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Full Length Research Paper

Sulphur dioxide as indoor pollutant in Kano municipality Kano-Nigeria

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Indoor sulphur dioxide concentration in Kano has been attributed to closed structured building pattern, substandard housing conditions and use of firewood. Samples of the gas were measured in the different residential districts within the Kano Metropolis; the high medium and low density residential districts. The distribution within the municipality is skewed towards high frequency of low concentrations with a mean and standard deviation of 3.92 ± 1.96 µg/m^3. The mean concentration of the gas in some parts of the city like Goron Dutse, Jakara, K/Mata and Gwale, Fagge, NNDC, Dorayi and Brigade were 5.01 ± 1.51, 4.94 ± 0.14, 3.53 ± 1.21, 4.55 ± 0.85, 5.18 ± 2.82, 4.86 ± 1.43 3.61 ± 1.6 and 3.21 ± 1.17 µg/m^3 respectively. Fagge and Goron Dutse recorded the highest levels of the gas. The home environment within the city is poor. Housing conditions are poor and substandard. Significant portions of the cooking take place in conditions where much of the air borne effluents are released into the living area and people in the inner core of the city rely on gas, wood dung and crop residues for domestic energy.

Key words: Indoor sulphur dioxide concentration, close-settled inner zone, Kano.

INTRODUCTION

Sources of air pollution are diverse and it is impossible to discriminate between them. Domestic sources often surround industrial sources and power or heat generations. Acute and chronic lung function responses to sulphur dioxide exposure have been investigated in a variety of epidemiological studies (Abbey et al., 1991; Abbey et al., 1993; Bates and Sizto, 1987; Lippmann, 1989). In most epidemiological studies, population SO_2 exposures are assumed identical to the concentrations determined at an ambient site. Lebowitz et al. (1985) reported that the assumption may be flawed and concluded that SO_2 exposures indoor may be different. Fixed location measurements do not account for the effects of spatial variation in SO_2 indoor concentrations differences (Benson et al., 1972; Hayes, 1989; Lebowitz et al, 1985). With the development of automatic samplers, indoor micro environments can be determined on a wide scale (Koutrakis et al., 1993).

The Pollution of the indoor atmosphere by sulphur dioxide and other noxious substances arising from the burning of fossil fuels for domestic and wood fuels is a problem whose gravity is increasing in large towns in the developed and developing countries are variously documented (Ross, 1972; John, 1983; Albert, 1992).

Indoor pollution by sulphur dioxide is wide spread since it exists wherever fossil fuels are used. Concentrations may aggravate bronchitis, involuntary coughing reflex, inflammation of the eyes, nausea, vomiting, abdominal pains, sore throat and often pneumonia (Frank, 1964; Wolff et al., 1975).

Sulphur dioxide is a recognized pollutant because of its role in forming cold time smog (Hermann, 1991). It is an acidic, irritant gas which in high concentrations can cause difficulties (Arch, 1954; Hermann, 1961; Purnendu, 1991). The pollutant causes constriction of the airways by stimulating nerves, nose, throat and airways of the lung (Frank, 1964; Wolff et al., 1975). People with asthma are more susceptible to the adverse effects of the gas as high concentrations may result in the fall of lung function in asthmatics and may lead to tight chest, coughing, wheezing and phlegm at high levels. It is a gas considered more harmful than other gases (Beilke and Elshout, 1983; Duesing and Duesing, 1980; Howell, 1983; Hutchinson and Havas, 1980). The effects are worse when exercising and the most vulnerable groups are healthy children, adults with lung disease and asthmatics

