Compared the Burden of Cardiovascular Disease attributable to Tobacco Exposure in China, Japan, USA and World

Xiaomei Wu
the first hospital of China medical university

Bo Zhu
Liaoning Cancer Institute and Hospital

Shuang Xu
China medical unversity

Yong Liu
Saarland unversity

Yifei Bi
leiden unversity

jingpu shi (shijingpu56@126.com)
The first Hospital of China Medical University

Research article

Keywords: Tobacco exposure, Cardiovascular Disease, Age-Period-Cohort Analysis

Posted Date: March 10th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-16505/v1

Version of Record: A version of this preprint was published at BMC Public Health on June 8th, 2020. See the published version at https://doi.org/10.1186/s12889-020-09031-7.

Abstract

Background Tobacco exposure (TE) is the major contributor of CVD mortality, but few published studies on CVD mortality attributable to TE analyzed the possible reasons underlying the long-term trends in China. Methods The mortality data in China, Japan, USA and World were obtained from GBD 2017. The joinpoint regression was used to assess the magnitude and direction of trends over time for CVD mortality, and the age-period-cohort method was used to analyze the temporal trends of CVD mortality by age, period, and cohort. Results There was a significant downward trend in age-standardized mortality rate (ASMR) of CVD attributable to smoking in four regions, but China has the smallest decline and the ASMR in China rose to the first rank in 2017. All the net drifts per year in four regions were negative, and the local drifts were below zero. The longitudinal age curves of the CVD mortality attributable to smoking increased in four regions and China had the largest increase. The period/cohort RRs indicated a decline, and China has the smallest decline. We further analyzed the trend of IHD and stroke, and found the morality, period/cohort RR of IHD in China was always in high level. Conclusions CVD mortality attributable to TE had declined in four regions, and it was at a high level in China. The proportion of IHD mortality attributable to TE had been similar to stroke, which had significantly changed the traditional cognition of CVD composition, and the control measure was not enough for IHD in China.

Introduction

Accompanying economic development and urbanization, the patterns of disease has shifted from infectious diseases to noncommunicable diseases. As one of noncommunicable diseases, cardiovascular disease (CVD) is the leading cause of premature morbidity and mortality in the world. In 2017, the estimated 17.8 million people died of CVD, which was the cause of 30% of deaths all over the world[1]. In China, CVD mortality had increased from 187.58 per 100,000 in 1990 to 309.95 per 100,000 in 2017, and the burden of CVD was also very high, the estimated number of CVD death had almost doubled, from 2.25 million in 1990 to 4.38 million in 2017[2]. In the world, China has the highest burden of CVD, China is facing enormous challenges in tackling the burden of CVD [3].

Tobacco exposure (TE) mainly included active smoking and secondhand smoke (SHS). In the world, nearly 7 million people died from TE, including approximately 6 million among tobacco users and an estimated 890,000 among nonsmokers exposed to SHS [4]. Long-term smokers lost at least 10 years of life on average. In the world, over 22000 people die from TE every day (one person dies every 4 seconds). Smoking is a widely recognized risk factor for premature morbidity and mortality, and adequate monitoring of smoking levels and trends throughout the world has been challenging. Nearly two-thirds of smokers in the world were mainly in ten countries, and China accounted for about 30%. In 2017, active smoking had become the first leading risk factor for DALYs and the second risk factor for death in China [5].

TE caused CVD by atherosclerosis and thrombosis. The mechanism of smoking-induced atherosclerosis and thrombosis was that oxidative stress mediated by cigarette smoke and/or endogenous oxygen free

radicals, multiple thrombosis-promoting and anti-fibrinolysis effects, lead to intravascular thrombosis and trigger acute cardiovascular events[6-8]. Eventually, TE can lead to plaque and blood clots, restrict blood flow, and lead to heart attack and stroke. Stroke, like heart disease, has a high risk of death, and survivors of stroke may experience disastrous disabling conditions, such as paralysis or loss of vision or speech [9-11]. Several epidemiological studies concluded that smoking is a major cause of CVD and causes one of every four deaths from CVD[12]. SHS also can cause CVD, including heart attack and stroke. Nonsmokers who breathe SHS at home or at work increase their risk of developing heart disease by 25–30%. SHS increases the risk for stroke by 20–30%[13]. The World Health Organization (WHO) considered that TE was the totally avoidable risk factor of CVD[14]. The probability of TE varied by different age and gender, and the different regions had different tobacco control strategies, so the disease burden attributable to TE varied among age, sex and regions[15].

Although previous studies had analyzed the disease caused by tobacco exposure, there was a lack of analysis on the impact of traditional factors (such as age, period and birth cohort), previous studies could not find a good way to reduce the harm of tobacco exposure [16, 17]. In our study, we wanted to find the possible reasons underlying the long-term trends and the differences between age-groups, and compared CVD mortality attributable to TE in China, Japan, United States (USA) and the world during the period between 1990 and 2017. The world represents the average level, USA is one of the earliest countries to implement tobacco control measures, and Japan is our neighboring country, similar race and harm of smoking to the population. Compared to the above three regions, we hoped to find out the gap and direction of reducing CVD mortality attributable to TE in China.

