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Trends in disease burden of hepatitis B infection in Jiangsu Province, China, 1990–2021

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A R T I C L E I N F O

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A B S T R A C T

Background: The incidence of hepatitis B virus (HBV) has decreased year by year in China after the expansion of vaccination, but there is still a high disease burden in Jiangsu Province of China.

Methods: The year-by-year incidence data of HBV in Jiangsu Province from 1990 to 2021 were collected. The incidence rates of males and females age groups were clustered by systematic clustering, and the incidence rates of each age group were analyzed and studied by using Joinpoint regression model and age-period-cohort effect model (APC).

Results: Joinpoint regression model and APC model showed a general decrease in HBV prevalence in both males and females. In addition, the results of the APC model showed that the age, period, and cohort effects of patients all affected the incidence of HBV, and the incidence was higher in males than in females. The incidence is highest in the population between the ages of 15 and 30 years (mean: 21.76/100,000), especially in males (mean: 31.53/100,000) than in females (mean:11.67/100,000). Another high-risk group is those over 60 years of age (mean: 21.40/100,000), especially males (mean: 31.17/100,000) than females (mean: 11.63/100,000). The period effect of the APC model suggests that HBV vaccination is effective in reducing the incidence of HBV in the population.

Conclusions: The incidence of HBV in Jiangsu Province showed a gradual downward trend, but the disease burden in males was higher than that in females. The incidence is higher and increasing rapidly in the population between the ages of 15 and 30 years and people over 60 years of age. More targeted prevention and control measures should be implemented for males and the elderly.

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1. Introduction

Hepatitis B, an acute and chronic infectious disease caused by the hepatitis B virus (HBV), is one of the most common infectious diseases worldwide and a leading cause of end-stage liver disease, hepatocellular carcinoma, and death(Bhattacharya & Thio, 2010). According to the World Health Organization (WHO), 350 million to 400 million people in the world are infected with chronic HBV(Din et al., 2020; Libbus & Phillips, 2009). China is a country with a large population, but also a country with a large number of HBV infections, and chronic HBV accounts for a large proportion, more than 93 million people are currently infected with HBV virus, bringing a great burden to the country. Yue T et al. studied the overall burden of HBV and HCV in China, noting that the burden of HBV/HCV infection in China has decreased over the past 30 years, but the incidence of HBV remains high, especially in males(Yue et al., 2022). Ji W et al. studied the disease burden of HBV in four regions of Xinjiang Autonomous Region and found that the disease burden of HBV might be expanding in the future and there was a difference in the incidence between males and females(Ji et al., 2019). In addition, there are a few of studies about the HBV disease burden in China, especially in Jiangsu province, which needs more research. In 1992, the Ministry of Health of China incorporated the HBV vaccine into the management of children's planned immunization and promulgated the Implementation Plan of National HBV Vaccine Immunization. In 2002, it was approved by the State Council to incorporate the HBV vaccine into children's planned immunization(Bai et al., 2022; Jin et al., 2021). Jiangsu Province began to fully implement the neonatal HBV vaccination in 2003. In 2005, all neonatal HBV vaccines were completely free of charge. In 2009, HBV vaccination for people under 15 years old was checked and retook(Wang & Cui, 2014). According to the historical statistics of Jiangsu Province, the incidence of HBV in Jiangsu Province decreased from 242.00/100,000 to 15.42/100,000 and the serological survey in 1992 showed that 20.0% of the general population were HBV carriers. According to the results of the serological survey in 2006, the prevalence of HBV surface antigen in the population aged 1–29 years was 7.7%(Sun et al., 2021).

In this study, we collected the data of the incidence of HBV in all age groups of males and females in Jiangsu Province from 1990 to 2021. By cluster analysis, we clustered the incidence of hepatitis B in different age groups of males and females respectively, and discussed the situation of the same category. The trend of the clustering results was fitted by Joinpoint regression model, and the trends of different categories and their influences on the trend of all age groups were discussed. APC model was used to analyze the influence of age, period and cohort effect on the incidence of HBV respectively.

2. Methods

2.1. Data collection

The Jiangsu CDC obtained the incidence population and HBV incidence rates for men and women of all ages, as well as the male and female populations in Jiangsu Province from 1990 to 2021. World standard population data from World Standard (https://seer.cancer.gov/stdpopulations/world.who.html).

2.2. Statistical analysis

2.2.1. Cluster analysis

System clustering is a multivariate statistical analysis method, the basic idea of which is: each sample was regarded as one class, the Euclidean distance between classes was calculated, the two classes with the closest distance were combined into a new class, and then the new class that had been clustered and other classes were combined again according to the distance, and the above steps were repeated many times until all the subclasses are combined into one class(Kabir et al., 2011; Zhao et al., 2011).

2.2.2. Joinpoint regression model

Joinpoint is a common statistical software developed by the American Cancer Research Center to study the potential trends of cancer mortality or morbidity. The Joinpoint regression model of this software was mainly used to explore the changing trends of diseases, usually consisting of several continuous line segments. The model is based on identifying the inflection points of the model, i.e. using a grid search method to determine the location and number of Joinpoint model points, splitting the data into segments based on the location and number of points, and calculating the annual percentage change, average annual percentage change and confidence intervals for each segment to derive the trend of incidence or mortality of the disease in question. In determining the segmentation points, the Monte Carlo permutation test is used for model selection, and the sum of squared errors and mean squared errors of the various segmentation point distributions are calculated, and the distribution with the smallest mean squared error is selected as the best segmentation point, and the model with the smallest sum of squared errors is the best model, and generally no more than five segmentation points are set.(Qiu et al., 2009; Wong et al., 2018).

