ABSTRACT

Air pollution is a well known risk factor of respiratory diseases throughout the world. Current problem of increasing level of air pollution as well as respiratory diseases in Sri Lanka led to this particular study which was carried out to determine the effect of outdoor air pollution on respiratory health of children living in an urban and a rural area in Kandy district. Kandy municipal council (KMC) area and Yatinuwara divisional secretariat area were selected as the urban and rural area respectively and thirty two grama niladhari (GN) divisions (sixteen from each area) were selected for the study. The study was done in two phases.

For the first phase, a prospective cohort study was carried out over a period of one year starting from 1st September 2004. It estimated the occurrence of episodes of selected respiratory symptoms (cough, nasal discharge, phlegm production, shortness of breath, throat irritation and wheezing) using 1033 children between 7-12 years of age from the urban area (518) and rural area (515) in every month during the year. Basic information regarding children and their household were also assessed using an interviewer administered questionnaire.

For the second phase, two components were included. First component determined the levels of outdoor concentrations of three pollutants (NO_2, SO_2 and Ozone) using passive sampling method in all thirty two GN divisions every month throughout the year. For the second component ventilatory functions were assessed in December 2004 using 173 Sinhalese children (82 from KMC area and 91 from Yatinuwara area) between 10 – 12 years of age

from the same study group used for the phase one. For this part ventilatory functions, forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), forced expiratory flow in the middle 50% of the FVC ($FEF_{25-75\%}$) and peak flow rate (PEFR) were studied.

The results showed that the monthly concentration of the three pollutants studied were significantly higher in urban (KMC) area compared to rural (Yatinuwara) area (NO_2; urban = 0.061 ppm, rural = 0.0158 ppm, $p<0.001$: SO_2; urban = 0.0693 ppm, rural = 0.0149 ppm, $p < 0.001$: O_3; urban = 0.0607 ppm, rural = 0.0206 ppm, $p<0.001$). The monthly levels of NO_2 and SO_2 in KMC area exceeded the recommended air quality standards for Sri Lanka. As monthly O_3 levels were below the recommended air quality standards for Sri Lanka, it was not considered as a risk factor and not considered for further analysis.

The annual averages of episodes of four respiratory symptoms; cough, nasal discharge phlegm production and throat irritation, per child were higher in KMC area compared to Yatinuwara area and the differences were statistically significant (cough; urban = 3.99, rural = 2.23, $p<0.001$: nasal discharge; urban = 4.39, rural = 3.13, $p<0.001$: phlegm production; urban = 2.12, rural = 1.29, $p = 0.003$: throat irritation; urban = 1.52, rural = 0.86, $p<0.001$). However, there was no difference of other two symptoms studied (shortness of breath and wheezing) in both areas (shortness of breath; urban = 0.49, rural = 0.44, $p = 0.6$: wheezing; urban = 0.47, rural = 0.48, $p = 0.92$).

The average duration in days of an episode of each symptom suffered per child was not significantly different between two areas (cough; urban = 3.73, rural = 3.64, $p = 0.44$: nasal discharge; urban = 3.72, rural = 3.91, $p = 0.1$: phlegm production; urban = 3.56, rural = 3.57, $p = 0.97$: shortness of breath; urban = 3.35, rural = 3.46, $p = 0.54$: throat irritation; urban = 3.08, rural = 3.14, $p = 0.62$: wheezing; urban = 3.18, rural = 3.12, $p = 0.78$).

Significant positive correlations were seen between NO_2 levels and episodes of cough and nasal discharge (cough; $r = 0.605$, $p = 0.013$: nasal discharge; $r = 0.531$, $p = 0.034$). However, the other four symptoms did not show a significant correlation with NO_2 (phlegm production; $r = 0.383$, $p = 0.143$: shortness of breath; $r = 0.374$, $p = 0.154$: throat irritation; $r = 0.259$, $p = 0.333$: wheezing; $r = -0.115$, $p = 0.671$). SO_2 levels also did not show a significant correlations with any of the symptoms studied (cough; $r = 0.380$, $p = 0146$: nasal discharge; $r = 0.448$, $p = 0.082$: phlegm production; $r = 0.319$, $p = 0.229$: shortness of breath; $r = 0.420$, $p = 0.106$: throat irritation; $r = 0.209$, $p = 0.438$: wheezing; $r = -0.024$, $p = 0.929$).

The protective factors identified for respiratory symptoms adjusted for confounders were: for cough; increasing age (OR = 0.862, 95% CI = 0.770 – 0.964): for nasal discharge; increasing age (OR = 0.860, 95% CI = 0.751 – 0.983): for shortness of breath; being a male (OR=0.611, 95% CI = 0.455 – 0.820): for wheezing; being a male (OR = 0.7, 95% CI = 0.521-0.940). The risk factors identified for respiratory symptoms adjusted for confounders were: for cough; $NO_2 \geq 0.05$ ppm (OR = 2.621, 95% CI =1.825 – 3.764): for nasal discharge; use of mosquito coils inside the house (OR = 1.822, 95% CI =1.113 – 2.981): for phlegm production; $SO_2 \geq 0.03$ ppm (OR = 1.509, 95% CI = 1.022 – 2.229), $NO_2 \geq 0.05$ ppm (OR = 4.709, 95% CI = 3.078 – 7.205): for throat irritation; $NO_2 \geq 0.05$ ppm (OR = 2.730, 95% CI = 2.099 – 3.552): for shortness of breath; $NO_2 \geq 0.05$ ppm (OR = 3.588, 95% CI = 1.971 – 6.531): for wheezing; $NO_2 \geq 0.05$ ppm (OR = 1.430, 95% CI = 1.062 – 1.925).

Two measurements of ventilatory functions, mean FVC and FEV_1 were higher in KMC area compared to Yatinuwara and the difference was statistically significant (FVC; urban =1.55 l, rural = 1.42 l, p = 0.002: FEV_1; urban = 1.52 l, rural = 1.4 l, p = 0.01). However, the means of other two measurements, $FEF_{25-75\%}$ and PEFR, were not different in the two areas ($FEF_{25-75\%}$; urban = 1.35 l, rural = 1.27 l, p = 0.017: PEFR; urban = 300.12 l /min, rural = 298.13 l / min, p = 0.78). Multiple linear regression analyses identified the predictors for ventilatory functions as sex, height, weight and exposure to biomass combustion (FVC: height; p = 0.002, weight; p = 0.005, sex; p<0.001, exposure to smoke due to biomass combustion; p = 0.018: FEV_1: height; p = 0.019, weight; p = 0.001, sex; p<0.001, exposure to smoke due to biomass combustion; p = 0.035: $FEF_{25-75\%}$: height; p<0.001: PEFR: height; p<0.001, age; p = 0.024, sex; p<0.001).

The air pollution was more evident in the urban areas and most of the episodes of respiratory symptoms also occurred in urban areas. High concentrations of these pollutants in the air predict the occurrence of respiratory symptoms. Programmes to promote respiratory health should aim at reducing levels of air pollutants. However, the other co- pollutants such as particulate matter, carbon monoxide and other co-factors such as allergy also play a role in prediction of respiratory symptoms and ventilatory functions and further research is needed to identify the associations of those factors with respiratory health.