Methods

Data Source

Data are available at the GBD Data Tool repository and can be accessed at http://ghdx.healthdata.org/gbd-results-tool. To analyze the status on CVD mortality attributable to TE in China, we extract the relevant data on CVD mortality, and compared to Japan, USA and the world. In 2017, ischemic heart disease (IHD) and stroke were top two in mortality rate of all the causes of death in China[2], so we not only analyzed the changes of CVD attributable to TE by the temporal trend and Age-Period-Cohort methods, but also analyzed the changes of IHD and stroke, in order to reflect the impact of TE on CVD systematically and comprehensively. CVD, IHD and stroke were diagnosed and defined based on the WHO clinical criteria and ICD 9.

Statistical Analysis

(See Statistical Analysis in the Supplementary Files)

Results

(1) The temporal trend in the age-standardized mortality rate (ASMR) of CVD (including IHD and stroke) attributable to TE from 1990 to 2017

Smoking: For both sexes, the ASMR of CVD attributable to smoking in China, Japan, USA and world significantly decreased by 0.4% (95%CI: 0.0%-0.7%), 4.0% (95%CI: 3.7%-4.3%), 4.9% (95%CI: 4.7%-5.1%) and 2.1% (95%CI: 1.8%-2.4%) per year, respectively (Figure 1). The ASMR of IHD attributable to smoking in Japan, USA and world significantly decreased by 4.2% (95%CI: 3.9%-4.5%), 5.1% (95%CI: 4.9%-5.3%) and 2.2% (95%CI: 2.0%-2.4%) per year, but increased by 0.6% (95%CI: 0.1%-1.0%) in China (Figure S1); There were significant downward trends in the ASMR of stroke attributable to smoking in China, Japan, USA and world. Though China was not the first rank in 1990, China was the first rank in 2017 (Figure S2). The change of CVD, IHD and stroke attributable to smoking in male and female was similar to those in both sexes in each region. The above detailed results were shown in table 1.

Table 1. The temporal trend in mortality rate of CVD, IHD and stroke attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure 1. The ASMR of CVD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S1. The ASMR of IHD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S2. The ASMR of stroke attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Secondhand smoke: For both sexes, the ASMR of CVD attributable to SHS in China, Japan, USA and the world significantly decreased by 1.2% (95%CI: 0.7%-1.7%), 3.8% (95%CI: 3.5%-4.1%), 3.9% (95%CI: 3.6%-4.2%) and 1.8% (95%CI: 1.5%-2.0%) per year, respectively (Figure S3). The ASMR of IHD attributable to SHS in Japan, USA and world significantly decreased by 3.8% (95%CI: 3.5%-4.0%), 4.1% (95%CI: 3.8%-4.4%) and 1.6% (95%CI: 1.3%-1.9%) per year, but there was no significant trend change in China (Figure S4); There were significant downward trends in the ASMR of stroke attributable to SHS in China, Japan, USA and world (Figure S5). The change of CVD, IHD and stroke attributable to SHS in male and female was similar to those in both sexes in each region. The above detailed results were shown in table S1.

Table S1. The temporal trend in mortality rate of CVD, IHD and stroke attributable to SHS in China, Japan, USA and the world from 1990 to 2017.

Figure S3. The ASMR of CVD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S4. The ASMR of IHD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S5. The ASMR of stroke attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

(2) The APC analysis in the mortality rate of CVD (including IHD and stroke) attributable to TE from 1990 to 2017

Smoking: For both sexes, in the same birth cohort, the mortality rate of CVD attributable to smoking rapidly increased 7.38 (95%CI: 6.34, 8.58) per 100,000 in age group 30-34 to 360.15 (95%CI: 338.97, 382.67) per 100,000 in age group 75-79 in China. The similar changes could be observed in Japan, USA and the world (Figure 2A). The mortality rate of IHD and stroke attributable to smoking also increased from age group 30-34 to age group 75-79 (Figure S6A and Figure S7A). All the period RRs of CVD and stroke showed a decreasing trend from 1990 to 2017 in four regions (Figure 2B and Figure S7B). The period RRs of IHD in Japan, USA and the world also showed a downward trend from 1990 to 2017. In China, the period RRs of IHD showed a downward trend, and then showed an upward trend (Figure S6B). All the cohort RRs of CVD and stroke showed a decreasing trend in four regions (Figure 2C and Figure S7C). The cohort RRs of IHD in Japan, USA and the world also showed a downward trend from 1990 to 2017, but the cohort RRs of IHD showed an upward trend, and then showed a downward trend (Figure S6C). The effects of age, period and cohort on CVD, IHD and stroke attributable to smoking in male and female were similar to those in both sexes in each region.

For CVD, the overall net drifts per year in China, Japan, USA and the world were below zero. For IHD, the overall net drifts per year in Japan, USA and the world were below zero, and 0.01% (95%CI: -0.22%, 0.23%) in China. For stroke, the overall net drifts per year in China, Japan, USA and the world were below zero. All the local drift values increased by age groups in China, decreased in Japan and USA, and fluctuated in the world (Figure S8). The change of CVD, IHD and stroke in male and female was similar to those in both sexes in each region. The above detailed results were shown in table 2.

