BMC Infectious Diseases

RESEARCH

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Prevalence of hepatitis B surface antibodies and hepatitis B exposure in Belgium: results from a nationwide population-based serosurvey

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Abstract

Background The WHO aims to eliminate hepatitis B virus (HBV) as a public health problem by 2030. HBV vaccination has reduced HBV incidence and mortality and is a cornerstone of the WHO elimination strategy. Belgium introduced universal infant HBV vaccination in 1999, with temporary catch-up vaccination for 12-year-olds, thereby covering all individuals born since 1987. This nationwide serosurvey assessed vaccine-induced hepatitis B surface antibody (anti-HBs) prevalence and natural HBV exposure in Belgium in 2020.

Methods We analyzed 4955 left-over samples from SARS-CoV-2 sero-epidemiology studies in 2020. Samples from ambulatory patients outside lockdown periods were tested for anti-HBs and hepatitis B core antibodies (anti-HBc) to evaluate vaccine-induced vs. natural exposure-derived anti-HBs responses. Samples were stratified by region, 10-year age band, and sex, and were weighted to reflect the Belgian population.

Results Overall, 47.3% (95%CI 45.6%-48.9%) of the Belgian population had anti-HBs ≥ 2 IU/L and was anti-HBc negative. Furthermore, 33.9% (95%CI 32.4%-35.5%) fulfilled the WHO-recommended threshold of anti-HBs ≥ 10 IU/L. Anti-HBc prevalence, indicating prior or current infection, was 3.8% (95%CI 3.2%-4.5%). Individuals born since 1987, thus eligible for universal vaccination, had higher anti-HBs (≥ 2 IU/L) and lower anti-HBc prevalences than those born before 1987 (71.6% vs. 31.4%, $p < 0.001$ and 0.8% vs. 5.9%, $p < 0.001$). Regional differences were observed with the lowest anti-HBc-/anti-HBs+ (≥ 2 IU/L) prevalence in Wallonia, and highest anti-HBc prevalence in the Brussels federal region. In weighted multivariate analysis, older age (aOR 0.96, 95%CI 0.96–0.97) and residency in Wallonia (aOR 0.80, 95%CI 0.69–0.93) were associated with lower anti-HBc-/anti-HBs+ (≥ 2 IU/L) positivity, while older age (aOR 1.03, 95%CI 1.03–1.04) and residency in Brussels (aOR 2.79, 95%CI 1.70–4.57), were associated with higher anti-HBc positivity.

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Conclusions Belgium has achieved high levels of vaccine-induced protection, especially in cohorts born after the implementation of universal HBV vaccination. However, regional differences remain, highlighting the need for targeted efforts to improve coverage and reduce HBV exposure.

Keywords Hepatitis B virus, Belgium, Public health, Serosurvey, Screening, HBV, Hepatitis B surface antigen

Background

Despite the commercial availability of safe and effective recombinant DNA vaccines since 1986, hepatitis B virus (HBV) remains a major global health problem. It is estimated that approximately 254 million people are chronically infected worldwide, and 1.2 million new infections occur yearly [1]. Chronic HBV infection increases the risk of cirrhosis, hepatic decompensation, and hepatocellular carcinoma, potentially leading to liver-related mortality [2, 3]. Moreover, the number of HBV-related deaths seems to be on the rise, ranking viral hepatitis as the second leading cause of death among communicable diseases in 2022 [1].

The World Health Organization (WHO) has set an ambitious target to eliminate viral hepatitis as a public health problem by 2030, aiming for a 95% reduction of the HBV-incidence and 65% reduction of HBV-related mortality compared to the 2015 baseline. The introduction of universal HBV vaccination programs has led to significant decreases in HBV incidence, prevalence of chronic HBV and subsequent liver-related complications such as liver cancer [4–6]. Therefore, HBV vaccination is one of the cornerstones of WHO's elimination strategy. Specifically, the WHO aims to reach ≥ 95% coverage of three doses of HBV vaccine (Hep-B3) and ≥ 90% timely administration of the birth dose vaccine within 24 h of delivery when indicated [7].

