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Original Article

Prevalence of hepatitis B and humoral response in children and adolescents born after the introduction of hepatitis B vaccine in the expanded program on immunization in Burkina Faso

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ABSTRACT

Hepatitis B virus (HBV) remains a major public health challenge in low- and middle-income countries. Burkina Faso, with a national prevalence of 9.3%, is highly endemic. Despite the introduction of DTP-HepB-Hib vaccine in 2006 and WHO recommendations for universal vaccination, coverage remains suboptimal in sub-Saharan Africa. Some vaccinated children and adolescents exhibit sub-protective antibody levels. This study evaluated HBV seroprevalence in children born after 2006, vaccination coverage, and the proportion of vaccinated children with protective anti-HBs antibodies in Burkina Faso. A cross-sectional descriptive study was carried out from 2021 to 2025 in schools and health centers in Ouagadougou, where blood samples (N = 1384) from children and adolescents born after January 2006 were collected. Rapid diagnostic tests (RDTs) were used to determine HBV seroprevalence and enzyme linked-immunosorbent Assay (ELISA) was used for titration of anti-HBs antibodies in children and adolescents. The Student's test was used for the comparison of quantitative variables and the Chi^2 test for the comparison of proportions with 5% as the statistical significance threshold. The study population consisted of 41.47% males. The average age was 8.96 ± 4.5 years. The prevalence of hepatitis B in our study population was 4.34%. The prevalence of hepatitis B was significantly impacted by age (p = 0.008). The vaccination coverage rate was 90.47%. The prevalence of hepatitis B varied significantly with anti-HBS antibody titration (p < 0.001). The difference of anti-HBs antibody titration was significant between age groups (p < 0.001). Despite satisfactory vaccination coverage, HBV prevalence remains high among children and adolescents.

KEYWORDS: hepatitis B, children and adolescents, humoral response, vaccination, Burkina Faso.

INTRODUCTION

Viral hepatitis type B is a global health problem, particularly in low- and middle-income countries [1].

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It can be prevented by vaccination. Hepatitis B Virus (HBV) is a partially double-stranded DNA virus in the Hepadnaviridae family that includes related viruses that cause liver damage in animals. More than 2 billion people have markers of contact with the HBV [2]. An estimated 257 million people, or 3.5% of the world's population, are living with chronic hepatitis B, of which about 68% live in the World Health Organization (WHO) regions of Africa and the Western Pacific [2]. Sub-Saharan Africa, with a prevalence rate of between 8 and 18%, is a highly endemic area [3]. It is described as a region of high endemicity to HBV. Hepatitis B infection is a major public health problem in Burkina Faso. It is estimated that the HBV affects about 75 million people in Africa, including 1.9 million in Burkina Faso [4]. The country is classified as a high-endemicity country for HBV [5]. Indeed, the prevalence of hepatitis B reported, from serum samples from a 2021 national household survey on COVID19 seroepidemiology across Burkina Faso's 17 regions, at the national level was 9.3% [6]. Studies in Burkina Faso show a prevalence of Hepatitis B surface antigen (HBsAg) ranging from 11% to 17% among health care workers, blood donors, sex workers and pregnant women [7-9]. HBsAg is the main marker of active infection and used for diagnosis. It reflects, to some degree, the presence of intrahepatic HBV DNA, the transcription of cccDNA (covalently closed circular DNA, the transcriptional model of the virus) and the host immune response. The quantification of HBsAg is now routinely done [10]. In areas with high endemicity, the most common routes of infection are vertical mother-to-child transmission and horizontal transmission between children, particularly between siblings, especially in African countries [11]. HBV infection is highly endemic in Sub-Saharan Africa, where more than 8% of the population remains chronically infected with HBV [12]. Following acute HBV infection, between 1% and 10% of healthy adults and 30% to 90% of infected babies become chronic carriers, some of whom are at risk for life-threatening diseases such as cirrhosis and primary hepatocellular carcinoma (HCC) [11, 13]. In fact, the resulting complications are responsible for 96% of hepatitis B virus-related mortality [14, 15]. It is in this context that strategies, such as vaccination, transfusion safety, injection safety and food safety, have been developed to reduce the transmission of viral hepatitis. In addition, current hepatitis B therapies give health professionals tools to fight the disease. HBV infection, when it occurs in early childhood, is more likely to progress to chronicity [16, 17]. Prevention mainly involves sanitation measures and, above all, vaccination.

