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ORIGINAL RESEARCH

Temporal Trends, Health Inequalities, and Risk Factors in the Global, Regional, and National Burden of Sexually Transmitted Infections Among Women of Child-Bearing Age (1990–2021): Analysis of the Global Burden of Disease Study

Zijiao Zhang[1], Jianbo Lei[1–4], Ailing Li[1], Jun Liang[5–7], Shanli Chen[1], Zheng Li[8], Songlin He[8], Gordon Liu[9]

[1]School of Public Health, Southwest Medical University, Luzhou, Sichuan, People's Republic of China; [2]Clinical Research Center, Affiliated Hospital of Southwest Medical University, Luzhou, Sichuan, People's Republic of China; [3]The First Affiliated Hospital, Hainan Medical University, Haikou, Hainan, People's Republic of China; [4]Center for Medical Informatics, Institute of Advanced Clinical Medicine, Peking University, Beijing, People's Republic of China; [5]Department of AI and IT, Second Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou, Zhejiang, People's Republic of China; [6]School of Medical Technology and Information Engineering, Zhejiang Chinese Medical University, Hangzhou, Zhejiang, People's Republic of China; [7]National Key Laboratory of Transvascular Implantable Devices, Second Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou, Zhejiang, People's Republic of China; [8]Department of Rehabilitation Medicine & Physical Therapy, the Affiliated Hospital of Southwest Medical University, Luzhou, Sichuan, People's Republic of China; [9]Institute for Global Health and Development, Peking University, Beijing, People's Republic of China

Correspondence: Jianbo Lei, Center for Medical Informatics, Institute of Advanced Clinical Medicine, Peking University, 38 Xueyuan Road, Haidian District, Beijing, 100191, People's Republic of China, Tel +86(10)8280-5901, Fax +86(10)8280-5900, Email jblei@hsc.pku.edu.cn

Purpose: Sexually transmitted infections (STIs) among women of child-bearing age (WCBA) are a major global public health issue. This study aims to systematically assess the epidemiological burden of HIV and five other major STIs among WCBA worldwide, and analyze their health inequality status and differences of risk factors, so as to help precise prevention and control.

Patients and Methods: Using data from the Global Burden of Disease (GBD) between 1990 and 2021, this research systematically analyzed the disease burden of six major STIs (including HIV, syphilis, chlamydia, gonorrhea, trichomoniasis, and genital herpes) among WCBA (15–49 years) worldwide by assessing their incidence, mortality, prevalence, and disability-adjusted life years (DALYs). To analyze temporal trends, the Joinpoint regression model was employed to estimate the annual percentage change (APC) and its 95% confidence interval. Health inequalities were quantified using the slope index of inequality (SII) and concentration index (CI). Additionally, risk factors' contributions to DALYs were assessed by stratifying according to sociodemographic index (SDI) quintiles.

Results: During 1990–2021, globally, the age-standardized incidence rate (ASIR) of HIV among WCBA showed a combined downward trend (AAPC −1.94%). Conversely, other STIs exhibited an upward trend (AAPC 0.13%), with the most notable increase from 2015 to 2019 (APC 1.68%). Regionally, Oceania showed the largest HIV ASIR increase, and Western sub-Saharan Africa had the largest increase for other STIs. In 2021, low SDI countries had the highest ASIR for HIV and other STIs. However, high-middle and low-middle SDI countries had the largest increases in ASIR for all STIs. Additionally, health inequality analysis revealed burden differences and inequality in STIs among WCBA.

Conclusion: The global incidence of non-HIV STIs among WCBA increased from 1990 to 2021, with regional variations. Governments and health systems should address social determinants—such as education, poverty, and inequality—to reduce STIs transmission in this group.

Keywords: reproductive health, sexually transmitted infections, women of child-bearing age, health inequalities, global burden of disease

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Introduction

Sexually transmitted infections (STIs) pose a serious threat to the reproductive health of women of child-bearing age worldwide. Due to the unique anatomical and physiological structure of women, they are not only more susceptible to STIs infection, but also often experience delayed diagnosis after infection due to hidden symptoms or confusion with non-specific vaginal secretions.[1] This delayed diagnosis can lead to serious consequences, including genital ulcers, chronic inflammation, and even cancer.[1,2] It is worth noting that there is a synergistic effect between HIV and other STIs infections: genital ulcers and inflammation caused by other STIs significantly increase the risk of HIV infection, and HIV infection accelerates the carcinogenic process of viruses such as human papillomavirus (HPV).[2–4] For example, HIV positive women have a very high risk of HPV infection, and their incidence rate of cervical cancer is six times that of the general population.[5] However, despite the clear harm of STIs, there is still a widespread problem of insufficient screening and delayed treatment worldwide, partly due to accessibility of medical resources and socio-cultural barriers.[1,6]

Furthermore, STIs have a more severe impact on pregnant women within the group of women of child-bearing age. Research has shown that infection with gonorrhea, syphilis, or chlamydia during pregnancy significantly increases the risk of premature birth, ectopic pregnancy, and infertility, and may lead to neonatal death.[7–9] According to WHO's global data for 2022, approximately 1.1 million pregnant women are infected with syphilis, directly causing up to390000adverse pregnancy outcomes.[10] Therefore, in order to achieve the UN 2030 Sustainable Development Goals (reducing maternal mortality to 70/100000 live births, eliminating STI epidemics such as AIDS),[11] it is still necessary to develop precise intervention strategies based on high-quality epidemiological evidence of the burden of sexually transmitted infections among women of child-bearing age.