2.2.3. Age-period-cohort effect model

The age-period-cohort effect of HBV incidence was estimated in this study using the APC network tool (https://dceg.cancer.gov/tools/analysis/apc) (Gao et al., 2020). The age-period-cohort effect (APC) model is a commonly used statistical model, which is usually used to describe and explain the long-term trend of individual or population diseases with time. The model decomposes the cohort data according to three dimensions: age, period, and cohort, and analyzes the influence of these three factors on diseases. Among the main results, the age effect mainly reflects the impact of individuals or groups on the incidence of disease or mortality with age. The period effect refers to the impact on disease incidence or mortality due to the change in period. The cohort effect is often used to describe the long-term change trend of the disease incidence rate or mortality rate in the population born in the same age(Yue et al., 2022; Zou et al., 2020). Longitudinal age-specific incidences from the model were age-specific incidences adjusted for period bias and represented fitted longitudinal age-specific ratios in the reference cohort. Cross-sectional age-specific incidence was an age-specific incidence adjusted for cohort bias and represented a fitted horizontal age-specific ratio in the reference cohort. The period rate ratio is the age-specific rate ratio of the period with the selected control period as a reference. The cohort rate ratio is the age-specific rate ratio for the cohort concerning the selected control cohort(Kupper et al., 1985; Ma et al., 2021). $P < 0.05$ was considered as statistical significance in this study. R 4.2.2 software was used for data processing in the early stage and drawing in the later stage, and all the incidence rates were 1/100,000.

3. Results

3.1. Time trend of disease burden in Jiangsu Province

From 1990 to 2021, the cumulative incidence of HBV in Jiangsu was 378,486 in males and 140,452 in females, and the age-standardized incidence rate in males (mean: 29.69/100000) was higher than that in females (mean: 10.94/100000).The age-standardized incidence rate trends for males and females from 1990 to 2021 are shown in Fig. 4A and B. It is also evident from both figures that overall the incidence of HBV is higher in males than in females. From the cohort of males and females (Fig. 1) and heat map (Fig. 2), it shows that the incidence is mainly concentrated in 15–30 years old, with an average incidence of 31.53/100,000 for males and 11.67/100,000 for females. The incidence of HBV in males and females in the 0–45 age group has been declining since 2005, while it has been increasing in the 45–84 age group. Among males born between 195 and 1962, the age group had the highest incidence in the 30–34 age group, with an average annual incidence of 16.82/100,000. Among females born between 1963 and 1967, the 25–29 age group had the highest incidence, with an average annual incidence of 5.96/100,000. The maximum difference between male incidence and female incidence is 2.82 times.

3.2. Cluster analysis

The clustering results are shown in Fig. 3, males and females are clustered into three groups according to their age groups. For males, 55–85 years old and above are grouped into the first group, 0–14 years old into the second group, and 15–54 years old into the third group. For females, the first group is 50–85 years old and above, the second group is 15–24 years old, and the third group is 0–14 years old and 25–49 years old.

3.3. Joinpoint regression model analysis

In this study, the world standard population was used to standardize the incidence of HBV in Jiangsu Province and the standardized incidence was calculated. Then the Joinpoint regression model was used to fit the standardized incidence rate of HBV for males and females, respectively, and the maximum number of turning points was set at 5 according to the number of turning points recommended by the software algorithm. The final turning points are two for males in 2006 and 2012, and three for females in 2001, 2004, and 2010 (Fig. 4A and B).

For males of all age groups, two transitions occurred: 1990–2006, 2006–2012, and 2012–2021. The annual percentage change rate of standardized incidence rate of HBV among males in 1990–2006 was −1.4% (95% CI: −2.5%, −0.3%), and the difference was statistically significant. From 2006 to 2012, the annual percentage change rate was −9.9% (95% CI: −16.2%, −3.1%), and the difference was statistically significant.

For female population of all age groups, there have been three transitions: 1990–2001, 2001–2004, 2004–2010 and 2010–2021. The annual percentage change rate of standardized incidence rate of HBV among the female population in 1990–2001 is −6.18% (95% CI: −8.0%, −4.3%), and the difference was statistically significant. From 2004 to 2010, the annual percentage change rate was −7.09% (95% CI: −8.0%, −4.3%), and the difference was statistically significant. Since the connection line between 2001-2004 and 2010–2021 in the model was not statistically significant, only 1990–2001 and 2004–2010 were studied.

For male population (Fig. 5A), the 15–54 age group had the largest mean normalized incidence of 55.22/100,000, 34.92/100,000, and 25.10/100,000, respectively, among the three stages, with the fastest declines occurring in the 0–14 age group, at 86.45% and 45.53%, respectively. For female population (Fig. 5B), the 15–24 age group had the highest mean standardized incidence of 18.02/100,000, 20.40/100,000, and 14.27/100,000, respectively, in the first three stages, and the 50–85 age group and above had the highest mean standardized incidence of 13.12/100,000 in the fourth stage.

