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The macroeconomic burden of hepatitis C and the economic benefit of accelerated investments in China

Yun Bao[1,2,3,4,5,6,7], Ying Chen[6], Huajie Jin[8], Chi Zhang[1], Lingli Zhang[2,4,5,9,10*] and Bin Wu[6*]

Abstract

Background Hepatitis C virus (HCV) poses a significant health and economic burden worldwide, with China bearing a considerable portion of this burden. Chinese treatment coverage remains low, and the full economic implications of achieving these goals are not well understood.

Objective This study aims to evaluate the macroeconomic burden of HCV from 2023 to 2050, as well as the investments required, health benefits, cost-effectiveness, net economic benefit, and the impact on economic growth associated with achieving WHO hepatitis C intervention coverage targets more rapidly during this period.

Methods A dynamic compartmental model was used to simulate the transmission, progression, and cascade of care for HCV patients in China. Intervention costs and healthcare costs were calculated using the cost-of-illness (COI) method. A health-augmented macroeconomic model projected macroeconomic outcomes. Scenarios were developed to evaluate different time points for achieving coverage targets.

Results The projected macroeconomic burden of HCV from 2023 to 2050 is $1.17 trillion. Achieving WHO targets by 2030 is expected to spend $69.72 (95% UI $66.22–$73.68) billion but will avert 0.66(95% UI 0.58–0.74) million hepatocellular carcinoma (HCC) cases, and 1.10(95% UI 1.03–1.18) million HCV-related deaths compared to status quo. Faster achievement of coverage targets is associated with investments becoming cost-effective sooner and facilitating greater economic growth.

Conclusion Achieving the WHO Global Health Sector Strategy diagnosis and treatment coverage targets by 2030 in China is projected to be cost-effective and result in significant health and economic benefits. The findings underscore the importance of increased investment in hepatitis C elimination efforts in China.

Keywords Hepatitis C, Macroeconomic burden, China, WHO targets, Cost-effectiveness

*Correspondence:
Lingli Zhang
zhanglingli@scu.edu.cn
Bin Wu
scilwsjtu-wb@yahoo.com

Full list of author information is available at the end of the article

Introduction

According to Polaris Observatory Collaborators, HCV remains a global public health issue, with approximately 50.67 million infected individuals globally in 2022. China ranks third among WHO member states, imposing substantial health and socioeconomic burdens [1].

In response, the WHO set ambitious targets for hepatitis elimination by 2030 [2, 3]. China, demonstrating strong commitment to this global initiative, has become one of the first countries to develop and implement a national action plan specifically targeting hepatitis C elimination [4, 5]. Since 2017, China's introduction of direct-acting antivirals (DAAs) into national healthcare insurance has significantly improved treatment accessibility [6]. However, HCV treatment coverage in China remained at just 9% in 2022, far from WHO's 80% target for 2030 [7], highlighting the urgent need for accelerated interventions.

The existing literature on hepatitis C economics in China has primarily focused on cost-effectiveness analyses of various screening and treatment strategies, along with short-term assessments of disease burden from a healthcare perspective [8, 9]. While these studies provide valuable insights - such as Zhou et al.'s finding of an incremental cost-effectiveness ratio of $9,503 per QALY gained for population screening [8], and Wu et al.'s projection of significant reductions in HCV incidence and mortality through enhanced screening and treatment [10] - they fail to capture the broader macroeconomic implications of the disease and its elimination efforts. Notably absent from current research are comprehensive assessments of productivity losses, capital investment impacts, and the relationship between intervention timing and economic outcomes. This knowledge gap is particularly critical given that chronic hepatitis C (CHC) affects individuals during their prime working years, potentially resulting in substantial economic losses through reduced productivity, increased unemployment, and decreased workforce participation.

Furthermore, the pace at which elimination targets are achieved may have far-reaching implications for both public health outcomes and economic development. Understanding these temporal dynamics is crucial for optimal resource allocation and policy planning, yet current research has not adequately addressed this aspect. This research gap becomes particularly significant when considering China's position as both a major economic power and one of the countries most affected by HCV.

Therefore, this study aims to address these critical knowledge gaps by: (1) Quantifying the productivity losses attributable to hepatitis C mortality in China from 2023 to 2050; (2) Comprehensively evaluating the economic implications of achieving WHO hepatitis C intervention coverage targets; (3) comparing economic and health outcomes of achieving these targets by 2030, 2040, or 2050. The findings will provide crucial evidence for policymakers in optimizing resource allocation and intervention strategies, while also offering valuable insights for other nations facing similar challenges in their pursuit of WHO's elimination targets.

Methods

Study design and overview

This study follows the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) 2022 guidelines to evaluate the macroeconomic burden of HCV in China [11]. We developed an integrated analytical framework comprising three components: (1) a dynamic compartmental model simulating HCV transmission and disease progression, (2) a cost-of-illness analysis calculating direct and indirect costs [12], and (3) a health-augmented macroeconomic model projecting macroeconomic outcomes. Both health outcomes and healthcare costs were then integrated into the health-augmented macroeconomic model to estimate the overall macroeconomic burden. All costs are standardized to 2024 US dollars.