However, existing research on the disease burden of STIs in women of child-bearing age still has significant limitations. Previous population-based analyses have helped to reveal the overall prevalence characteristics of STIs, but often fail to fully reflect the risk heterogeneity within the reproductive age female population, and comparisons based solely on gender are also relatively vague.[12,13] On the other hand, most studies targeting specific populations tend to focus on adolescents or the elderly,[14,15] and among women of child-bearing age, existing literature mainly focuses on HIV/AIDS,[16] with relatively insufficient attention paid to other important STIs such as syphilis, chlamydia, gonorrhea, etc. In addition, the differences in health equity issues and key risk factors related to STIs in this population have not been systematically evaluated.

Based on the above research gaps, this study uses GBD datas to systematically assess the disease burden and time trends of six major STIs (including HIV, syphilis, chlamydia, gonorrhea, trichomoniasis and genital herpes) among women of child-bearing age (15–49 years) from 1990 to 2021, and further reveal the current situation of health inequality and differences in related risk factors from the socio-economic and geographical levels. By expanding the coverage of pathogens, focusing on women of child-bearing age, and introducing the perspective of health equity, this study makes up for the shortcomings of existing studies, and provides a scientific basis for formulating more targeted STIs prevention and control strategies and promoting reproductive health equity.

Methods

Study Population and Data Collection

GBD 2021 provided the global burden of 371 diseases and injuries, as well as 88 risk factors, in 21 regions and 204 countries and regions between 1990 and 2021.[17] We obtained data on HIV and other STIs (syphilis, chlamydia, gonorrhoea, trichomoniasis, and genital herpes caused by herpes simplex virus 2) from the Global Health Data Exchange (GHDx) results tool (https://vizhub.healthdata.org/gbdresults/). We defined the study population as women of child-bearing age (WCBA), according to the definition from WHO, which specifies WCBA as women aged 15–49 years.[18] GBD 2021 only estimated disease burden for five common STIs and HIV, with their International Classification of Diseases codes defined in the supplementary appendix. For GBD's data collection, modeling, analysis and transmission of these diseases, please refer to appendix p4-10's data supplement and modeling flowchart Figures SD1 to SD8 in these instructions.

We obtained data for STIs in WCBA from GBD 2021, including incidence, prevalence, deaths, and DALYs (both numbers and rates), along with the number, rate, and 95% UIs for risk-attributable DALYs. Attributable DALYs are

a metric for quantifying the contribution of specific risk factors to the burden of disease. DALYs signify the changes and reduction in current burden of disease if a change occurs to population level exposure to a particular risk factor.

The socio-demographic index (SDI) is estimated to represent a comprehensive development status that exhibits a robust correlation with health outcomes. The SDI ranges from 0.005 to 1, 1 represented the highest education level, highest per capita income, and lowest fertility rate. For GBD 2021, the SDI is divided into five categories: low, low-middle, middle, high-middle, and high.[17]

Statistical Analysis

We calculated the age-standardized rates (ASR) and corresponding 95% confidence intervals (CIs) based on the standard population reported in the Global Burden of Disease Study 2021 for fairly comparison between regions,[19] and further estimated average annual percentage changes (AAPC) by joinpoint regression to measure the temporal trend.[20] Our estimates are shown per100000population using the equation (1) in Method Supplement P11. The AAPC are used to represent the average increase or rate of change of a specific variable over a specified period. In this study, it is the annual change percentage (APC) transformed from the weighted average of the slope coefficients of the underlying joinpoint regression model from 1990 to 2021. The AAPC value denotes the percentage annual change (increase, decrease, or no change). If AAPC and 95% CIs were both >0 (or both <0), we considered the corresponding rate to be in an upward (or downward) trend.

This study employed the slope index of inequality (SII) and concentration index(CI), as defined by the WHO, to measure absolute and relative inequality in disease burden.[21] These indices were used to quantify disparities in the distribution of HIV and other STIs across countries and territories, offering a comprehensive evaluation of health inequalities. The SII is calculated by regressing the DALYs rate on the SDI, using the midpoint of the cumulative population distribution sorted by SDI. The concentration index is calculated by matching the cumulative proportion of DALYs with the cumulative population distribution ranked by SDI and numerically integrating the area under the Lorenz curve (details in Method Supplement Page11-13).

We regarded $p < 0.05$ as statistically significant. All statistical analyses were done using R software (version 4.0.1) and Joinpoint Regression Program (version 5.2.0).

Results

Global Trends

Regarding HIV incidence analysis, an estimated 670,804 (95% UI 762,161 to 596,594) new HIV cases among WCBA were reported in 2021, with an age-standardized incidence rate (ASIR) of 34.73 cases (95% UI 34.65 to 34.82) per 100,000 population (Table S1). Regarding HIV incidence trend, the overall combined trend of ASIR is decreasing (AAPC −1.94 [95% CI −2.19 to −1.68]) (Table 1). However, there is a specific trend of first increasing and then decreasing significantly in 1997–2005 (APC=−7.07%) and 2015–2021 (APC=−4.49%) (Figure 1A). The age-standardized DALYs rate (ASDR) of HIV decreased between 2002 and 2021, but not to 1990 levels (Table S2 and

Table 1 Global AAPC in Age-Standardized Prevalence, Incidence, Mortality, and DALYs of HIV and Other Sexually Transmitted Infections Among Women of Child-Bearing Age

HIV								
	Incidence		**Prevalence**		**Mortality**		**DALYs**	
	AAPC (95% CI)	**p value**	**AAPC (95% CI)**	**p value**	**AAPC (95% CI)**	**p value**	**AAPC (95% CI)**	**p value**
1992-2001	−2.17(−2.60 to −1.73)	<0.001	7.97(7.61 to 8.32)	<0.001	12.76(12.00 to 13.52)	<0.001	12.26(11.54 to 12.98)	<0.001
2002-2011	−2.42(−2.62 to −2.22)	<0.001	0.06(−0.03 to 0.16)	0.183	−5.10(−5.84 to −4.35)	<0.001	−4.85(−5.57 to −4.13)	<0.001
2012-2021	−3.02(−3.35 to −2.68)	<0.001	1.17(1.03 to 1.31)	<0.001	−5.60(−5.97 to −5.23)	<0.001	−5.23(−5.58 to −4.87)	<0.001
1990-2021	−1.94(−2.19 to −1.68)	<0.001	3.76(3.62 to 3.89)	<0.001	1.56(1.17 to 1.96)	<0.001	1.59(1.21 to 1.97)	<0.001

(*Continued*)

Table 1 (Continued).