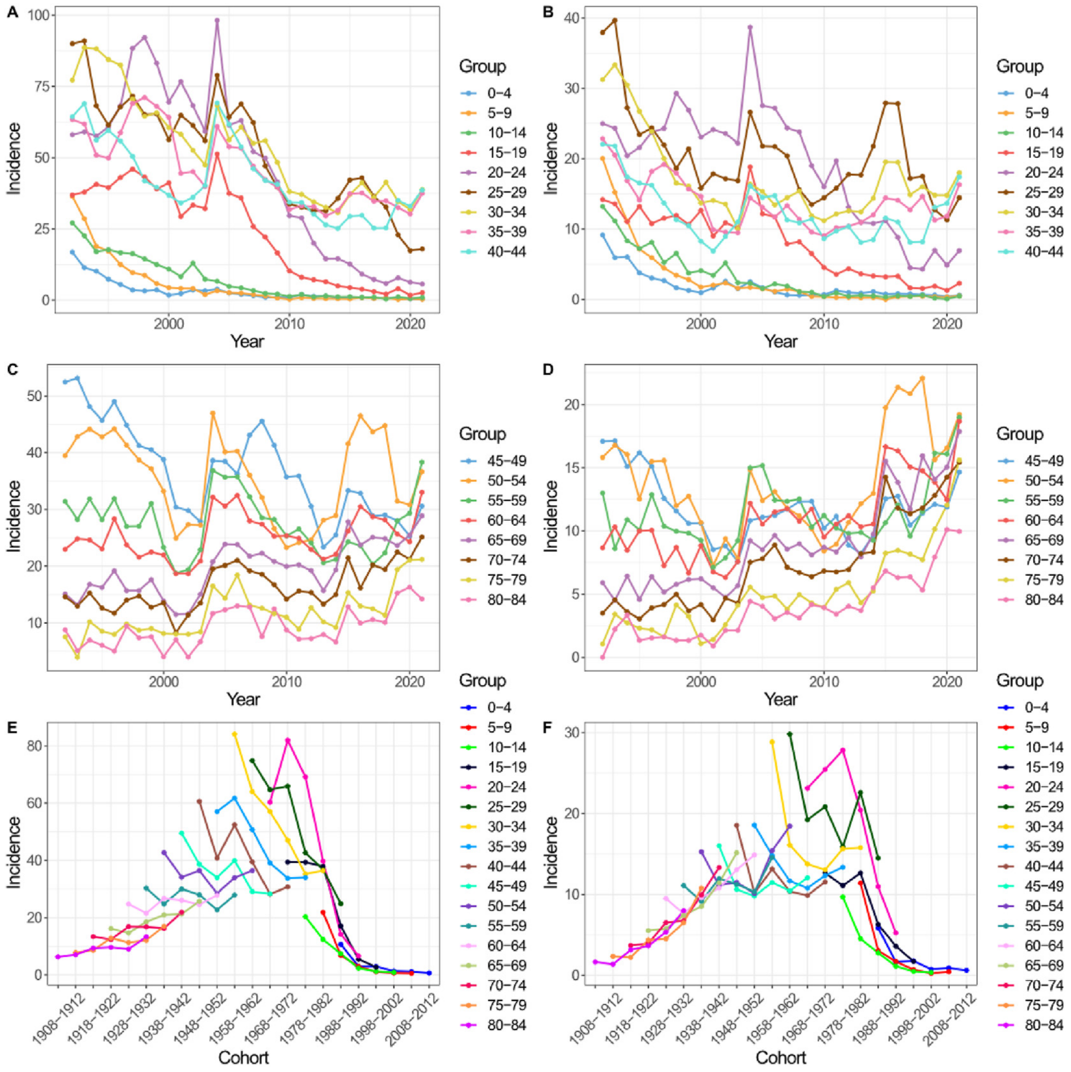

Fig. 1. Cohort diagram of incidence period of HBV among males and females aged 0-84 years old in Jiangsu Province from 1992-2021. (A, and C are period plots for males; B and D are period plots for females; E and F are cohort plots for males and females).

3.4. Age-period-cohort analysis of HBV incidence in Jiangsu Province

APC model was used to analyze the incidence of HBV in male and female population from 1992 to 2021. The chi-square test results of each index were statistically significant, as shown in Table 1.

The net drift represents the overall annual percentage change in the age group adjusted with time. From 1992 to 2021, the net drift in the incidence rate of HBV among males was −3.3718 (95%CI: −3.8202%,-2.9214%) per year, indicating that the incidence rate of HBV among males gradually decreased at the rate of 3.3718% per year. The net drift in the incidence rate of HBV among females was −1.3538% (95% CI: −1.7913%, −0.9143%) per year. The local drift represents the annual percentage change in each age group, and the net drift and local drift results were shown in Fig. 6A.

