HEALTH ASSESSMENT OF FINE PARTICLE ON CARDIOVASCULAR DISEASE MORBIDITY AND MORTALITY

Wen-Chao Ho[1*], Meng-Hung Lin[1], Hsien-Ho Lin[2], Pau-Chung Chen[3*], Tsun-Jen Cheng[3]

1Department of Public Health, China Medical University, Taichung, Taiwan,
2Institute of Epidemiology and Preventive Medicine National Taiwan University, Taipei, Taiwan,
3Institute of Occupational Medicine and Industrial Hygiene, National Taiwan University, Taipei, Taiwan.
**Corresponding Author, Tel: +886 4 2205 3366*6117, Fax: +886 4 2201 9901,*
E-mail: whocmu@gmail.com

ABSTRACT

In recent years, Taiwan EPA air quality monitoring station data show that there is an improving trend in air quality, but the particles (particular matter, PM) concentration compared with the standard value is still high. The impact of fine suspended particles (PM2.5) on the environment and human health are more widely concerned recently, especially in developed countries. The National Morbidity Mortality Air Pollution Study, NMMAPS, in USA pointed out that the fine suspended particles PM2.5 had health impact on mortality more than suspended particles PM10. Harvard Six Cities Study also showed that the fine suspended particles PM2.5 could increase the cardiovascular and respiratory diseases mortality. Furthermore, the component composition of fine suspended particulate and its interaction with ozone may have significant effects related to respiratory and cardiovascular disease mortality[1-9]. Although the health effects of suspended particles have been studied in Taiwan[10-17], fine suspended particulate (PM2.5) is not well assessed. Nevertheless, PM2.5 may also interact with traffic pollutants and ozone and cause further harm to health.

INTRODUCTION

There is highly traffic density in Taiwan. In the meantime, the ozone episode day also continues to increase. The issues of fine suspended particulate (PM2.5) on health hazards, especially for respiratory and cardiovascular, have recently been raised.

Four main databases were assessed in this study. They were: 1) air pollution data, hourly air pollution data collected by using air monitoring stations from Taiwan EPA during 2000-2009 (with modeling estimation for PM2.5 during 2000-2005), 2) death registration database, study population collected from death registry system in Taiwan during 2000-2009, 3) National Health Insurance Registry database during 2000-2009, both mortality and morbidity study areas were the townships having air quality

stations (Figure 1), total 64 townships included, and 4) cancer screening cohort. Both long term and short term effects were assessed based on annual diseases morbidity and mortality analyses, survival analyses and case-crossover design analyses. Repeated-Poisson regression, Cox-proportional hazard model and conditional logistic regression were used. Controlling risk factors included: sex, age, degree of urbanization, density of cardiology physicians, temperature, and humidity. Personal risk factors were further assessed in the cohort study.

The daily and annual average (medium and Inter-quartile Range, IQR) of PM2.5 was 34.61ug/m3 (30.05ug/m3 and 27.21ug/m3) and 35.97ug/m3 (34.69ug/m3 and 13.74ug/m3), respectively (Table 1). Based on the morbidity and mortality analyses, the air quality standard for PM2.5 to be lower than 32.15ug/m3 and 27.8ug/m3 for short term (daily) and long term (annual) exposure was suggested (Figures 2-3). Cancer screening cohort study showed the comparable and similar results with previous findings from other cohort studies (Figure 4). To summarize the findings of this study, there were: 1) it showed more potential significant results of PM2.5 related to health effects in urban cities, especially Taipei, 2) there were some city-specific seasonal diseases that should be considered, for example: Taichung and Kaohsiung, and 3) the results of long-term and short-term showed highly comparable. Further research was in need and suggested.

Acknowledgments

This study was supported by grant NSC 99-EPA-M-001-001 from the Environmental Protection Administration in Taiwan.

REFERENCES

1. Villeneuve PJ, Goldberg MS, Krewski D, Burnett RT, Chen Y. 2002. Fine particulate air pollution and all-cause mortality within the Harvard Six-Cities Study: variations in risk by period of exposure. Ann Epidemiol 12(8): 568-576.

2. Dockery DW, Pope CA, 3rd, Xu X, Spengler JD, Ware JH, Fay ME, et al. 1993. An association between air pollution and mortality in six U.S. cities. N Engl J Med 329(24): 1753-1759.

