Progress in Cardiovascular Diseases 53 (2011) 369–378
www.onlinepcd.com

Progress of Ambient Air Pollution and Cardiovascular Disease Research in Asia

Ta-Chen Su[a], Szu-Ying Chen[b,c], Chang-Chuan Chan[c,*]

[a]*Division of Cardiology, Department of Internal Medicine, National Taiwan University Hospital, Taipei, Taiwan*
[b]*Department of Anesthesiology, E-Da Hospital, I-Shou University, Kaohsiung, Taiwan*
[c]*Institute of Occupational Medicine and Industrial Hygiene, College of Public Health, National Taiwan University, Taipei, Taiwan*

Abstract Asian countries are with deteriorating air quality accompanying the rapid economic and social development of the past decades, and the potential health impacts of air pollution have been noticed by researchers in the region. We reviewed the scientific literature on air pollution and cardiovascular diseases (CVD) published by Asian researchers in English since the 1980s to determine whether the findings in Europe and North America can be extrapolated to Asia. Epidemiological studies show that short-term particulate matter pollution is a strong predictor for CVD morbidity and mortality and suggestive on cerebrovascular morbidity and mortality in newly developed countries in Asia. Multicountry epidemiological studies are needed to fully appreciate the extent of air pollution on CVD in Asia, especially less developed Asian countries. New cohort studies should be initiated to improve our understanding of particulate matter's toxicological pathways, long-term exposure effects, and gene-environment interaction on CVD among the Asian population. (Prog Cardiovasc Dis 2011;53:369-378)

Keywords: Cardiovascular disease; Air pollution; Epidemiology; Panel study; Asia

Background: A knowledge gap in environmental cardiology

Cardiovascular disease (CVD) is the leading cause of mortality and a major health burden in developed countries and has the same profile in many Asian countries, such as China and India.[1] Cardiovascular diseases, cerebrovascular diseases, and cancers are the top 3 causes of death over the past 2 decades in China and Taiwan.[2,3] The increasing rate of CVD morbidity and mortality, in particular, has become a major focus of public health policies and epidemiological studies among Asian countries. The causes of CVD are very complex, and disease susceptibility is closely associated with both genetic traits and environmental factors. Environmental cardiology is gaining recognition as an important field to uncover environmental risk factors for CVD and providing useful medical knowledge for both public health practitioners and clinicians in their management of a rising epidemic of CVD worldwide. Environmental epidemiological and panel studies are the 2 most frequently used research types to investigate the relation between air pollution and CVD in environmental cardiology.

Numerous epidemiological studies have consistently reported that ambient air pollution, especially particulate matters (PM), is associated with cardiovascular morbidity and mortality in North America and Europe.[4-9] The World Health Organization (WHO) published an air quality guideline in 2005, providing detailed information on health risk–associated air pollutants including PM. The American Heart Association (AHA) has also issued 2

The work reported was done from National Taiwan University.
* Address reprint requests to Chang-Chuan Chan, ScD, Professor, Institute of Occupational Medicine and Industrial Hygiene, College of Public Health, National Taiwan University, Rm. 722, 17 Xu-Zhou Road, Taipei 100, Taiwan.
E-mail address: ccchan@ntu.edu.tw (C.-C. Chan).

0033-0620/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.pcad.2010.12.007

Abbreviations and Acronyms

AHA = American Heart Association

ADS = Asian dust storms

BP = blood pressure

CAVI = cardio-ankle vascular index

CHF = congestive heart failure

CO = carbon monoxide

CVD = cardiovascular disease

HF = high frequency

HRV = heart rate variability

IQR = interquartile range

LF = low frequency

NO_2 = nitrogen dioxide

O_3 = ozone

PAPA = Public Health and Air Pollution in Asia

PM = particulate matters

PM_{10} = particulate matters with diameter <10 μm

$PM_{2.5}$ = particulate matters with diameter <2.5 μm

SDNN = standard deviation of normal-beat to normal-beat intervals

SO_2 = sulfur dioxide

SPM = suspended particulate matters

TSP = total suspended particles

UFP = ultrafine particle

VOC = volatile organic compound

WHO = World Health Organization

scientific statements on PM air pollution and CVD to medical communities in 2004 and 2010.[4,10]

Most cardiologists in Asia, however, are still not fully aware of such new findings and have not yet linked ambient air pollution to CVD in their clinical practice. Such a knowledge gap is due, in part, to relatively less research on this important issue in the region than the United States and Europe. For example, less than 10% of studies in the 426 references in the AHA Scientific Statement of 2010 are from Asia.[4] This is an intriguing phenomenon considering the rapidly worsening air pollution in many countries in Asia. In past decades, Asian countries experienced enormous economic and social development, as well as an accompanying rapid increase in industrialization, urbanization, and motorization. As a result, some of the highest levels of outdoor air pollution in the world are found in Asian cities, and the health impact of air pollution in this region has been already estimated to be substantial. The WHO cautioned that urban air pollution might contribute to approximately 800,000 deaths and 6.4 million lost life–years worldwide in 2000, with two thirds of these losses occurring in rapidly developing Asian countries.[11]

There is an urgent need to fill the knowledge gap of our understanding of the impact of air pollution on health in Asia, now the region with the worst air pollution in the world. In this article, we will summarize existing evidence associating ambient air pollution with CVD and cerebro-

A short description of "time series," "case crossover" and "panel study"

Times-series analysis is a statistical approach used to examine associations between air pollution levels (usually daily concentrations measured at fixed monitoring sites) and changes in morbidity or mortality of cardiopulmonary diseases for a study population in several cities or even an entire country over a period (usually several years). It can also be applied to analyze associations between personal air pollution exposures (usually hourly concentrations measured by either fixed monitoring sites or personal samplers) and changes in individual's physiologic functions (eg, blood pressure, heart rate, and heart rate variability) for a group of people (usually in tens to hundreds) over a period (usually days to months). Such analysis can be readily performed in standard statistical packages.

Case-crossover is a statistical approach used to examine acute effects (eg, increases in daily mortality or morbidity) of air pollution episodes (eg, dust storm days or unusual high pollution days) for a population (usually the patients covered by the service of hospitals or all residents in cities or entire country) over a period time (usually years). For each study subject, this approach defines the onset time of their illness or death as "case periods" and the matched time before or after their case periods as the "control periods." This method can be regarded as a variant of the traditional case-control design, and hence, conditional logistic regressions can be used to estimate the odds ratios for the study population. Because both "case" and "control" components are from the same individuals, the case-crossover design has the advantage of eliminating individual's confounding factors (eg, age, sex, and education level).

Panel study is a commonly used study design to investigate the mechanisms of air pollution effects on humans by collecting pollution (usually in seconds to hours) and pathophysiologic data (eg, continuously monitored blood pressure or heart rate variability or periodically measured biomarkers in urine or blood) for a group of study subjects (eg, children, adults, elderly people or patients) and following them up for a period (usually days to months). The collected data can be readily analyzed by either time-series or mixed-effects regression models.