As shown in Fig. 6B, the longitudinal age-specific HBV incidence rates of males and females increased sharply at first and then decreased, but the longitudinal age-specific HBV incidence rate of males was higher than that of females all the time, and the two rates were approximately equal until the age of 80. As shown in Fig. 6C, the incidence of cross-sectional age-specific HBV in males and females increased sharply at first and then stabilized, but the incidence of cross-sectional age-specific HBV in males was always higher than that in females. The changing rate ratio (Fig. 6D), taking June 2004 as a reference ($RR = 1$), first decreased and then showed an upward trend for females, and the difference was statistically significant ($P < 0.001$). For males, the rate ratio also decreased and then increased, and the difference was statistically significant ($P < 0.001$). The changing rate ratio of the cohort (Fig. 6E), compared with 1962 ($RR = 1$), increased first and then decreased, but the difference was statistically significant ($P < 0.001$). For males, the rate ratio also increased first and then decreased, but the difference was statistically significant ($P < 0.001$).

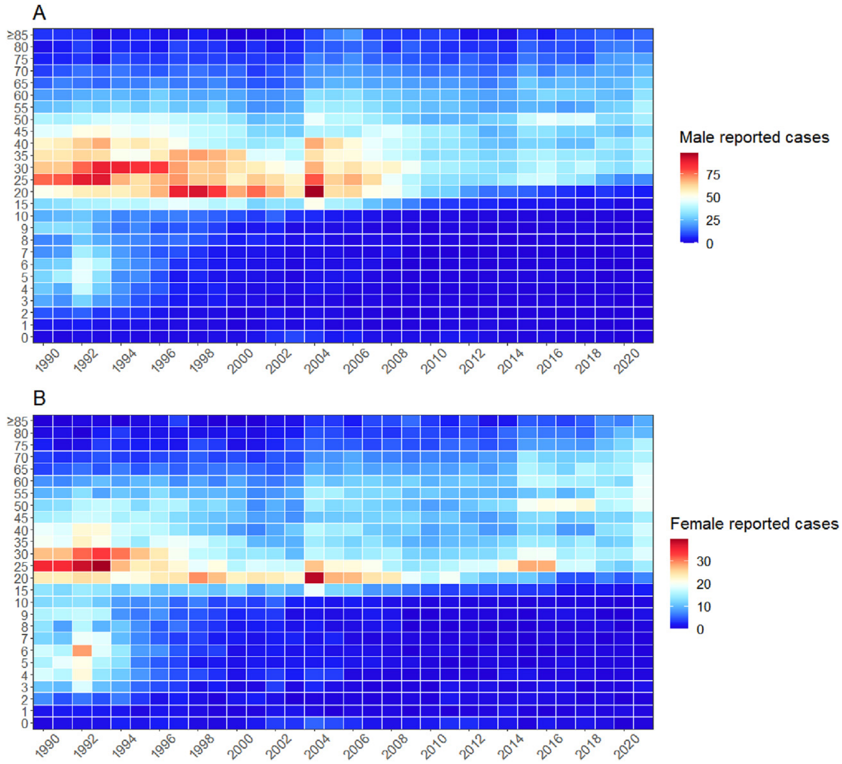

Fig. 2. Heat map of HBV incidence in Jiangsu Province from 1990 to 2021. (A. Heat map of males HBV incidence in Jiangsu Province; B. heat map of females HBV incidence in Jiangsu Province).

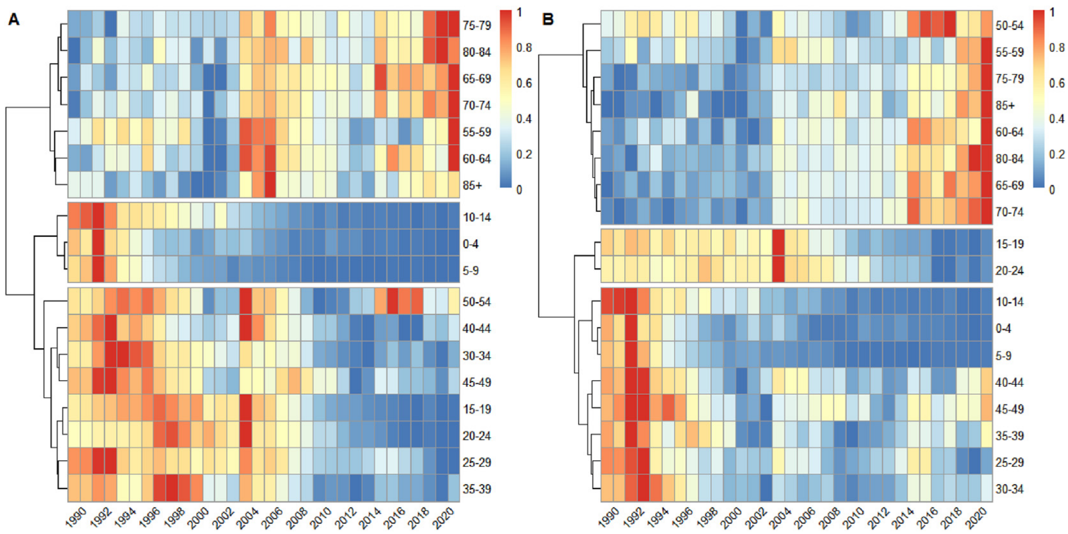

Fig. 3. Cluster diagram of HBV incidence in Jiangsu Province from 1990 to 2021. (A. Cluster diagram of males HBV incidence in Jiangsu Province; B. Cluster diagram of females HBV incidence in Jiangsu Province).

