 47.0% (202/430) had anti-HBs <10 mIU/mL, indicating insufficient protection against HBV. Additionally, 20.7% (89/430) had anti-HBs 10–<100 mIU/mL, suggesting waning long-term immunity. The proportion with long-term immunity (≥100 mIU/mL) was 32.3% (139/430), whereas 67.7% (291/430) had titers <100 mIU/mL, indicating a substantial gap in durable protection. These results highlight the substantial proportion of patients at risk of HBV infection in the surgical setting, particularly among older adults. In addition, HBsAg positivity was 4.4% (19/430). The coexistence of limited durable protection, a sizable pool of HBV carriers, and a non-negligible subset of previously undiagnosed cases identified during preoperative screening underscores the need for targeted booster vaccination, systematic linkage to care, and strict adherence to universal precautions in ophthalmic theatres. Our primary aim was to quantify the degree and robustness of HBV protective immunity using anti-HBs titer strata (<10, 10–<100, ≥100 mIU/mL); a secondary aim was to estimate the preoperative seroprevalence of HBV (HBsAg), HCV, and HIV. Differentiating vaccine-induced from infection-induced immunity was not a prespecified objective.

Following vaccination or natural infection, anti-HBs antibody levels gradually decline and may fall below protective thresholds within around 5 to 20 years [16–19]. The rate and degree of antibody decline are influenced by factors like vaccination age, the original peak antibody response, and certain health problems (e.g., immunosuppression, comorbidities) [20–22]. While primary HBV vaccination provides enduring protection, the decline of humoral immunity requires continuous monitoring, especially in elderly individuals who may not have received the universal childhood immunization implemented in Türkiye in 1998 [23].

Although the incidence of breakthrough infections among vaccinated individuals remains low, the observed decrease in anti-HBs levels raises concerns regarding the durability of vaccine-induced protection [24]. T-lymphocyte-mediated immune memory often persists longer than humoral responses; however, a progressive decline in this memory has been documented, with anamnestic response rates decreasing from 85.3% at 10 years to 73.6% at 15 years post-vaccination [24,25]. This attrition could lead to HBsAg seroconversion and increased vulnerability to HBV infection.

In accordance with previous booster-response studies, those with very low pre-booster titers (<2 mIU/mL) are more likely to demonstrate only marginal post-booster responses compared to those with detectable although sub-protective titers (2.00–9.99 mIU/mL) [25–27]. Earlier research found that 65% of adults with pre-booster <10 mIU/mL had undetectable titers (<2 mIU/mL). After the booster, low responders with <2 mIU/mL were overrepresented among those who stayed <10 mIU/mL (≈11% vs 2.3% for the 2.00–9.99 mIU/mL subgroup), and they also more often fell into the 10–100 mIU/mL band (≈26.6% vs 10.2%) instead of exceed-

https://doi.org/10.5455/annalsmedres.2025.10.328

Table 3. Distribution of Anti-HBs Titer Strata (<10, 10-<100, ≥100 mIU/mL) by Overall Comorbidity Statusand Specific Chronic Diseases, with P-values.

Variable	Group	<10 mIU/mL	10–<100 mIU/mL	≥100 mIU/mL	Total	P value (test)
Any comorbidity	No	54 (48.6%)	25 (22.5%)	32 (28.8%)	111	0.639 (χ^2)
	Yes	148 (46.4%)	64 (20.1%)	107 (33.5%)	319	
Hypertension	No	118 (47.0%)	49 (19.5%)	84 (33.5%)	251	0.724 (χ^2)
	Yes	84 (46.9%)	40 (22.3%)	55 (30.7%)	179	
Type 2 diabetes mellitus	No	148 (47.1%)	68 (21.7%)	98 (31.2%)	314	0.616 (χ^2)
	Yes	54 (46.6%)	21 (18.1%)	41 (35.3%)	116	
Coronary artery disease	No	179 (49.2%)	76 (20.9%)	109 (29.9%)	364	0.036 (χ^2)
	Yes	23 (34.8%)	13 (19.7%)	30 (45.5%)	66	
COPD	No	170 (45.8%)	75 (20.2%)	126 (34.0%)	371	0.191 (χ^2)
	Yes	32 (54.2%)	14 (23.7%)	13 (22.0%)	59	
Chronic kidney disease	No	197 (47.2%)	86 (20.6%)	134 (32.1%)	417	0.819 (FE)
	Yes	5 (38.5%)	3 (23.1%)	5 (38.5%)	13	