Sexually transmitted infections excluding HIV								
	Incidence		**Prevalence**		**Mortality**		**DALYs**	
	AAPC (95% CI)	**p value**	**AAPC (95% CI)**	**p value**	**AAPC (95% CI)**	**p value**	**AAPC (95% CI)**	**p value**
1992-2001	0.27(0.23 to 0.31)	<0.001	0.22(0.17 to 0.28)	<0.001	−0.24(−0.83 to 0.34)	0.414	−0.05(−0.12 to 0.02)	0.191
2002-2011	−0.45(−0.63 to −0.28)	<0.001	−0.27(−0.39 to −0.16)	<0.001	−3.37(−3.72 to −3.03)	<0.001	−0.90(−1.00 to −0.80)	<0.001
2012-2021	0.63(0.48 to 0.78)	<0.001	0.37(0.33 to 0.41)	<0.001	−0.37(−0.52 to −0.22)	<0.001	0.45(0.32 to 0.59)	<0.001
1990-2021	0.13(0.06 to 0.20)	<0.001	0.12(0.08 to 0.16)	<0.001	−1.28(−1.49 to −1.06)	<0.001	−0.15(−0.21 to −0.08)	<0.001

Abbreviations: AAPC, average annual percentage change; DALYs, disability adjusted life year.

Figure 1B). Notably, The age-standardized prevalence rate (ASPR) of HIV demonstrated a continuous upward trend from 1990 to 2021 (Table S3 and Figure SR1A). The age-standardized mortality rate (ASMR) of HIV also decreased between 2002 and 2021 (Table S4 and Figure SR1B).

Regarding other five common STIs (excluding HIV) incidence analysis, in 2021, an estimated 286,514,651 (95% UI 235,563,126 to 352,758,123) new cases were reported among WCBA, with ASIR of 14,579.09 cases (95% UI 14,577.40 to 14,580.78) per 100,000 population (Table S1). From 1990 to 2021, the ASIR of other STIs exhibited fluctuations but demonstrated an overall upward trend (AAPC 0.13, 95% CI 0.06–0.20), with a notable surge between 2015 and 2019 (APC = 1.68%) (Figure 1C). Similarly, the global ASDR and ASPR caused by other STIs also increased from 2015 to 2021 (Figures 1D, SR1C). However, the global ASMR caused by other STIs showed a decreasing trend (Figure SR1D). Besides, from 1990–2021, in all age groups of WCBA, the highest incidence rate of HIV is 25–29 years old (Figure SR2A and SR2B), while other STIs is 30–34 years old (Figures SR2C and SR2D). Specifically, the overall global incidence of Trichomoniasis (AAPC 0.26 [95% CI 0.23 to 0.28]), Syphilis (AAPC 0.21 [95% CI 0.01 to 0.41]) and Genital Herpes (AAPC 0.23 [95% CI 0.19 to 0.27]) has shown a marked upward trend between 1990 and 2021 (Table S5).

Global Trends by SDI

In 2021, the ASIR of HIV and other STIs among WCBA of low-SDI quintile countries were the highest, at approximately 76.12 cases per 100,000 population (95% UI 75.79 to 76.45) and 19,207.86 cases per 100,000 population (95% UI 19,202.48 to 19,213.25), respectively (Table S1).

The highest increase in ASIR for HIV was observed in High-middle-SDI quintile countries (AAPC 5.13 [95% CI 4.36 to 5.90]) (Figure SR3A). For other STIs, the highest increase in ASIR was observed in Low-middle-SDI quintile countries (AAPC 0.11 [95% CI 0.05 to 0.16]) (Figure SR3B). The ASDR and ASMR of HIV in High-middle, Middle, and Low-middle-SDI quintile countries are both on the rise.

In 2021, only High-middle-SDI quintile countries had the highest proportion of chlamydial infections among all sexually transmitted infections (n=45%), while the rest of the regions had the highest proportion of trichomoniasis (Figure SR4A). HIV accounted for the largest proportion of DALYs burden among all level-SDI countries (Figure SR4B).

Regional Trends

In 2021, the ASIR of HIV and other STIs among WCBA in sub-Saharan Africa was the highest, at 552.07 cases per 100,000 population (95% UI 548.96 to 555.19) and 41,462.45 cases per 100,000 population (95% UI 41,435.43 to 41,489.48), respectively (Table S1). From 1990 to 2021, Oceania had the largest increase in ASIR of HIV (APPC 11.36 [95% CI 10.27 to 12.46]), the largest increase in ASDR of HIV was observed in South Asia (APPC 14.52 [95% CI 12.07 to 17.02]). For other STIs, the largest increase in ASIR is sub-Saharan Africa West (APPC 0.08 [95% CI 0.04 to 0.12]) (Figure SR3C), the largest increase in ASDR was observed in tropical Latin America (APPC 0.63 [95% CI 0.53 to 0.73]) (Figure SR3D).