Table 2. The net drift value of the mortality rate of CVD, IHD and stroke attributable to smoking.

Figure 2. The APC results of CVD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S6. The APC results of IHD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S7. The APC results of stroke attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S8. The local drift with net drift values of the mortality rate of CVD, IHD and stroke attributable to smoking.

Secondhand smoke: All the results were similar to those of smoking for each disease in each region. The above detailed results were shown in table S2.

Table S2. The net drift value of the mortality rate of CVD, IHD and stroke attributable to secondhand smoke.

Figure S9. The APC results of CVD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S10. The APC results of IHD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S11. The APC results of stroke attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S12. The local drift with net drift values of the mortality rate of CVD, IHD and stroke attributable to secondhand smoke.

Discussion

One in three deaths is attributed to CVD in the world, and TE is the major contributor, causing approximately 3 million cardiovascular deaths every year in the world [18]. In 2019, WHO reported estimates of the smoking prevalence for all countries on the global tobacco epidemic [19]. From the report, we found that compared with other three regions, the smoking prevalence in China had been at highest level, and the decline of smoking prevalence in China was the smallest, the exposure of second-hand smoke would also be at a high level. Due to the possibility of TE, sex was one of important demographic risk factor for CVD [20]. In our results, we found that the mortality rates of CVD, IHD and stroke attributable to smoking in male were similar to those in both sexes, and the mortality rates of CVD, IHD and stroke attributable to SHS in female were similar to those in both sexes. It suggested that male were the main victims of smoking, while women were the main victims of SHS.

Our results showed that there was a significant downward trend in ASMRs of CVD attributable to smoking from 1990 to 2017 in four regions. Compared to the world, the ASMRs of CVD, IHD and stroke attributable to smoking had the bigger decline in USA and Japan and the smallest decline in China from 1990 to 2017. We found that the ASMRs of CVD and IHD attributable to smoking rose to the first rank by 2017, and the ASMR of stroke remained the first rank from 1990 to 2017. All the ASMRs of CVD, IHD and stroke attributable to smoking in China were higher than those in the world, and the ASMRs of CVD, IHD and stroke attributable to smoking in Japan and USA were lower than those in the world. In SHS, from 1990 to 2017, the ratio of SHS to smoking in the ASMR of CVD ranged from 1/4 to 1/3 in China. Compared with other three regions, the ratio of China was highest, SHS exposure caused a serious burden of CVD in China. A study on SHS found that an almost 40% increase in mortality risk among non-smoking women whose husbands smoked, and the incidence of heart disease increased [18]. A national population-based case-control study found that SHS could increase the risk of death by 10% for all strokes by adjustment for related variables [19]. In 2017, we also found all the ASMRs of CVD, IHD and

stroke attributable to SHS in China were higher than those in the world, and the results in Japan and USA were reverse.

In 2017, we found all the ASMRs of CVD, IHD and stroke attributable to TE in China rose to the first rank. It might be caused by the start time of the implementation of tobacco control measures. Tobacco control is a global health priority for non-communicable diseases. Compared to the world in tobacco control, the start time of tobacco control in USA and Japan were earlier, while the start time of tobacco control in China was later[19]. The WHO Framework Convention on Tobacco Control (FCTC) formalized global commitment by 180 countries, and began to implement in 2005[21]. The United States Congress had passed the Federal Cigarette Labeling and Advertising Act and the Cigarette Act in 1965 and 1969, respectively. The Family Smoking Prevention and Tobacco Control Act, which passed in 2007, was stricter than FCTC[22]. In Japan, the start time of tobacco control was not early in developed countries. In 1978, the non-governmental movement of tobacco control was launched. In 1985, the tobacco monopoly system was reformed[22]. In 2010, the cigarette tax raised by a large extent. China signed FCTC, which came into operation in 2006. China carried out restrictions on the packaging, advertising and ingredients of tobacco products, for example one cigarette with 15mg tar would be regarded as unqualified products and not allowed to enter the cigarette market[23].

In APC analysis, the longitudinal age curve reflects the impact of age on the mortality rate of disease. In our study, the longitudinal age curves of the mortality rate of CVD, IHD and stroke attributable to smoking increased by age in China, Japan, USA and the world, and China had the largest increasing extent. Before age 60, the morality rates of CVD, IHD and stroke attributable to smoking were at lower levels and the slight difference in four regions, and after 60, the difference had become wider. In each age group, the morality rates of CVD, IHD and stroke attributable to smoking in Japan were at the lowest level. The similar results were also found in the mortality rate of CVD, IHD and stroke attributable to SHS. Age is an important factor of CVD, our results might be mainly caused by two reasons: On the one hand, long-term TE led to vascular damage; on the other hand, physical resistance declined with age [24]. By aging in China, it suggested that the elderly should be listed as the key persons in the prevention and treatment of CVD in China in the future, the basic public health services should be optimized for them, and the screening and management of the elderly should be done well.