3. Pope CA, 3rd, Thun MJ, Namboodiri MM, Dockery DW, Evans JS, Speizer FE, et al. 1995. Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. Am J Respir Crit Care Med 151(3 Pt 1): 669-674.

4. Pope CA, 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, et al. 2002. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA : the journal of the American Medical Association 287(9): 1132-1141.

5. Pope CA, 3rd, Muhlestein JB, May HT, Renlund DG, Anderson JL, Horne BD. 2006. Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. Circulation 114(23):

2443-2448.

6. Brook RD, Rajagopalan S, Pope CA, 3rd, Brook JR, Bhatnagar A, Diez-Roux AV, et al. 2010. Particulate matter air pollution and cardiovascular disease: An update to the scientific statement from the American Heart Association. Circulation 121(21): 2331-2378.

7. Puett RC, Schwartz J, Hart JE, Yanosky JD, Speizer FE, Suh H, et al. 2008. Chronic particulate exposure, mortality, and coronary heart disease in the nurses' health study. Am J Epidemiol 168(10): 1161-1168.

8. Laden F, Schwartz J, Speizer FE, Dockery DW. 2006. Reduction in fine particulate air pollution and mortality: Extended follow-up of the Harvard Six Cities study. Am J Respir Crit Care Med 173(6): 667-672.

9. Yorifuji T, Kashima S, Tsuda T, Takao S, Suzuki E, Doi H, et al. 2010. Long-term exposure to traffic-related air pollution and mortality in Shizuoka, Japan. Occupational and environmental medicine 67(2): 111-117.

10. Hsieh YL, Yang YH, Wu TN, Yang CY. 2010. Air pollution and hospital admissions for myocardial infarction in a subtropical city: Taipei, Taiwan. J Toxicol Environ Health A 73(11): 757-765.

11. Tsai SS, Chiu HF, Wu TN, Yang CY. 2009. Air pollution and emergency room visits for cardiac arrhythmia in a subtropical city: Taipei, Taiwan. Inhalation toxicology 21(13): 1113-1118.

12. Bell ML, Levy JK, Lin Z. 2008. The effect of sandstorms and air pollution on cause-specific hospital admissions in Taipei, Taiwan. Occupational and environmental medicine 65(2): 104-111.

13. Chan CC, Chuang KJ, Chien LC, Chen WJ, Chang WT. 2006. Urban air pollution and emergency admissions for cerebrovascular diseases in Taipei, Taiwan. European heart journal 27(10): 1238-1244.

14. Lee IM, Tsai SS, Ho CK, Chiu HF, Yang CY. 2007. Air pollution and hospital admissions for congestive heart failure in a tropical city: Kaohsiung, Taiwan. Inhalation toxicology 19(10): 899-904.

15. Tsai SS, Goggins WB, Chiu HF, Yang CY. 2003. Evidence for an association between air pollution and daily stroke admissions in Kaohsiung, Taiwan. Stroke; a journal of cerebral circulation 34(11): 2612-2616.

16. Yang CY, Chang CC, Chuang HY, Tsai SS, Wu TN, Ho CK. 2004. Relationship between air pollution and daily mortality in a subtropical city: Taipei, Taiwan. Environment international 30(4): 519-523.

17. Wang CH, Chen CJ, Lee MH, Yang HI, Hsiao CK. 2010. Chronic hepatitis B infection and risk of atherosclerosis-related mortality: A 17-year follow-up study based on 22,472 residents in Taiwan. Atherosclerosis 211(2): 624-629.

Figure 1. Air quality monitoring network in Taiwan

Table 1. Descriptive statistics of annual and daily average values from sixty-four air monitoring stations in Taiwan