Belgium has been a low-endemic country, with estimated HBV prevalences ranging from 0.7% in 1997 to 0.25% in 2020 [8–10]. Universal infant vaccination was introduced in 1999, alongside a temporary catch-up vaccination of the 12-year-olds (for a period of 12 years), thereby covering everybody born in Belgium since 1987. Since 2007, the estimated vaccine coverage rates have consistently been above 90%, exceeding 96.8% since 2012 [11]. Although the hepatitis B vaccination program is a national policy, the implementation and practical organization of universal HBV vaccination in childhood (unlike traveler and occupational HBV vaccination) fall under the responsibility of the federated entities (communities). This decentralized approach, combined with existing sociocultural differences between regions, may contribute to important regional differences in vaccine uptake.

Robust serological monitoring is essential to evaluate the effectiveness of vaccination programs, identify remaining gaps in population-level protection, and check regional or age-related differences. In addition, population-based serosurveys give insight into long-term immunity and HBV exposure, which is not captured by administrative vaccine coverage data. Measurement of hepatitis B surface antibody (anti-HBs) titers also allows to assess the number of individuals that reach the WHO-recommended threshold of 10 IU/L. Additionally, measuring the prevalence of hepatitis B core antibodies (anti-HBc) gives an indication of past or current HBV infection.

In this study, we conducted a nationwide, population-based serosurvey using residual serum samples representative for the Belgian population. We systematically analyzed anti-HBs and included previously reported anti-HBc data [10] as proxies for HBV vaccination and HBV exposure, respectively, and investigated differences across sex, age groups, and regions. These results provide essential data to evaluate the real-world impact of Belgium's vaccination policy and guide future public health strategies.

Methods

Study design

This is a prospective, cross-sectional nationwide serosurvey using left-over serum samples of the study previously described by Herzog et al. [12] In the current study, collection periods 4 (8 to 13 June 2020), 5 (29 June to 4 July 2020), and 6 (7 to 12 September 2020) were analyzed. In brief, the original study established a serum bank representative of the Belgian population by collecting left-over serum samples from ten private routine clinical laboratories. Each laboratory had a fixed number of samples per region (Brussels, Flanders, and Wallonia), per collection period, and per age group (10-year age bands), which were stratified by sex within each age group. All samples originated from ambulatory patients consulting their primary care physician. Samples collected in hospitals or severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) triage centers were excluded. In the current study, only samples collected outside Belgian SARS-CoV-2 lockdown periods were included, assuming these are periods with normalized health-seeking behavior.

The HBV testing strategy has been described previously [10]. In short, the analyses were done in two phases: first, the adult samples and, subsequently, the samples from minors (≤ 18 years old). Given the anticipated low HBV prevalence in minors, all available samples were tested, resulting in an intentional oversampling of the 10-19-year-old age group (Figure S1). The samples were anonymized, with only limited demographic data

available: sample date, age, sex, and postal code of the place of residence. The anti-HBc results of this serosurvey were previously reported as part of HBV prevalence estimates in Belgium [10]. In the current study the anti-HBc results were included to differentiate between natural exposure-related and vaccine-induced responses.

Analytical assays

Anti-HBs and anti-HBc testing was carried out on automated Abbott Alinity I analyzers, according to the procedures provided in the technical leaflets. Samples were considered anti-HBc positive if the signal-to-cutoff ratio (S/CO) was ≥ 1.0, in line with the manufacturer's guidelines. The anti-HBs assay had a limit of quantification (LOQ) of 2.00 IU/L. Anti-HBs titers exceeding the LOQ were considered positive.

Statistical analyses

Weighting was performed to represent the Belgian population structure of 2020. The weights were computed by comparing sample and population frequencies by sex, age (10-year age bands), and province, and were trimmed to a maximum value of 3 to ensure that a small number of samples with large weights did not disproportionally affect the weighted prevalence estimates. This threshold was selected based on inspection of the weight distribution (Figure S2), which showed a separation between the main body of weights and a small number of outlying values: only 45 of 4945 (0.91%) weights exceeded this threshold. A sensitivity analysis was performed comparing weight trimming thresholds of 3, 4, and 5, as well as untrimmed weights, showing that both Belgian and regional prevalence estimates remained consistent across all thresholds (Table S1). One sample lacked postal code data, precluding province assignment. This sample was excluded from weighted analyses but retained in the reported results for the sample population. Fifteen samples had a missing postal code and were excluded from the number of samples per municipality (Fig. 1A). The Rao-Scott scaled chi-square distribution was used for the weighted confidence intervals [13]. All analyses were done with the statistical software R (version 4.4.1, R Foundation, Vienna, Austria) [14]. The R package "survey" (version 4.4) was used for weighting and weighted analyses, and R package "BelgiumMaps.StatBel" (version 1.0) was used for the municipality, province and region plots.