Anti-HBs: hepatitis B surface antibody; HT: hypertension; T2DM: type 2 diabetes mellitus; CAD: coronary artery disease; COPD (KOAH): chronic obstructive pulmonary disease; CKD: chronic kidney disease; Data are presented as n (%). P values were calculated using Pearson's chi-square test (χ^2) unless otherwise indicated. FE indicates Fisher's exact test, used when expected cell counts were <5.

Table 4. Multivariable logistic regression analysis for predictors of non-protective anti-HBs (≤10 mIU/mL).

Predictor	β (SE)	Wald χ^2	Adjusted OR	95% CI	P value
Female sex (vs male)	0.551 (0.213)	6.70	1.74	1.14–2.63	0.010
Age (per 1-year increase)	-0.036 (0.011)	10.71	0.96	0.94–0.99	0.001
Diabetes mellitus	-0.202 (0.235)	0.74	0.82	0.52–1.30	0.390
Hypertension	0.040 (0.224)	0.03	1.04	0.67–1.62	0.858
Coronary artery disease	-0.499 (0.290)	2.96	0.61	0.34–1.07	0.085
COPD	0.587 (0.297)	3.91	1.80	1.01–3.22	0.048
Constant	2.656 (0.766)	12.01	---	---	<0.001

OR: odds ratio; CI: confidence interval; SE: standard error; AUC: area under the receiver operating characteristic curve. Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test. Constant indicates the intercept term of the logistic regression model.

ing 100 mIU/mL [26]. This pattern is consistent with waned immune memory rather than a strong anamnestic response. Interestingly, individuals who stayed below 10 mIU/mL after one booster shot were able to respond well following a full secondary vaccination course. This suggests that they were not true primary "non-responders" but had lost their immunological memory about 18–20 years after their first immunization. Our study did not give boosters or check anti-HBc levels, but our preoperative distribution, which showed that 19.5% of participants fell in the 10–100 mIU/mL range, likely includes a large group of people with partial or waning immunity who could benefit from targeted booster vaccination and, if possible, post-booster titer checks to confirm durability. From a practical point of view, these data support a pragmatic approach in ophthalmic settings: (i) offer boosters to patients with anti-HBs 10–100 mIU/mL (and strongly to those <10 mIU/mL), (ii) consider aiming for ≥100 mIU/mL in higher-risk contexts (e.g., haemodialysis, profound immunosuppression), and (iii) reserve etiologic attribution (vaccine- vs infection-derived immunity) for settings where anti-HBc is available. This approach is in line with our main goal, which is to map actionable immunity gradients before surgery.

Data from immunosuppressed groups shows that having an anti-HBs level of at least 100 mIU/mL (100mIU/mL) protects against clinically significant HBV reactivation. On the other hand, patients with low (≤100 mIU/mL) or no anti-HBs levels have higher rates of reactivation and more frequent HBsAg seroreversion during treatments like anti-TNF [28–30]. These findings underscore the therapeutic significance of baseline quantitative anti-HBs prior to the commencement of anti-TNF (and other potent immunosuppressants) and advocate for vaccination/booster dose to elevate titers to ≥100 mIU/mL before and/or during treatment. Our study did not assess treatment-related reactivation; nevertheless, the preoperative identification of individuals with 10–<100 mIU/mL or <10 mIU/mL offers a chance to identify vaccination requirements and facilitate care coordination with treating specialists during planned or continuing immunosuppression.