4. Discussion

Based on the data of Jiangsu Province for 32 years, this study estimates the influence of age, period, and cohort on the incidence of HBV for the first time. It has found that age has the greatest influence on the incidence of HBV, in which people aged 15–30 and over 60 are the high-risk groups. It is of great significance to take reasonable control measures to prevent the occurrence and infection of HBV and reduce the harm caused by it.

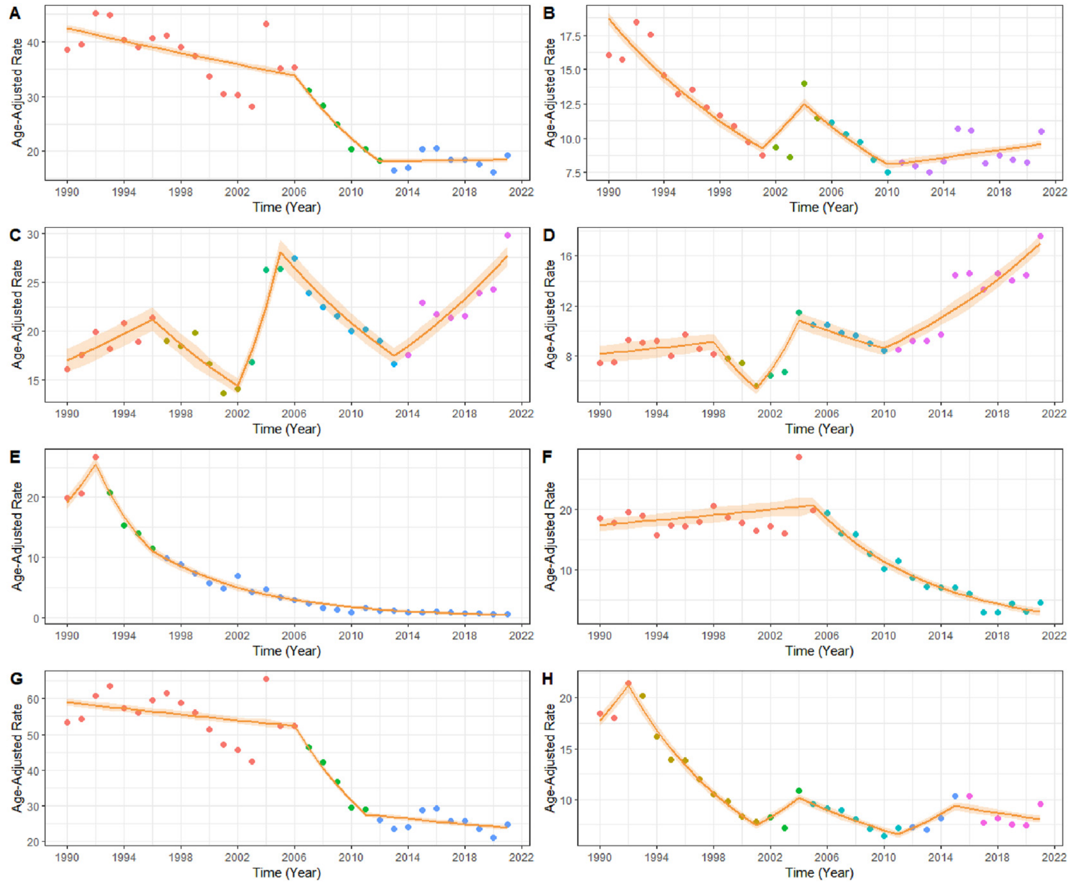

Fig. 4. Joinpoint regression model of standardized incidence rate of HBV in Jiangsu Province from 1990 to 2021. (A and B were Joinpoint regression model diagrams of standardized incidence rate of HBV in all age groups of males and females in Jiangsu Province, respectively. C, E, and G were Joinpoint regression model diagrams of standardized incidence rate of HBV for males grouped according to the clustered age group. D, F, and H were Joinpoint regression model diagrams of standardized incidence rate of HBV among females grouped according to the clustered age group. Note: the graphic order is consistent with the clustering order above).