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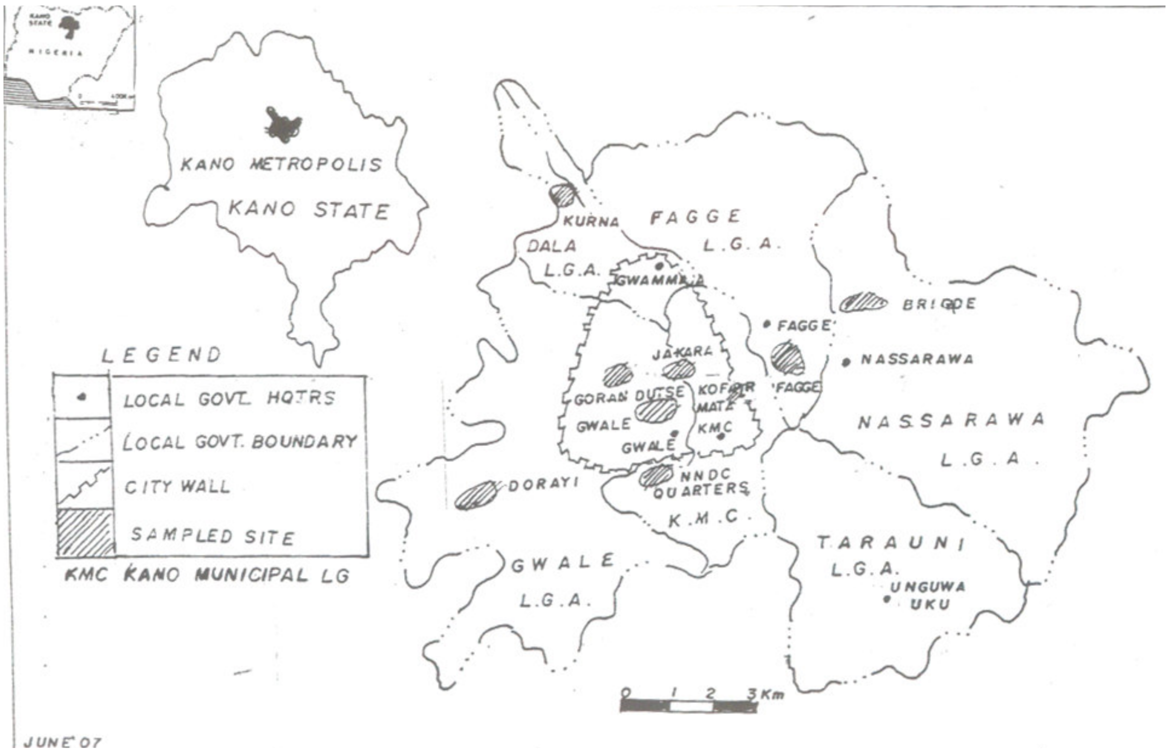

Figure 1. Kano metropolis showing the locations of sampling area.

asthmatics and may aggravate such illnesses as bronchitis (Frank, 1964; Amdur, 1971; Wolff et al., 1975). Textiles have in some cases not only faded (Ajax et al.,1976) or weakened (Slavin, 1963) but dissolved (PHS, 1967).

Other sources of sulphur dioxide apart from the combustion of fossil fuels, incineration of refuse, transport, and the production of elemental sulphur (Cullis and Hirschler, 1980; Moller, 1984) include decay of organic wastes and refuse in the surroundings (Ayodele and Bernard, 2006; Ayodele et al., 2007a and b).

Different workers have employed different methods to determine the concentration of sulphur oxides (Stratman, 1954; Fritz and Yamamura, 1955; Jacobs, 1959 Jacob et al., 1957; Nauman et al., 1960; Perry and Tabor, 1962; Terraglio and Manganelli, 1962;Avrabami and Golding,1968; Atkins 1986;Perry and Purnedu,1991; Kumar and Balasubramah, 1992; Gregory et al., 1993; Bloomquist et al., 1993; Eisele and Tanner, 1993; Saltzman et al., 1993; Vasilenko et al., 1993). By bubbling air through dilute H_2O_2 solution Ayodele and Mohammed, (2001) reported the ambient SO_2 concentration over Kano municipality as in the range 14 - 22 $\mu g/m^3$ with a coefficient of variation of 12.74%. West and Gaeke (1956) used the colorimetric method for the determination of air borne sulphur dioxide. The hydrogen peroxide method of determination was used by Greenburg and Jacob (1956a and b). Huggen (1962) employed the impregnated filter tape for the measurement of sulphur dioxide. Kozlyaeva (1989) reported the determination of air borne sulphur dioxide using evacuated flasks for its collection. This paper reports level of indoor sulphur dioxide in different residential parts of Kano Municipal environment using automatic gas sensors.

MATERIALS AND METHODS

Samples of sulphur dioxide were measured from different locations in the municipality (Figure 1). A total of 1600 samples were taken between October, 2006 and April, 2007 on a continuous basis through out the sampling period. Indoor monitoring was performed in 1600 homes. Indoor samples were collected with sampling times in the evenings when cooking activities were at its peak. Automatic samplers were clipped on a camera tripod and placed a metre from the walls, windows, air-conditioners and other ventilation devices to avoid excess airflow (Ayodele and Bernard, 2006; Ayodele et al., 2007). Samplers were located 1.2 m above the floor so that sulphur dioxide concentrations were measured at about the sitting and breathing zone.