In this perspective, it is significant that, despite a substantial reduction in acute HBV incidence in Italy, 212 cases were recorded in 2018 (incidence 0.8 per 100,000), including 16 cases among vaccinated patients, five of whom had seemingly completed a full and properly timed vaccination series [26]. This persistent burden, especially in highly vaccinated environments, highlights the necessity of quantitative anti-HBs evaluation, targeted boosters for diminishing immunity, and the facilitation of care for carriers detected opportunistically

https://doi.org/10.5455/annalsmedres.2025.10.328

in surgical procedures.

Recent guidelines for haemodialysis patients suggest keeping anti-HBs levels at least 100 mIU/mL because they tend to go down over time [28–30]. As a result, experts recommend checking anti-HBs levels once a year and giving a booster shot if they drop below 100 mIU/mL. A comparable high-titer approach has been utilized following liver transplantation to avert HBV-related disease. In line with this methodology, Khiangte et al. found no HBV reactivation in individuals who sustained anti-HBs levels exceeding 100 mIU/mL, despite the lack of antiviral treatment [31,32]. These studies underscore the clinical significance of identifying preoperative patients between the 10–<100 mIU/mL or <10 mIU/mL categories and prioritizing targeted boosters to provide more sustained protection, particularly among high-risk populations such as those with chronic kidney disease or haemodialysis and immunosuppressed persons. In accordance with this, our group of participants exhibited significant immune deficiencies within comorbidity subgroups: 39.5% of patients with diabetes mellitus and 64.7% of those with chronic renal disease demonstrated reduced or non-existent seroprotection (anti-HBs <100 mIU/mL, including <10 mIU/mL). These results highlight the necessity of regular preoperative screening for hepatitis B indicators in cataract surgical protocols, particularly for elderly or immunocompromised individuals, and advocate for targeted booster immunization to improve seroprotection in these groups.

Meta-analytic evidence indicates diminished seroprotection following HB vaccination in older adults, individuals with a body mass index ≥25, smokers, and those with comorbidities [33]. Other pooled data show that in people who are immunocompetent and have been properly vaccinated, protection usually lasts for about 20 years, with just a few short-lived HBsAg seroconversions [34]. In light of this, our preoperative screening of patients who underwent cataract surgery showed that a lot of older people had weak immunity: 39.1% had anti-HBs levels below 10 mIU/mL, 19.5% had levels between 10 and 100 mIU/mL, and 39.5% of patients with diabetes and 64.7% of patients with chronic kidney disease had levels below 100 mIU/mL. These findings advocate for a risk-stratified, opportunistic strategy within cataract pathways: uphold standard vaccination practices universally, while identifying and administering targeted boosters to individuals with anti-HBs <10 mIU/mL or 10–<100 mIU/mL—especially older adults and patients with diabetes or chronic kidney disease—to augment seroprotection identified during routine preoperative assessments.

Although our cohort showed a higher proportion of women with anti-HBs <10 mIU/mL, multiple studies and reviews report that males often mount weaker HBV vaccine responses than females, with sex-based differences observed across regions and settings [33,35–37]. When combined, our female-dominant non-protection may indicate cohort-specific factors (e.g., demographic characteristics, comorbidity burden, time since vaccination, undocumented vaccination histories) or residual confounding if body mass index (BMI), metabolic status, or the interval from vaccination to testing varied by sex. From a methodological standpoint, these observations endorse the presentation of sex-stratified results in conjunction with adjusted models that incorporate BMI and the interval since vaccination. Operationally, irrespective of sex-based directionality in a specific context, the identification of individuals with anti-HBs <10 mIU/mL or 10–<100 mIU/mL continues to be therapeutically relevant for targeted booster methods identified via standard preoperative screening.