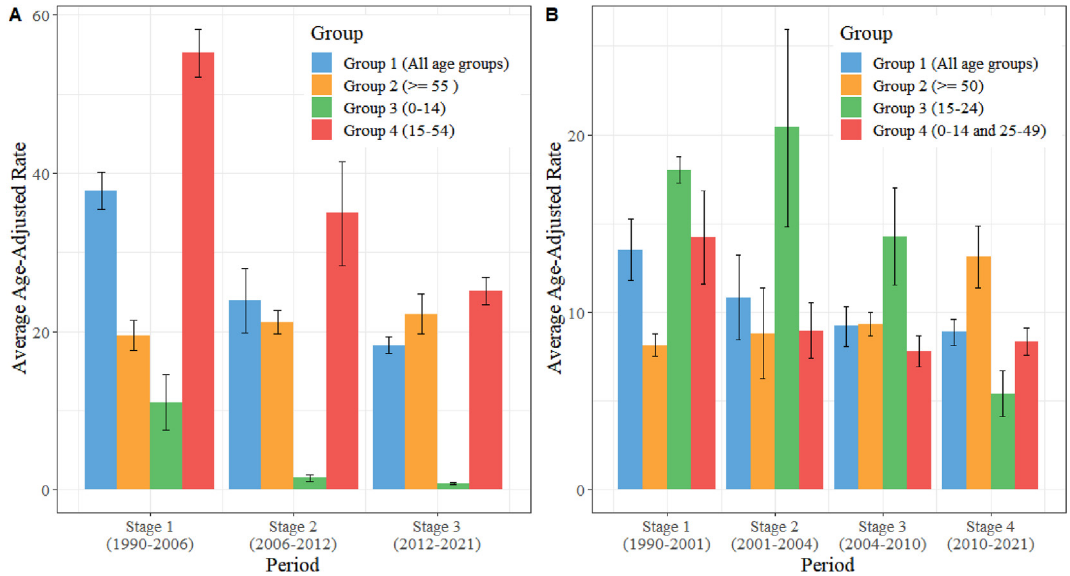

Fig. 5. Mean normalized HBV incidence at the turning point and its 95% confidence interval for each clustered age group. (A. males; B. females).

Table 1
APC model test of HBV incidence in Jiangsu province from 1992 to 2021.

Sex	Null hypothesis	Alternative hypothesis	χ^2	Free degree	*P* value
Male	Net Drift = 0	Net Drift ≠ 0	208.9491	1	<0.001
	All Age Deviations = 0	All Age Deviations ≠ 0	402.9135	15	<0.001
	All Period Deviations = 0	All Period Deviations ≠0	33.7506	4	<0.001
	All Cohort Deviations = 0	All Cohort Deviations ≠ 0	413.5353	20	<0.001
	All Period Rate Ratio = 1	All Period Rate Ratio≠ 1	246.6174	5	<0.001
	All Cohort Rate Ratio = 1	All Cohort Rate Ratio≠ 1	755.2181	21	<0.001
	All Local Drifts = Net Drift	All Local Drifts≠Net Drift	378.0247	17	<0.001
Female	Net Drift = 0	Net Drift ≠ 0	36.1222	1	<0.001
	All Age Deviations = 0	All Age Deviations ≠ 0	471.0028	15	<0.001
	All Period Deviations = 0	All Period Deviations≠0	117.7800	4	<0.001
	All Cohort Deviations = 0	All Cohort Deviations≠0	412.3017	20	<0.001
	All Period Rate Ratio = 1	All Period Rate Ratio≠1	160.8073	5	<0.001
	All Cohort Rate Ratio = 1	All Cohort Rate Ratio ≠ 1	462.1499	21	<0.001
	All Local Drifts = Net Drift	All Local Drifts≠ Net Drift	356.3382	17	<0.001