Disease model

Following Brennan's criteria for model selection, this study employed a compartmental model as it provides the most appropriate and feasible approach for quantifying the population-level burden of HCV [12]. Compartmental models are a type of mathematical model that represent system dynamics by dividing the system into distinct "compartments," each representing different states or stages. The model accounted for age-, sex-, and risk behavior-specific groups, including both vertical and horizontal transmission (Fig. 1). Since people who inject drugs (PWID) currently represent the main route of HCV transmission and have a high risk of infection in China, individuals aged 15–49 years were further classified into current injectors and former injectors (general population) based on risk behaviors [13, 14]. Horizontal transmission rates were dynamic and aggregated across all composite transmission routes. In the model, decompensated cirrhosis (DC) and HCC can lead to HCV-related deaths. Model details are described on the supplementary file page 1. The compartmental model was developed using the Atomica package (1.28.1) in Python (3.12) [15]. Atomica is a cascade care analysis tool that tracks the progressive stages of patient engagement [16]. The model runs from 1990 to 2051 with a simulation time step of 0.25 years.

To improve the predictive accuracy and generalizability of the model, we implemented a calibration process, often known as "model fitting," which involves identifying parameter values that align the model's projections

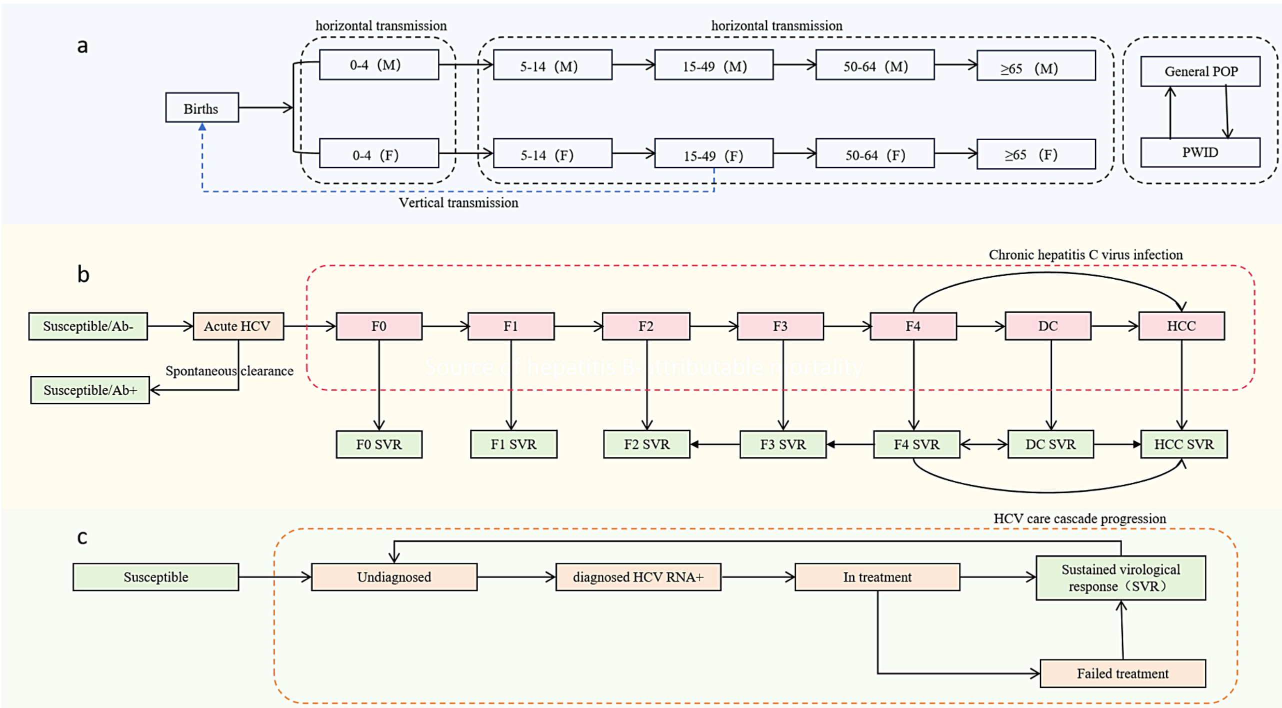

Fig. 1 HCV transmission, disease progression and care cascade model. (**A**) Population dynamics within the model, (**B**) Natural history of hepatitis C infections. Health stated included liver fibrosis stages F0, F1, F2, F3, F4 (compensated cirrhosis), decompensated cirrhosis and hepatocellular carcinoma, (**C**) Care cascade of patient in healthcare system. PWID: people who inject drug

with empirical observations. The primary objective of this calibration is to refine the model's input parameters, thereby enabling it to accurately predict outcomes in populations or datasets different from those used for internal validation. This calibration process was conducted in two stages: initially, we applied an adaptive stochastic descent optimization method, followed by a series of manual adjustments. Calibration was executed by fitting the model to data including HCV prevalence of general population and HCV prevalence of PWID from the Polaris Observatory Collaborators, HCC incidence and HCV-attributable deaths based on data from GBD 2021 data [1, 7, 17, 18]. This involved the simultaneous adjustment of parameters related to birth rates, all-cause mortality, interaction of each group, disease progression rates, and the annual probability of HCV-related mortality. Additional disease-specific parameters are detailed in supplementary file Tables S1 and S2.

