Aspirin use in patients with diagnosed diabetes in the United States and China: Nationally representative analysis

Xin Wang, MD¹, Guang Hao, PhD², Zuo Chen, PhD¹, Linfeng Zhang, PhD¹, Yuting Kang, PhD¹, Ying Yang, PhD¹, Congyi Zheng, PhD¹, Haoqi Zhou, PhD¹, Lu Chen, PhD¹, Zengwu Wang, MD, PhD¹ and Runlin Gao, MD³

Abstract

Background: The epidemiological data on the use of aspirin in diabetic patients is very limited. The main purpose of this study is to examine the current status of aspirin use in the United States (US) and China in large representative populations.

Methods: Data came from the National Health and Nutrition Examination Survey (NHANES) and China Hypertension Survey (CHS), two nationally representative cross-sectional studies.

Results: The percentage of aspirin use was 73.8% in US diabetic patients with ASCVD, and the percentage of aspirin use in diabetic patients with high ASCVD risk was marginally higher in men (p = .052), 54.5% in men and 37.1% in women. The percentages of aspirin use in diabetic patients with intermediate and low ASCVD risk were 55.1% and 35.0%, respectively. In China, the percentage of aspirin use in diabetic patients with ASCVD was 53.5%, and were 14.3%, 9.7%, and 3.2% among diabetic patients with high, intermediate, and low ASCVD risk, respectively.

Conclusions: In summary, the percentage of aspirin use in primary prevention in US diabetic patients in men was higher than in women, and this percentage for primary and secondary prevention in US patients was higher than that in Chinese patients.

Keywords
Aspirin use, diabetes, China, United States

Introduction

Cardiovascular disease (CVD) and diabetes are two major causes of death, imposing a heavy burden on public health worldwide.¹ Diabetic patients had more than two to three times higher risk of CVD than people without diabetes.² Aspirin is effective in reducing cardiovascular morbidity and mortality in high-risk patients with previous myocardial infarction or stroke (secondary prevention) and is strongly recommended by the American Diabetes Association (ADA) and other guidelines.³

The epidemiological data on the use of aspirin in diabetic patients is very limited. The main purpose of the present study is to examine the current status of aspirin use in the United States (US) and China using data from the National Health and Nutrition Examination Survey.
(NHANES) and China Hypertension Survey (CHS), two
technically representative cross-sectional studies.

**Methods**

**Survey participants**

We used the data from two nationally representative
samples from the US and China, which have been designed
to determine the health status of the community population.
CHS study, conducted between October 2012 and Dec-
ember 2015, was a cross-sectional national survey to assess
the status of hypertension and major CVD. The design of
CHS was published previously. For the US, we accordingly
selected three cycles (2011–2012, 2013–2014, and 2014–
2015) from the NHANES. The research ethics boards of
the National Center for Health Statistics (NCHS) and Fuwai
Hospital approved these two studies, and all participants
gave written informed consent at each examination.

The following selection criteria were used: 1) aged 40–
75 years older; 2) data for calculating the atherosclerotic
cardiovascular disease (ASCVD) scores were available on age,
sex, race, smoking status, blood pressure (BP), total cholesterol
(TC), and high-density lipoprotein cholesterol (H-DLC) for
NHANES; and age, sex, waist, smoking status, family history
of CVD, BP, total cholesterol (TC), high-density lipoprotein
cholesterol (H-DLC), geographical region and living in urban/
rural for CHS; 3) the participants responded to the questions on
low-dose aspirin. Finally, a total of 964 US and 1642 Chinese
diabetic patients were included in the analysis.

Current ASCVD was defined as self-reported coronary
heart disease or stroke. Hypertension was defined as sys-
tolic BP ≥140 mm Hg, and/or diastolic BP ≥ 90 mm Hg,
and/or use of antihypertensive medicine within 2 weeks.
The 10-years predicted risk of developing ASCVD for the
US was estimated by the equations recommended by ACC/
AHA Prevention Guideline; and for Chinese, we used the
equations developed by Yang et al. which performed better
in the Chinese population. In the primary analysis,
we have divided the ASCVD risk categories into <7.5%,
7.5%–15%, and ≥15% groups, and were defined as low-
risk, intermediate, and high groups accordingly.

**Statistical analysis**

The sample weights to account for oversampling and
nonresponse were used to provide nationally representative
results for CHS and NHANES. Variables were summarized
using means for continuous data; frequencies, percentages,
and proportions were used for categorical data. All 95% confidence intervals (CI) for the parameters were estimated
(sv: proportion or mean command). Differences were
examined by the two-sample t-test for continuous variables
or by the Chi-square test for categorical variables. A two-
sided p < .05 was considered significant. Statistical analyses
were conducted with Stata 14 (STATA Corp., TX, USA).

**Results**

For NHANES, a total of 964 diabetic patients aged 40–
75 years older (50.7% men and 49.3% women) were
included in the analysis. Overall, 43.6% of participants had
high ASCVD risk, and male diabetic patients had a higher
risk to develop ASCVD than female diabetic patients
(57.1% vs. 29.8%, p < .001).