For specific STIs among WCBA, from the perspective of the regions with the largest increase in ASIR, syphilis is in the Caribbean (APPC 0.39 [95% CI 0.30 to 0.48]), chlamydia infection is in high-income North America (APPC 0.61

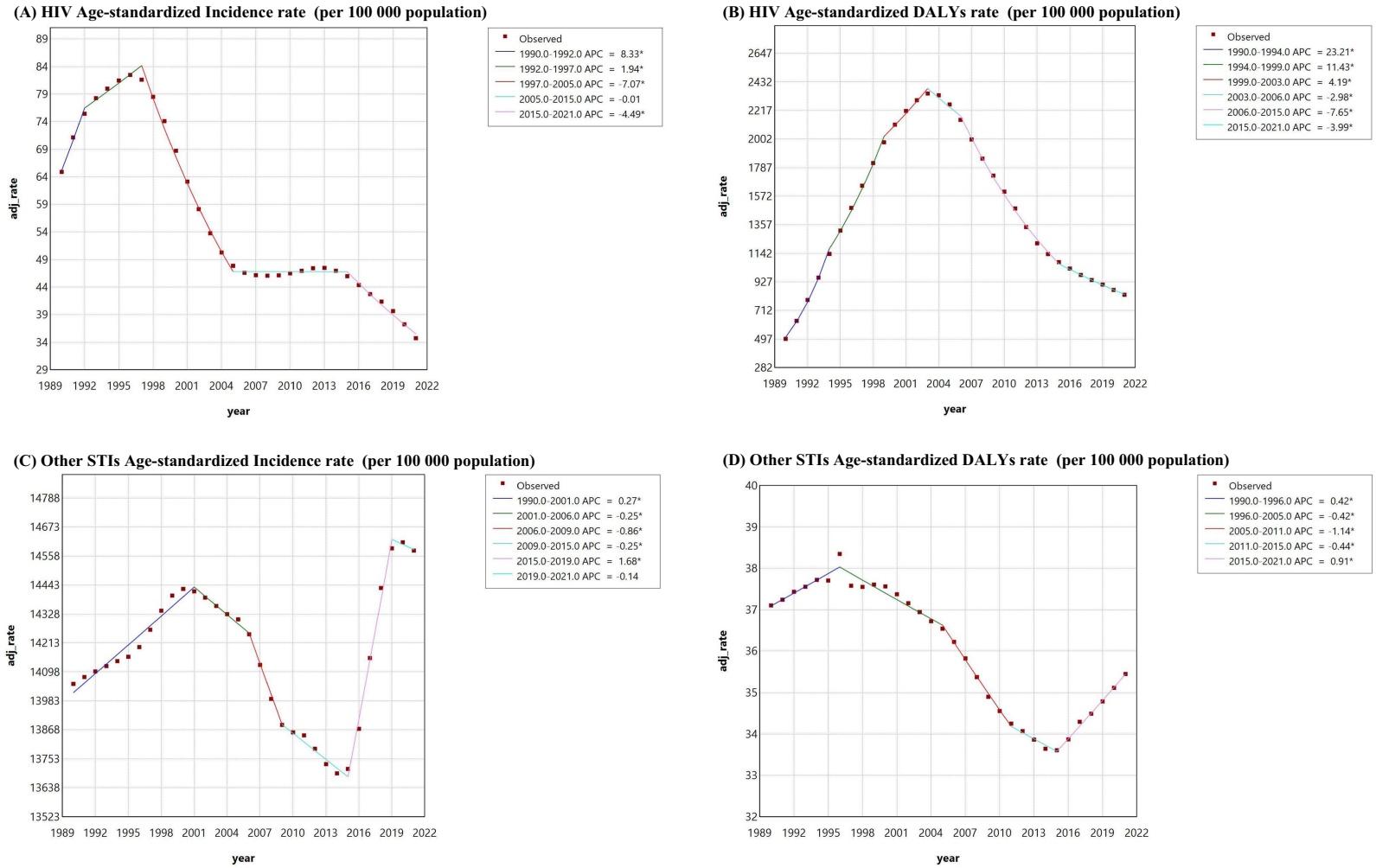

Figure 1 Joinpoint regression analysis of global HIV incidence (**A**), DALYs (**B**), and other STIs incidence (**C**) and DALYs (**D**) among women of Child-bearing age, 1990–2021. *Indicates that the APC is significantly different from zero at the alpha= 0.05 level.

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[95% CI 0.39 to 0.84]), gonorrhea infection is in Oceania (APPC 0.34 [95% CI 0.32 to 0.36]), trichomoniasis is in Central Asia (APPC 0.33 [95% CI 0.30 to 0.36]), genital herpes is in South Asia (APPC 0.21 [95% CI 0.19 to 0.22]), details in Figure SR5A and Table S5. The ASDR showed distinct regional patterns: Syphilis increased most in the Caribbean (APPC 0.78 [95% CI 0.34–1.22]), Tropical Latin America had the highest increase in both chlamydia (APPC 1.75 [95% CI 1.57–1.93]) and gonorrhea (APPC 1.13 [95% CI 0.93–1.32]). Central Asia (APPC 0.13 [95% CI 0.09–0.17]) had the greatest DALYs increase for trichomoniasis, while South Asia (APPC 0.29 [95% CI 0.24–0.35]) showed the highest increase for genital herpes (Figure SR5B and Table S6).

From 1990 to 2021, the Caribbean and Eastern Europe exhibited higher-than-expected ASIR and ASDR of HIV, given their Socio-demographic Index levels (Figures SR6A, SR6B). The ASIR ($r = -0.30$ [95% CI: −0.37 to −0.21], $p < 0.001$) and the ASDR ($r = -0.36$ [95% CI: −0.45 to −0.28], $p < 0.001$) were both negatively correlated with SDI across regions. For other STIs, Oceania, Central Asia, Central Latin America, Tropical Latin America, the Caribbean, Eastern Europe, and Central Europe exhibited higher-than-expected ASIR and ASDR relative to their Socio-demographic Index levels (Figure SR6C, and SR6D). Both ASIR ($r = -0.43$ [95% CI: −0.51 to −0.34], $p < 0.001$) and ASDR ($r = -0.54$ [95% CI: −0.61 to −0.47], $p < 0.001$) showed significant negative correlations with SDI across regions.