Vaccination is one of the most effective public health measures to prevent morbidity, mortality and complications of infectious diseases [18]. Vaccination at birth against hepatitis B is an essential intervention to prevent mother-to-child transmission of the virus at birth, which could be improved by prenatal screening and the administration of antiviral drugs. Knowledge of the pathogenicity and antigenic determinants of HBV has led to the development of vaccines. The integration of these HBV vaccines into the national immunization programs of highly endemic countries has been recommended by the WHO since 1995. As of December 2020, 190 (98%) of WHO's 194 Member States have introduced universal infant hepatitis B vaccination [19]. This involves the administration of the monovalent vaccine (e.g. Engerix B) against the virus to all infants after birth, preferably within 24 hours, followed by two or three doses of monovalent vaccine or combination HBV vaccine at least four weeks apart to complete the series [12]. Several hundred million doses of hepatitis B vaccine have been administered worldwide with an excellent track record of safety and efficacy. Following full vaccination (3 doses of vaccine administered), seroprotection rates against HBsAg (antibodies anti-HBs) are close to 100% in children and nearly 95% in healthy young adults. For example, in most African countries, pentavalent vaccine (hepatitis B, diphtheria, tetanus, pertussis and Haemophilus influenza type b) has been introduced into the expanded program on immunization as part of prevention. Routine childhood hepatitis B immunization coverage is estimated at 72% in Africa, well below the global target of 90%, at which point the virus will no longer pose a public health threat. The number of countries with coverage above 90% increased from 23 in 2019 to 27 in 2021. In addition, overall

vaccination coverage at birth was 10% in 2019 [20]. Vaccination of newborns at birth is not optimal, yet it is a key element in breaking the chain of HBV transmission. Most countries in sub-Saharan Africa have chosen to vaccinate all children against HBV under the WHO-sponsored expanded program on immunization, and the current WHO-AFRO recommendation is HBV vaccination at birth to prevent mother-to-child transmission and early horizontal transmission of HBV [12].

Burkina Faso integrated the HBV vaccine into the expanded program on immunization (EPI) in January 2006 [21]. This introduction was made in the context of the launch of the pentavalent vaccine. The country uses the pentavalent DTP-HepB-Hib (diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae b) vaccine against HBV. This strategy has shown good results. However, some preliminary work and analyses show that in vaccinated children and adolescents, the level of antibodies produced is not always sufficient to confer definitive immunity against the virus [22-24]. Indeed, the vaccine against the hepatitis B virus is composed of HBsAg and induces the production of anti-HBs antibodies (antibodies) directed against the surface protein of the virus. Individuals with an anti-HBs antibody level greater than or equal to 10 IU/L are considered immune to the disease [5]. In 2016, the WHO adopted a resolution aimed at eliminating viral hepatitis, a serious public health threat, by 2030. This will be achieved through a 65% reduction in mortality, a 90% reduction in incidence and the initiation of treatment for at least 80% of eligible patients by 2030 [25]. Achieving these goals requires high-quality epidemiological data to measure baseline and monitor progress, as well as information on possible obstacles to the effective implementation of key interventions. These data are very few in sub-Saharan Africa.

It is in this context that our study aimed to assess the seroprevalence of hepatitis B and the level of immunological protection of children born and vaccinated after the introduction of the vaccine in the expanded program on immunization in January 2006. Specifically, the aim was to determine the prevalence of hepatitis B in children born after January 2006, to assess the vaccination coverage rate in the study population and to determine the proportion of vaccinated children with a protective anti-HBs titer against HBV.