Results

Sample population

A total of 4955 serum samples were analyzed. The number of samples per region, age group, and sex are shown in Table 1. A comparison of the sample population with the 2020 Belgian population distribution is shown in Figure S1.

Anti-HBs results in the sample population and estimates for Belgian population

In total, 2436/4955 (49.2%) samples were anti-HBc negative and had an anti-HBs titer < 2 IU/L, whereas 47.1% (2336/4955) of the samples had an anti-HBs titer ≥ 2 IU/L and were anti-HBc negative, indicative of prior HBV vaccination (Table 2). Of those, 69.1% (1614/2336) had an anti-HBs titer ≥ 10 IU/L, fulfilling the WHO-recommended threshold. In addition, 3.7% (183/4955) samples were anti-HBc positive, reflecting previous HBV exposure (Table 2).

Overall, the weighted prevalence of anti-HBs ≥ 2 IU/L in anti-HBc negative individuals was 47.3% (95% CI 45.6–48.9%) for the Belgian population in 2020. When

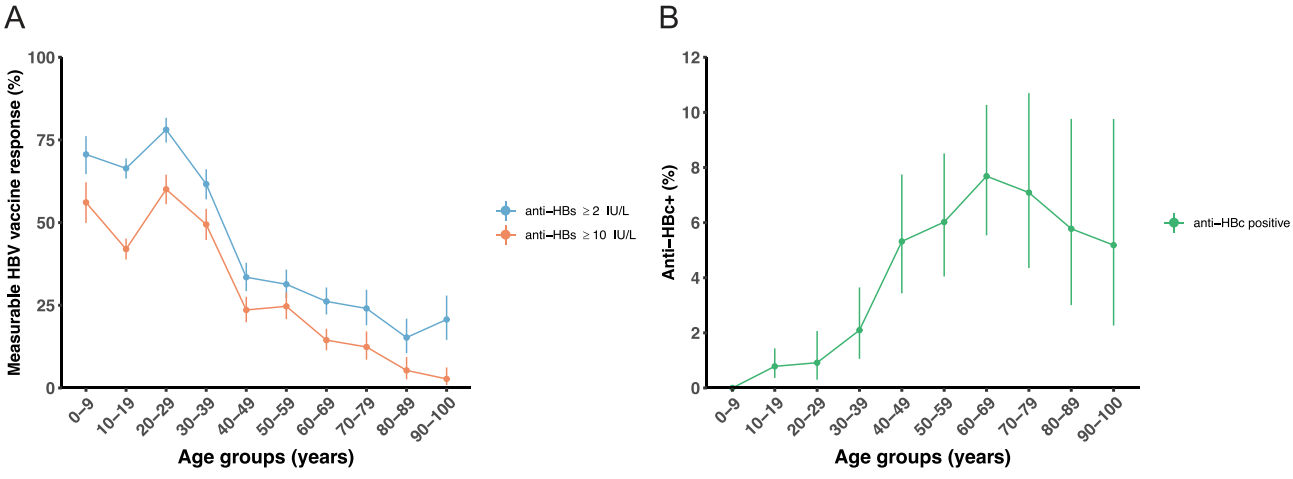

Fig. 1 Age-stratified analysis of anti-HBc-/anti-HBs+ and anti-HBc+ prevalence in the Belgian population per 10-year age group. A) Weighted proportion of anti-HBs ≥2 and ≥10 IU/L per age group, and B) weighted proportion of anti-HBc positives per age group. The range indicates 95% confidence intervals. The 10 – 19-year age group was oversampled

Table 1 Distribution of the sample population by region, age group and sex

Sample population		*N* = 4955	%
Region	Brussels	443	8.9
	Flanders	2257	45.5
	Wallonia	2254	45.5
Age group (years)	< 10	291	5.9
	10–19	1026	20.7
	20–29	574	11.6
	30–39	578	11.7
	40–49	580	11.7
	50–59	580	11.7
	60–69	587	11.8
	70–79	305	6.2
	80–89	238	4.8
	≥90	196	4.0
Sex	Male	2380	48.0
	Female	2575	52.0

Table 2 Anti-HBs and anti-HBc qualitative results for the sample and Belgian population

Anti-HBs ≥ 2 IU/L	Anti-HBc	Sample population		Weighted for the Belgian population	
		N	%	%	95% CI
-	-	2436	49.2	48.9	47.3–50.5
+	-	2336	47.1	47.3	45.6–48.1
-	+	16	0.3	0.3	0.2–0.5
+	+	167	3.4	3.6	3.0–4.2

Anti-HBs, hepatitis B surface antibodies; anti-HBc, hepatitis B core antibodies; CI, confidence interval.