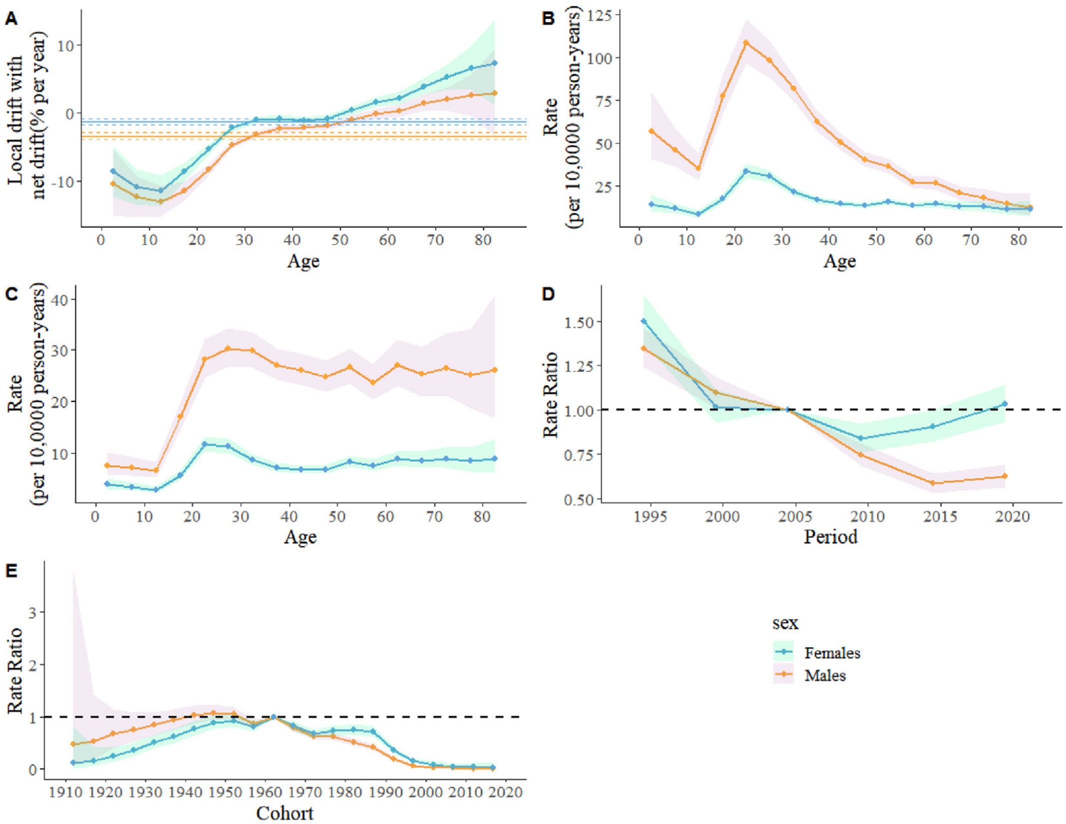

Fig. 6. Analysis of Age-period-cohort effect of HBV incidence in Jiangsu Province from 1992 to 2021. (A. The local drift and net drift of the incidence of HBV and its 95% confidence interval; B. Longitudinal age-specific incidence of HBV and its 95% confidence interval; C. cross-sectional age-specific incidence of HBV and its 95% confidence interval; D. The period change of the incidence rate of HBV and its 95% confidence interval; E. Incidence ratio of HBV in birth cohort and its 95% confidence interval).

4.1. Epidemiological characteristics

The advent of HBV vaccine and the implementation of the national expanded immunization program have greatly reduced the infection of HBV in the population(Stasi et al., 2016; Walayat et al., 2015). In 2003, Jiangsu Province began to implement the strategy of neonatal HBV vaccination in an all-around way. The incidence of HBV in 0–10 years old before 2003 was higher than that after 2003, indicating that neonatal HBV vaccination played a great role in reducing the infection of HBV in children. Before 2003, the incidence rate in children and young people was high. After 2003, the incidence rate in the old increased gradually and became dominate. Because vaccine policies were not implemented at birth at this time for older adults, most may not have been vaccinated against HBV, and as they age and their body's resistance weakens, they are known as a susceptible population for HBV. Therefore, it is considered that reseeding HBV vaccine for this population to reduce the risk of HBV infection is of significance.

Applying statistical models to analyze infectious diseases is important for policy adjustment and disease prevention and control. In Joinpoint regression model, the standardized incidence of hepatitis B among males in all age groups decreased by 1.4% per year from 1990 to 2016, and by 9.91% per year from 2006 to 2012. The standardized incidence of hepatitis B among females in all age groups decreased by 6.18% per year from 1990 to 2001 and by 7.00% per year from 2004 to 2010. This may be related to the free vaccination of hepatitis B vaccine for newborns in Jiangsu Province in 2005 and the replanting of hepatitis B vaccine for people under 15 years old in 2009. The implementation of these policies has greatly increased the rate of decline of hepatitis B incidence, especially for males. For the male population, the standardized incidence trend of the whole age group is very similar to that of the 15-54-year-old population. In each period, the average standardized incidence of the 15-54-year-old population is higher than that of other cluster groups, which indicates that this age group has a great influence on the incidence of HBV in the whole age group. This group of people is mostly young and middle-aged. People in this age group have a wide-ranged and various activities, which greatly increases the infection rate of HBV. These people are mainly infected through blood transmission, sexual transmission, and contact transmission, so strengthening the intervention of these modes of transmission can effectively reduce the infection of HBV(Lavanchy, 2005; Thompson et al., 2021). However, the standardized incidence of this part of the population is decreasing, while the incidence of people aged 50–85 and above is gradually increasing. This part of the population is mainly middle-aged and old, among which the elderly account for a large proportion, mainly because the people aged 15–54 are getting older with time, and most of these people have not been vaccinated against HBV. Therefore, it is obvious that everyone should be vaccinated against HBV, and it is an effective measure to vaccinate those who have not been vaccinated against HBV. In 1990–2001, the incidence trend of female HBV was mainly determined by the 0–49 age group, which was mainly children, young people, and middle-aged people. Because most of the people had not been vaccinated at this time, and their activities were diverse, they were more likely to be infected with HBV. In 2004–2010, the incidence trend of HBV in females was mainly determined by the 15-24-year-old age group. This part of the population was in adolescence or just entered the society, and it was difficult to resist the temptation. It might have more dangerous behaviors, and it was a high incidence of HBV(Darmawan et al., 2015).

4.2. Age-period-cohort effect model

When building the APC model, in order to study whether COVID-19 will affect the model results, we removed the data during the COVID-19 period and built the APC model again. The results show that the occurrence of COVID-19 has little influence on the model parameters, so the APC model is constructed by using the data of HBV incidence from 1992 to 2021 (Supplementary material).In APC model, the net drift of both males and females was below 0, and the difference had statistical significance, which indicates that the incidence of HBV among males and females in Jiangsu Province is decreasing year by year, which is closely related to the improvement of economic level and medical and health conditions, especially the vaccination for HBV(Das et al., 2019; Udomkarnjananun et al., 2020). After the age of 50, the local drift of female population is greater than 0, and that of male population is greater than 0 around the age of 60, all of which reach the highest at the age of 80. This may be due to the accumulation of HBV in human body, the decrease of human immunity, and the gradual decline of vaccination effect with the increase of age, which leads to the infection of HBV in these people. From 1992 to 2021, the incidence of HBV by longitudinal age-specific and cross-sectional age-specific in Jiangsu Province shows that the incidence of HBV in both males and females increases rapidly and reaches the peak at the age of 15–30, which indicates that this age group is a high-risk group of HBV. Many people in this age group have unhealthy living habits, such as multiple sexual partners between young males and females, same-sex behaviors, smoking and drinking due to excessive stress, and even some people may take drugs, which are all risk factors for HBV(Akman et al., 2010; Kuo et al., 2004; Yin et al., 2013). In addition, the study also shows that the incidence of HBV in males is higher than that in females, so we should pay more attention to this group, especially for males. For example, regular screening of HBV in bars, karaokes and other high-risk places of HBV can effectively control the occurrence of HBV. At the same time, people in this age group should also pay attention to self-protection, avoid intimate contacts with strangers, avoid blood exposure, regularly check their HBV antibodies, and avoid being infected with HBV(Funk et al., 2021).