MATERIALS AND METHODS

Study setting, area and population

This was a descriptive cross-sectional study that involved children and adolescents born after January 2006. Indeed, these children constitute a population that is supposed to be vaccinated and therefore protected against hepatitis B. It is also a young population, particularly exposed to HBV infection and with a very high risk of a chronic phase of the disease. The study ran from 2021 to 2025. The children were recruited from schools and health centers in the commune of Ouagadougou, the capital of Burkina Faso.

Participant recruitment and data collection

There was no prior determination of a sample size. All children born after January 2006 were included in this study. First, we randomly selected schools and health centers in the city of Ouagadougou. The enrolment of participants in these places was also done randomly. A phase of interviews and awareness-raising with school officials and parents of students to explain the rationale for the study followed. Then, parental consent was requested before the inclusion of each child. Indeed, the legal representative of each child signed a free, informed and written consent form with the help of a member of the research team, and the children old enough to understand and give their opinion signed an assent form. We asked children and adolescents to bring the vaccination records on the day of the collection after having had the free, informed and written consent of the parents and adolescents over 12 years old. Finally, we administered a questionnaire and took venous blood samples from the children and adolescents. Sociodemographic data (age, sex), presence of vaccination records, vaccination status and biological data were collected. Whole blood (3 mL) was collected from each participant by venipuncture at the elbow crease in one (01) EDTA tube. We conducted diagnostic testing for hepatitis B virus (HBV) at collection sites using rapid diagnostic tests

(RDTs, Gyeonggi-do, Republic of Korea), to detect direct markers such as hepatitis B surface antigen (HBsAg). Serology determination was performed using HBsAg rapid diagnostic tests with a sensitivity and specificity greater than 99.1%. All analyses were performed according to the procedures provided by the manufacturer and in accordance with Good Laboratory Practices.

Analysis of biological data in the laboratory

After centrifugation at 4000 rpm for 05 minutes, the plasma was aliquoted in two copies per sample and stored in the freezer at -20 °C for subsequent analyses. To assess the level of protection of children against hepatitis B, we quantified antibodies to HBs in children who had received at least one dose of hepatitis B vaccine. The ELISA assay was used for titration of anti-HBs antibodies in the laboratory. The ELISA technique was performed in several steps with each sample in duplicate, a blank and a negative control:

Coating: 50 µL of HBsAg at a concentration of 0.1 µg/mL was applied to each well. The deposit was placed in incubation at 4 °C overnight.

Washing: The wells of the plate were rinsed 4 times a minute with a buffer solution (PBS + Tween 20 at 0.05%).

Blocking: The reaction was blocked by adding 200 µL of 3% milk to each well and incubating for 2 hours at room temperature.

Addition of the primary antibody (plasma of each participant): after washing with the same initial buffer solution, 100 µL of plasma from each sample diluted to 1/200 was added per well followed by incubation for 1 h 30 min.

Addition of the secondary (conjugated) antibody: after the washing step, 100 µL of the antibody coupled to the Horseradish Peroxidase (HRP) enzyme, diluted to 1/10,000, was added to each well and incubated for 1 hour under an agitator.

Staining reaction (Addition of the specific substrate of the enzyme): After washing with PBS + Tween 20 at 0.05%, 50 µL of TMB (3,3',5,5'-tetramethylbenzidine) was added per well. A 30-minute incubation period was then carried out in the dark and at room temperature.

Solution stop and read: The enzymatic reaction was stopped by adding 100 µL of H_2SO_4 (Sulphuric Acid) at 4 M per well and the optical densities (OD) were read by spectrophotometry at a wavelength of 450 nm. The final OD was obtained by averaging the ODs per sample and then subtracting the blank value. The value of the final OD is proportional to the concentration of the human anti-HBs antibody. The determination of the concentration of human anti-HBs antibodies in plasma was done using a standard curve.

Data management and statistical analysis

The data was compiled in Excel 2016 (MS Corp., USA). The Stata software version 17.0 was used for the analyses. The figures were generated using the GraphPad Prism 8 software. Quantitative variables were expressed as mean ± standard deviation and qualitative variables as percentages. The Student's test was used for the comparison of quantitative variables and the Chi^2 test for the comparison of proportions with 5% as the statistical significance threshold.