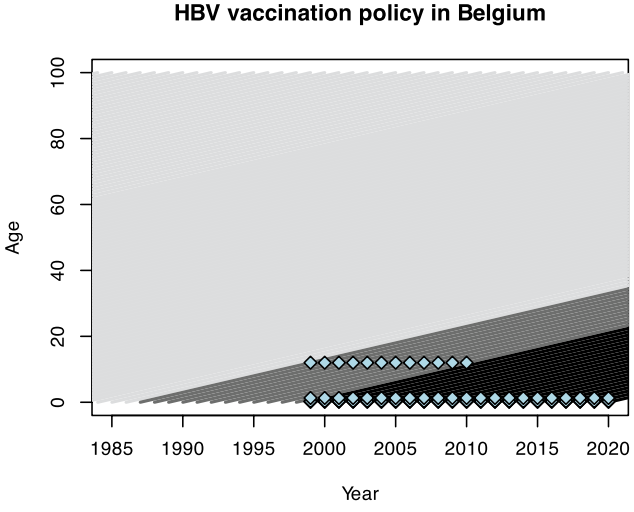

Fig. 2 Graphical overview of the HBV vaccination policy in Belgium for three different birth cohorts. The light gray lines: birth cohort not subject to the HBV vaccination policy, the medium gray lines: birth cohort subject to the catch-up vaccination at 12 years of age, and the dark gray lines: birth cohort subject to the infant vaccination policy. The blue diamonds indicate the time of vaccination

applying the WHO-recommended threshold of anti-HBs ≥ 10 IU/L, this prevalence was 33.9% (95% CI 32.4% – 35.5%). The weighted anti-HBc prevalence was 3.8% (95% CI 3.2% – 4.5%) (Table 2).

Age and sex-stratified analyses

Weighted age-stratified analysis shows a decreasing proportion of anti-HBc-/anti-HBs+ (≥ 2 IU/L) with increasing age (Fig. 2A), which is in line with the Belgian vaccination policy that introduced universal vaccination for infants and 12-year-olds in 1999 (Fig. 1). Moreover, a 71.6% (95% CI 69.3% – 73.9%) of those subject to the universal vaccination policy (born since 1987, i.e. 33 years or younger at the time of sampling) were anti-HBc negative and had anti-HBs titers ≥ 2 IU/L, which was more than double the prevalence observed in those older than 33 years (31.4%, 95% CI 29.4% – 33.4%; $p < 0.001$) (Table 3).

Vice versa, a higher weighted anti-HBc prevalence was observed with increasing age, corresponding to birth cohorts that predate universal HBV vaccination (Fig. 2B). Similarly, the anti-HBc prevalence was significantly higher in those who were not subject to the universal vaccination policy (i.e. born < 1987) than the younger cohort (5.9%, 95% CI 4.9% – 6.9% vs. 0.8%, 95% CI 0.4% – 1.2%; $p < 0.001$, Table 3).

There was no significant difference in weighted anti-HBc-/anti-HBs+ (≥ 2 IU/L) proportions between females and males ($p = 0.76$), nor was there an association between sex and anti-HBc positivity ($p = 0.55$).

Regional differences

Figure 3A indicates the number of samples analyzed per municipality. 78.8% (471/598) of all municipalities had at least one sample included (Fig. 3A). The sample population of the Walloon provinces, the Southern region of Belgium, had a lower percentage of anti-HBs positive samples in comparison to Brussels, the Capital region, and Flanders, the Northern region (Fig. 3B). In addition, at the provincial level, the highest anti-HBc positivity rates were observed in Brussels (6.5%), followed by Antwerp (5.3%) in Flanders and Liège (5.2%) in Wallonia (Fig. 3C).