Furthermore, the detection of HBsAg positivity in 4.4% of patients (n:19; females: 8 [42.1%], males: 11 [57.9%])— which is comparable to the reported national prevalence [38–40] - underscores the silent burden of HBV infection in surgical populations. Routine serological screening facilitates early diagnosis and targeted infection control interventions, thereby reducing intraoperative transmission risk. Although anti-HCV positivity was detected in only 0.5% of patients and HIV seroprevalence was minimal, universal screening remains essential to ensure the safety of patients and staff.

Comprehensive infection control protocols were implemented for seropositive patients undergoing surgery. These included preoperative infectious disease consultations, enhanced barrier precautions (double gloves, impermeable gowns, and eye protection), use of dedicated surgical instruments, and meticulous administration of local anaesthesia to prevent needlestick injuries. The surgical team received targeted training on universal precautions and post-exposure management protocols, which significantly mitigated the risk of blood-borne pathogen transmission. Routine booster doses are not advised for the general populace in low-endemicity areas; nevertheless, our context indicates moderate endemicity (HBsAg ≈4%), where exposure risk is significant, especially among older persons and individuals with comorbidities. In light of our preoperative findings of substantial immunity gaps (anti-HBs <10 or 10–<100 mIU/mL), a targeted, opportunistic booster strategy integrated into preoperative workflows is warranted: evaluate seroprotection, administer boosters as necessary, and facilitate care linkage for HBsAg-positive individuals. The implementation of WHO recommendations has altered HBV endemicity in several Asian nations; nonetheless, the underlying risk remains variable, being elevated in certain contexts and moderate in others. Guidance established in low-endemicity regions (Europe/North America) typically emphasizes the completion of the primary series and does not support routine boosters for the general population—except for immunocompromised groups (e.g., chronic kidney disease/haemodialysis, advanced immunosuppression), for whom periodic monitoring and booster dosing are recommended.

Translating these principles to moderate-endemicity contexts like ours, the higher lifetime probability of exposure argues

https://doi.org/10.5455/annalsmedres.2025.10.328

against blanket boosting yet for a risk-stratified, opportunistic approach: use the preoperative visit to identify low/non-protected patients (anti-HBs <10 or 10–<100 mIU/mL), offer targeted boosters, and ensure linkage to care for those who are HBsAg-positive.

Limitations

This study is limited by its cross-sectional, single-centre design, which restricts causal inference and limits the generalizability of the findings. Longitudinal multicentre studies are warranted to assess the durability of vaccine-induced immunity and effectiveness of booster doses in maintaining long-term protection.

CONCLUSION

This study revealed that a considerable proportion of patients undergoing cataract surgery, predominantly older adults, exhibited inadequate protective anti-HBs levels. These findings highlight the urgent need for targeted booster immunization strategies and early vaccination initiatives to ensure sustained protection against HBV infection. Enhancing serological screening and vaccination efforts within surgical settings aligns with the World Health Organization's goal of achieving 90% global hepatitis B vaccination coverage by 2030, representing a critical step towards HBV elimination. Ophthalmologists and surgical teams must maintain heightened vigilance regarding the patients' serological status to ensure optimal infection control and patient safety.

Abbreviations

HBV: Hepatitis B Virus

HBsAg: Hepatitis B Surface Antigen

Anti-HBs: Antibodies Against Hepatitis B Surface Antigen

HCV: Hepatitis C Virus

HIV: Human Immunodeficiency Virus

WHO: World Health Organization

OR: Odds Ratio

CI: Confidence Interval

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

Ethics Committee Approval: This study was approved by the Ağrı İbrahim Çeçen University Scientific Research Ethics Committee (date: 26.12.2024, decision no: 500).

Informed Consent: Written informed consent was obtained from all participants.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors declare that they have no competing interests.

Author Contributions: Conception: E.K, S.K, M.K, Y.O; Design: E.K, S.K, M.K, Y.O; Supervision: S.K, M.K, Y.O; Materials: S.K; Data Collection and/or Processing: E.K, M.K; Analysis and/or Interpretation: E.K, M.K; Literature Review: E.K, Y.O; Writing: E.K, S.K, Y.O; Critical Review: E.K, S.K, M.K, Y.O.