Ethical considerations

The study was approved by the Health Research Ethics Board (renewal N° 2023 000194/MSHP/MESRI/CERS) and the consent and collection sheets were validated by the same committee. This study was carried out in strict compliance with good clinical and biological research practices. The data collected was kept confidential and access to the data was limited to members of the investigation team. HBsAg rapid diagnostic test results were provided to the children's parents or legal guardians. Positive cases were referred to care centers for adequate follow-up. Study information sheets and informed consent sheets were made available to all participants and their parents.

RESULTS

Description of the study population

The total number of children and adolescents included was 1384. There were 574 boys (41.47%), giving a sex ratio of 0.71. The average age was 8.96 ± 4.5 years. The majority age group was 5 to 10 years old (see Table 1).

Table 1. Socio-demographic characteristics of the study population (N = 1384).

Sex	**N**	**%**
F	810	58.53
M	574	41.47
Sex-ratio M/F	**0.71**	
Age		
[0-5 y]	251	18.14
[5-10 y]	498	35.98
[10-15 y]	489	35.33
[15-20 y]	146	10.55
Mean age	**8.96 ± 4.5**	

Hepatitis B seroprevalence in the study population

The prevalence of hepatitis B in our study population was 4.34 (60/1384). Details can be found in Figure 1.

Influence of age on the distribution of hepatitis B in the study population

The prevalence of hepatitis B was significantly impacted by age ($p = 0.008$). The age group of 15-20 years showed the highest prevalence (8.90%). Together with the 0-5 years group, these age categories recorded prevalences above the overall prevalence observed in the study population (Table 2).

Vaccination coverage rate according to information in vaccination records

Out of a total of 1384 children and adolescents enrolled, less than half (598) had immunization records on the day of data collection. The vaccination coverage rate was 90.47% among children who had verifiable records and 57 of the 598 did not have proof of vaccination in their records (Figure 2).

Anti-HBS antibody response rates and protection levels in children and adolescents

A total of 541 children and adolescents received the hepatitis B vaccine. However, anti-HBS antibodies were measured in 437 vaccinated children/adolescents and 148 children/adolescents had a level below 10 IU/L, defined as a non-protective level against the HBV. These results are detailed in Table 3.

Levels of protection and prevalence of hepatitis B

The prevalence of hepatitis B varied significantly with anti-HBS antibody titration ($p < 0.001$). All positive hepatitis B cases were detected in vaccinated but unprotected children (Table 4).

Human anti-HBS antibodies titration and age

In the pediatric and adolescent population studied, 60.49% of subjects aged 10 to 15 years had anti-HBs antibody titers below the protection threshold. The proportion of children without a protective level of anti-HBs antibodies increases with age: it was 18.63% in children under 5 years of age, and reached 40.13% in children aged 5 to 10 years. The difference was significant between the three age groups ($p < 0.001$); 60.49% of subjects aged 10 to 15 had anti-HBS antibodies below the protective threshold. The proportion of children without protective level of anti-HBS antibodies increased with age: it was 18.63% in children under 5 years old and reached 40.13% in children aged 5 to 10. The difference was significant between the three age groups ($p < 0.001$) (Table 5).

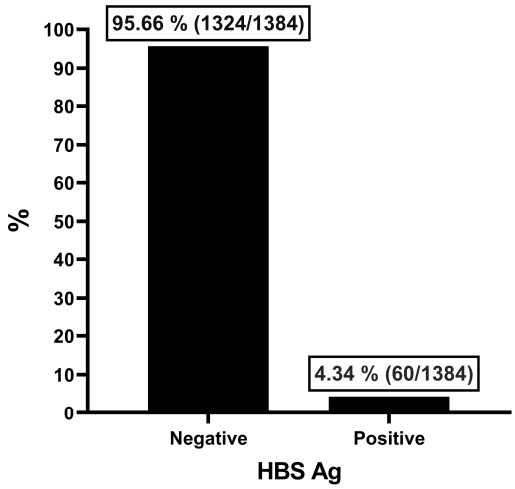

Figure 1. Prevalence of Hepatitis B among people under 20 years of age in Ouagadougou.