RESULTS AND DISCUSSION

The indoor inputs of sulphur dioxide in the Kano metropolis are as shown in Figure 2 (A - J). Kano metropolis has been subdivided into several sampling zones as shown in Figure 1. The frequency distribution pattern for indoor sulphur dioxide concentration in the municipallity is as shown in Figure 2A. The distribution is multi-modal

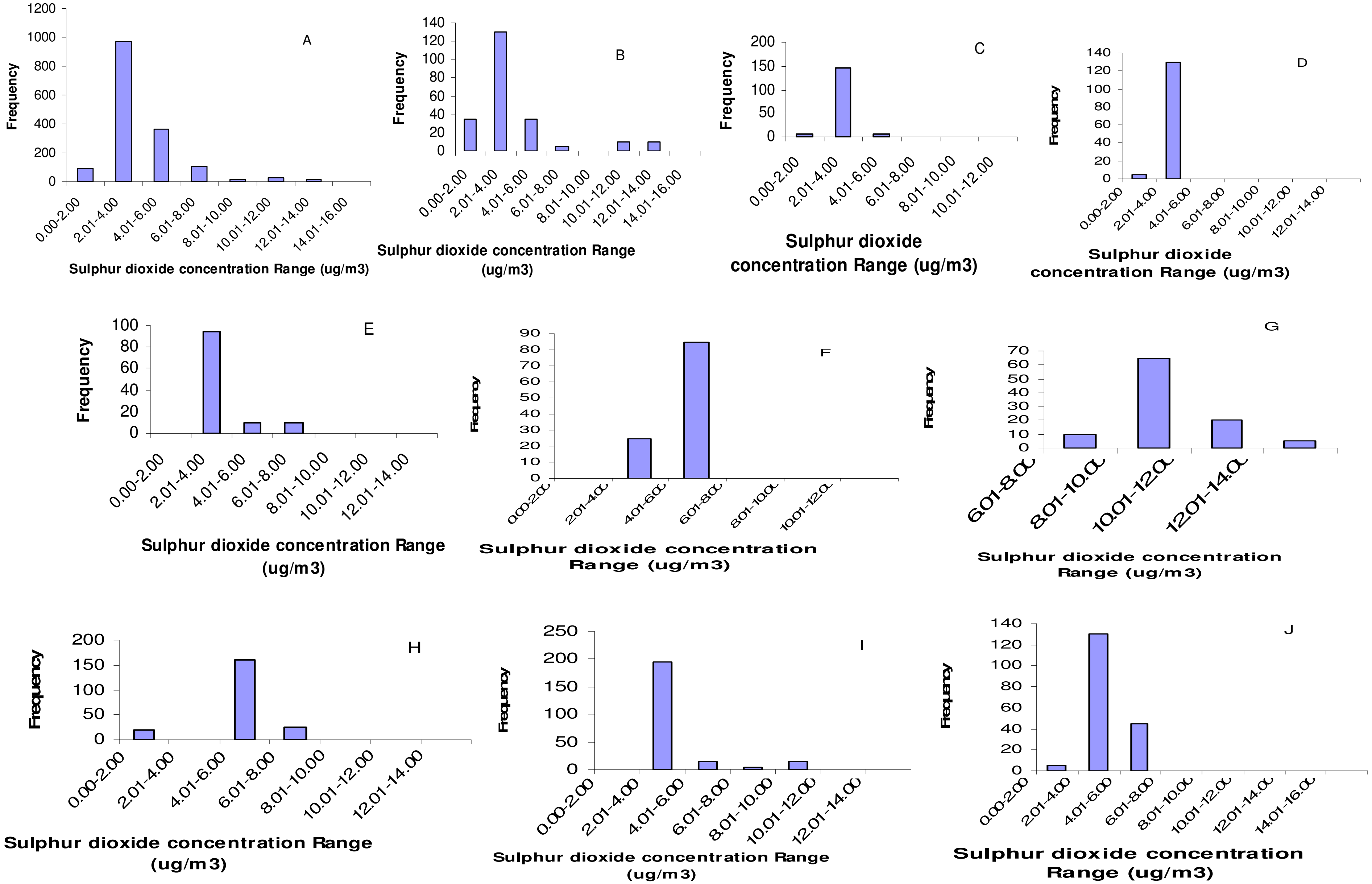

Figure 2. Frequency distribution pattern for sulphur dioxide; (a) Municipality, (b) Kurna, (c) Goron Dutse, (d) Jakara, (e) K/Mata (f) Gwale (g) Fagge (h) NNDC (I) Dorayi and (j) Brigade.