The period effect shows that incidence rate was 1 in June 2004. This may be due to the full implementation of HBV vaccination for newborns in Jiangsu Province since 2003. After 2005, the incidence rate ratio of males and females was less than 1. Before that, the incidence rate ratio of males and females was greater than 1. This may be related to the free HBV vaccine policy implemented in 2003 and 2005. Because vaccination reduces the susceptibility of people to HBV, its incidence rate was the highest in 1995, and the incidence rate of females was higher than that of males. After 2015, its incidence rate increased and showed an upward trend, especially that of females, which deserves attention. With the outbreak of the COVID-19 epidemic in late 2019, people paid more attention to the possibility that COVID-19's attention to other diseases might decrease, so Jiangsu still needs to strengthen the attention and control of HBV.

The cohort effect shows that the incidence ratio of people born before 1962 increased with the birth time. At that time, the people were in poverty, hunger and war. The medical conditions were relatively backward and it was more likely to cause the disease epidemic. After 1962, the incidence rate ratio gradually decreased, with the greatest decrease in 1992. This may be since the Ministry of Health of China included HBV in the management of children's immunization in 1992. Therefore, people born in this period had the opportunity to receive HBV vaccine, resulting in a significant decrease in the incidence rate ratio of people born in this period. Later, with the gradual improvement of the policy and the improvement of people's living standards and medical conditions, the incidence rate ratio of HBV in the birth cohort showed a downward trend every year(Gao et al., 2020; Ji et al., 2019).

In general, the implementation of the national expanded immunization program had a large impact on the APC model. First, the longitudinal age-specific incidence rate and the cross-sectional age-specific incidence rate were in a decreasing trend during 0–10 for both males and females due to the implementation of the national expanded immunization program, which may be due to the protective effect of the HBV vaccine. Second, the incidence ratio of the period effect was greater than 1 before the implementation of the national expanded immunization program, while its incidence ratio of the period effect was less than 1 after the implementation of the national expanded immunization program, indicating that the national expanded immunization program had a significant effect on the incidence of HBV. In the cohort effect, the incidence rate ratio of the cohort population vaccinated against HBV was lower than that of the cohort population not vaccinated against HBV, and the subsequent value was also consistently lower than that of the pre-vaccination population, indicating that the national expanded immunization program influenced the change in the value of the incidence rate ratio.

This study also has some limitations. As the APC model requires that the age group distance of data must be the same as the period group distance, the incidence data of a single age group from 0 to 9 years old are combined into age groups of 0–4 years old and 5–9 years old every 5 years. At the same time, the data of 1990 and 1991 are excluded from the model, which undoubtedly loses the information about the data. In addition, in this study, the data was modeled based on their own characteristics, without considering the effects of climate, season, temperature, and other factors on HBV. It may be more scientific and accurate to add these variables to the model in the future to analyze the incidence of HBV.

5. Conclusions

Generally, the incidence of HBV in Jiangsu Province showed a gradual decline from 1990 to 2021, and the incidence of males was higher than that of females. The incidence rate of people aged 15–30 was higher and increased rapidly. Another high-risk group was people aged over 60. More targeted prevention and control measures should be taken for males and this part of people.

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Authors' contributions

K.F.: Conceptualization, data analyze, visualization, writing—original draft; Y.-Y.S.: methodology, data curation, data analysis, writing—original draft; Z.-Y.Z.: methodology, resources, data analyze, writing—review and editing; Y.-K.Z.: methodology, visualization, writing—review and editing; Y.-C.G.: data curation, visualization; B.A.: writing—review and editing; H.-M.Q.: data curation, resources; Q.L.: data analyze; G.-D.K.: visualization; Z.-G.W.: resources; J.-L.H.: conceptualization, project administration, supervision, writing—review and editing; T.-M.C.: conceptualization, methodology, project administration, writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Ethics statement

The study was approved by the Medical Ethics Committee of Jiangsu Provincial Center for Disease Control and Prevention. The epidemiology data we used for this study was without specific and detailed patient information and therefore the informed consent was waived by the ethics committee/institutional review board (IRB) of the Medical Ethics Committee of Jiangsu Provincial Center for Disease Control and Prevention. All processes were carried out following the relevant guidelines and regulations of the Helsinki Declaration.

Availability of data and materials

The epidemiology data of HBV was acquired from Jiangsu Provincial Center for Disease Control and Prevention, and the institution has not permitted researchers to share its data. Data requests can be made via contacting this phone number: 025–83759311.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.idm.2023.07.007.

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