National Trends

In 2021, Lesotho had the highest ASIR and ASDR for HIV among WCBA, with 1,257.39 cases per 100,000 population (95% UI 1,226.88 to 1,288.57) and 33,601.75 cases per 100,000 population (95% UI 33,433.10 to 33,771.11), respectively. Other STIs have the highest ASIR in South Africa, at 44,732.91 cases per 100,000 population (95% UI 44,699.78 to 44,766.05), while Mozambique has the highest ASDR, at 111.30 cases per 100,000 population (95% UI 108.83 to 113.81) (Tables S7–S10 and Figures 2A and B, SR7A, SR7B). From 1990 to 2021, the ASIR, ASDR, and ASMR of HIV in Pakistan's WCBA showed the highest increases, with AAPC 22.39 (95% CI 13.88 to 31.54), APPC 31.19 (95% CI 28.56 to 33.87), and APPC 29.73 (95% CI 26.76 to 32.77), respectively (Figures 2C, SR7C).

Other STIs showed the highest increase in ASIR in Kenya (AAPC 0.22 [95% CI 0.17 to 0.26]), Italy had the highest increase in ASDR (APPC 0.98 [95% CI 0.78 to 1.18]), and Kuwait had the highest increase in ASMR (APPC 12·70 [95% CI 8.77 to 16.78]) (Figures 2D, SR7D). The prevalence and mortality rates of HIV and other STIs in 204 countries from 1990 to 2021, as well as the related AAPC, are shown in Tables S11–S14.

Analysis of Health Inequality

For WCBA with HIV, the slope index of inequality (SII) increased from −370.70 (95% CI: −466.15 to −275.25) in 1990 to −1,286.23 (95% CI: −152.55 to −1,047.24) in 2021, but the concentration index (CI) decreased from 0.62 in 1990 to 0.47 in 2021, indicating that the inequality in HIV burden between high-income and low-income countries has been reduced to some extent, but inequality still exists (Figure 3A and B).

For other STIs, the SII decreased from −65.20 (95% CI: −72.94 to −57.45) in 1990 to −51.38 (95% CI: −57.62 to −45.14) in 2021, but the CI increased from 0.21 in 1990 to 0.23 in 2021, indicating that although the absolute inequality of STI burden has decreased, relative inequality has increased and inequality still exists (Figure 3C and D).

Risk Factors

The three main risk factors associated with the burden of DALYs causing STIs among WCBA worldwide include intimate partner violence, unsafe sex, and drug use risk. In 2021, the DALYs for these factors globally were 79.66 cases per 100,000 population (95% UI 79.53 to 79.78), 792.88 cases per 100,000 population (95% UI 792.49 to 793.27), and 40.36 cases per 100,000 population (95% UI 40.28 to 40.45), respectively (Table S15). From 1990 to 2021, DALYs caused by the three risk factors of STI showed an upward trend globally, with AAPC of 0.29%, 1.14%, and 3.19%, respectively (Figure 4A). At the SDI level, except for high-SDI and low-SDI countries, the disease burden caused by the three risk factors in other SDI countries is on the rise (Figure 4B).