Financial Disclosure: This study did not receive any specific grants from funding agencies in the public, commercial, or not-for-profit sectors.

Artificial Intelligence Disclosure: The authors declare that ChatGPT (OpenAI, GPT-4 series) was used during the preparation of this manuscript for language editing, grammatical correction, and improving clarity and readability of the text. The artificial intelligence tool did not contribute to the study design, data collection, statistical analysis, data interpretation, or the generation of scientific conclusions. All content produced with the assistance of ChatGPT was carefully reviewed, verified, and approved by the authors, who take full responsibility for the accuracy, originality, and integrity of the manuscript. The AI tool was not listed as an author and did not assume responsibility for any part of the work.

REFERENCES

1. Kuhar DT, Henderson DK, Struble KA, et al. Updated US Public Health Service Guidelines for the Management of Occupational Exposures to Human Immunodeficiency Virus and Recommendations for Postexposure Prophylaxis. *Infect Control Hosp Epidemiol.* 2013;34(9):875–92. doi: 10.1086/672271.
2. Nayak B, Bhatt B. Commentary: Viral serology testing before cataract surgery: Where do we stand? *Indian J Ophthalmol.* 2022;70(2):405. doi: 10.4103/ijo.IJO_2484_21.
3. WHO. Global Health Sector Strategies on HIV, Viral Hepatitis and the sexually transmitted infections. World Health Organization. 2022–30.
4. WHO. Epidemiological update: increasing mortality calls for action 03. Global Hepatitis Report, 2017. 2017:7–20.
5. Tozun N, Ozdogan O, Cakaloglu Y, Idilman R, et al. Seroprevalence of hepatitis B and C virus infections and risk factors in Turkey: A fieldwork TURHEP study. *Clin Microbiol Infect.* 2015;21(11):1020–6. doi: 10.1016/j.cmi.2015.06.028.
6. Mehmet D, Meliksah E, Serif Y, Gunay S, Tuncer Ö, Zeynep S. Prevalence of Hepatitis B Infection in the Southeastern Region of Turkey: Comparison of Risk Factors for HBV Infection in Rural and Urban Areas. *Jpn J Infect Dis.* 2005;58(1):15–9. doi: 10.7883/yoken.JJID.2005.15.
7. Schweitzer A, Horn J, Mikolajczyk RT, Krause G, Ott JJ. Estimations of worldwide prevalence of chronic hepatitis B virus infection: a systematic review of data published between 1965 and 2013. *Lancet.* 2015;386(10003):1546–55. doi: 10.1016/S0140-6736(15)61412-X.
8. Hepatitis B vaccines: WHO position paper – July 2017. https://www.who.int/publications/i/item/WER9227 (accessed April 28, 2025).
9. Leuridan E, Van Damme P. Hepatitis B and the Need for a Booster Dose. *Clin Infect Dis.* 2011;53(1):68–75. doi: 10.1093/cid/cir270.
10. Bruce MG, Bruden D, Hurlburt D, et al. Antibody Levels and Protection After Hepatitis B Vaccine: Results of a 30-Year Follow-up Study and Response to a Booster Dose. *J Infect Dis.* 2016;214(1):16–22. doi: 10.1093/infdis/jiv748.
11. Redd JT, Baumbach J, Kohn W, Nainan O, Khristova M, Williams I. Patient-to-patient transmission of hepatitis B virus associated with oral surgery. *J Infect Dis.* 2007;195(9):1311–4. doi: 10.1086/513435.

