ORIGINAL ARTICLE

Ambient Air Pollution by Second Hand Tobacco Smoke in Public Entertainment Places In Selected Areas of Lusaka, Zambia

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ABSTRACT

Background: The deleterious effects on health by fine particulate air matter ($PM_{2.5}$) pollution has been studied and established. People who are often exposed to pollutants by inhaling second-hand tobacco smoke are at risk of adverse health consequences such as heart disease and stroke, increased risk of sudden infant death syndrome, acute respiratory infections, ear problems and worsening of asthma symptoms. The objective of the study on which this article reports was to document the prevalence of indoor smoking of cigarettes and the corresponding air quality put in public places in Lusaka.

Methods: The TSI SidePak AM510 Personal Aerosol Monitor was used to sample and record the levels of respirable suspended particles in 40 public places across 4 areas of Lusaka. The TrakPro Data Analysis Software was used to analyse the pollution levels. The data from the other parameters of measurement were entered and analysed using Microsoft excel 2003-2007.

Results: Fifty-five per cent (22) of the venues were observed to have indoor smoking. An overall mean of the number of cigarettes smoked during the air sampling period was 74. The total average number of patrons in all the venues visited was 516, with the mean of 13 per venue. The average total mean for $PM_{2.5}$

levels for both places where smoking was observed and where it was not observed, was above the World Health Organization air quality guidelines regarding/for particulate matter.

Conclusion: Unsafe levels of indoor air pollution were found in public places in Lusaka. Indoor smoking was commonly found in various types of public venues. Comprehensive clean indoor air laws, which completely ban all indoor smoking, regardless of smoking type or physical features of the venue, should be strongly supported and enforced in our country.

INTRODUCTION

The World health Organization framework convention on tobacco control states that "there is no safe amount of fine particulate matter (PM) air pollution levels within an indoor public venue to which one can be exposed without being at risk of adverse health effects"[1]. Substantial epidemiological evidence suggests that fine PM has adverse human health effects. Over the last decade, there has been a growing body of epidemiological and clinical evidence that has heightened concern about the potential deleterious effects of ambient air pollution on health and its relation to heart disease and stroke [1]. Of special interest are several environmental air pollutants that include carbon monoxide, oxides of nitrogen, sulphur dioxide, ozone, lead, and particulate matter. PM constitutes the "thoracic particles" [PM_{10}] <10 μm in aerodynamic diameter, "fine particles" [$PM_{2.5}$] <2.5 μm, and "coarse particles" [PM_{10} to $_{2.5}$] [2]. Some of there are constituents of second-hand tobacco smoke.

Second-hand smoke (SHS) is a complex mixture of the gases and particles from the burning end of a cigarette and exhaled mainstream smoke[2]. SHS contains over 2,500 chemical constituents. Approximately 250 of these are known to be toxic or carcinogenic[3]. Exposure to SHS and other pollutants among children is a major paediatric problem. It is associated with increased risk of sudden

infant death syndrome, acute respiratory infections, ear problems and worsening of asthma symptoms[2]. Pollutants are also associated with increased hospitalisation[4] and mortality due to cardiovascular disease[5–7], especially in persons with congestive heart failure, frequent arrhythmias, or both[8].

The World Health Organization (WHO) has established air quality guidelines (AQG)[6] for particulate matter. This is based on the scientific evidence demonstrating a link between exposure to fine particulate air pollution and adverse health outcomes. To protect the public□s health, the current WHO guidelines for $PM_{2.5}$ pollution is a daily mean exposure of 0.025 mg/m^3.[6] Epidemiological evidence has reported that the levels of PM2.5 pollution in public venues that permit smoking have been found to exceed the WHO recommendation for AQG by severalfold.[5]

To address the widespread public health problem of SHS exposure, a growing number of countries have enacted legislation prohibiting indoor smoking in public places. To encourage broader adoption of such policies, Article 8 of the WHO□s Framework Convention on Tobacco Control (FCTC), the world□s first global public health treaty calls for the implementation of effective measures to protect all people from exposure to SHS[9]. Zambia ratified the FCTC in May 2008.

A comprehensive policy response to SHS exposure first requires the development of an appropriate research base to document the nature and extent of the problem in Lusaka and also within Zambia as a whole. This however has not been done yet.