	Pollutant	N	Mean	Minimum	Maximum	IQR	percentile 25th	percentile 50th	percentile 75th
Annual	Taiwan (2000-2009)								
	PM2.5, μg/m3	616	35.97	13.78	65.14	13.74	29.42	34.69	43.16
	SO2, ppb	638	4.58	0.87	15.02	2.09	3.12	4.01	5.21
	NO2, ppb	638	19.47	6.80	35.09	8.21	15.38	18.82	23.59
	CO, ppm	626	0.58	0.25	1.50	0.25	0.44	0.54	0.68
	O3, ppb	622	27.86	15.95	40.80	5.60	25.21	27.85	30.81
	Temperature, ℃	634	23.74	18.50	26.70	1.41	23.08	23.63	24.49
	Relative Humidity, %	629	74.86	48.11	86.70	5.90	72.10	74.56	78.00
Daily	Taiwan (2006-2009)								
	$PM_{2.5}$, μg/m^3	89751	34.61	0.21	176.94	27.21	19.29	30.05	46.50
	SO_2, ppb	92125	4.66	0.18	52.58	2.91	2.73	3.89	5.64
	NO_2, ppb	91746	18.01	0.33	80.93	11.95	11.36	16.61	23.32
	CO, ppm	92544	0.51	0.03	3.01	0.29	0.33	0.46	0.62
	O_3, ppb	92237	29.38	2.32	94.26	15.93	20.67	27.85	36.60
	Temperature, ℃	91576	23.93	6.40	36.60	8.01	20.15	24.83	28.16
	Relative Humidity, %	91491	74.11	0.11	100.00	10.99	68.70	74.13	79.68