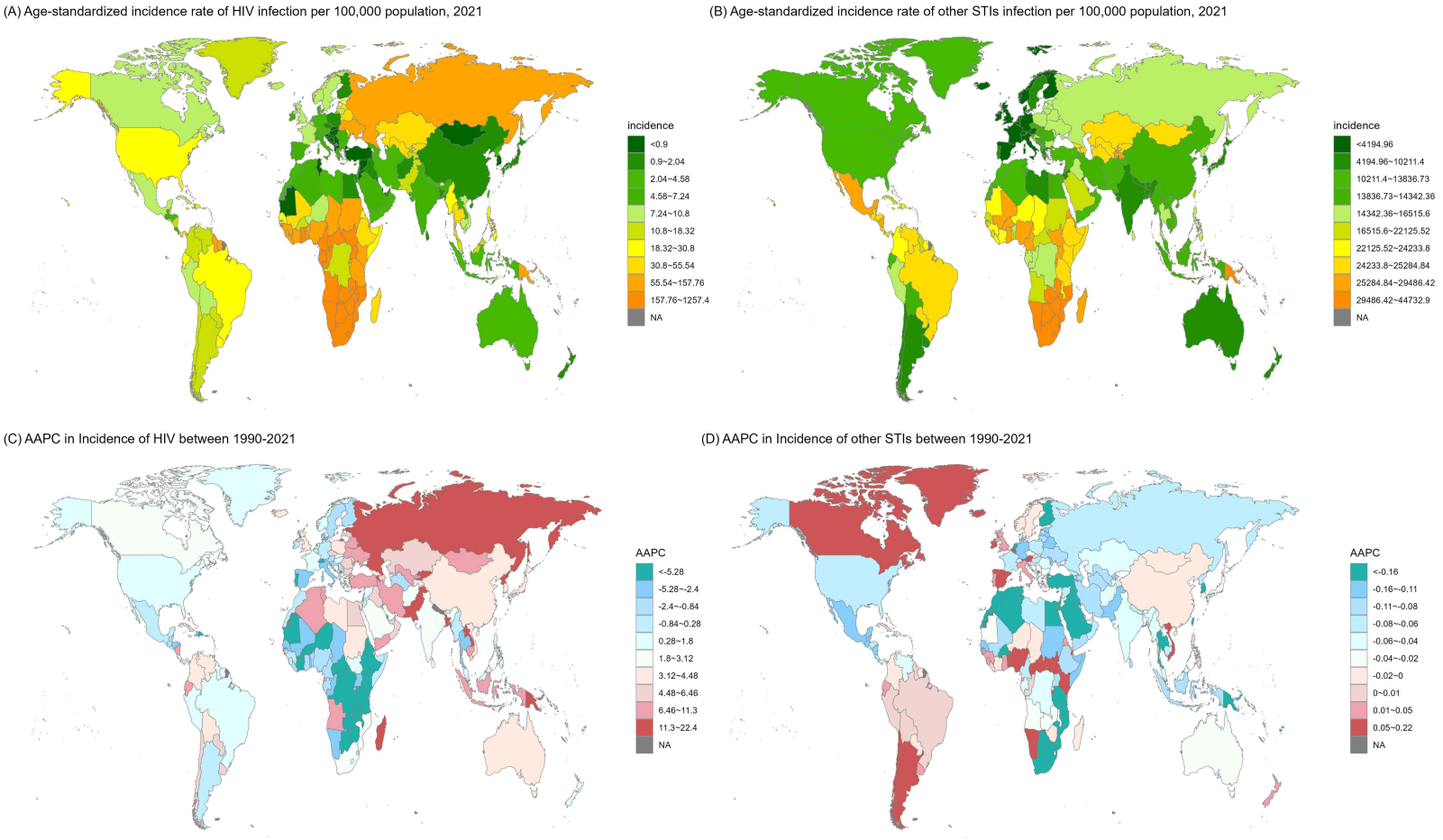

Figure 2 Global map of 2021 age-standardized incidence rate and average annual percentage change (AAPC, 1990–2021). (**A**) HIV incidence. (**B**) Other sexually transmitted infections (STIs) incidence. (**C**) HIV AAPC. (**D**) Other STIs AAPC.

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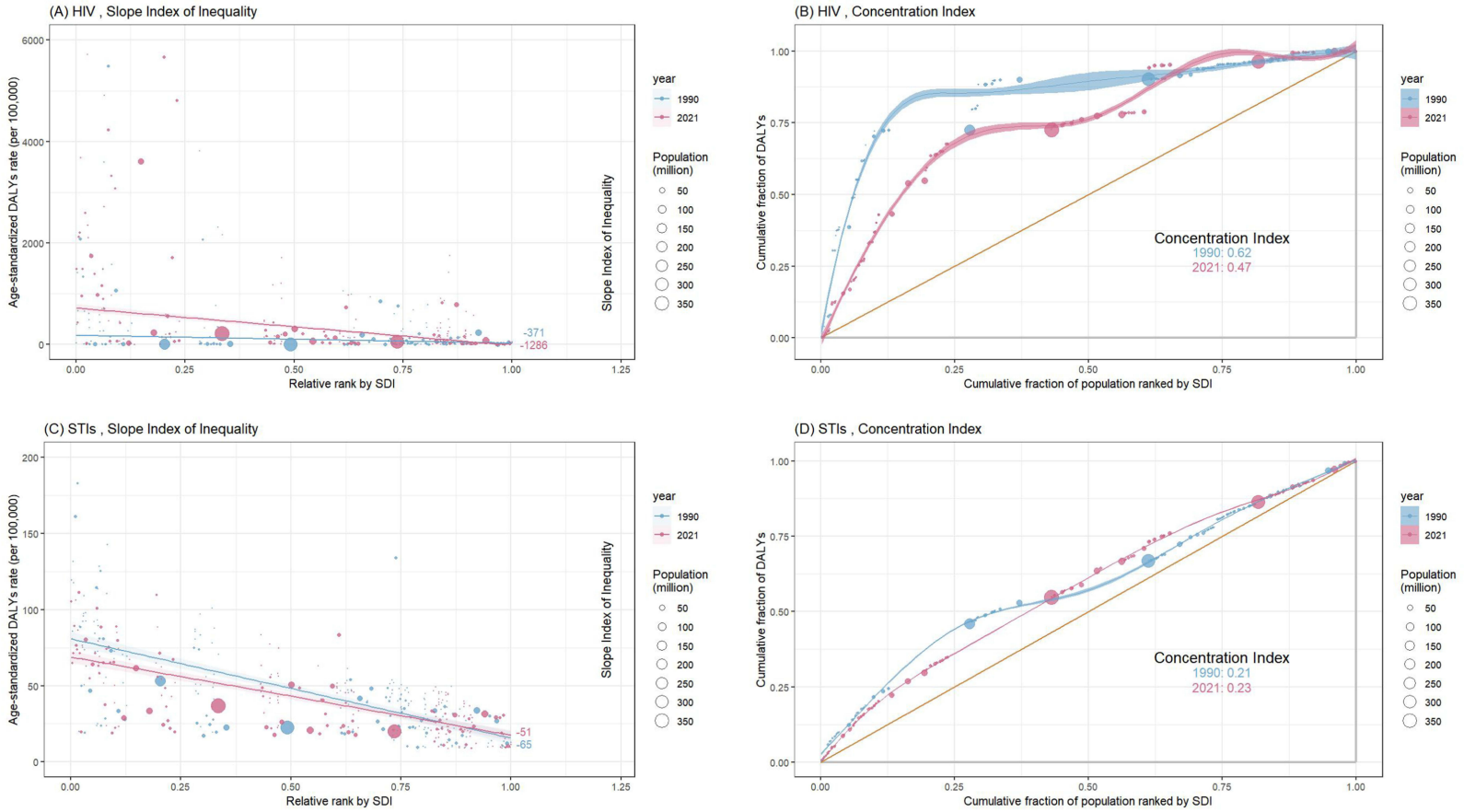

Figure 3 Health inequality regression curves and concentration curves for the DALYs of HIV (**A** and **B**) and other STIs (**C** and **D**) worldwide,1990 and 2021.