Therefore there is a need to provide empirical evidence on the extent of the pollution caused by indoor tobacco smoking. The study on which this article reports documented the prevalence of indoor smoking of cigarettes and corresponding indoor air quality in Lusaka. The study was undertaken in the methodology described below.

MATERIALS AND METHODS

The major focus was the sampling of indoor air for $PM_{2.5}$ pollution levels. The immediate outdoor air was also sampled for $PM_{2.5}$ pollution levels to provide a comparison. Other parameters were considered which contribute the levels of the $PM_{2.5}$ air pollution

Study setting and design

The study was conducted in Lusaka, the capital city of Zambia. It was a cross sectional, descriptive - quantitative study in a number of selected areas in Lusaka.

Sample size and sampling

Under the Zambia Tobacco Control Campaign (ZTCC), four areas governed by the Ministry of Health Centres were investigated for the indoor levels of second-hand tobacco smoke emission. These places included Chawama, Matero, George and Chipata compounds. Between March and April 2011, indoor quality was measured in 40 enclosed public places, 10 from each of the four selected areas. Study venues were purposively selected, and included a range of hospitality venues, including cafes, restaurants, taverns, pubs and nightclubs.

Data collection

The TSI SidePak AM510 Personal Aerosol Monitor was used to sample and record the levels of respirable suspended particles. The SidePak is a portable, batteryoperated device using a built in sampling pump drawing air inside the device where the particulate matter in the air scatters the light from a laser. The mass concentration of particles is then calculated based on the amount of light scattered.

A SidePak calibration factor of 0.32 was used. The data-logging interval was 1 minute. The device was turned on and off inside each venue to avoid contamination with outside air. The outside environment was also sampled for the levels of respirable suspended particles, so as to provide a comparison between the indoor and outdoor levels. All these venues were visited at peak time (after 18hrs) when most patrons were present.

During a visit to each venue, the monitoring device was positioned in a central location inside and the air within occupants□ normal breathing area was sampled. This was done in an unobtrusive manner so as not to attract the attention of the patrons and employees of the venues and

not to disrupt their normal behaviour. While the process of air quality monitoring was going on, other observational data was collected. This included; 1, the average number of people in the venue, 2, average number of burning cigarettes, 3, number of "no smoking" signage, 4, presence of ashtrays and, 5, presence of air filtration devices. The first two items of the observational data were counted at the time of entry, after 15 minutes and at the time of exit.

Time spent inside each venue was 30 minutes, with an extra 5 minutes spent monitoring the air just outside and the surrounding environment of each venue. Time of both entry and exit was recorded.

Table 1 below shows the distribution of the public places visited in each area. Minimums of 3 places were visited per evening and at least 3 evenings were spent in each locality.

Table 1. Distribution of public places per area

Venue type	Area			
	Chawama compound	Chipata Compound	George compound	Matero township
Bar	3	2	6	7
Bottle store	0	1	2	0
Night club	3	3	1	1
Pub	3	2	0	1
Restaurant	1	0	0	1
Tavern	0	2	1	0
Total	**10**	**10**	**10**	**10**

Ethical considerations

The University of Zambia Research Ethics Committee approved the study protocol.

Permission to conduct the study was given by the Ministry of Health, Zambia.

Data entry and analysis

Data from the TSI SidePak AM510 Personal Aerosol Monitor on the air quality was entered using the TrakPro Data Analysis Software. The data from the other parameters of measurement were entered and analysed using Microsoft Excel 20032007. Descriptive data including mean, median, minimum and maximum $PM_{2.5}$ levels, mean number of burning cigarettes and mean active smoker densities were determined for each venue.

RESULTS

Smoking was observed in 22 out of 40 venues. The total number of burning cigarettes in these venues was 71. Across all venues, the median number of cigarette smokers was 2.0. The total average number of patrons in all the venues visited was 516, with the mean of 13 per venue. Not a single ashtray or air filtration device was observed in any of the selected venues. Only in 16 venues were the "no smoking" signs observed.