The percentage of aspirin use in diabetic patients with
ASCVD was 73.8% (95% CI: 48.7–65.1%), and there were
no sex differences; the percentage in diabetic patients with
high ASCVD risk was marginally higher in men (p = .052),
54.5% (95% CI: 42.4–64.4%) in men and 37.1% (95% CI:
26.1–49.5%) in women. The percentages of aspirin use in
diabetic patients with ASCVD intermediate and low risk were
55.1% (95% CI: 43.5–66.1%) and 35.0% (95% CI: 27.0–
44.0%), respectively (Figure 1A). Among diabetic patients
without ASCVD, 42.1% (95% CI: 37.2–47.1%) taking
aspirin under the doctor’s advice, and only 4.3% (95%CI:
2.5–7.3%) take them on their own. Furthermore, for the
patients who take them on their own, less than half of them
take them every day. However, majority of the patients
taking aspirin under the doctor’s advice [91.0% (95% CI:
80.8–96.1%)] take them every day. On the other hand,
61.1% and 56.7% of patients were told by a doctor or health
care provider to take daily low-dose aspirin in men and
women, of them, 84.7% and 74.6% of patients were taking
aspirin under the doctor’s advice, respectively.

In CHS, a nationally representative dataset from China,
1603 diabetic patients aged 40–75 years old (46.0% men and
54.0% women) were eligible for the analysis. Overall,
43.6% of participants had high ASCVD risk, and male
diabetic patients had a higher risk to develop ASCVD than
female diabetic patients (57.1% vs. 29.8%, p < .001).

The percentage of aspirin use in diabetic patients with
ASCVD was 53.5% (95% CI: 36.2–70.0%), and there was
no evidence of sex differences; the percentages in diabetic patients with
high ASCVD risk were 14.3% (95% CI: 6.2–29.9%), 9.7% (95% CI: 3.5–2.4%), and 3.2% (95% CI: 1.1–8.8%), respectively. Also, we did not find sex
differences for aspirin use in diabetic patients. (Figure 1B)
However, the percentages of aspirin use in diabetic patients
living in urban were significantly higher than those living in
rural; the percentage in diabetic patients with ASCVD was
60.2% (95% CI: 40.5–77.0%) in urban and 31.0% (95% CI:
9.0–67.1%) in rural (p < .001). For the diabetic patients with
high intermediate and low ASCVD risk, the percentages were
23.8% (95% CI: 9.7–47.4%), 17.1% (95% CI: 6.4–38.4%), and
6.4% (95% CI: 1.9–19.2%) for those living in urban, and only
5.4% (95% CI: 2.3–12.0%), 2.4% (95% CI: 0.9–6.5%), and
0.7% (95% CI: 0.1–3.2%) for those living in rural (p < .001).
Discussion

Overall, the percentage of aspirin use for primary prevention in US diabetic patients with high ASCVD risk in men was higher than in women, and this percentage in US patients was higher than those in Chinese patients. Aspirin was used for secondary prevention in 73.8% of US diabetic patients, and this percentage was 53.5% in China. Aspirin is effective in reducing cardiovascular morbidity and mortality in diabetic patients with ASCVD; therefore, using aspirin therapy as a secondary prevention strategy in those patients has been strongly recommended by ADA guideline. Although the protective effect of aspirin has been well established, it is still not commonly used in China, especially in rural areas. Differences in health insurance between urban and rural may explain some of the disparities in aspirin use. The New Rural Cooperative Medical Scheme for rural population only provides cover for in-hospital costs, and the requirement for long-term antplatelet agents require out-of-pocket payment; whereas, urban residents usually hold Urban Employee/Resident Insurance that provides some coverage (70%) of outpatient medication.

Emerging data have highlighted the beneficial role of aspirin in primary prevention in high ASCVD risk populations. Our analysis showed that 61.1% and 56.7% of US patients were told by a doctor or health care provider to take daily low-dose aspirin in men and women. In line with this analysis, previous studies showed that non-compliance with clinical practice guidelines is about 50% in the US and China. On the other hand, majority of the US patients (84.7% and 74.6% in men and women) were taking aspirin under the doctor’s advice. Therefore, strategies for improving the adherence of doctors to the clinical practice guidelines are urgently required.

Our analysis showed that the percentage of aspirin use in China was less than a third of the percentage in the US, and the aspirin use in the rural area was even lower in China. Aspirin treatment is cost-effective not only for secondary prevention but also for primary prevention. Therefore, the appropriate use of aspirin in diabetic patients could be an avenue to decrease the heavy burden of CVD. In line with a previous study, there was a 75% high ASCVD risk of diabetic patients (data not shown) who followed doctors’ advice to take aspirin in the US. Although the CHS study did collect information on the adherence of aspirin, previous studies conducted in China reported that up to 80% of patients followed the prescription of aspirin for CVD prevention. The high adherence also indicated that guideline-directed use of aspirin in doctors plays a vital role in ASCVD prevention.

Our study also has some limitations. One limitation is that CHS did not collect the data on traditional Chinese medicine for CVD prevention in Chinese diabetic patients, so the results in China should be explained cautiously. Another limitation is that certain variables in NHANES and CHS are based on self-reporting, so recall bias may exist.