Vaccination coverage, estimated by the percentage anti-HBc negative with anti-HBs levels ≥ 2 IU/L, differed significantly between the three Belgian regions ($p = 0.011$). Weighted estimates were 48.5% (95% CI 46.2% – 50.8%) in Flanders, 50.8% (95% CI 45.6% – 56.0%) in Brussels, and 43.7% (95% CI 41.2% – 46.2%) in Wallonia. In weighted multivariate logistic regression including age and region, age (aOR 0.96, 95% CI 0.96–0.97, $p < 0.001$) and residency in Wallonia (aOR 0.80, 95% CI 0.69–0.93, $p = 0.003$, compared to Flanders) were independently associated with lower likelihood to be anti-HBc-/

Table 3 Anti-HBs and anti-HBc qualitive results according to the Belgian vaccination policy

Anti-HBs ≥ 2 IU/L	Anti-HBc	Born since 1987 Subject to universal vaccination				Born before 1987 No universal vaccination			
		Sample population		Weighted for the Belgian population		Sample population		Weighted for the Belgian population	
		N	%	%	95% CI	*N*	%	%	95% CI
-	-	614	28.6	27.6	25.4–29.9	1822	64.8	62.8	60.7–64.8
+	-	1511	70.4	71.6	69.3–73.9	825	29.4	31.4	29.4–33.4
+ or -	+	20	0.90	0.8	0.46–1.26	163	5.8	5.9	4.9–6.9

Anti-HBs, hepatitis B surface antibodies; anti-HBc, hepatitis B core antibodies; CI, confidence interval