In Chawama compound, 6 out of the 10 venues had burning cigarettes observed in them. This was mainly in pubs and 1 nightclub. The total average number of people who were exposed to second-hand smoke in these venues in Chawama was 64. Smoking was observed in 5 venues (50%) in Chipata compound. This comprised pubs, a tavern and 2 nightclubs. In George Compound, the venues with cigarettes burning were 9 out 10. Matero had the least number of places where burning cigarettes were observed, only in 2 places out of 10. It must be noted that despite certain places having had no one smoking during the period of observation, many cigarette butts were observed on the floor.

Mean $PM_{2.5}$ levels among all the venues visited ranged from 0.018mg/m^3 to 0.278mg/m^3 and the overall mean for these venues was 0.059 mg/m^3. In the venues were smoking was observed, the mean $PM_{2.5}$ concentration levels ranged from 0.018 mg/m^3 to 0.278mg/m^3, and the overall mean was 0.081mg/m^3. In the venues were no smoking was observed during the time of the air sampling, the $P.M_{2.5}$ levels ranged from 0.018mg/m^3 to 0.054mg/m^3 and the overall mean for all these venues was 0.029mg/m^3. Outdoors air quality from all the venues visited had mean $PM_{2.5}$ levels ranging from 0.013 mg/m^3 to 0.213mg/m^3 and the overall mean for all outdoor air sampling was 0.039mg/m^3. The following figures show the findings in the places visited.

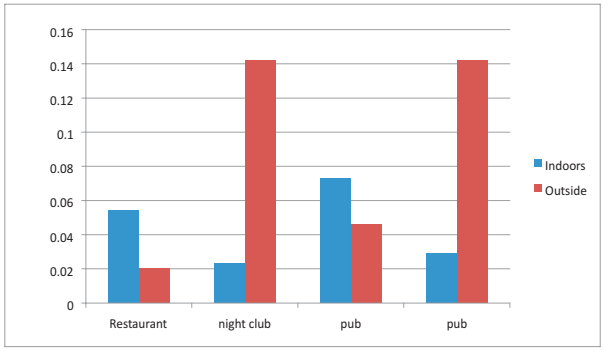

Figure 1. Matero□s levels of PM both indoor and outdoor

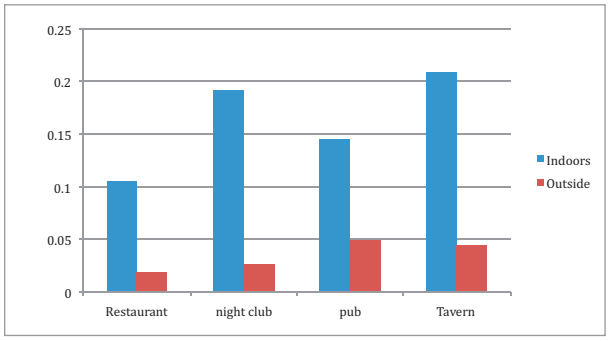

Figure 2. George Compound□s levels of PM both indoor and outdoor

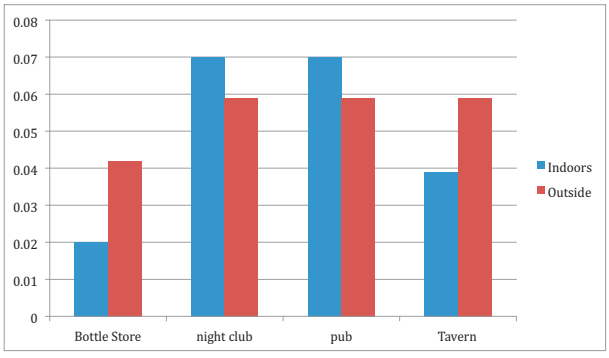

Figure 3. Chipata Compound□s levels of PM both indoor and outdoor

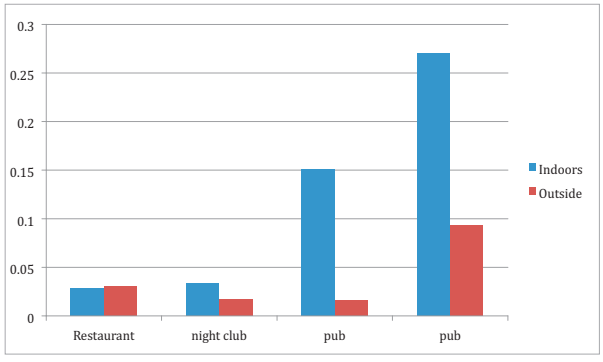

Figure 4. Chawama□s levels of PM both indoor and outdoor

DISCUSSION

The findings of the study provided a basis for reviewing and analysing the policy on