Scenarios

The study evaluated four scenarios to illustrate the impact of delaying WHO target achievement by each subsequent decade. Scenario 1 (Status Quo): Diagnosis and treatment coverage remain at current growth rate. Scenario 2 (WHO 2030 Target): Diagnosis and treatment coverage targets are achieved by 2030. Scenario 3 (WHO 2040 Target): Diagnosis and treatment coverage targets are achieved by 2040. Scenario 4 (WHO 2050 Target): Diagnosis and treatment coverage targets are achieved by 2050. Intervention scale-up rates were assumed to be linear, and diagnosis and treatment coverage rates were applied uniformly across modeled populations.

Outcomes

Health-related outcomes

Hepatitis C-related health outcomes from 2023 to 2050 were calculated for each scenario. Health outcomes included cumulative incident cases of CHC, cumulative incident cases of HCC, cumulative HCV-attributable deaths, and disability-adjusted life years (DALYs) for each scenario. Cost and health-related parameters are presented in Supplementary file Table S3 and Page 6–7.

Economic outcomes

The economic burden of the disease from 2023 to 2050 were calculated for each scenario. The cost-effectiveness of scenario 2, 3, and 4 was calculated relative to the status quo from both health care perspective and societal perspective.

Cost-effectiveness of each scenario Incremental cost-effectiveness ratios (ICERs; US$ per DALY averted) were calculated from the healthcare perspective. Healthcare cost included both intervention costs and disease management costs. Intervention costs encompassed antibody and RNA testing, as well as antiviral drugs (commodity costs). The cost of antiviral drugs was based on the Pan-genotype DAA price. The duration of antiviral treatment was assumed to be 12 weeks [17]. Disease management costs included annual health management costs for F0-F4, DC, HCC, F3-F4 (SVR), DC (SVR), and HCC (SVR), which encompassed costs for liver-related and other laboratory tests, medications, and hospitalizations. Due to the lack of data on the fraction of patients at different stages of CHC with access to care and engagement, we assumed that 25% of patients received annual health management (0% and 50% were estimated in sensitivity analyses).

The net economic benefits of each scenario The net economic benefit is defined as the difference in total costs from a societal perspective. Total costs were calculated as the sum of healthcare costs and productivity costs. Direct non-health costs were considered but not included in this study due to a lack of data. Productivity costs were estimated using the human capital approach [18]. Cumulative productivity losses were assessed for working individuals aged 15 to 64, with annual wages approximated at GDP per capita. The GDP was discounted at a rate of 3%. Lost productivity was restricted to mortality attributable to hepatitis C. Productivity losses for patients due to morbidity, as well as losses for their caregivers, were not considered due to a lack of data. The details of productivity loss are presented in Supplementary file page 6.

Macroeconomic burden and impact on economic outputs The health-augmented macroeconomic model was employed to calculate the macroeconomic burden of HCV and the impact of investment speed on economic growth in China. A counterfactual scenario was assumed in which the prevalence of hepatitis C is eliminated starting in 2023, compared to the status quo. The cumulative difference Y_t between the counterfactual scenario and the status quo represents the macroeconomic burden of HCV from 2023 to 2050. The differences in cumulative differences Y_t between the various scenarios and the status quo were also calculated to assess their impact on economic outputs. Specific details of the model are available in Supplementary file page 6.

The health-augmented macroeconomic model could be written as [19, 20]

$$Y_t = A_t K_t^{\propto} H_t^{1-\propto}$$

$$K_{t+1} = (1-\delta)K_t + Y_t - C_t - \sum\nolimits_{j \in L} TC_{j,t} = (1-\delta)K_t + s_t Y_t$$

$$H_t = \sum\nolimits_{a=15}^{R} h_t^{(a)} l_t^{(a)} N_t^{(a)}$$

Y_t was the production function at time t, $K_t$was physical capital, and H_t was human capital at time t. A_t was technological level of the economy that evolves exogenously and α is the elasticity of final output with respect to physical capital. δ was the rate of depreciation. C_t was consumption and $\sum_{j \in L} TC_{j,t}$ was treatment costs of disease $j \in L$. s_t was saving rate. $h_t^{(a)}$ was the exponential function of education and work experience of the age groups at time t. $l_t^{(a)}$ was the labor participation rate of people age group a at time t. $N_t^{(a)}$ was the population of age group a at time t.