https://doi.org/10.5455/annalsmedres.2025.10.328

12. Global health sector strategy on viral hepatitis 2016-2021. Towards ending viral hepatitis. https://www.who.int/publications/i/item/WHO-HIV-2016.06 (accessed April 28, 2025).
13. Seekircher L, Mühlbacher A, Tschiderer L, et al. Anti-HBs Seroprevalence in Blood Donors from Tyrol, Austria. *Vaccines (Basel).* 2024;12(10):1156. doi: 10.3390/vaccines12101156.
14. Sahana H V., Sarala N, Prasad SR. Decrease in Anti-HBs Antibodies over Time in Medical Students and Healthcare Workers after Hepatitis B Vaccination. *Biomed Res Int.* 2017;2017:1327492. doi: 10.1155/2017/1327492.
15. Elrashidy H, Elbahrawy A, El-Didamony G, et al. Antibody levels against hepatitis B virus after hepatitis B vaccination in Egyptian diabetic children and adolescents. *Hum Vaccin Immunother.* 2013;9(9):2002–6. doi: 10.4161/hv.25426.
16. Coppeta L, Pompei A, Balbi O, et al. Persistence of Immunity for Hepatitis B Virus among Heathcare Workers and Italian Medical Students 20 Years after Vaccination. *Int J Environ Res Public Health.* 2019;1616(9):1515. doi: 10.3390/ijerph16091515.
17. Dumaidi K, Al-Jawabreh A. Persistence of Anti-HBs Among Palestinian Medical Students After 18-22 Years of Vaccination: A Cross-Sectional Study. *Hepat Mon*. 2015;15(11):e29325. doi: 10.5812/hepatmon.29325.
18. Verso MG, Costantino C, Marrella A, Immordino P, Vitale F, Amodio E. Kinetics of Anti-Hepatitis B Surface Antigen Titers in Nurse Students after a Two-Year Follow-Up. *Vaccines (Basel).* 2020;88(3):467. doi: 10.3390/vaccines8030467.
19. Phattraprayoon N, Kakheaw J, Soonklang K, et al. Duration of Hepatitis B Vaccine-Induced Protection among Medical Students and Healthcare Workers following Primary Vaccination in Infancy and Rate of Immunity Decline. *Vaccines (Basel).* 2022;10(2):267. doi: 10.3390/vaccines10020267.
20. Bagheri-Jamebozorgi M, Keshavarz J, Nemati M, et al. The persistence of anti-HBs antibody and anamnestic response 20 years after primary vaccination with recombinant hepatitis B vaccine at infancy. *Hum Vaccin Immunother.* 2014;10(12):3731-6. doi: 10.4161/hv.34393.
21. Karabulut N, Çatak Z. Frequency of Hepatitis B Virus, Hepatitis C Virus and HIV Infections in Cannabis and Opioid Addicts. *Viral Hepat J.* 2017;23:26–9. doi: 10.4274/vhd.74046.
22. Zheng Z, Li G, Liao F, et al. Seroconversion of hepatitis B surface antigen among those with previously successful immune response in Southern China. *Hum Vaccin Immunother.* 2021;17(3):845-851. doi: 10.1080/21645515.2020.1801076.
23. Jan CF, Huang KC, Chien YC, et al. Determination of immune memory to hepatitis B vaccination through early booster response in college students. *Hepatology.* 2010;51(5):1547-54. doi: 10.1002/hep.23543.
24. Papadopoli R, De Sarro C, Torti C, Pileggi C, Pavia M. Is There Any Opportunity to Provide an HBV Vaccine Booster Dose before Anti-Hbs Titer Vanishes? *Vaccines (Basel).* 2020;8(2):227. doi: 10.3390/vaccines8020227.
25. Lu CY, Ni YH, Chiang BL, et al. Humoral and Cellular Immune Responses to a Hepatitis B Vaccine Booster 15–18 Years after Neonatal Immunization. *J Infect Dis.* 2008;197(10):1419–26. doi: 10.1086/587695.