Conclusion

In summary, there was a sex difference in aspirin use for primary prevention in the US. In comparison with the US, aspirin use for primary and secondary prevention was significantly lower in China. These results suggested that, according to current guidelines, informed shared decision-making between clinicians and patients regarding the use of aspirin for primary prevention of CVD could be a suitable approach. On the other hand, effective strategies to improve guideline-directed use of aspirin are urgently required.

Figure 1. Percentages with standard errors of aspirin use in diabetic patients. (A) The national health and nutrition examination survey. (B) The China Hypertension Survey. ASCVD = atherosclerotic cardiovascular disease.
Acknowledgements
The authors thank all the colleagues involved in the study. This study was accomplished through the fine work of the staff at the national level. The authors are grateful to OMRON Corporation, Kyoto, Japan, for supporting the blood pressure monitor (HBP-1300) and body fat and weight measurement device (V-body HBF-371); Henan Huanan Medical Science and Technology Co., Ltd, China, for digital ECG device (GY-5000); and Microlife, Taipei, Taiwan, for the automated ABI device (Watch BP Office device). Finally, the authors are thankful to BUCHANG PHARMA, Xian, China; Kinglian Technology, Guangzhou, China; Merck Serono; Pfizer, China; and Essen Technology (Beijing) Company Limited for their support funding the project. The authors also thank the NHANES participants and the staff numbers for their contributions of the data and data collection.

Author contributions
ZWW and RLG designed the study. GH analyzed data, and GH and XW wrote the manuscript. XW, LC, LFZ, ZC, YTK, YY, CYZ, HQZ, ZWW, and RLG contributed to critically revising the manuscript. All authors approved the final article.

Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by the China National Science and Technology Pillar Program (2011BAI11B01), the National Health and Family Planning Commission, China (201402002), and the CAMS Innovation Fund for Medical Sciences (Grant 2017-I2M-1-004).

Availability of data and materials
The data of the HNEANS are available at https://www.cdc.gov/nchs/nhanes/index.htm. For CHS, the data cannot be made available to other researchers for purposes of reproducing the results or replicating the procedure. The code for analyses is available upon request from the authors.

Ethics approval and consent to participate
All participants provided written informed consent and the research ethics boards of the National Center for Health Statistics and Fuwai Hospital approved these two studies.

Appendix

Abbreviations

- CVD: Cardiovascular disease
- ADA: American Diabetes Association
- CHS: China Hypertension Survey
- ASCVD: Atherosclerotic cardiovascular disease
- BP: Blood pressure
- TC: Total cholesterol
- H-DLC: High-density lipoprotein cholesterol

ORCID iDs

Guang Hao https://orcid.org/0000-0003-3780-0223
Zengwu Wang https://orcid.org/0000-0003-1613-5076

References

1. Roth GA, Mensah GA, Johnson CO, et al. Global burden of cardiovascular diseases and risk factors, 1990-2019: update from the GBD 2019 study. J Am Coll Cardiol 2020; 76(25): 2982-3021.
2. Stamler J, Vaccaro O, Neaton JD, et al. Diabetes, other risk factors, and 12-yr cardiovascular mortality for men screened in the multiple risk factor intervention trial. Diabetes Care 1993; 16(2): 434-444.
3. American Diabetes A. 10. Cardiovascular disease and risk management: standards of medical care in diabetes-2021. Diabetes Care 2021; 44(suppl 1): S125–S150.
4. Wang Z, Zhang L, Chen Z, et al. China hypertension survey G: survey on prevalence of hypertension in China: background, aim, method and design. Int J Cardiol 2014; 174(3): 721–723.
5. National Center for Health Statistics. National health and nutrition examination survey. Available at: https://www.cdc.gov/nchs/nhanes/index.htm (accessed 1 May 2019).
6. Andrus B and Lacaille D. ACC/AHA guideline on the assessment of cardiovascular risk. J Am Coll Cardiol 2014; 63(25 Pt A): S49–S73.
7. Yang X, Li J, Hu D, et al. Predicting the 10-year risks of atherosclerotic cardiovascular disease in Chinese population: the China-PAR project (prediction for ASCVD risk in China). Circulation 2016; 134(19): 1430–1440.
8. Xia S, Du X, Guo L, et al. Sex differences in primary and secondary prevention of cardiovascular disease in China. Circulation 2020; 141(7): 530–539.
9. Liu M, Zhang C, Zha Q, et al. A national survey of Chinese medicine doctors and clinical practice guidelines in China. BMC Comp Altern Med 2017; 17(1): 451.
10. McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. N Engl J Med 2003; 348(26): 2635–2645.
11. Gu Q, Dillon CF, Eberhardt MS, et al. Preventive aspirin and other antiplatelet medication use among U.S. adults aged >/= 40 years: data from the national health and nutrition examination survey, 2011-2012. Pub Health Rep 2015; 130(6): 643–654.
12. Zhu J, Shi Y, Li J, et al. Role of risk attitude and time preference in preventive aspirin use adherence. J Eval Clin Pract 2020; 26(3): 819–825.