The saving rate and gross domestic product came from the World Bank World Development Indicators Database [21, 22].The labor force participation rate was predicted by linear regression using data from the International Labor Organization [23]. Years of education were predicted by linear regression and linear interpolation using BarroLeeDataSet [24]. Specific parameters are shown in Supplementary file Table S4.

Sensitivity analysis

One-way sensitivity analyses were conducted to evaluate the lower and upper bounds of disease mortality, treatment effectiveness, and the halving and doubling of annual diagnosis costs, DAA costs, F0-F4 health management costs, and DC and HCC health management costs. Additionally, the medical resource utilization rates (0% and 50%) and discount rates (0% and 5%) were assessed in both the status quo and the scenario in which WHO coverage targets are achieved by 2030.

Statistical analysis

Disease-related health outcomes and economic costs were calculated on an annual basis. Point estimate and probabilistic sensitivity analyses (PSA) were performed for each scenario to assess the uncertainty of the model variables. Parameters for vertical transmission risks and natural history were drawn from truncated normal distributions, with ranges derived from the existing literature. The results from 1,000 simulations were utilized to obtain a 95% uncertainty interval (UI), defined as the 2.5th and 97.5th percentiles of the distribution. Health outcomes and economic costs were discounted at a rate of 3% per year [25].

Results

Health-related outcomes

The projected health-related outcomes are presented in Table 1 and Supplementary file Fig. S2. Under the status quo scenario from 2023 to 2050, there would be 7.09(95% UI 6.76–7.46) million incident cases of CHC, 1.19(95% UI 1.05–1.31) million cases of HCC, and 1.88(95% UI 1.75–2.01) million HCV-related deaths. Modeled intervention coverage is illustrated in Supplementary file Fig.

Table 1 Projected outcomes of health from 2023 to 2050

	Scenario 1: Status quo	Scenario 2: WHO coverage target achieved in 2030	Scenario 3: WHO coverage target achieved in 2040	Scenario 4: WHO coverage target achieved in 2050
Cumulative incident CHC(million)	7.09(6.76, 7.46)	3.10(2.96, 3.26)	4.11(3.92, 4.32)	5.00(4.77, 5.26)
Cumulative incident HCC(million)	1.19(1.05, 1.31)	0.52(0.47,0.57)	0.66(0.60, 0.73)	0.82(0.73, 0.90)
Cumulative HCV attributable deaths(million)	1.88(1.75, 2.01)	0.77(0.73, 0.83)	1.00(0.94, 1.07)	1.24(1.16, 1.32)
Cumulative HCV attributable DALYs(million)	13.21(12.40, 14.12)	6.90(6.51, 7.34)	8.88(8.36, 9.47)	10.29(9.67, 10.98)

Table 2 Projected outcomes of economic from 2023 to 2050

	Scenario 1: Status quo	Scenario 2: WHO coverage target achieved in 2030	Scenario 3: WHO coverage target achieved in 2040	Scenario 4: WHO coverage target achieved in 2050
Cumulative productivity losses(billion)	140.35(143.73,150.29)	72.02(67.79,76.79)	93.42(87.73,99.66)	108.85(102.23,116.25)
Cumulative total economic costs*(billion)	234.89(222.29,249.07)	141.74(134.44,149.90)	173.56(164.43,183.66)	196.57(186.11,208.07)
Cost per DALY compared to status quo#	NA	Cost-saving	Cost-saving	Cost-saving
Year investment met cost-saving*	NA	2034	2036	2036

* From societal perspective; # From healthcare perspective

S1. Outcomes of the calibrations are shown in Supplementary file Fig. S2.

Compared to the status quo, achieving WHO diagnosis and treatment coverage targets by 2030 would avert 3.99(95% UI 3.84–4.20) million new CHC infections, 0.66(95% UI 0.58–0.74) million HCC cases, and 1.10(95% UI 1.03–1.18) million HCV-related deaths between 2023 and 2050. Achieving coverage by 2030 would prevent an additional 1.01 million new CHC cases, 0.14 million more HCC cases, and 0.23 million more HCV-related deaths compared to 2040. Additionally, it would prevent 1.90 million new CHC cases, 0.30 million more HCC cases, and 0.24 million more HCV-related deaths compared to 2050.

We estimate that if WHO diagnosis and treatment coverage targets are achieved by 2030, the incidence of new CHC cases would be reduced by 90% by 2050, although the elimination target for HBV-related mortality would not be met by 2050.

Economic outcomes

Cost-effectiveness analysis

The projected economic outcomes are presented in Table 2; Fig. 2. If the current rate of diagnosis and treatment is maintained, it would spend $2.23 (95% UI $2.14–2.33) billion and $92.18 (95% UI $87.63–$0.97.85) billion on intervention and disease management between 2023 and 2050.