Table 2. Hepatitis B prevalence by age group.

Age range (years)	RDTs Hepatitis B			*p-value*
	Negative n (%)	Positive n (%)	Total n (%)	
[0-5]	236 (94.02)	15 (5.98)	251 (100.00)	$p = 0.008$
[5-10]	482 (96.79)	16 (3.21)	498 (100.00)	
[10-15]	473 (96.73)	16 (3.27)	489 (100.00)	
[15-20]	133 (91.10)	13 (8.90)	146 (100.00)	

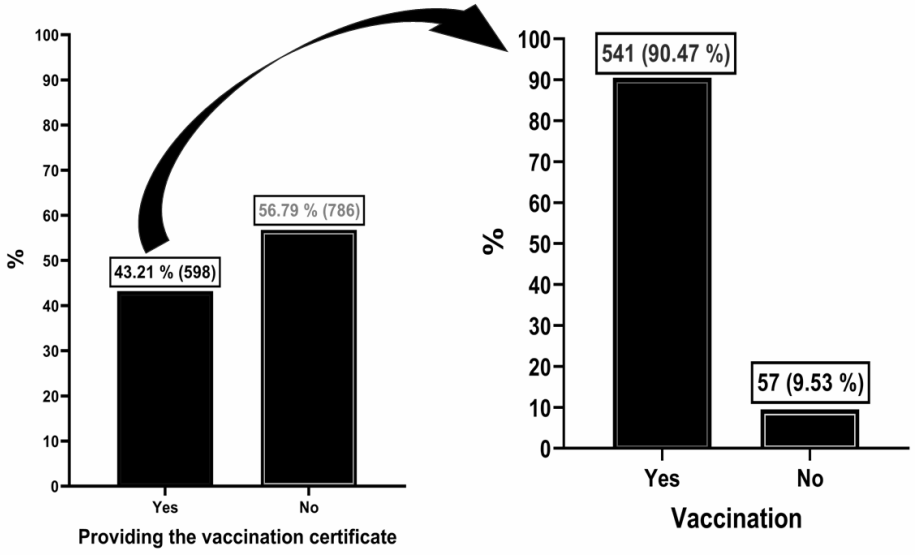

Figure 2. Vaccine coverage rate among children and adolescents in Ouagadougou.

Table 3. Proportion of children protected after vaccination.

Anti-HBs antibodies titration (UI/L)	n	%
[0-10]	148	33.87
[10-100]	93	21.28
[100-1000]	132	30.21
≥1000	64	14.65
Total	**437**	**100.00**

Table 4. Prevalence by anti-HBS antibodies response rate.

Antibodies anti-HBS (UI/L)	RDT Hepatitis B		*p*-value
	Negative	Positive	
	n (%)	n (%)	
[0 to 10]	117 (79.05)	31 (20.95%)	*p < 0.001*
[10 to 100]	93 (100.00)	0 (00.00)	
[100 to 1000]	132 (100.00)	0 (00.00)	
≥1000	64 (100.00)	0 (00.00)	
Total	**406 (92.91)**	**31 (7.09)**	

Table 5. Comparison of anti-HBs antibody titers by age group.

Antibodies anti-HBs (UI/L)	[0-5 y]	[5-10 y]	[10-15 y]	*p*-value
	n (%)	n (%)	n (%)	
[0 to 10]	38 (18.63)	61 (40.13)	49 (60.49)	*p* < 0.001
[10 to 100]	40 (19.61)	38 (25.00)	15 (18.52)	
[100 to 1000]	78 (38.24)	41 (26.97)	13 (16.05)	
≥1000	48 (23.53)	12 (7.89)	4 (4.94)	
Total	**204 (100.00)**	**152 (100.00)**	**81 (100.00)**	