In four regions, the period RRs indicated a down trend in the mortality rate of CVD attributable to smoking from 1990 to 2017. Similarly, the cohort RRs also indicated a down trend in CVD mortality from 1910 birth to 1990 birth. China has the smallest decline in the cohort and period RRs, and the cohort and period RRs in female had more quickly declining trends than that in male. The changes of the period and cohort RRs in stroke were similar to CVD, while that in IHD were a little different from CVD. When the period and cohort RRs indicated a down trend in USA, Japan and the world, the trends of the period and cohort RRs in China fluctuated. In four regions, all the net drifts were significant and below zero, except the net drift of IHD in China. All the results of SHS were similar to those of smoking, and all the results of male and female were also similar to those of both sexes. Compared to USA, there were significant differences in the morality pattern of CVD in China, the proportion of stroke was higher, and the proportion of IHD was

lower, the morality pattern of CVD in China was similar to Japan[25]. We could also see the similar pattern from Tables S3 and S4. In China, because medical conditions had been improved, public health funding had been increased, and China's early diagnosis and treatment in noncommunicable diseases, such as CVD and cancer had been well implemented, so the occurrence and death of CVD had been under the effective control. In particular, there had been a significant improvement in stroke mortality, It might be due to the larger proportion of CVD is stroke in China, stroke was paid more attention. But our results reflected the downtrend in mortality rate of IHD was not obvious. Through comparison, we found that the mortality rate of IHD decreased in Japan, which is similar to CVD composition in China; the mortality rate of IHD also decreased in USA, where IHD was the main component of CVD. Based on the actual situation of country, China should learn from these two countries to explore appropriate measures of CVD and tobacco control.

There were some limitations in our study. First, GBD 2017 had undergone many modifications and adjustment for data source, collation, and evaluation methods to to fulfil missing data and improve data quality and comparability, but it is still difficult to avoid bias. Therefore, the integrity and accuracy of the data in our study would be affected. Compared to the pool analysis on secondary data, we preferred to analyze more raw data, which came from GBD 2017. Second, APC model only regarded population as the unit of observation and analysis, which might lead to ecological fallacy. Therefore, the results of this study need to be further confirmed in the future research. Third, we only estimated the effects of age, period, and cohort on CVD mortality data attributable to tobacco exposure, and made no further analysis on other risk factors.

Consequently, in China, with economic development and social progress, people had a certain level of understanding of the dangers of TE, resulting in lower smoking prevalence, and lower exposure to SHS in public areas, lead to decline in the mortality rate of CVD attributable to TE. Compared to Japan, USA and the world, we found the mortality rate of CVD in older people was higher, and IHD was not well control. Therefore, China should strengthen tobacco control measures in two aspects to achieve the goal of reducing the burden of CVD in the next few years.

List Of Abbreviations

Cardiovascular Disease: CVD

Secondhand smoke: SHS

World Health Organization: WHO

Ischemic heart disease: IHD

Average annual percentage change: AAPC

The age–period–cohort: APC

Age-standardized mortality rate: ASMR

Declarations

Ethics approval and consent to participate

GBD 2017 was publicly available for free use, the protocol was approved by the Medical Research Ethics Committee of the First Hospital of China Medical University.

Consent for publication

Not applicable

Availability of data and materials

All our research data are obtained from GBD 2017, the website was http://ghdx.healthdata.org/ gbd-results-tool.

Conflict of interest

The authors declare that they have no competing interests.

Funding

This work was supported by General Foundation of scientific research in the Department of Education in Liaoning (L2015592).

Author Contributions

Xiaomei Wu and Bo Zhu designed the whole research, Bo Zhu, Shuang Xu, and Yong Liu conducted the data collection, Bo Zhu and Xiaomei Wu analyzed the data. Bo Zhu, Yifei Bi and Xiaomei Wu wrote the manuscript. Jingpu Shi, Bo Zhu, Shuang Xu, Yong Liu, Yifei Bi and Xiaomei Wu discussed the relevant results. All authors provided approval of the version to be published.

Acknowledgements

Not applicable.

References

1. Jagannathan R, Patel SA, Ali MK, Narayan KMV: Global Updates on Cardiovascular Disease Mortality Trends and Attribution of Traditional Risk Factors. *Current diabetes reports* 2019, 19(7):44.
2. Global Health Data Exchange. GBD Results Tool [http://ghdx.healthdata.org/ gbd-results-tool]

