Abstract

This study presents the development and validation of modified air pollution related quality of life (AP-QOL) questionnaire in Indian context. The modified AP-QOL aimed to investigate the association of dietary habits, social life style, medical history and air pollution exposure with cardiopulmonary illness in Indian society. Further, air pollution exposure (APE) scoring scheme was developed and validated using the Delphi technique. The study was carried out in two geographically and social different region including Delhi (Mega city) and Hamirpur, UP (town). Two economically different groups including academician (477) and security guards (519) of Indian Institute of Technology Delhi (IITD) and National Institute of Technology Hamirpur (NITH) participated in a questionnaire survey and health monitoring. Higher number of active smoker participated in IIT Delhi (84) compared to NIT Hamirpur (28). Most of the participants reported routine exercise and clean working environment. A larger number of academician reported the consumption of carbohydrates (77-90% of 272-205), sweet (44-54% of 272-205), and fruits (47-55% of 272-205) compared to security guards, indicated relatively better food habits of academicians. While unhealthy food habit reflected by high consumption of fried foods (74-96% of 448-71) among security guards. A lesser number of participants from academic group reported exposure to cooking (13-20% of 272-205) compared to security guards (62-70% of 448-71). The academician groups at both institutes have access to clean fuel for cooking compared to security guards. Large number academic group of IITD and NITH have reported exposure to road dust (24-35% of 272-448), while minimal number (2-6%) have reported exposure road traffic emissions, waste burning (1-2%), and industries (1%). Compared to academic group large fraction of security guards of both campuses reported exposure to road dust (59-66% of 205-71), and road traffic emissions (34-51% of 205-71).
Overall the academic groups at both institute had better living and working environment compared to security guards, which affect their respiratory illness symptoms.

In comparison to NIT Hamirpur, higher number of IIT Delhi participants have reported respiratory illness symptoms such as cough, dyspnea, and phlegm. After scoring the responses based on quantitative assessment of expert’s, it was found that 29, 22, 49% out of 477 participants at IITD and 27, 30, 42% out of 519 participants at NITH can be grouped under good (<16; below 1st quartile score) moderate (16-23; 1st to 3rd quartile score) and poor (>23; above 3rd quartile) health categories respectively.

Further, the cardiopulmonary parameters were monitored along with ambient PM$_{2.5}$ concentration to investigate the link between them for identified groups of good, moderate and poor health. The PM$_{2.5}$ mass concentration and chemical characterization were done for two year sampling period from January 2013 to December 2015. The high PM$_{2.5}$ concentrations were observed in winters followed by post monsoon, summer and monsoon seasons. The secondary aerosol formation from inorganic ions dominated the PM$_{2.5}$ mass in winter. The mean OC and EC and potassium concentrations were high in post-monsoon compared to other seasons indicated influence of biomass burning to ambient aerosol.

The odd ratios (ORs) of lung functions for IITD academician showed 6-8% increase with an increase in quartile range of PM$_{2.5}$ concentrations. In academic group of NITH, ORs increased by 12.7% for increase in PM$_{2.5}$ concentration in interquartile range. A similar trend was observed for the percentage reduction of Force Expiratory Volume in 1 sec (FEV$_1$/Force vital capacity (FVC) with increase in PM$_{2.5}$ concentrations by 1.4 times between Q1(25$^{th}$ percentile), and Q2 (50$^{th}$ percentile). In academic group of NITH, the ORs for the reduction in FEV$_1$ showed an increase by 14.4% increase in PM$_{2.5}$ concentrations. This finding clearly
illustrated an increasing number of affected population with considerable change (>10%) in respiratory functions with increasing PM$_{2.5}$ concentrations.

The relative risk for cardiac parameters relevant to heart rate variability which induce arrhythmia were analyzed. The standard deviation of normal to normal (R-R) peaks (SDNN) showed a negative association with PM$_{2.5}$, indicating the increasing risk of arrhythmia with increasing PM$_{2.5}$ concentration. The SDNN in the range 50-100 implies medium risk and greater than 100 implies low risk of cardiac attack. The analysis showed there were 28 samples with SDNN between 50-100 and 42 with SDNN greater than 100. The proportion of NN50 (pNN50: NN50 is the number of pairs of the successive NN interval that differs by more than 50 ms to the total number of NN) LF/HF ratio also showed insignificant negative correlation with PM$_{2.5}$. Further relative risk of the change in cardiovascular function with 10 µg m$^{-3}$ increase in PM$_{2.5}$ concentration was estimated as 0.7-3.0 for a non-smoker and 0.3-4.0 for a smoker for various cardiac parameters. The findings from this study showed clear evidence of an increase in cardiopulmonary dysfunctionality with increasing fine aerosol mass concentration.