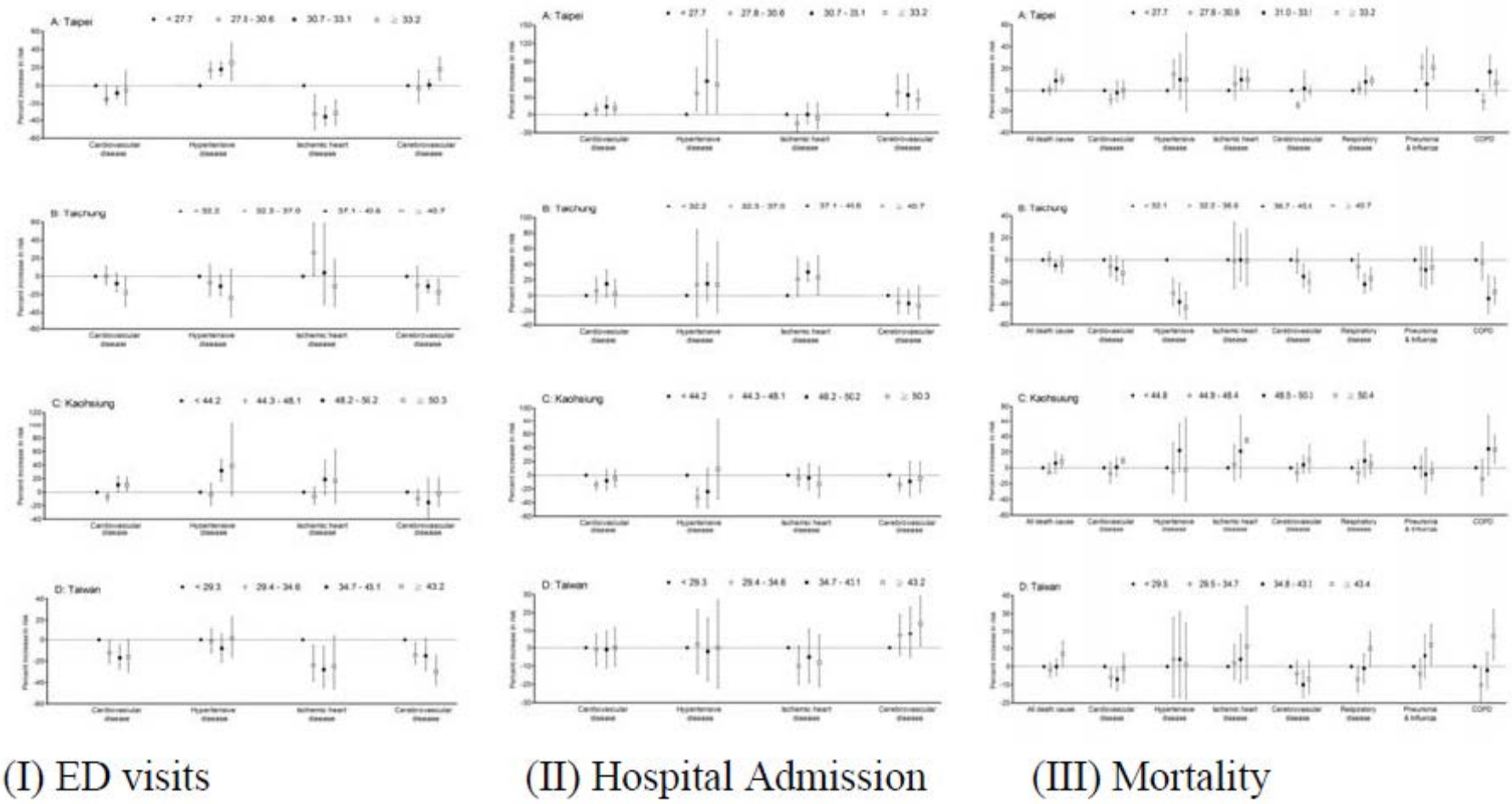

Figure2. Adjusted RR[*] for disease specific emergency department(ED) visits (I), Hospital Admission (II), and Mortality (III) in two-pollutant model[†] using Poisson regression in Taiwan (including Taipei, Taichung, and Kaohsiung), 2006-2009.

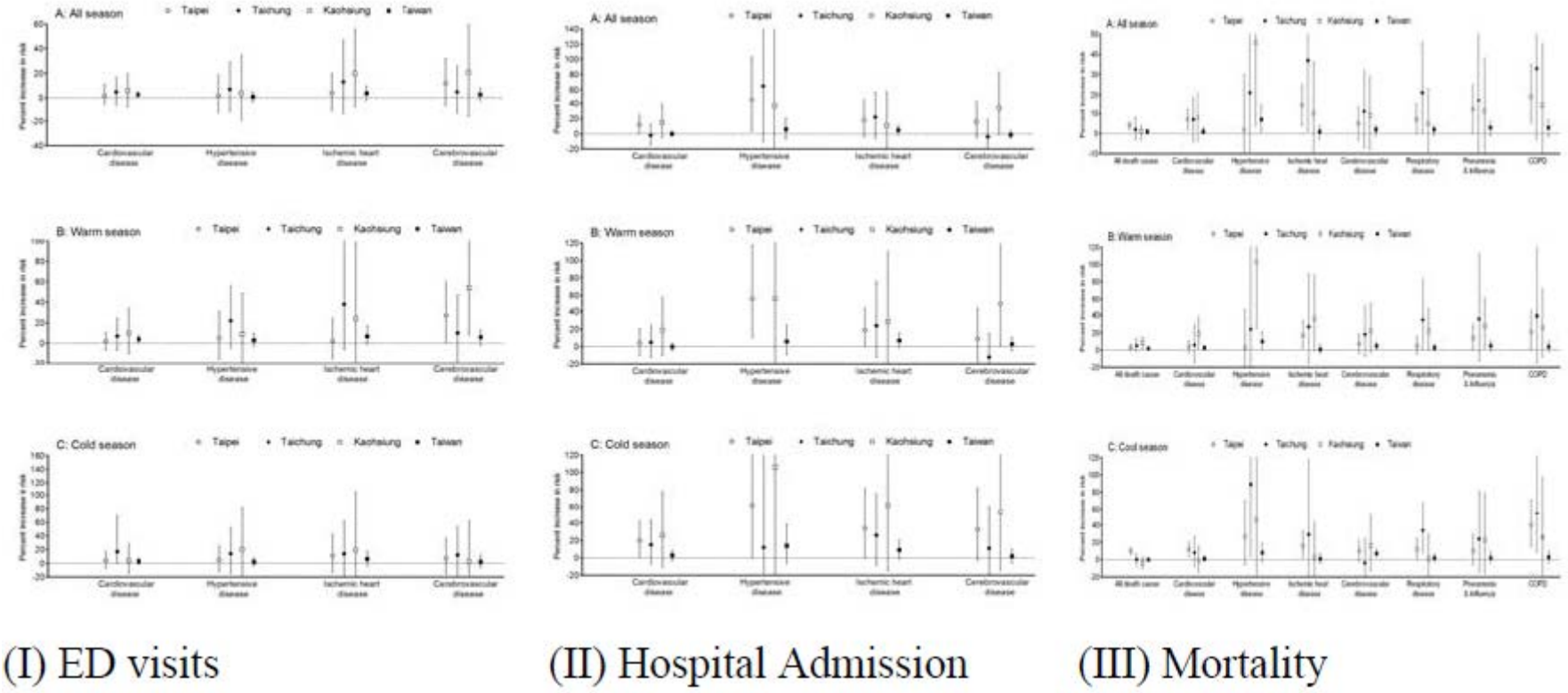

Figure 3. Percent increase in risk and 95% CI of disease specific emergency department (ED) visits (I), Hospital Admission (II), and Mortality (III) associated with annual average $PM_{2.5}$ stratified by various season (A: all season, B: warm season and C: cool season), 2000-2009.