3. Du X, Patel A, Anderson CS, Dong J, Ma C: Epidemiology of Cardiovascular Disease in China and Opportunities for Improvement: JACC International. *Journal of the American College of Cardiology* 2019, 73(24):3135-3147.
4. GBD 2015 Tobacco Collaborators: Smoking prevalence and attributable disease burden in 195 countries and territories, 1990-2015: a systematic analysis from the Global Burden of Disease Study 2015. *Lancet (London, England)* 2017, 389(10082):1885-1906.
5. Zhou M, Wang H, Zeng X, Yin P, Zhu J, Chen W, Li X, Wang L, Wang L, Liu Y *et al*: Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet (London, England)* 2019.
6. Roelsgaard IK, Esbensen BA, Ostergaard M, Rollefstad S, Semb AG, Christensen R, Thomsen T: Smoking cessation intervention for reducing disease activity in chronic autoimmune inflammatory joint diseases. *The Cochrane database of systematic reviews* 2019, 9:CD012958.
7. Ambrose JA, Barua RS: The pathophysiology of cigarette smoking and cardiovascular disease: an update. *Journal of the American College of Cardiology* 2004, 43(10):1731-1737.
8. Messner B, Bernhard D: Smoking and cardiovascular disease: mechanisms of endothelial dysfunction and early atherogenesis. *Arteriosclerosis, thrombosis, and vascular biology* 2014, 34(3):509-515.
9. DiGiacomo SI, Jazayeri MA, Barua RS, Ambrose JA: Environmental Tobacco Smoke and Cardiovascular Disease. *International journal of environmental research and public health* 2018, 16(1).
10. Sandler P, Mastella B, Uchoa D, Jotz GP, Leao HZ, Cavazzola LT: The effects of passive tobacco smoking on the microcirculation of the abdominal wall in rats. *Acta cirurgica brasileira* 2016, 31(11):714-719.
11. Benowitz NL, Burbank AD: Cardiovascular toxicity of nicotine: Implications for electronic cigarette use. *Trends in cardiovascular medicine* 2016, 26(6):515-523.
12. National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health: The Health Consequences of Smoking-50 Years of Progress: A Report of the Surgeon General. Atlanta GA; 2014.
13. Centers for Disease Control and Prevention (CDC) United States: Vital signs: nonsmokers' exposure to secondhand smoke --- United States, 1999-2008. *MMWR Morbidity and mortality weekly report* 2010, 59(35):1141-1146.
14. Mannan H, Stevenson C, Peeters A, Walls H, McNeil J: Framingham risk prediction equations for incidence of cardiovascular disease using detailed measures for smoking. *Heart international* 2010, 5(2):e11.
15. Brown Q, Milam AJ, Bowie JV, Ialongo NS, Gaskin DJ, Furr-Holden D: The Moderating Role of Gender in the Relationship Between Tobacco Outlet Exposure and Tobacco Use Among African American Young Adults. *Prevention science : the official journal of the Society for Prevention Research* 2016, 17(3):338-346.

16. Carreras G, Lugo A, Gallus S, Cortini B, Fernandez E, Lopez MJ, Soriano JB, Lopez-Nicolas A, Semple S, Gorini G: Burden of disease attributable to second-hand smoke exposure: A systematic review. *Prev Med* 2019, 129(1096-0260 (Electronic)):105833.
17. Mainali P, Pant S, Rodriguez AP, Deshmukh A, Mehta JL: Tobacco and cardiovascular health. *Cardiovasc Toxicol* 2015, 15(2):107-116.
18. Rigotti NA, Clair C: Managing tobacco use: the neglected cardiovascular disease risk factor. *European heart journal* 2013, 34(42):3259-3267.
19. World Health Organization: WHO global report on trends in prevalence of tobacco smoking 2000-2025. 2018.
20. Chiuve SE, Cook NR, Shay CM, Rexrode KM, Albert CM, Manson JE, Willett WC, Rimm EB: Lifestyle-based prediction model for the prevention of CVD: the Healthy Heart Score. *Journal of the American Heart Association* 2014, 3(6):e000954.
21. Bilano V, Gilmour S, Moffiet T, d'Espaignet ET, Stevens GA, Commar A, Tuyl F, Hudson I, Shibuya K: Global trends and projections for tobacco use, 1990-2025: an analysis of smoking indicators from the WHO Comprehensive Information Systems for Tobacco Control. *Lancet (London, England)* 2015, 385(9972):966-976.
22. Li C, Zhao Z, Chang T, Yu Z: A Comparative Study of Tobacco Control System in China and Foreign Countries. *Value Engineering* 2017, 36(18):89-91.
23. Zhang J, Ou JX, Bai CX: Tobacco smoking in China: prevalence, disease burden, challenges and future strategies. *Respirology (Carlton, Vic)* 2011, 16(8):1165-1172.
24. Heitzer T, Meinertz T: [Prevention of coronary heart disease: smoking]. *Zeitschrift fur Kardiologie* 2005, 94 Suppl 3:III/30-42.
25. Shay CM, Stamler J, Dyer AR, Brown IJ, Chan Q, Elliott P, Zhao L, Okuda N, Miura K, Daviglus ML *et al*: Nutrient and food intakes of middle-aged adults at low risk of cardiovascular disease: the international study of macro-/micronutrients and blood pressure (INTERMAP). *Eur J Nutr* 2012, 51(8):917-926.