Compared to the status quo, achieving WHO diagnosis and treatment coverage targets by 2030 would incur an additional $15.16 (95% UI $14.39–$16.00) billion in intervention costs while saving $39.35 (95% UI $37.34–$41.79) billion in disease management costs, resulting in cost savings by 2037 from healthcare perspective.

Achieving coverage targets earlier (2030 scenario) reduces long-term healthcare expenditures over time (Fig. 2). In contrast, delaying the achievement of coverage targets (2040 and 2050 scenarios) involves lower initial costs but results in persistently higher healthcare costs than 2030 scenario in the long run, with a slower rate of reduction. From healthcare perspective, the ICER become cost saving by 2041 and 2042 at 2040 and 2050 scenarios. The peak healthcare costs are projected for 2024 at $5.80 billion, $4.91 billion, and $4.67 billion, respectively, when achieving WHO targets in 2030, 2040, and 2050. Under the scenarios of achieving the targets in 2030, 2040, and 2050, annual healthcare costs were estimated to become cheaper than the status quo by 2031, 2033, and 2033, respectively. Details regarding healthcare costs are available in Supplementary file Fig. S3.

The net economic benefits

Under the status quo scenario, the productivity loss due to HCV-related death would amount to $140.35 (95% UI $143.73-150.29) billion over time.

Compared to the status quo, achieving WHO diagnosis and treatment coverage targets by 2030 would become cost saving by 2034 from social perspective and generate $68.33 (95% UI $63.93–$73.66) billion in economic productivity gains. Achieving coverage by 2030 would averting $21.40 billion and $36.83 billion in productivity losses compared to 2040 and 2050, respectively. Additionally, from social perspective, the net economic benefits were estimated to become cost saving by 2036 under 2040 and 2050 scenarios (Fig. 2).

Macroeconomic burden and impact on economic outputs

We estimate the macroeconomic burden of HCV from 2023 to 2050 to be $1.17 trillion (95% UI $1.10 - $1.25). Achieving coverage targets earlier significantly impacts GDP growth and has a greater effect compared to achieving the targets later (Fig. 3). Compared to the status quo,