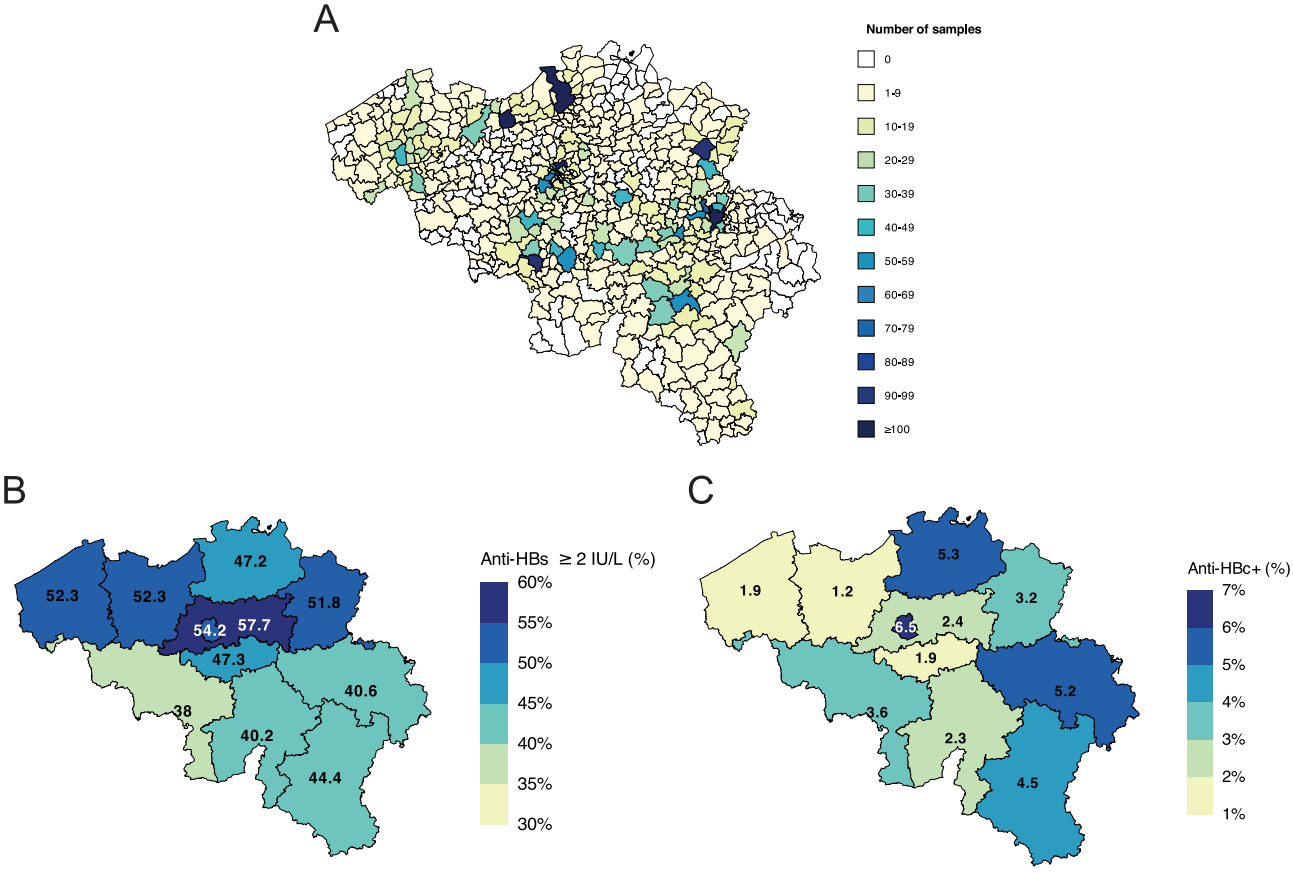

Fig. 3 Anti-HBc-/anti-HBs+ (≥ 2 IU/L) and anti-HBc prevalence at the provincial level. (**A**) Number of samples tested per municipality, () proportion of anti-HBc-/anti-HBs+ (≥ 2 IU/L) per province, and (**C**) proportion of anti-HBc positive samples per province

anti-HBs+ (≥ 2 IU/L). Age-stratified analysis of anti-HBs seroprevalence per region showed comparable rates, with broadly overlapping confidence intervals across all age groups (Figure S3).

In addition, we observed that HBV exposure, as estimated by anti-HBc prevalence, differed significantly between regions ($p < 0.001$), with an estimated 3.4% (95% CI 2.5% – 4.3%) in Flanders, 7.4% (95% CI 4.7% – 10.2%) in Brussels, and 3.4% (95% CI 2.6% – 4.2%) in Wallonia. Including age and region, age (aOR 1.03, 95% CI 1.03–1.04) and residency in Brussels (aOR 2.79, 95% CI 1.70–4.57, compared to Flanders) were independently associated with higher likelihoods for anti-HBc positivity in weighted multivariate logistic regression.

Discussion

This nationwide, population-based serosurvey provides an estimate of hepatitis B vaccination coverage and HBV exposure in Belgium by systematically analyzing anti-HBs and anti-HBc in 4955 residual serum samples, collected in three time-periods in 2020 outside SARS-CoV-2 lockdown periods.

Overall, 47.3% of the Belgian population had measurable anti-HBs levels (≥ 2 IU/L) and were anti-HBc negative, of whom approximately 70% had anti-HBs titers

above the WHO-recommended threshold of 10 IU/L. The latter corresponds to a weighted 33.9% of the Belgian population, indicating that a substantial proportion of the population has evidence of vaccine-induced immunity. In addition, an estimated 3.8% were anti-HBc positive (≥ 1 S/CO), reflecting past or current HBV infection. Among individuals subject to the universal infant vaccination program, the weighted anti-HBs prevalence (≥ 2 IU/L) was 71.6%, while anti-HBc positivity was low (0.8%).

Our results show clear differences across age groups, supporting the effectiveness of Belgium's vaccination policy which introduced universal infant vaccination in 1999 together with a temporary, school-based catch-up program for 12-year-olds. This catch-up strategy was implemented for 12 years, thereby ensuring coverage of individuals born since 1987. Consistent with this policy, those born in or after 1987 had significantly higher rates of quantifiable anti-HBs titers compared to the older age groups. This is in line with Belgium's high vaccination coverage rates that were consistently higher than 90% since 2007 [11]. In contrast, nearly one-third of individuals born before 1987 were anti-HBc negative and had quantifiable anti-HBs titers. As universal vaccination was not yet implemented, this likely reflects targeted vaccination of specific risk groups, including healthcare workers, travelers, and other high-risk populations.

In this study, an estimated 3.8% of the Belgian population was anti-HBc positive, reflecting exposure to HBV. In our previous report, we further showed that only a weighted 0.25% of the population were HBsAg+/anti-HBc+, indicative of current HBV infection [10]. In line with the higher anti-HBs prevalences also lower anti-HBc positivity rates were observed in the younger age groups. Although, anti-HBc alone cannot differentiate between acute, chronic, occult or resolved infection [15], it further strengthens the value of Belgium's vaccination policy in preventing HBV infection in the vaccinated cohorts.

