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# Potential Impact of Time Trend of Life-Style Factors on Cardiovascular Disease Burden in China

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## ABSTRACT

**BACKGROUND** Cardiovascular disease (CVD) is a leading cause of death in China. Evaluation of risk factors and their impacts on disease burden is important for future public health initiatives and policy making.

**OBJECTIVES** The study used data from a cohort of the China Health and Nutrition Survey to estimate time trends in cardiovascular risk factors from 1991 to 2011.

**METHODS** We applied the comparative risk assessment method to estimate the number of CVD events attributable to all nonoptimal levels (e.g., theoretical-minimum-risk exposure distribution [TMRED]) of each risk factor.

**RESULTS** In 2011, high blood pressure, high low-density lipoprotein cholesterol, and high blood glucose were associated with 3.1, 1.4, and 0.9 million CVD events in China, respectively. Increase in body mass index was associated with an increase in attributable CVD events, from 0.5 to 1.1 million between 1991 and 2011, whereas decreased physical activity was associated with a 0.7-million increase in attributable CVD events. In 2011, 53.4% of men used tobacco, estimated to be responsible for 30.1% of CVD burden in men. Dietary quality improved, but remained suboptimal; mean intakes were 5.4 (TMRED: 2.0) g/day for sodium, 67.7 (TMRED: 300.0) g/day for fruits, 6.2 (TMRED: 114.0) g/day for nuts, and 25.0 (TMRED: 250.0) mg/day for marine omega-3 fatty acids in 2011.

**CONCLUSIONS** High blood pressure remains the most important individual risk factor related to CVD burden in China. Increased body mass index and decreased physical activity were also associated with the increase in CVD burden from 1991 to 2011. High rates of tobacco use in men and unhealthy dietary factors continue to contribute to the burden of CVD in China. (J Am Coll Cardiol 2016;68:818–33) © 2016 by the American College of Cardiology Foundation.

In the past 2 decades, China experienced a dramatic shift in diet from traditional to Western dietary patterns (1). Decreased consumption of coarse grains and legumes were countered by increased intake of animal-source food and cooking oil (2). Rapid urbanization and industrialization led to a steep decline in physical activity levels (3). These changes have been accompanied by marked increases in serum cholesterol levels (4,5), obesity (6,7), and type 2 diabetes (8,9). Smoking prevalence in China

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remains high (10). Overall, cardiovascular disease (CVD) has surpassed infectious diseases to become the leading cause of death in China (11). Therefore, it is imperative to study the trends in CVD risk factors and their relationship to disease burden, to evaluate current public health policies and provide guidance for future disease prevention and health promotion.

SEE PAGE 834

In this study, we describe time trends in dietary and other life-style risk factors for CVD from 1991 to 2011 using data from an ongoing open cohort of the China Health and Nutrition Survey (CHNS) (12). We then apply the comparative risk assessment method (13) to estimate the number of CVD events attributable to nonoptimal levels of these risk factors.

## METHODS

**STUDY POPULATION.** The CHNS (12) is an ongoing prospective household-based study of multiple age groups across 9 rounds of data collection, including 4,400 households with a total of 26,000 individuals in nine provinces. The CHNS was initiated in 1989 and conducted follow-up visits in 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011. Data are publicly available for download at the University of North Carolina at Chapel Hill Population Center project website (12).

A stratified probability sampling method was applied to the study population, as described in detail previously (12). Briefly, the CHNS used a multistage, random cluster design in 9 provinces (Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou, and Heilongjiang). Within each province, 2 cities (1 large and 1 small, usually the provincial capital and a lower-income city) and 4 counties (stratified by income, 1 high-, 1 low-, and 2 middle-income) were selected. Within cities, 2 urban and 2 suburban communities were randomly selected. Within counties, 1 community in the capital city and 3 rural villages were randomly chosen. Twenty households per community were then selected for participation. We excluded data from the 1989 wave because it enrolled only adults 20 to 45 years of age. We also excluded the data for 3 megacities from the comparison of time trend, as those data were available only in 2011. Additionally, we excluded participants who were pregnant or under 35 years of age at the time of the survey.

**COMPARATIVE RISK ASSESSMENT METHOD.** We applied population-level comparative risk assessment method to calculate the population-attributable risk (13) (i.e., the proportion of CVD burden that would have been prevented if the distribution of specific risk factor exposure had been changed to a hypothetical alternative distribution while holding other risk factors constant). We conducted all analyses separately (20 groups in total): by sex, community-level urbanization as classified by the Chinese government (urban or rural), and age group on the basis of age at measurement (35 to 44, 45 to 54, 55 to 64, 65 to 74, and ≥75 years of age). We restricted analyses to participants ≥35 years of age because of limited data on the effects of these risk factors and fewer CVD events among younger participants.

For the comparative risk assessment analysis, we included data from different sources, including: 1) the current distribution of risk factor exposure in each wave; 2) the etiological effects of risk factor exposures on coronary heart disease (CHD), ischemic stroke, and hemorrhagic stroke, respectively; 3) an alternative theoretical-minimum-risk exposure distribution (TMRED); and 4) the total number of CVD events in the population.

**RISK FACTOR SELECTION.** We selected 17 dietary and life-style risk factors for which: 1) there was sufficient evidence for the presence and magnitude of probable causal relationships with CHD, ischemic stroke, and hemorrhagic stroke; 2) there were available intervention strategies to modify exposure of risk; and 3) data on risk factor exposure were available in CHNS without systematic bias. Factors included high systolic blood pressure (SBP), high low-density lipoprotein (LDL) cholesterol, high blood glucose, high body mass index (BMI), low physical inactivity, current tobacco smoking, and 11 dietary risk factors. Table 1 summarizes these 17 risk factors, their optimal level (TMRED), CVD outcomes, and sources of the relative risk (RR) used for estimating CVD burden. As the blood samples for LDL and glucose were collected only once in the CHNS, we included all 17 risk factors for CVD burden in 2011 but only 15 factors for time trend analysis.

**MEASUREMENTS.** Sex, age, primary occupation category, highest educational level achieved, and smoking status were self-reported in each wave. Dietary information was collected by 3-day 24-h dietary recalls in addition to using the 3-day food-weighted method to assess cooking oil and condiment consumption. Nutrient intakes were calculated using the China Food Composition Tables. Specifically, Food Composition Tables-1991 (14) was used for dietary

**ABBREVIATIONS AND ACRONYMS**

**BMI** = body mass index

**CHD** = coronary heart disease

**CHNS** = China Health and Nutrition Survey

**CVD** = cardiovascular disease

**LDL** = low-density lipoprotein

**MET** = metabolic equivalent of task

**PAF** = population-attributable fraction

**PUFA** = polyunsaturated fatty acid

**RR** = relative risk

**SBP** = systolic blood pressure

**SSB** = sugar-sweetened beverages

**TMRED** = theoretical-minimum-risk exposure distribution