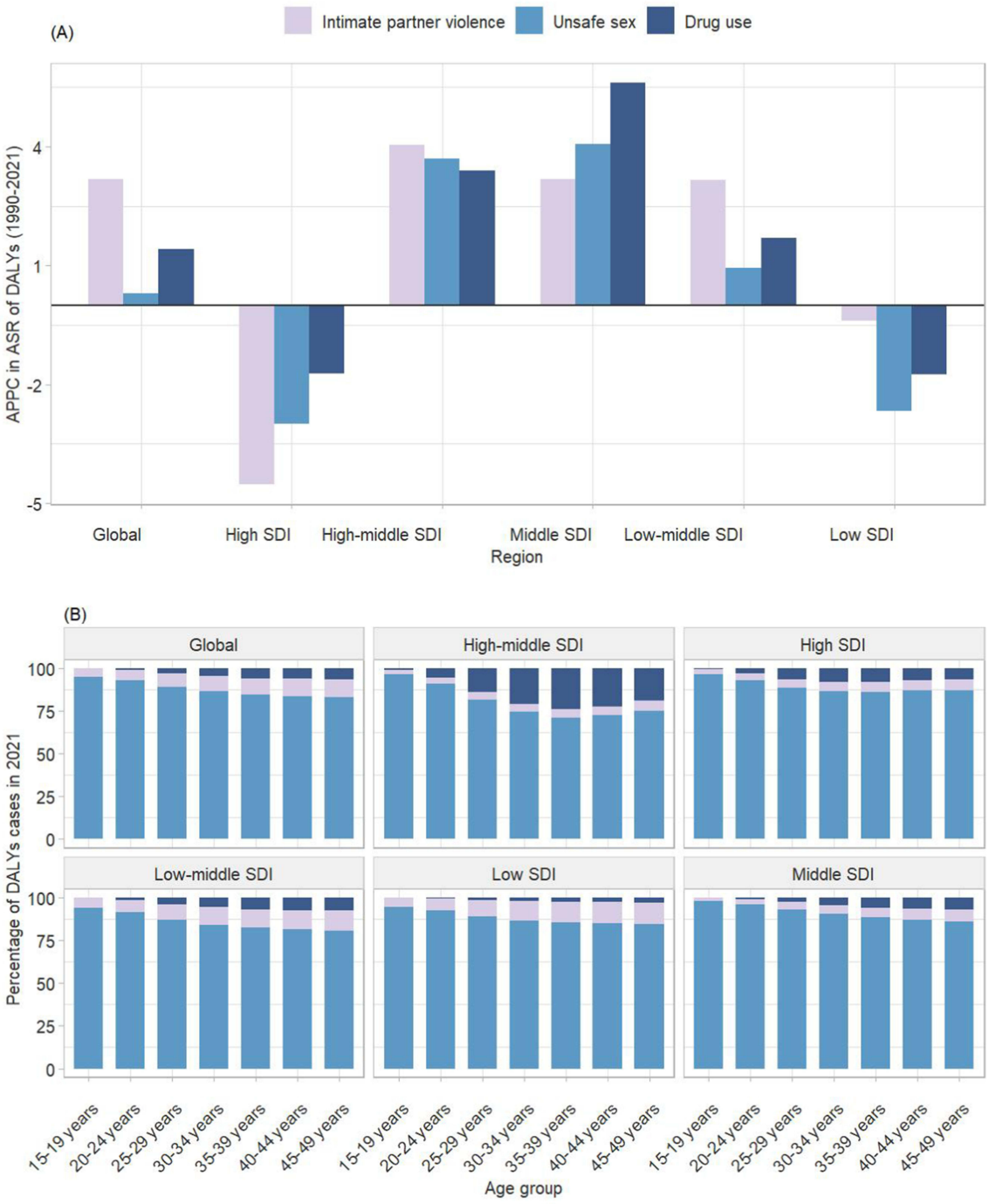

Figure 4 Main risk factors for Sexually Transmitted Infections-related DALYs among women of child-bearing age. (**A**) AAPC in the age-standardized DALYs rate (1990–2021) at the global and regional levels (five SDI quintiles). (**B**) Proportional distribution of DALYs cases in 2021, stratified by age group.

Discussion

Main Research Results and Policy Implications

This study utilized the GBD 2021 database to conduct a comprehensive analysis of the burden, health inequality, and risk factors of both HIV and other STIs diseases among WCBA worldwide for the first time. The main findings are as follows:

First, regarding HIV, the findings of this study are consistent with the analysis by Tang et al based on GBD 2021 data.[16] Both studies indicate that between 1990 and 2021, the age-standardized incidence rate of HIV/AIDS among women of reproductive age globally showed a declining trend, while the prevalence continued to rise. The mortality rate

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gradually decreased after the 2000s but remained higher than the 1990 level. Furthermore, the disease burden was highest in Sub-Saharan Africa, and the incidence increased most rapidly in Eastern Europe. The disproportionately high burden in low-SDI countries was particularly notable These consistent trends further validate the progress made by current global HIV prevention and control strategies in reducing new infections and deaths. Specifically, at the global level, from 1990 to 2021, the ASIR of HIV among WCBA showed a significant downward trend in 1997 and after 2015, which was closely related to the first introduction of antiretroviral therapy (ART) in 1996, the approval of the United States Food and Drug Administration for pre -exposure prevention of HIV (PrEP) in 2012, and the recommendation issued by WHO to expand the scope of oral PrEP drugs in 2015,[22,23] indicating that the historical efforts to control HIV have provided real and effective help for WCBA who are infected or at risk of HIV infection. However, as of 2023, there are still approximately 1.2 million pregnant women worldwide infected with HIV.[24] Without intervention, the rate of HIV transmission from HIV infected mothers to their children during pregnancy, childbirth, or breastfeeding is 15% to 45%.[25] Therefore, there is still a long way to go to meet the WHO 2030 Sustainable Development Goals and achieve a generation free of AIDS. For pregnant women, it is necessary to strengthen the comprehensive care system before and after childbirth, such as maternal peer support programs, postpartum follow-up, and infant prevention and treatment, which can reduce the risk of HIV vertical transmission by 23% to 43% in an economically efficient way.[26]