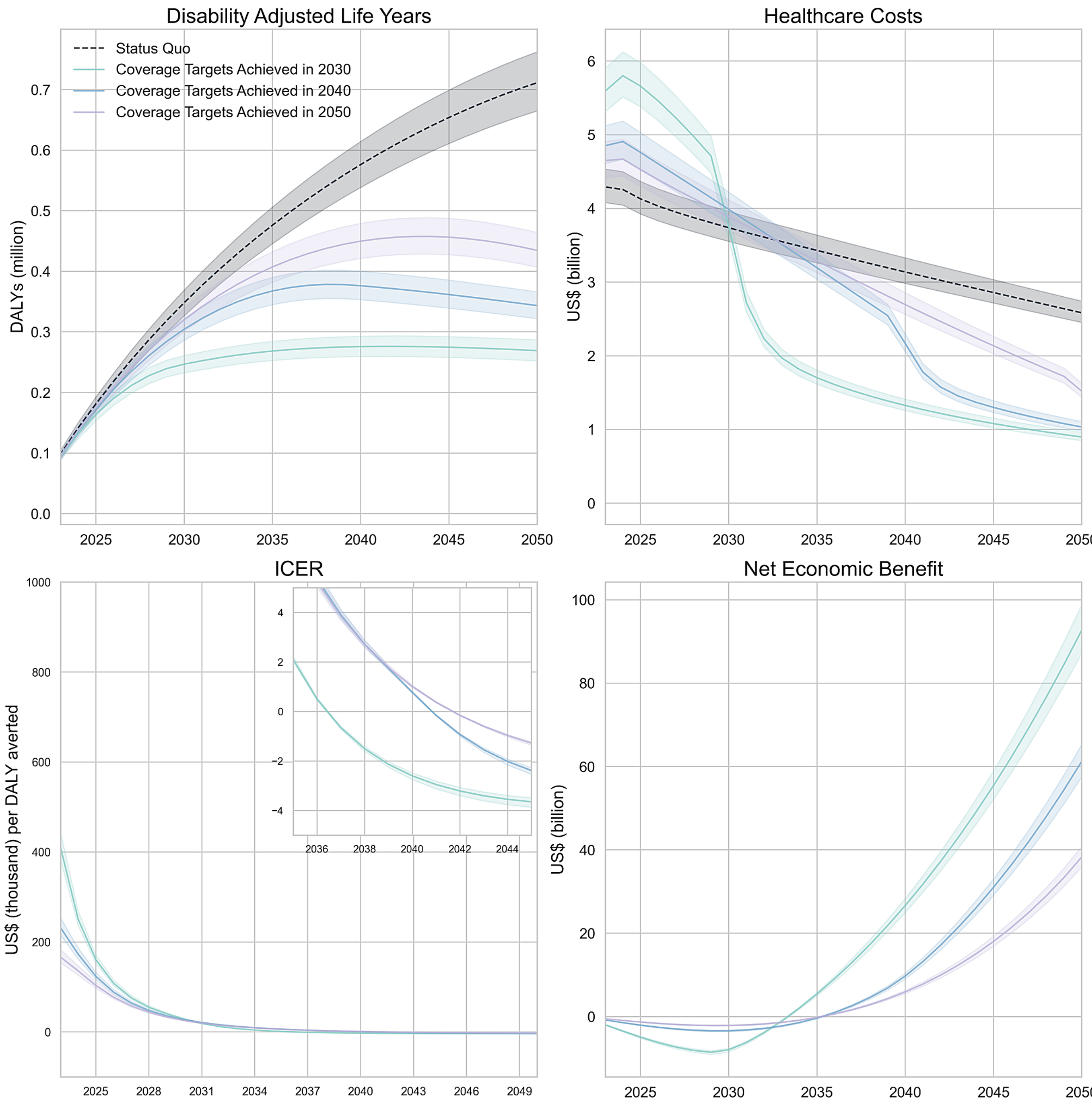

Fig. 2 Economic outputs from the hepatitis C disease model. ICERs shown are from a health systems perspective compared with the status quo. Net economic benefit is the difference in total costs from a societal perspective compared with the status quo

achieving the targets in 2030, 2040, and 2050 would increase GDP by \$0.56 trillion (95% UI \$0.52 - \$0.61), \$0.38 trillion (95% UI \$0.35 - \$0.41), and \$0.25 trillion (95% UI \$0.23 - \$0.27), respectively.

The macroeconomic impact findings are robust. The cost and proportion of disease management significantly impact healthcare costs and year of cost saving (Table 3, Supplementary file Table S5). Halving the price of DAA could decrease the healthcare costs and enhance the year at net benefit of investment (from a societal perspective by 2031 and a health system perspective by 2033), whereas raising DAA prices would have the opposite effect.

Discussion

This research represents the first comprehensive attempt to evaluate the macroeconomic burden of hepatitis C and the economic benefits of accelerated investments in China. Our study estimates the macroeconomic burden of HCV from 2023 to 2050 to be \$1.17 trillion (95%