SHS that the Zambian government ratified in May 2008. The world□s first global public health treaty, as found in the FCTC, calls for the adoption of measures to protect the public from „exposure to tobacco smoke in indoor workplaces□[14]. The absence of the enforcement of clean indoor air laws has allowed the continuation of widespread indoor smoking as was observed in more than 50% of the venues visited. The overall mean of $PM_{2.5}$ concentration was 0.081mg/m^3, which is over 69% above that of the recommended AQGs.

The overall mean of P.$M_{2.5}$ levels in the venues were smoking was not observed during the time of the air sampling was 0.029mg/m^3. Even though this was not too much, it was nonetheless higher than the recommended average exposure by the WHO AQG. This seems to indicate a potential fact that indoor smoking did take place in these venues sometime before the sampling was done. The presence of cigarette butts on the floor in these places also confirms this assertion. Despite having „no smoking□ signage in some of the venues, smoking was still observed suggesting a weakness in the enforcement of the „no smoking□ laws in indoor places.

To put the measured $PM_{2.5}$ levels into perspective, a comparison can be made to the WHO□s AQG.[5] According to these guidelines, exposure to $PM_{2.5}$ pollution should not exceed a daily average of 0.025mg/m^3. Among the 22 places where smoking was observed, the overall mean $PM_{2.5}$ concentration far exceeded this value. The most polluted venue had a mean concentration of 0.278mg/m^3. Individuals working in many of these venues are thus exposed for prolonged periods, multiple times per week, to unsafe $PM_{2.5}$ levels. They are also exposed to multiple toxic smoke constituents that include a number of known carcinogens.[2]

The outdoor environment had 13 places with the P.$M_{2.5}$ concentration above 0.025mg/m^3. This was either because the smoke from indoor diffused outside or, as observed in some places, people were smoking outside the premises. The reason was that most patrons who frequented these places preferred to sit just outside the

venue. In some places where the „no smoking rule was enforced; most patrons were forced to smoke just outside the patronised place.

Most venues visited had poor ventilations. They seldom had enough windows to enable the free flow of air. There were often stuffy rooms yet parked with a lot of people. This ventilation problem was worsened by the smallness of most of the public places visited. Even though the internal volume of the places visited were not measured by a specialised instrument, general observation and casual measurement provided substantial evidence for the small volumes of the venues. Therefore these two issues increased the risk of health hazards to the people who frequented these venues and those who worked there.

The elevated levels of indoor air pollution are consistent with measurements taken within smoking-permitted venues in other countries. This underscore the urgent need to implement smoke-free policies to protect employees and patrons. For instance, measurements taken in Romania, Syria and Tunisia, had geometric mean levels of 0.386 mg/m^3, 0.372 mg/m^3 and 0.328 mg/m^3, respectively.[4] Unsafe levels of indoor air pollution were found in public places in multiple cities, and indoor smoking was commonly found in various types of public venues in Lebanon[15]. In jurisdictions that have enacted smoke-free legislation, significant declines in $PM_{2.5}$ pollution[9-11] and related health risks and outcomes[12-14] have resulted after implementation.

CONCLUSION AND RECOMMENDATIONS

The study findings showed that the areas visited where indoor smoking took place had higher levels of particulate air pollution than places without smoking. Places with smoking had $PM_{2.5}$ levels exceeding WHO s target of AQGs.

A need for comprehensive indoor smoke-free air policies in Lusaka was established by the findings of the study. Non-compliance with existing smoke-free policies was the biggest challenge in most places and venue types, highlighting the need for improved enforcement of the no smoking law for indoors-public places.

In view of the substantial epidemiological evidence of the adverse health effects of exposure to second hand-smoke, it is judicious to eliminate indoor smoking, which is a major source of $PM_{2.5}$ particulate pollution, in all venue types. Smoke-free policies consistent with FCTC Article 8, have proven to be an effective means of dramatically reducing exposure to second-hand smoke when properly implemented and enforced.

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