It is noteworthy that, compared with HIV, the ASIR of other STIs among WCBA globally exhibits an upward trend. Historically, other STIs has been largely overlooked compared to HIV and not been considered a public health priority.[27] In the Joinpoint regression analysis, the ASIR, ASDR, and ASPR due to other STIs globally all demonstrated an upward trend after 2015. Possible reasons for this upward trend include: an increase in sexual activity among WCBA, which is also confirmed in the analysis of all STIs risk factors in this study, where unsafe sex is identified as the primary risk factor for STIs in this population. Therefore, it is crucial to enhance WCBA's awareness of STIs risks, while encouraging their active participation in sexual health interventions,[28–30] empowering them with autonomy and control, creating an environment for discussing sexual health issues with their partners, and ensuring the availability of resources such as PrEP.[31] Another factor is the escalating issue of drug resistance, posing another major challenge to reducing the global burden of STIs.[32] However, it is worth noting that improvements in diagnostic and testing technologies, along with increased female attention to their own health, may have also contributed to the detection of previously hidden or undiagnosed infections.

Secondly, at the regional and national levels, WCBA in sub-Saharan Africa still bear the heaviest burden of HIV and other STIs. A study has drawn an estimated map of the number of female sex workers in sub Saharan African countries, and the results show that there are 2.5 million female sex workers aged 15–49 in the region, accounting for 1.1% of the total number of WCBA.[33] At the national level, Lesotho will have the highest HIV ASIR and ASDR among WCBA in 2021. Between 1990 and 2021, Pakistan had the largest increase in HIV ASIR, ASDR, and ASMR, indicating that WCBA in the country may be vulnerable to STIs. Therefore, in terms of STIs prevention and control for WCBA in key areas, future interventions and management should be focused on, taking into account the special STIs risk factors faced by WCBA (such as intimate partner violence), such as optimizing diagnosis and treatment services to reduce the shame of victims;[34] Strengthen legal protection;[35] Improve education and sexual health knowledge to alleviate the negative impact of STIs stigmatization on WCBA.[6]

Thirdly, based on different levels of SDI, we found that the ASIR of all STIs among WCBA in low SDI countries showed a downward trend, indicating that previous efforts to prevent and control STIs in these countries have achieved certain results. However, low SDI countries still have the highest burden of all STIs diseases, and further analysis of health inequality also shows that compared to regions with higher levels of development, the burden of DALYs caused by STIs among WCBA is still concentrated in low development countries and regions. In addition, it is worth noting that WCBA in middle-income SDI countries are showing worrying trends in HIV and other STIs. From 1990 to 2021, the ASIR and ASDR of HIV in middle-income SDI countries showed an upward trend. And in other STIs, higher than expected ASIR has also been observed. In the analysis based on all STIs risk factors, it was also confirmed that ASDR caused by intimate partner violence, unsafe sex, and drug use risk significantly increased in moderate SDI countries. In the future, it is necessary to focus on the increasingly serious trend of STIs among WCBA in medium SDI countries.

Strengths and Limitations

This study used GBD 2021 data to assess the time trend of disease burden and health inequality of HIV and other STIs among WCBA for the first time. With the continuous development of global health conditions, assessing the complexity of health inequalities between different countries and regions has become increasingly important. Traditional linear regression models have limitations in capturing this complexity. Therefore, we utilized the SII and CI defined by the World Health Organization to provide a more detailed analysis of inequality, taking into account population size and relative positioning of subgroups, making it particularly suitable for GBD 2021 data.

However, our research still has several limitations: firstly, the estimation of disease burden depends on the availability and quality of raw data in GBD 2021. For some low - and middle-income countries, there is a lack of relevant data, which to some extent limits the comprehensiveness and accuracy of the research. Secondly, this study only focused on five common types of other STIs - syphilis, chlamydia infection, gonorrhea, trichomoniasis, and genital herpes, and did not cover other types of STIs, which may lead to an incomplete assessment of the overall disease burden of STIs. In addition, data heterogeneity, especially in areas with insufficient data coverage, may lead to selection bias, which in turn affects the accurate assessment of disease burden and the effectiveness of health inequality analysis. To alleviate these issues, we have adopted inequality analysis slope index methods such as robust regression model, aimed at controlling data heterogeneity and extremum.

Conclusions

During 1990–2021, the global incidence rate of HIV among WCBA showed a significant downward trend, but the incidence rate of other STIs showed an upward trend, and there were significant regional differences and health inequalities. In the context of global declining fertility rates, the government and healthcare providers need to continue strengthening their current practice in HIV prevention and control, while paying special attention to the special risks of STIs among WCBA, optimizing preventive and health care strategies, and enhancing legislative protection and women's empowerment, with the ultimate goal of eliminating the infection of HIV and other STIs set by the WHO 2030.

Abbreviations

AAPC, average annual percentage changes; ASDR, age-standardized DALYs rate; ASIR, age-standardized incidence rate; ASMR, age-standardized mortality rate; ASPR, age-standardized prevalence rate; ASR, age-standardized rates; DALYs, disability adjusted life year; GBD, Global Burden of Disease; SDI, Socio-Demographic Index; STIs, sexually transmitted infections; WCBA, women of child-bearing age.

Data Sharing Statement

The data used for these analyses are all publicly available at online GBD repository (http://ghdx.healthdata.org/gbdresults-tool).

Ethics Approval and Consent to Participate

The requirement for ethical approval was waived by the Ethics Committee of Peking University, as this study utilized publicly available and de-identified data from the Global Burden of Disease (GBD) database.

Consent for Publication

All authors gave consent for the publication of this study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically

reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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