Our study reveals important regional differences. Measurable anti-HBs rates among anti-HBc negative individuals were higher in Flanders and Brussels compared to Wallonia (48.5% and 50.8% vs. 43.7%, respectively), suggesting that regional disparities in effective coverage may exist despite a nationally determined vaccination policy. Belgium has achieved high coverage rates since the introduction of universal infant vaccination in 1999, though uptake varied between regions in the early years of implementation. In infants, Hep-B3 coverage exceeded 90% from 2005 in Flanders and from 2006 in Wallonia, while Brussels initially lagged behind. In school-aged adolescents targeted by the catch-up program, coverage was initially lower in the early years, particularly in Wallonia. These early regional differences in uptake have been translated into lower prevalence of vaccine-induced anti-HBs seropositivity in Wallonia compared to Flanders [16]. Since then, coverage has improved substantially, and the most recent vaccination coverage reports do not show significant regional differences in Hep-B3 coverage (Flanders 2020: 97.4%, Wallonia 2019: 96.7%, and Brussels 2019: 96.5%), all exceeding the WHO interim target of 95% [11]. However, age-stratified analysis of anti-HBs seroprevalence per region did not reveal a clear concentration of the regional differences in any specific age cohort. This suggest that the lower overall anti-HBs seroprevalence in Wallonia is unlikely to be an artefact of the early regional variation in vaccine uptake alone, but may rather reflect broader differences in the practical organization, implementation, and awareness or outreach campaigns across regions, as this is the responsibility of the federated authorities. In addition, differences in study design may contribute to the apparent discordance. Vaccination coverage studies are mainly conducted in infants and school-attending adolescents, therefore reflecting early-life vaccination status within specific birth cohorts. In contrast, our serosurvey included individuals across all age groups. These differences in target population and sampling frame, including the potential underrepresentation of individuals outside the school system, may therefore further contribute to discrepancies between reported uptake rates and observed regional variation in anti-HBs seroprevalence. The underlying causes for the lower anti-HBs seroprevalence rates in Wallonia warrant further investigation. Region-specific serosurveys collecting individual-level data, including vaccination history, socioeconomic status, and migration background, could help clarify whether the observed differences reflect true disparities in effective coverage or are attributable to underlying demographic and epidemiological differences between regions. Anti-HBc prevalence also varied regionally, with the highest estimate in the Brussels region (7.4%). Weighted multivariate regression including age and region, reveals that the regional differences in anti-HBs and anti-HBc reflect a broader sociodemographic or epidemiological situation rather than age distribution alone.

In post-hoc analyses at the provincial level, the highest anti-HBc prevalences were observed in Brussels (6.5%), Antwerp (5.3%), and Liège (5.2%), suggesting localized differences in exposure history. These provinces are characterized by high urban density, population diversity, and a large proportion of foreign-born residents. Moreover, they also have the highest percentages of foreign-born population in Belgium (Brussels: 46.2%; Liège: 17.7%; Antwerp: 17.2%). Notably, among foreign-born residents in these provinces, individuals originating from high-endemic regions such as Africa or Asia account for 45.7% in Brussels, 47.2% in Antwerp, and 43.6% in Liège [17]. Although, our data lacked migration or ethnicity data,

the regional variations likely reflect demographic differences, including the contribution of migrant populations born in intermediate or high endemic countries, as reported in previous European studies [18–21]. These findings also underscore the representativeness of our serosurvey, capturing individuals from diverse population strata and origins.

The anti-HBs prevalence observed in Belgium broadly parallels findings from other European sero-epidemiological studies performed in Germany and Serbia [22, 23]. However, most current European studies are not designed to systematically quantify anti-HBs titers across adult age groups, and comparable population-based data from neighboring countries remains scarce, limiting direct cross-country comparisons. According to the European Centre for Disease Prevention and Control, Belgium is among the 10 countries meeting the 2025 WHO target of > 95% vaccine coverage (97.1% in 2021 [11]). In the same report, 21 of 25 reporting countries achieved vaccination coverage > 90% [24]. Although overall HBV vaccination coverage in EU/EEA is high, the lack of harmonized population-level anti-HBs prevalence precludes direct comparison of the long-term impact of national vaccination programs across countries.