DISCUSSION

Sub-Saharan Africa is a highly endemic area for hepatitis B with a prevalence between 8 and 18% of the general population [12]. The prevalence rates observed (4.34% among all children under 20 years of age and 8.90% among adolescents aged 15 to 20) are consistent with the epidemiological profile of the region, given that Burkina Faso is located within the sub-Saharan African zone. In addition, our study revealed a statistically significant variation in prevalence by age group ($p = 0.008$), highlighting a heterogeneous dynamic of exposure within this juvenile population. The elevated prevalence among children and

adolescents highlights Burkina Faso's status as a highly endemic area and clearly illustrates the magnitude of the public health challenge posed by viral hepatitis B in the country. However, the prevalence rate reported in our study remains lower than the 11.2% documented by Nanelin Guingane's team in 2021 in Ouagadougou [26] and a study conducted in Ghana (7.2%) [27] but higher than the 4.1% found in 313 newborns in 2009 [9] and the 0.5% found by Ouédraogo *et al.* in 200 children in Ouagadougou [5]. Globally, the African region maintains the highest prevalence rate of infection among children under 5 years of age, estimated at 2.34% in 2017 [28] despite the introduction of HBV vaccination in African countries' Expanded Programs on Immunization (EPI). This trend is supported by our results, which indicate a prevalence of 5.98% in children under 5 years of age. By comparison, a 2015 national estimate in Burkina Faso reported a 4.3% rate of chronic HBV infections in the same age group [26].

Among children with a vaccination record in our study, the vaccination coverage rate was 90.47%. In contrast, Nanelin Guingane *et al.* reported that 78.3% of children received the HBV vaccine within 24 hours of birth [26]. A study conducted in Ouagadougou in 2016 found that 83.6% of newborns had received the vaccine within the first 24 hours of birth [29]. Several socio-demographic factors could contribute to a vaccination coverage rate of less than 100% observed in our study, including the age of the mothers, their level of education, their literacy status, the household wealth index, the child's place of birth, and the mothers' access to the media. In Burkina Faso, children born to illiterate mothers have been shown to have an increased risk of incomplete vaccination compared to those born to literate mothers [30]. A study conducted in Côte d'Ivoire showed an overall vaccination coverage of 68.6% [31]. Knowledge of the vaccination schedule, the marital status of mothers and the type of housing have been identified as factors associated with complete vaccination of children. It is essential to take these determinants into account in strategies to increase immunization coverage [31].

Among children and adolescents who received vaccination, 33.87% had anti-HB antibodies below the protection threshold (<10 IU/L), indicating that they remain at risk of hepatitis B virus infection despite their vaccination status. By comparison, a study carried out in 2013 in Ouagadougou reported that 90% of vaccinated children had an antibody level considered protective (≥10 IU/L) [5]. A study in Germany found that 46.4% of vaccinated children and adolescents aged 8 to 14 years were anti-HB negative (anti-HBs less than 10 IU/L [32]. A study conducted in rural Ghana showed a protective rate of 78.2% in children and adolescents [27]. Antibodies to hepatitis B virus surface antigen (HBsAg) primarily target its hydrophilic region, known as the major HBsAg determinant. This interaction confers effective protection against all HBV genotypes, explaining the broad immunity induced by vaccination. However, changes in amino acid residues in this region can lead to conformational alterations, which can allow infection in previously vaccinated individuals, especially when their anti-HB antibody level is insufficient to provide protection (<10 IU/L) [11]. Indeed, 7.09% of vaccinated participants had a positive hepatitis B surface antigen (HBsAg) rapid diagnostic test, and all of these cases were in individuals with anti-HB antibodies below the 10 IU/L protection threshold. For comparison, a study in Ghana reported a proportion of 3.0% of vaccinated children with HBsAg positivity [27]. In our study, the prevalence of hepatitis B varied significantly depending on the anti-HB antibody titer. Individuals with low antibody levels had a higher prevalence of infection ($p < 0.001$).

