The association of children's lung function and air pollution in Kaohsiung, Taiwan

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Introduction

Recently, the association between the air pollution and human health has been widely mentioned. Children are more sensitive to air pollution then adult due to their higher metabolism rate and smaller body size. In most of the previous studies, data from air monitoring station were used to evaluate children exposure whereas questionnaire was used to evaluate their health effect. In the present study, we measured children`s lung function and air pollutants including CO, CO_2, NO_2, O_3, PM_1, $PM_{2.5}$, PM_{10}, ultrafine particles, fungal and bacterial bioaerosols in classrooms to evaluate the association between air pollutants and children's lung function.

Materials and Methods

Three elementary schools, reference, industry and traffic school, were selected in Kaohsiung, Taiwan. Twenty classrooms were randomly selected in each elementary school with a total sample size of sixty classrooms. Temperature, relative humidity, CO, CO_2, NO_2 (Airboxx, KD UK), O_3 (Ozone Monitor, Model 202, 2B Technologies, Inc),PM_1,$PM_{2.5}$, PM_{10} (DUSTTRAK™ DRX Aerosol Monitor; Model 8533, TSI USA), ultrafine particles (P-TRAK® Ultrafine Particle Counter ; Model 8525, TSI USA) were monitored in real-time from 8 am to 4 pm between April 2009 and November 2009. We also sampled fungal and bacterial bioaerosols indoor and outdoor of classroom at 8 am and 4 pm (MAS-100, MERCK USA). Tryptic soy agar (TSA) and Malt extract agar (MEA) was used for cultivated of bacteria and fungus, respectively. Lung function was measured for 1026 schoolchildren (HI-801, JAPAN). To investigate the explainability of air pollution for children's lung function, we analyze the air pollution concentration and the abnormal rate of lung function in the same classroom by using multiple regression.

Results and Discussion

The abnormal rate of lung function's parameter was analyzed as the product variables, and the concentrations of air pollutants were analyzed as the explain variables. If combining the data of three schools, ultrafine particles (R^2=10%) and $PM_{2.5}$ (R^2=13.3%) could significantly affect vital capacity (VC)'s abnormal rate. The abnormal rate of VC is defined as (measured VC/predicted VC)*100% below 70%. Ultrafine particles and $PM_{2.5}$ could explain 10%, and 13% of VC's abnormal rate, respectively. For traffic school, ultrafine particles (R^2=13.2%), $PM_{2.5}$ (R^2=19.9%), and O_3 (R^2=19.9%) could significantly explain each R^2= 20% of VC's abnormal rate, respectively. In industry school, the significant factors for VC's abnormal rate were ultrafine particles (R^2=13.1%), indoor fungi (R^2=7.1%), bacteria (R^2=7.5%), and CO (R^2=39.4%). In referece school, ultrafine particles (R^2=12.1%) could significantly affect VC's abnormal rate. Regarding forced expiratory volume (FVC), the significant affecting factors for FVC's abnormal rate were ultrafine particles (R^2=10.92%) and $PM_{2.5}$ (R^2=6.25%). Ultrafine particles, the only significant factor for both industry and traffic school, could explain 12% and 27% of FVC's abnormal rate in traffic and industry school, respectively. In background school, ultrafine (R^2=8.4%), indoor fungi (R^2=6.87%), and CO (R^2=39.4%) were the significant factors.

Table1. The explainability of significant air pollutants for the abnormal rate of children's Vital capacity (VC) by Stepwise model

Traffic	pollutant	Ultrafine	$PM_{2.5}$	O_3	
	partial R^2	13.2%	19.9%	7.0%	
Industry	pollutant	CO	Ultrafine	Bacteria	Fungi
	partial R^2	39.4%	13.1%	7.5%	7.1%
Reference	pollutant	Ultrafine			
	partial R^2	12.1%			
Three schools	pollutant	Ultrafine	$PM_{2.5}$		
	partial R^2	10.0%	13.3%		

Table2. The explainability of significant air pollutants for the abnormal rate of children's forced expiratory volume (FVC) by Stepwise model

Traffic	pollutant	Ultrafine	
	partial R^2	12.1%	
Industry	pollutant	Ultrafine	
	partial R^2	27.4%	
Reference	pollutant	Ultrafine	Indoor fungi
	partial R^2	8%	6.9%
Three schools	pollutant	$PM_{2.5}$	Ultrafine
	partial R^2	6.3%	10.9%