Several limitations should be acknowledged. As this study was performed on anonymized residual serum samples, there was no detailed demographic or clinical data available, such as ethnicity, migration background, socioeconomic status, vaccination history, and risk behavior. This limits the ability to investigate important social determinants of immunity and exposure and to directly link serological outcomes to individual vaccination status. In addition, although we specifically only analyzed samples from periods without SARS-CoV-2 lockdown restrictions, the health-seeking behavior of certain groups may be altered. Nonetheless, thanks to our nationwide coverage, large sample population, systematic testing strategy, and weighted analyses, we here provide representative estimates for the Belgian population. In addition, we here analyzed anti-HBs as a proxy for vaccination coverage, however, it is important to acknowledge that those with unquantifiable anti-HBs titers are not necessarily unvaccinated. Circulating antibody concentrations can wane over time and may fall below the detection limit. This does not per se imply a loss of protection as immune memory can outlast the presence of vaccine-induced antibodies, as demonstrated by multiple longitudinal studies [25–28]. In addition, HBV vaccination at young age confers a high immune response, guaranteeing strong immune memory and long-term protection [25]. Therefore, anti-HBs prevalence as a proxy for HBV vaccination coverage likely underestimates true immunity at the population level, especially in older vaccinated cohorts. Nonetheless, serological data provide a complementary perspective by directly measuring anti-HBs titers, including the proportion exceeding the WHO-recommended threshold of 10 IU/L, an aspect that administrative vaccine coverage data cannot provide, even though coverage remains a closer approximation of true population-level protection. Additionally, given the high anti-HBs prevalence in the study population, odds ratios derived from logistic regression may overestimate the magnitude of the reported associations. A sensitivity analysis using modified Poisson regression to estimate prevalence ratios confirmed that the direction and statistical significance of all associations remained consistent.

Conclusions

This serosurvey demonstrates that Belgium has achieved high levels of vaccine-induced protection, especially in the cohorts subject to the universal vaccination policy. The combination of anti-HBs and anti-HBc testing provides insight in both vaccine-induced immunity and natural HBV exposure, highlighting the value of serological monitoring alongside administrative coverage data. Despite the implementation of a national vaccination policy, regional differences remain, highlighting the need for improved regional efforts, identification of subgroups with lower vaccine coverage and higher HBV exposure, and targeted interventions, such as enhanced screening and catch-up vaccination programs in urban areas with large migrant populations from intermediate- and high-endemic countries, such as Antwerp, Liège, and Brussels. In addition, our findings provide updated nationally representative anti-HBs and anti-HBc prevalences for Belgium, that can be used to inform and monitor other indicators for HBV elimination in order to strive to country-level validation of HBV control under the WHO European Region Action plan [29].

Abbreviations

Anti-HBc	Hepatitis B core antibody
anti-HBs	Hepatitis B surface antibody
HBV	Hepatitis B virus
LOQ	Limit of quantification
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
S/CO	Signal-to-cutoff
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-026-13266-x.

Supplementary Material 1

Acknowledgements

Not applicable.

Author contributions

Arno Furquim d'Almeida: Conceptualization, Methodology, Formal analysis, Investigation, Project administration, Data curation, Writing – Original Draft. Erwin Ho: Conceptualization, Investigation, Writing – Review & Editing.

Philippe Beutels: Methodology, Resources, Writing – Review & Editing. Kirsten Maertens: Methodology, Writing – Review & Editing. Niel Hens: Methodology, Writing – Review & Editing. Pierre Van Damme: Methodology, Resources, Writing – Review & Editing. Heidi Theeten: Methodology, Resources, Writing – Review & Editing. Thomas Vanwolleghem: Conceptualization, Methodology, Writing – Original Draft, Supervision, Project administration, Funding acquisition.

Funding
This work was supported by Gilead Sciences [BeLux Fellowship 2020]; Research Foundation Flanders: FWO senior clinical investigator [18B2821N and 18B2826N to Thomas Vanwolleghem]; Antwerp University Fund, which is a community of donors who contribute to research and education with their personal commitment through a donation, gift, bequest or through academic chairs. The funders had no role in study design, data collection, data analysis, data interpretation, writing or submission of the report.

Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki. Ethical committee approval for this study and the re-use of the samples was obtained from the University of Antwerp – Antwerp University Hospital Ethical Committee (reference 21/02/021 and 6712). The original SARS-CoV-2 study was approved by the Ethical Committee of the University of Antwerp – Antwerp University Hospital (reference 20/13/158). The requirement of informed consent was waived by the University of Antwerp – Antwerp University Hospital Ethical committee because the study involved secondary use of anonymized leftover serum samples.

Consent for publication
Not applicable.

Competing interests
Thomas Vanwolleghem has received grants from Gilead Sciences and Fujirebio, served as a consultant for Janssen Pharmaceuticals, Gilead Sciences, AbbVie, and has served as a sponsored lecturer for Gilead Sciences, Roche and AbbVie. All other authors have nothing to disclose in relation to this research.

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Received: 11 February 2026 / Accepted: 1 April 2026
Published online: 22 April 2026

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