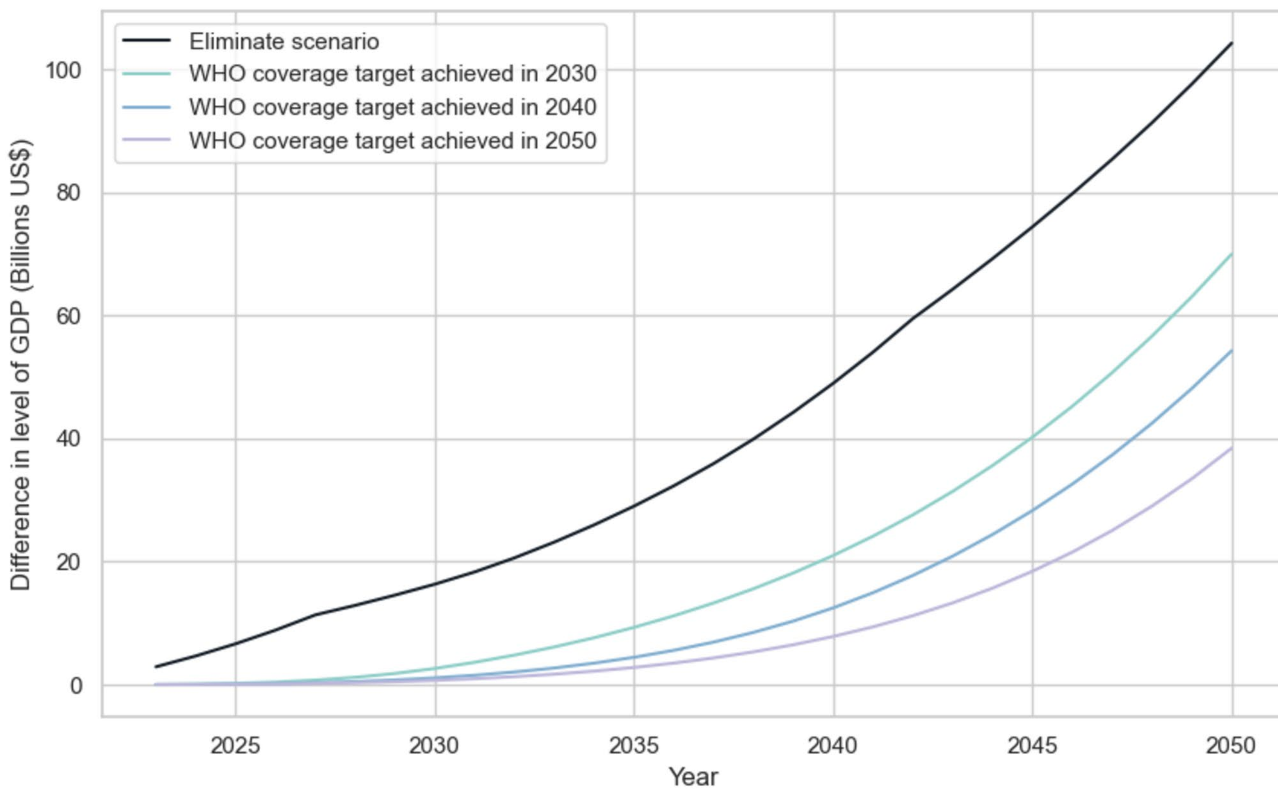

Fig. 3 Time trends in gains of GDP (in billions). The elimination scenario reflects the difference between the elimination scenario and the status quo. The difference in GDP levels for WHO coverage targets achieved in 2030, 2040, and 2050 corresponds to the difference between the status quo and the GDP levels for those coverage targets

UI $1.10 - $1.25), accounting for 0.15% (95% UI 0.14% – 0.16%) of China's total GDP during this period. Notably, the macroeconomic burden of HCV in 2023 alone represents 6.58% of China's GDP, which is close to the 7.2% of China's total health expenditure in the same year.

Our findings indicate that the quicker the action taken to scale up intervention coverage, the greater the improvement in disease burden and economic growth, as well as the faster achievement of cost-effectiveness. Specifically, compared to maintaining the status quo, achieving the WHO diagnosis and treatment targets by 2030 would prevent approximately 3.12 million new CHC infections, 1.05 million HCC cases, and 1.25 million HCV-related deaths. From healthcare and societal perspectives, investments to achieve the WHO targets by 2030 would result in net cost savings as early as 2037 and 2034, respectively, while contributing $0.56 trillion to overall economic growth. These results directly support China's ongoing National Action Plan to Eliminate the Public Health Threat of Hepatitis C (2021–2030), which aims to rapidly scale up screening, diagnosis, and treatment coverage through enhancing public awareness, improving patient referral systems, establishing specialized hospitals for hepatitis C care, and so on [5]. Our study provides robust evidence that investing in accelerated scale-up strategies is economically favorable and can inform timely policy decisions, helping policymakers prioritize resources effectively to achieve hepatitis C elimination goals in China. While the estimated investment required for China to achieve the WHO hepatitis C elimination targets by 2030 is $69.72 billion, this represents only 12.6% of the projected $554.4 billion global expenditure on HIV prevention and treatment over the same period [24].

Achieving WHO targets by 2030 necessitates higher healthcare costs in the early stages, with costs peaking at $5.80 billion in 2024. These costs are projected to gradually decline until they fall below the status quo by 2031. This trend mirrors that observed in the global investment case studies for HCV. In a global context, a finite period of investment in hepatitis C could generate a net economic benefit of $22.7 billion by 2030, leading to considerable reductions in transmission and mortality, with minimal ongoing costs [26]. Among healthcare costs, disease management expenses represent more than half, comprising 70% in 2023. With the progress of HCV elimination, the proportion of investment in DAAs and diagnosis continues to decrease, and the proportion of disease management costs continues to increase. Reducing disease management costs and increasing the proportion

Table 3 Outcomes of one-way sensitivity analysis in WHO coverage targets are achieved by 2030

	cumulative incident CHC(millions)	cumulative incident HCC(millions)	cumulative HCV attributable deaths(millions)	cumulative HCV attributable DALYs(millions)	cumula-tive direct costs(billions)	cumulative productivity losses(billions)	macroeconomic burden(trillions)	ICER (year achieved ICER < 0)	NEB (year achieved)
Base Case	3.10	0.52	0.77	6.90	69.71	72.02	0.56	2037	2034
Mortality worst case	3.10	0.52	0.79	6.96	69.10	73.30	0.57	2037	2034
Mortality best case	3.11	0.53	0.76	6.84	70.85	70.62	0.55	2037	2034
Treatment Effectiveness worst case	3.11	0.52	0.78	6.93	70.22	72.43	0.56	2037	2034
Treatment Effectiveness best case	3.09	0.52	0.77	6.92	69.85	72.25	0.56	2037	2034
Annual Ab-hcv and hcv RNA costs halved	3.10	0.52	0.77	6.90	68.61	72.02	0.56	2037	2034
Annual Ab-hcv and hcv RNA costs double	3.10	0.52	0.77	6.90	71.64	72.02	0.56	2037	2034
Annual DAA costs halved	3.10	0.52	0.77	6.90	62.24	72.02	0.56	2033	2031
Annual DAA costs double	3.10	0.52	0.77	6.90	84.39	72.02	0.56	2045	2038
Annual F0-4 management costs halved	3.10	0.52	0.77	6.90	49.38	72.02	0.56	2045	2036
Annual F0-4 management costs doubled	3.10	0.52	0.77	6.90	110.11	72.02	0.56	2032	2032
Annual DC and HCC management costs halved	3.10	0.52	0.77	6.90	63.45	72.02	0.56	2037	2034
Annual DC and HCC management costs doubled	3.10	0.52	0.77	6.90	81.96	72.02	0.56	2037	2034
0% disease management	3.10	0.52	0.77	6.90	16.78	72.02	0.56	$2392	2039
50% disease management	3.10	0.52	0.77	6.90	122.45	72.02	0.56	2033	2032
0% discount	3.10	0.52	0.77	6.90	69.62	72.02	0.56	2037	2034
5% discount	3.10	0.52	0.77	6.90	69.62	72.02	0.56	2037	2034