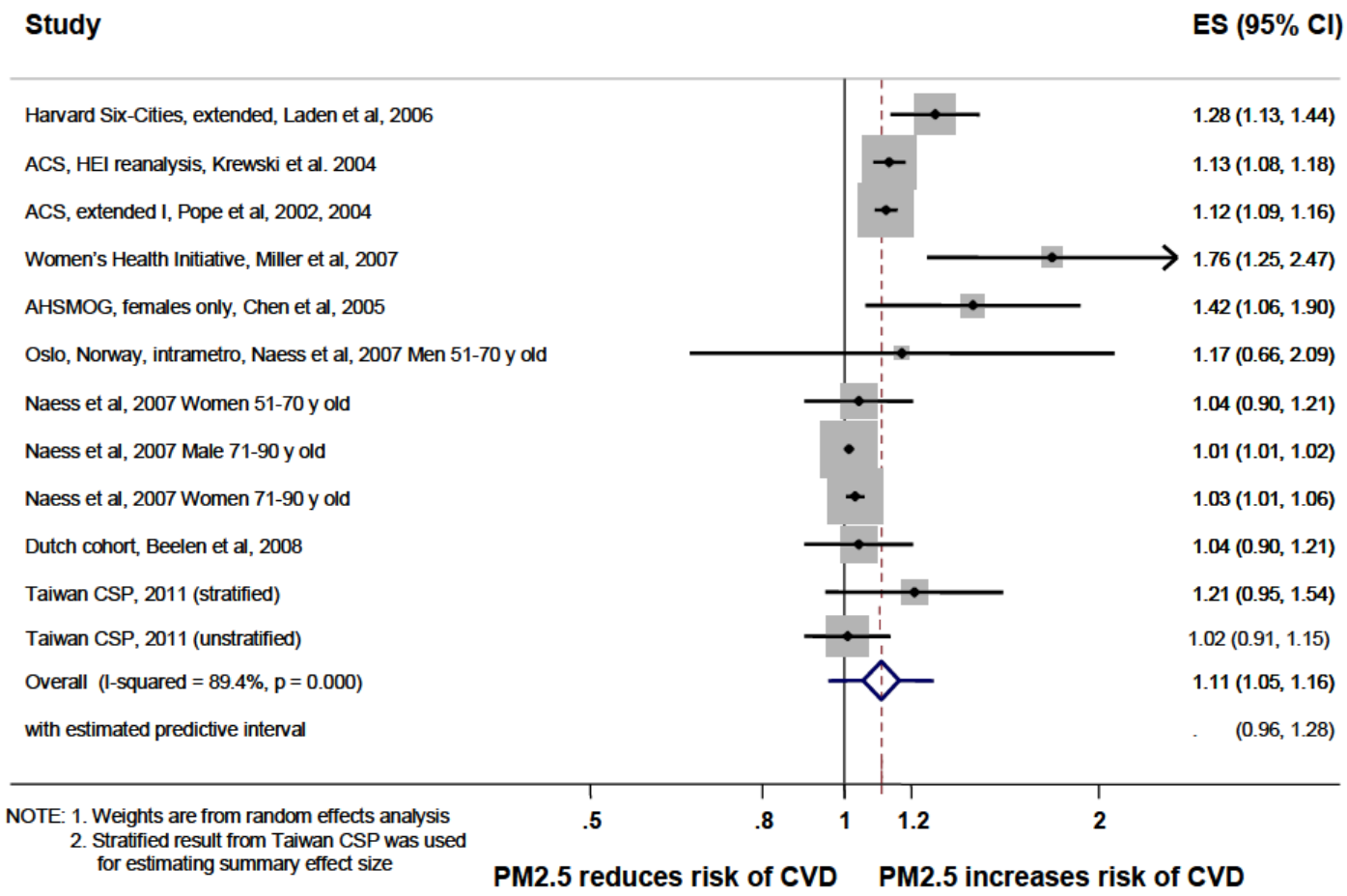

Figure 4. Summary of cancer screening cohort study and related study with increasing of 10μg/m3 $PM_{2.5}$ exposure and cardiovascular disease (CVD) mortality risk.