Indoor particulate matter (PM$_{2.5}$) concentration and lung function impairment among housewives of selected quarters in Mingaladon cantonment

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Abstract. Lung function parameters (FEV$_1$, FVC, FEV$_1$/FVC ratio) were reduced in women cooking with biomass cook stove (54.5%, 45.5% and 57%) compared with those cooking with clean cook stove (42%, 33%, 44%), based on lower limit of normal. Indoor PM$_{2.5}$ concentrations in both groups were below the reference value level (3mg/m$^3$). Although both PM$_{2.5}$ concentrations were not exceeded the reference level, PM$_{2.5}$ concentration was higher in biomass cook stove group (0.055mg/m$^3$) than clean cook stove group (0.501 mg/m$^3$). Relationship between particulate matter concentration and lung function impairments of housewives in both two groups were negatively correlated ($r$=-0.7538, $r$=-0.6877 and $r$=-0.3568). So, lung function was reduced in high PM$_{2.5}$ concentration generated from biomass cook energy sources. In conclusion, lung function impairments were more detected in high indoor particulate matter (PM$_{2.5}$) concentration in study populations.

1. Introduction

Indoor air pollution is ten times more polluted than outdoor air pollution. The health effects of indoor air pollution more worsen than outdoor air pollution in developing countries. Indoor air pollution from biomass fuels represented 3.5 million deaths and 4.5% worldwide daily adjusted life year in 2010. It additionally represented 16% particulate matter pollution. In spite of the fact that there is a decline in household air pollution from biomass fuels in South East Asia, still it positioned third among risk factors in the Global Burden of Disease [1].

There are numerous types of particulate pollutants in living homes. Most of them were came from industrial sources, construction sites, burning origins, dust, and other sources. Particulate matters are additionally created by a wide range of household activities, such as, cooking, strolling over the floor covering and animals. Airborne allergens, form spores, microscopic organisms, and insect excrement are additionally present [2].
Around the world, nearly 3 billion individuals are utilizing conventional biomass fuels, which is the greater number in human history. About more than 2.8 billion individuals are presented to the conventional biomass fuel consuming in developing countries. Further, it is also showed that the households from South Asian Region are dominantly presented to warning levels of PM as the respirable smoke release from utilization of biomass fuels in insufficiently ventilated homes [3].

In 2016, 3.8 million deaths, and 7.7% of worldwide mortality were due to household air pollution. Household air pollution is one of the main sources of illness and unexpected deaths in developing countries. Exposure to smoke from cooking flames causes 3.8 million unexpected deaths every year, for the most part in low-and middle-income countries [4].

World Health Organization shows that particulate matter in the atmosphere can infiltrate deep into the lungs and enter the body, influencing the cardiovascular and other major organ systems. Long term exposure to particulate matter raised the dangers of premature mortality from heart attack, cerebrovascular accidents, respiratory diseases, and lung malignancy. In 2012 investigation by EPA scientists assessed that there were exactly 130,000 unexpected deaths within one year due to increased PM2.5 concentration [5].

2. Materials and Methods

2.1. Materials
This study was conducted in Mingaladon cantonment from June 2019 to October 2019 by using the pre-structured questionnaires from American Thoracic Society, Airborne Particulate Monitor, SKC Tech, Made in USA and Micro plus Lung Function Calculator supported by the Occupational and Environmental Health Division, Department of Public Health, Ministry of Health and Sports, Myanmar.

2.2. Methods
This study was cross-sectional comparative study. The survey was conducted at the Zee Gone family quarter from the ShwePyiThar Township and (106) family quarter under the administration of Mingaladon cantonment in Yangon Region.

Lung functions of all respondents were tested by using micro plus spirometer. Before conducting spirometer testing, interview the housewives to identify health conditions that may interfere with safely performing maximal efforts in a testing [6].

Only 10% of study population was selected from two different populations for particulate matters concentration measuring. The sampler was placed in the kitchen about 8 hours.

3. Results and Discussion
Indoor air quality and indoor air pollutants are currently perceived as a potential origin of health risks to uncovered population all over the world. The most vulnerable population were women and children. The source of indoor air pollution mostly depends on the nature of fuel utilized. Housewives being the primary cook in the home are probably going to be uncovered quite more. About 60% of all IAP-actuated deaths fall on housewives [7].
Figure 1. Distribution of indoor PM$_{2.5}$ concentration.

Figure (1) showed the particulate matter PM$_{2.5}$ concentration was higher in the biomass cook stove group than the clean cook stove group due to more usage of biomass fuels, presence of household smoker and furry pets, situation of kitchen and cooking period.

Biomass using cookers had 5.4 times higher PM$_{2.5}$ concentration than clean fuels using cookers. Biomass using cookers spent 2.5 times more hours per day cooking than clean fuels counterparts. This study indicated that biomass using for cooking substantially increased to indoor particulate matter concentration than clean fuels using for cooking [8].

| Type of Fuel            | No. of Households | Mean (mg/m$^3$) | SD  | T     | p value |
|-------------------------|-------------------|-----------------|-----|-------|---------|
| Households using Clean Cook Stove | 9                 | 0.038           | 0.015 | -33.4 | <0.001  |
| Households using Non-clean Cook Stove | 9             | 0.445           | 0.033 |

A student’s t test was performed to determine the relationship between type of fuel used and measured PM$_{2.5}$ concentration among the two groups and showed that there was statistically significant between two groups. The mean 8 hours concentration of indoor PM$_{2.5}$ level was higher in the households using biomass cook stove (0.445mg/m$^3$) compared to the kitchen using clean cook stove (0.038mg/m$^3$).

There was a significant reduction in the mean particulate matter PM$_{2.5}$ concentration in the clean cook stove group compared with biomass cook stove group (p = 0.02) [9].
Table 2. Relationship between Lung Function Parameters and PM2.5 (n=18).

| PM2.5 Mean (SD) | Lung function parameters | R     | p value |
|-----------------|--------------------------|-------|---------|
|                 | Parameters | Mean (SD) |       |
|                 | FEV1       | 1.204     | -0.69  | 0.002   |
|                 | (0.213)    | (0.466)   |        |         |
|                 | FVC        | 1.713     | -0.60  | 0.008   |
|                 | (0.249)    | (0.647)   |        |         |

FEV1: Forced Expiratory Volume in 1st second, FVC: Forced Vital Capacity

Table (2) showed that relationship between lung function parameters and PM2.5 concentration were statistically significant (p=0.002, p=0.008) because of higher level of particulate matter PM2.5 concentration could decrease the lung function status of housewives due to use of unclean fuels, age of respondents, domestic work at home and lower awareness on indoor air pollution.

There was a strong association between type of fuel and lung function of housewives. The reduction in the lung function status in the biomass fuel exposed women could be due to greater exposure of biomass pollutants with insufficient ventilation in cooking area, leading to the chronic pulmonary disease [10].

Another similar study showed that there was the correlation between exposure to fine particulate matter (PM2.5) level and lung function impairment of biomass fuel group compared to clean fuel group [11].

4. Conclusion
The present study mentioned that the significant association of indoor particulate matters (PM2.5) concentration and lung functions impairment among housewives of selected households in the Mingaladon cantonment. So, the awareness of indoor air pollution and health problems should be promoted among the community regarding with the clean fuel used. Further study and research should be carried out for prevention of indoor particulate matters (PM2.5) pollution and health problems among the most vulnerable population.

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