of disease management are key factors in alleviating the healthcare costs of HCV. China's implementation of the DRG/DIP payment model within its healthcare system will enable more refined management of disease-related costs [27]. Currently, inadequate primary care capacity presents a significant barrier to effective management of hepatitis C patients [28]. The national hepatitis C elimination action plan in China (2021–2030) has established designated service models to improve referral and management rates for these patients [29]. Additionally, there is a need to raise public awareness and reduce the stigma associated with the disease.

This is the first study to estimate the macroeconomic burden of HCV in China and its impact on national economic growth. A commonly used method to estimate and predict the economic burden of a disease is the COI, which calculates the disease-related burden over a specific period by assessing both direct and indirect costs [30]. However, the COI method only assesses the disease burden at the individual level and cannot capture the broader impact of the disease on the national economy. Another approach is the macroeconomic simulation model, which estimates the projected impact of a disease on GDP by considering how the disease affects labor, capital, and other factors, thus linking the disease to economic growth and influencing a country's production levels [31].The health-augmented macroeconomic model incorporates the effects of mortality and morbidity on the accumulation of human capital across various ages, sexes, work experiences, and education levels [20]. These two methods assess the economic burden of disease from individual and national perspectives, providing different implications for consideration. The two methods are not directly comparable and must be interpreted with caution.

This study has several limitations. First, due to a lack of relevant data, the model did not include productivity losses resulting from morbidity associated with hepatitis C, nor did it account for the productivity losses incurred by caregivers. This omission means that factors other than mortality—such as long-term sick leave, partial disability due to hepatitis C, and the time costs associated with care giving—were not accounted for. As a result, our estimates likely underestimate the total economic burden of hepatitis C. This underestimation may also lead to a more conservative assessment of the cost-effectiveness analysis. Second, the study used diagnostic effectiveness (positive rate) based on the general population to calculate diagnostic costs without considering the effectiveness for key population screenings. This limitation caused the estimated intervention costs to represent an upper limit.

Conclusions

From 2023 to 2050, the macroeconomic burden of HCV is projected to reach $1.17 trillion. More rapid achievement of coverage targets is associated with investments becoming cost-effective sooner and facilitating greater economic growth. These findings should catalyze increased investment in hepatitis C elimination efforts in China.

Abbreviations

HCV	Hepatitis C virus
COI	Cost-of-illness
HCC	Hepatocellular carcinoma
DAAs	Direct-acting antivirals
CHC	Chronic hepatitis C
CHEERS	Consolidated Health Economic Evaluation Reporting Standards
PWID	People who inject drugs
DC	Decompensated cirrhosis
DALYs	Disability-adjusted life years
ICERs	Incremental cost-effectiveness ratios
PSA	Probabilistic sensitivity analyses
UI	Uncertainty interval

Supplementary Information

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Supplementary Material 1

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Author contributions

Drafted the manuscript: YB. Collected and analyzed the data: YB, YC, CZ. Revised and approved the final version of the manuscript: HJJ, LLZ, BW. Participated in the data preparation and provided important comments on the manuscript: HJJ, BW. Read and approved the final manuscript and are accountable for all aspects of the work, including accuracy and integrity: all authors.

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Data availability

All data were derived from public reports and database. Information on how to access the data can be found in the references cited in this paper.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details
[1]Department of Pharmacy, Ren Ji Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, Shanghai, China
[2]Department of Pharmacy/Evidence-Based Pharmacy Center, West China Second University Hospital, Sichuan University, Children's Medicine Key Laboratory of Sichuan Province, Chengdu, Sichuan, China
[3]West China School of Pharmacy, Sichuan University, Chengdu, Sichuan, China
[4]NMPA Key Laboratory for Technical Research on Drug Products In Vitro and In Vivo Correlation, Chengdu, Sichuan, China
[5]Key Laboratory of Birth Defects and Related Diseases of Women and Children, Sichuan University, Ministry of Education, Chengdu, Sichuan, China
[6]Department of Pharmacy, Shanghai Chest Hospital, Shanghai, China
[7]Institute of Clinical Research and Evidence Based Medicine, Gansu Provincial Hospital, Lanzhou, Gansu, China
[8]King's Health Economics (KHE), Health Service and Population Research Department, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, UK
[9]West China Biomedical Big Data Center, West China Hospital, Sichuan University, Shanghai, China
[10]Chinese Evidence-based Medicine Center, West China Hospital, Sichuan University, Chengdu, Sichuan, China

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