The proportion of children without a protective anti-HB antibody level increased significantly with age ($p < 0.001$). It is estimated at 18.63% in children under 5 years of age, compared to 40.13% in those aged 5 to 10 years. This trend could be explained by a gradual decrease in the level of antibodies over time, as the vaccine is administered from birth in Burkina Faso. A recent study showed that 44.6% of participants had levels <10 mIU/mL 18 to 26 years after vaccination [33]. In addition, compliance with the vaccination schedule seems to be more rigorous among mothers who benefit from continuous awareness of the importance of vaccination.

CONCLUSION

Leading health authorities agree that the most effective strategy to reduce the burden HBV is based on primary prevention through universal vaccination and transmission control. However, our results indicate that, despite satisfactory vaccination coverage, HBV prevalence remains high among children and adolescents, which could be explained by a persistence of vertical transmission.

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AUTHORS' CONTRIBUTIONS

NAR, MK, YEH and SGS participated in the conception, the design of the work, and data acquisition/analysis/interpretation. NAR, MK, DK, SCD and AK contributed to sample acquisition and analysis. YEH, MK and SGS contributed to the final validation of the manuscript. All authors read and approved the final manuscript. All authors approved the submitted version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical assessments were obtained in Burkina Faso: *Comité d'Éthique pour la Recherche en Santé du Burkina Faso* (n° 2020-10-217 and n° 2023-000194). Site leaders provided prior permission to conduct surveys at each site. Consent was obtained from a parent or guardian of each participating child and adolescent participants. In addition to parental consent, adolescents aged 12 and over gave their free, informed, and written consent.

CONSENT FOR PUBLICATION

All participants were informed about the publication of the collected data in the form of anonymity before giving their consent.

CONFLICT OF INTEREST STATEMENT

None of the authors has a relationship or support that could be perceived as constituting competing interests.

ABBREVIATIONS

ELISA : Enzyme-Linked Immunosorbent Assay
IgG : Immunoglobulin G
OD : Optical density

REFERENCES

1. WHO. 2022, https://www.who.int/fr/publications/i/item/9789240053779
2. WHO. 2020, https://iris.who.int/bitstream/handle/10665/333391/9789240002708-eng.pdf
3. Aniaku, J. K., Amedonu, E. K. and Fusheini, A. 2019, Ann. Glob. Health, 85(1), 18.
4. Schweitzer, A., Horn, J., Mikolajczyk, R. T., Krause, G. and Ott, J. J. 2015, Lancet Lond. Engl., 386(10003), 1546-1555.
5. Ouedraogo, H. G., Kouanda, S., Tiendrebeogo, S., Liestman, B., Tarnagda, G., Bationo, F., Rasmata, O. T. and Yves, T. 2015, J. Pediatr. Infect. Dis., 8, 167-173.
6. Nikiema, A. R., Cissé, K., Hien, Y. E., Koné, Y., Dabiré, S. C. and Meda, I. B. 2025, J. Biosci. Med., 13(10), 1-12.
7. Pietra, V., Kiema, D., Sorgho, D., Kabore, S. P. C. G., Mande, S., Castelli, F., Puoti, M. and Simpore, J. 2008, Science et Technique, 31, 53-59.
8. Ilboudo, D., Sawadogo, A. and Simpore, J. 2002, Med. Trop. Rev. Corps Sante Colon., 62(1), 99-101.
9. Sangaré, L., Sombié, R., Combasséré, A. W., Kouanda, A., Kania, D., Zerbo, O. and Lankoandé, J. 2009, Bull. Soc. Pathol. Exot. 102(4), 226-229.
10. Brunetto, M. R., Moriconi, F., Bonino, F., Lau, G. K. K., Farci, P., Yurdaydin, C., Piratvisu, T., Kangxian, L., Wang, Y.,