Tables

Table 1 The temporal trend in mortality rate of CVD, IHD and stroke attributable to smoking in China, Japan, USA and the world from 1990 to 2017

		China		Japan		USA		World	
		AAPC (%)	95%CI (%)	AAPC (%)	95%CI (%)	AAPC (%)	95%CI (%)	AAPC (%)	95%CI (%)
CVD	both sexes	-0.4*	(-0.7,0.0)	-4.0*	(-4.3,-3.7)	-4.9*	(-5.1,-4.7)	-2.1*	(-2.4,-1.8)
	male	-0.3	(-0.6,0.0)	-3.9*	(-4.4,-3.5)	-4.9*	(-5.1,-4.7)	-1.8*	(-2.2,-1.5)
	female	-1.1*	(-1.4,-0.7)	-5.1*	(-5.4,-4.8)	-5.0*	(-5.2,-4.8)	-3.5*	(-3.6,-3.4)
IHD	both sexes	0.6*	(0.1,1.0)	-4.2*	(-4.5,-3.9)	-5.1*	(-5.3,-4.9)	-2.2*	(-2.4,-2.0)
	male	0.7*	(0.3,1.0)	-4.1*	(-4.5,-3.7)	-5.1*	(-5.3,-4.9)	-1.9*	(-2.2,-1.7)
	female	0.2	(-0.4,0.8)	-5.4*	(-5.8,-5.1)	-5.2*	(-5.4,-5.0)	-3.6*	(-3.7,-3.4)
stroke	both sexes	-1.2*	(-1.4,0.9)	-4.5*	(-4.7,-4.2)	-4.3*	(-4.6,-4.1)	-2.0*	(-2.2,-1.8)
	male	-1.0*	(-1.2,-0.8)	-4.5*	(-4.9,-4.1)	-4.1*	(-4.3,-3.9)	-1.7*	(-1.9,-1.5)
	female	-2.3*	(-2.9,-1.8)	-5.4*	(-5.8,-5.0)	-4.7*	(-4.9,-4.4)	-3.5*	(-3.6,-3.3)

*: statistically significant ($p<0.05$); AAPC: average annual percent change.

Table 2 The net drift value of the mortality rate of CVD, IHD and stroke attributable to smoking

		China		Japan		United States		Global	
		Net Drift (%/year)	95%CI	Net Drift (%/year)	95%CI	Net Drift (%/year)	95%CI	Net Drift (%/year)	95%CI
CVD	both sexes	-1.049	(-0.837,-1.26)	-2.983	(-2.855,-3.11)	-4.341	(-4.25,-4.433)	-2.126	(-2.085,-2.167)
	male	-0.847	(-0.624,-1.071)	-2.895	(-2.8,-2.989)	-4.359	(-4.256,-4.462)	-1.845	(-1.803,-1.888)
	female	-2.507	(-1.817,-3.192)	-3.774	(-3.458,-4.089)	-4.379	(-4.259,-4.499)	-3.593	(-3.488,-3.698)
IHD	both sexes	0.005	(0.234,-0.224)	-2.982	(-2.835,-3.128)	-4.472	(-4.369,-4.576)	-2.100	(-2.058,-2.143)
	male	0.198	(0.434,-0.037)	-2.890	(-2.771,-3.008)	-4.564	(-4.451,-4.676)	-1.838	(-1.798,-1.878)
	female	-1.323	(-0.709,-1.932)	-3.799	(-3.447,-4.149)	-4.319	(-4.173,-4.465)	-3.420	(-3.315,-3.526)
stroke	both sexes	-1.904	(-1.688,-2.12)	-3.665	(-3.521,-3.809)	-4.100	(-3.996,-4.203)	-2.236	(-2.165,-2.307)
	male	-1.684	(-1.45,-1.917)	-3.594	(-3.445,-3.744)	-3.631	(-3.492,-3.771)	-1.901	(-1.823,-1.979)
	female	-3.618	(-2.834,-4.395)	-4.327	(-4.007,-4.646)	-4.688	(-4.533,-4.842)	-4.024	(-3.88,-4.167)

Supplementary File Legends

Supplementary tables:

Table S1. The temporal trend in mortality rate of CVD, IHD and stroke attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Table S2. The net drift value of the mortality rate of CVD, IHD and stroke attributable to secondhand smoke.

Table S3. The percent of IHD and stroke in CVD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Table S4. The percent of IHD and stroke in CVD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Supplementary figures:

Figure S1. The ASMR of IHD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S2. The ASMR of stroke attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S3. The ASMR of CVD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S4. The ASMR of IHD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S5. The ASMR of stroke attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S6. The APC results of IHD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S7. The APC results of stroke attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Figure S8. The local drift with net drift values of the mortality rate of CVD, IHD and stroke attributable to smoking.

Figure S9. The APC results of CVD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S10. The APC results of IHD attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S11. The APC results of stroke attributable to secondhand smoke in China, Japan, USA and the world from 1990 to 2017.

Figure S12. The local drift with net drift values of the mortality rate of CVD, IHD and stroke attributable to secondhand smoke.