26. Garthwaite E, Reddy V, Douthwaite S, Lines S, Tyerman K, Eccles J. Clinical practice guideline management of blood borne viruses within the haemodialysis unit. *BMC Nephrol.* 2019;20(1):388. doi: 10.1186/s12882-019-1529-1.
27. Paul S, Dickstein A, Saxena A, et al. Role of surface antibody in hepatitis B reactivation in patients with resolved infection and hematologic malignancy: A meta-analysis. *Hepatology.* 2017;66(2):379–88. doi: 10.1002/hep.29082.
28. Poola S, Kratzer MK, Sewell K, Tillmann HL. Size Matters! Anti-HBs Titer and HBV Reactivation During Anti-TNF Therapy. *Dig Dis Sci.* 2023;68(12):4511–20. doi: 10.1007/s10620-023-08141-7.
29. Khiangte B, Kothakota SR, Sasidharan M, et al. Hepatitis B Reactivation in Liver Transplant Recipients With Hepatitis B Virus Core Antibody Positive Grafts: a Retrospective Study. *J Clin Exp Hepatol.* 2020;10(6):548–54. doi: 10.1016/j.jceh.2020.05.001.
30. Nasir M, Wu GY. Prevention of HBV Recurrence after Liver Transplant: A Review. *J Clin Transl Hepatol.* 2020;8(2):150–60. doi: 10.14218/JCTH.2020.00003.
31. Yang S, Tian G, Cui Y, et al. Factors influencing immunologic response to hepatitis B vaccine in adults. *Sci Rep.* 2016;6:27251. doi: 10.1038/srep27251.
32. Poorolajal J, Mahmoodi M, Majdzadeh R, Nasseri-Moghaddam S, Haghdoost AA, Fotouhi A. Long-term protection provided by hepatitis B vaccine and need for booster dose: A meta-analysis. *Vaccine.* 2010;28(3):623–31. doi: 10.1016/j.vaccine.2009.10.068.
33. Hudu SA, Jimoh AO, Shinkafi SH, et al. Hepatitis B Vaccine Nonresponse and Associated Risk Factors: Insights From a Cohort Study. *J Trop Med.* 2025;2025:3879562. doi: 10.1155/jotm/3879562.
34. Trevisan A, Giuliani A, Scapellato ML, et al. Sex Disparity in Response to Hepatitis B Vaccine Related to the Age of Vaccination. *Int J Environ Res Public Health.* 2020;17(1):327. doi: 10.3390/ijerph17010327.
35. Ruggieri A, Anticoli S, D'ambrosio A, Giordani L, Viora M. Monographic section The influence of sex and gender on immunity, infection and vaccination. *Ann Ist Super Sanità.* 2016;52(2):198–204. doi: 10.4415/ANN_16_02_11.
36. Naeem SS, Siddiqui EU, Kazi AN, Khan S, Abdullah FE, Adhi I. Prevalence of Hepatitis 'B' and Hepatitis 'C' among preoperative cataract patients in Karachi. *BMC Res Notes.* 2012;5:492. doi: 10.1186/1756-0500-5-492.
37. Khan S, Rafique A, Khizer MA, Zafar O. Frequency of Hepatitis B and C in Patients Undergoing Cataract Surgery in a Tertiary Care Eye Hospital. *Pak Armed Forces Med J.* 2021;71(1):234–7. doi: 10.51253/pafmj.v71i1.4834.
38. Mishra D, Singh H, Gogate P, et al. Prevalence of incidental and total human immunodeficiency virus, hepatitis B and hepatitis C seropositivity among patients posted for cataract surgery at a tertiary care center in India. *Indian J Ophthalmol.* 2022;70(2):400-404. doi: 10.4103/ijo.IJO_1970_21.
39. John TJ, Cooksley G, Chan VF, et al. Hepatitis B vaccine boosters: Is there a clinical need in high endemicity populations? *J Gastroenterol Hepatol.* 2005;20(1):5–10. doi: 10.1111/j.1440-1746.2004.03398.x.
40. Al-Busafi SA, Alwassief A. Global Perspectives on the Hepatitis B Vaccination: Challenges, Achievements, and the Road to Elimination by 2030. *Vaccines (Basel).* 2024;12(3):288. doi: 10.3390/vaccines12030288.

https://doi.org/10.5455/annalsmedres.2025.10.328