Hadziyannis, S., Wolf, E., McCloud, P., Batrla, R. and Marcellin, P. 2009, Hepatology, 49(4), 1141-1150.
11. Zanetti, A. R., Van Damme, P. and Shouval, D. 2008, Vaccine, 26(49), 6266-6273.
12. Howell, J., Lemoine, M. and Thursz, M. 2014, J. Viral Hepat., 21(6), 381-396.
13. Lee, W. M. 1997, N. Engl. J. Med., 337(24), 1733-1745.
14. Shimakawa, Y., Lemoine, M., Bottomley, C., Njai, H. F., Ndow, G., Jatta, A., Tamba, S., Bojang, L., Taal, M., Nyan, O., Alessandro, U., Njie, R., Thursz, M. and Hall, A. J. 2015, Liver Int. Off. J. Int. Assoc. Study Liver, 35(10), 2318-2326.
15. van den Ende, C., Marano, C., van Ahee, A., Bunge, E. M. and De Moerlooze, L. 2017, Expert Rev. Vacc., 16(8), 789-809.
16. Pande, C., Sarin, S. K., Patra, S., Kumar, A., Mishra, S., Srivastava, S., Bhutia, K., Gupta, E., Mukhopadhyay, C. K., Dutta, A. K. and Trivedi, S. S. 2013, J. Viral Hepat., 20(11), 801-810.
17. Li, Z., Hou, X. and Cao, G. 2015, Emerg. Microbes Infect., 4(1), 1-9.
18. Vesikari, T., Langley, J. M., Segall, N., Ward, B. J., Cooper, C., Poliquin, G. and Smith, B. 2021, Lancet Infect. Dis., 21(9), 1271-1281.
19. WHO. Countries overview | World Health Organization, 2022.
20. Khetsuriani, N., Lesi, O., Desai, S., Armstrong, P. A. and Tohme, R. A. 2022, Wkly Epidemiol Rec., 71(30), 958-963.
21. Ministère de la Santé du Burkina Faso. Avril 2021, GTCV_Burkina Faso.pdf .
22. Madalinski, K. 2008, EBSCOhost, 5, 51.
23. Bauer, T. and Jilg, W. 2006, Vaccine, 24(5), 572-577.
24. Velu, V., Saravanan, S., Nandakumar, S., Dhevahi, E., Shankar, E. M., Murugavel, K. G., Kumarasamy, T. and Thyagarajan, S. P. 2008, Jpn. J. Infect. Dis., 61(1), 73-76.
25. WHO. 2016. https://iris.who.int/bitstream/handle/10665/250577/WHO-HIV-?sequence=1
26. Guingane, N. 2021, Prévention de la transmission mère-enfant du virus de l'hépatite B au Burkina Faso : état des lieux et nouvelles stratégies [phd thesis]. Université Montpellier
27. Kreuzberg, C., Buggisch, P., Ehrhardt, S., Appiah-Thompson, P., Lüthgehetmann, M., Polywka, S., Feucht, H. H., Adjei, O., May, J. and Lohse, A. 2008, Z. Für Gastroenterol., 46, P4_37.
28. Shimakawa, Y., Lemoine, M., Njai, H. F., Bottomley, C., Ndow, G., Goldin, R. D., Jatta, A., Jeng-Barry, A., Wegmuller, R., Moore, S. E., Baldeh, I., Taal, M., D'Alessandro, U., Whittle, H., Njie, R., Thursz, M. and Mendy, M. 2016, Gut, 65(12), 2007-2016.
29. Guingané, A. N., Meda, N., Boyer, S., Sombié, R., Bougouma, A. and Gaudart, J. 2016, Rev. DÉpidémiologie Santé Publique, 64, S178.
30. Douba, A., Aka, L. B. N., Yao, G. H. A., Zengbé-Acray, P., Akani, B. C. and Konan, N. 2015, Santé Publique, 27(4), 575-584.
31. Sackou, K. J., Oga, A. S. S., Desquith, A. A., Houénou, Y. and Kouadio, K. L. 2012, Bull. Société Pathol. Exot., 105(4), 284-290.
32. Huber, B., Wenzel, J. J., Leisner, U. and Jilg, W. 2012, Z. Für Gastroenterol., 50, P4_28.
33. Erdoğdu, H. İ., Bozlak, Ç. E. B., Başak, M., Başar, S. K., Topaloğlu, İ. and Tural, K. 2025, Curr. Microbiol., 82(5), 223.