Figures

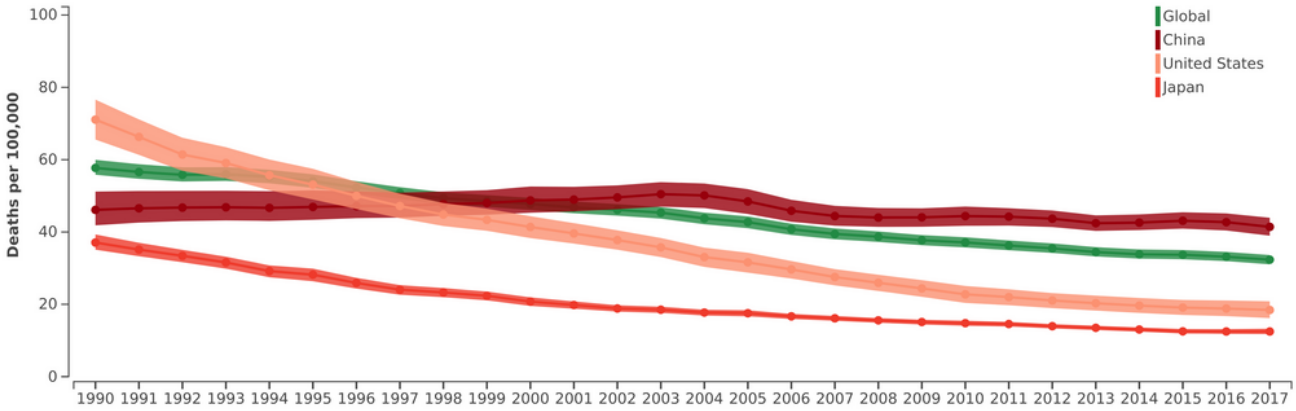

Figure 1A. The ASMR of CVD attributable to smoking for both sexes in China, Japan, USA and the world from 1990 to 2017.

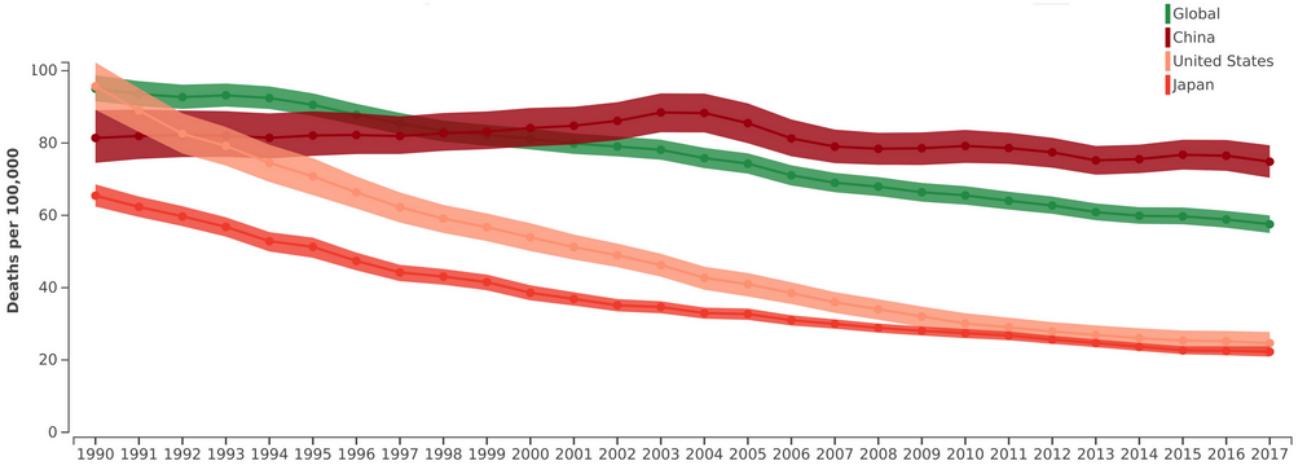

Figure 1B. The ASMR of CVD attributable to smoking for male in China, Japan, USA and the world from 1990 to 2017.

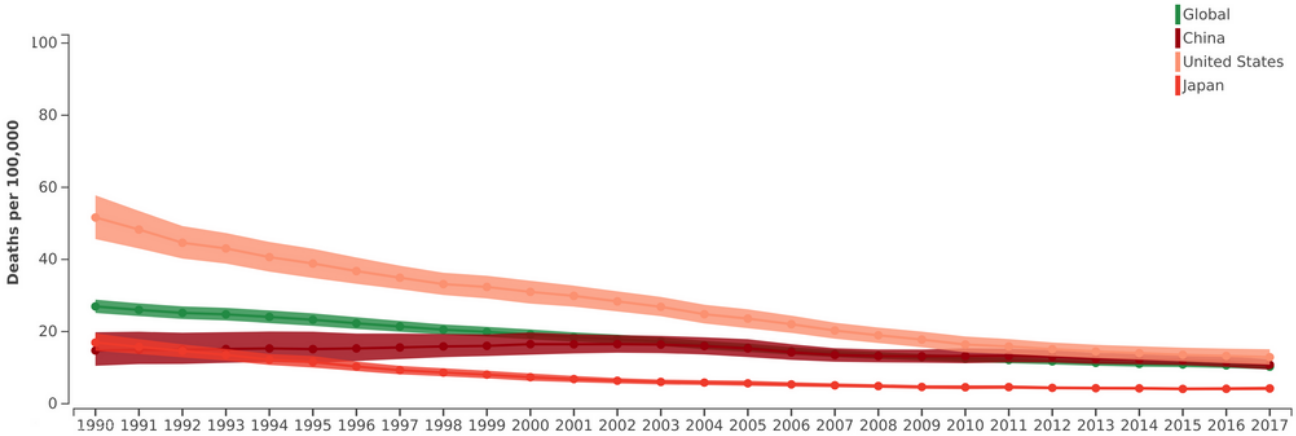

Figure 1C. The ASMR of CVD attributable to smoking for female in China, Japan, USA and the world from 1990 to 2017.

Figure 1

The ASMR of CVD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

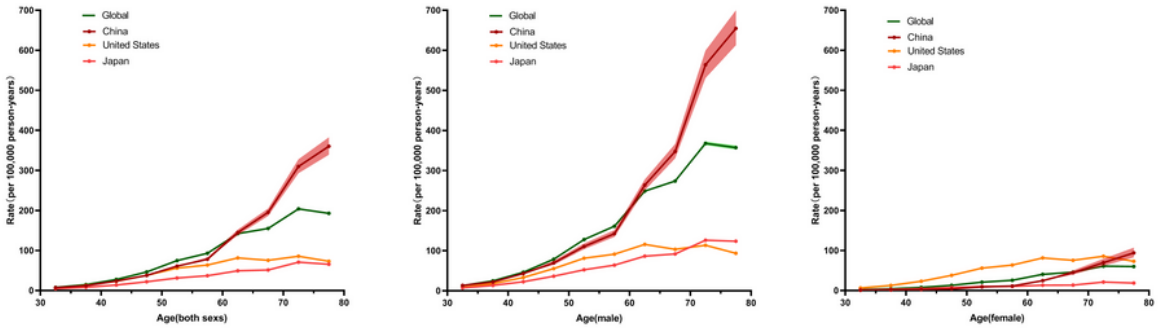

Figure 2(A). the longitudinal age curves of the mortality rate of CVD attributable to smoking in global, China, United States and Japan.

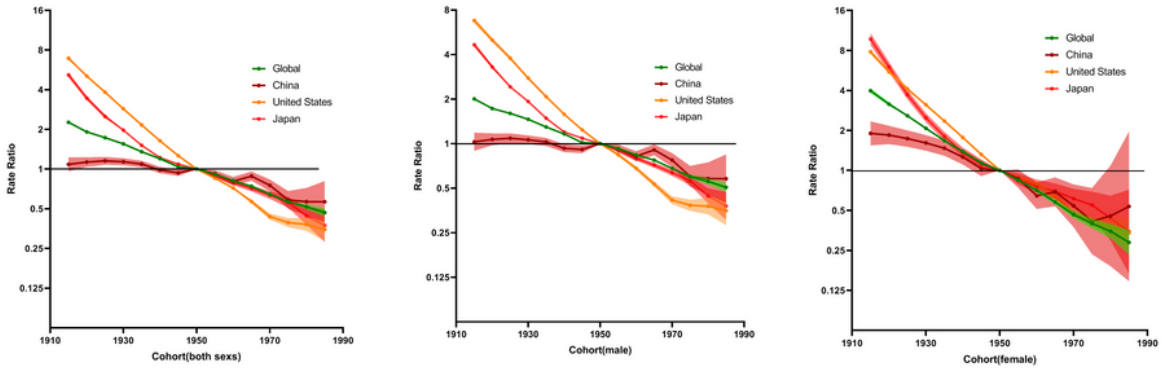

Figure 2(B). The estimated cohort RRs of the mortality rate of CVD attributable to smoking in global, China, United States and Japan.

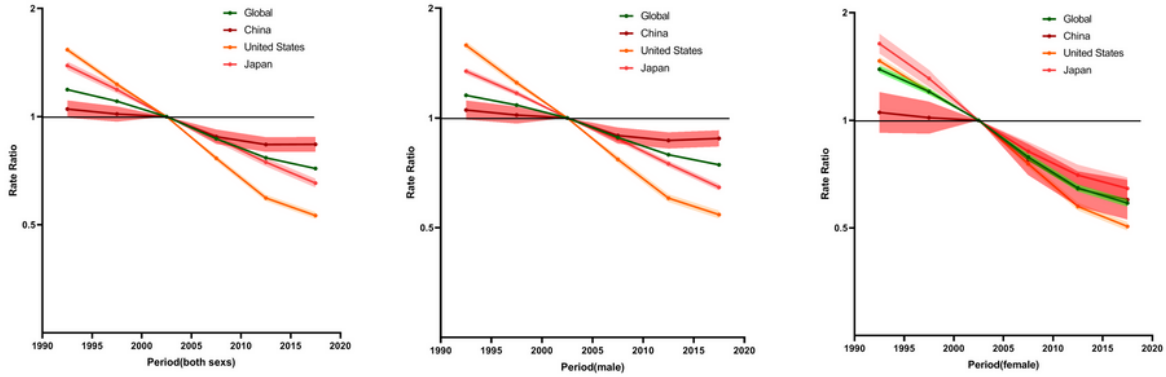

Figure 2(C). The estimated period RRs of of the mortality rate of CVD attributable to smoking in global, China, United States and Japan.

Figure 2

The APC results of CVD attributable to smoking in China, Japan, USA and the world from 1990 to 2017.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- StatisticalAnalysis.pdf
- Supplementarytables.docx
- Supplementaryfigures.docx