multi-modal and is skewed towards high frequencies of low concentration with a mean and standard deviation of 3.92 ± 1.96 µg/m^3. This distribution pattern may be attributed to the burning of solid and fossil fuels and wood fuels (Howard et al., 1985; Ayodele and Mohammed, 2001). Table 1 shows the means, standard deviation and coefficient of variation for sulphur dioxide gas in the municipality as well as the sampled areas.

The frequency distribution pattern for SO_2 concentration in Kurna is as shown in Figure 2B. The distribution is multimodal and is skewed towards high frequency of low concentration with a mean and standard deviation of 3.89 ± 2.84 µg/m^3. This observed distribution pattern may be attributed to the burning of solid and fossil fuels (Howard et al., 1985).

The frequency distribution pattern for SO_2 concentration at Goron Dutse is as shown in Figure 2C. The distribution is uniformly distributed with a mean and standard deviation of 5.01 ± 0.51 µg/m^3. The observed pattern has been attributed to the burning of solid and fossil fuels, The frequency distribution pattern for SO_2 concentration at Jakara is as shown in Figure 2D. The distribution is symmetrical with a mean and standard deviation of 4.94 ± 0.14 µg/m^3. This observed distribution may be attributed to low traffic flow and maintenance of a clean environment. The frequency distribution patterns of SO_2 concentration at Kofar Mata is as shown in Figure 2E. The distribution is skewed towards high frequency of low concentration with a mean and standard distribution of 3.53 ± 1.21 µg/m^3.

The frequency distribution pattern for SO_2 concentration at Gwale is as shown in Figure 2F. It is skewed towards high frequency of high concentration, with a mean and standard deviation of 4.55 ± 0.85 µg/m^3.

The frequency distribution pattern for SO_2 concentration at Fagge is as shown in Figure 2G. The distribution is symmetrical with a mean and standard deviation of 5.18 ± 2.82 µg/m^3. The frequency distribution pattern for SO_2 concentration in the is as shown in Figure 2H. The distribution is skewed towards high frequency of low concentration with a mean and standard deviation of 4.86 ± 1.43 µg/m^3. The gas concentration observed may be due to the burning of fossil and solid fuels. The frequency distribution patterns for SO_2 concentration at Dorayi is as shown in Figure 2I. The distribution is skewed towards low frequency of low concentrations with a mean and standard deviation of 3.61 ± 1.61 µg/m^3. This observed distribution pattern may be attributed to the several processes such, as well as fuel combustion in stationary sources (primarily electric utilities)(Howard et al., 1985). The frequency distribution patter for SO_2 concentration at Brigade is as shown in Figure 2J. The distribution is skewed toward low frequency of low concentration with a mean and standard deviation of 3.21 ± 1.17 µg/m^3.

Factors influencing the deterioration of materials include the concentration of the pollutant, the reactions of various pollutants, the influence of moisture, the effect of temperature, the amount of sunlight and the degree of air movement including wind speed and direction (Sherwin, 1983).

Table 1. Indoor sulphur dioxide concentration (µg/m^3) within the residential districts in Kano.

Location	Mean ±SD
Municipality	3.92 ± 1.96
Kurna	3.89 ± 2.84
G/Dutse	5.01 ± 0.51
Jakara	4.94 ± 0.14
K/Mata	3.53 ± 1.21
Gwale	4.55 ± 0.85
Fagge	5.18 ± 2.82
NNDC	4.86 ± 1.43
Dorayi	3.61 ± 1.61
Brigade	3.21 ± 1.17

The spatial distribution of the gas may however be useful for the improvement of environmental quality planning, in the reduction of indoor pollution, direction for future development, reduction of pollution in urban area and creation of pollution free zone (Ayodele and Ahmed, 2001).The indoor sulphur dioxide concentrations at and were high because of the ghetto-like living conditions as houses here are poorly ventilated and lacking proper drainages.

Conclusion

Although definite experimental proof may be difficult to obtain, epidemiological and circumstantial evidence has implicated it as a hazard as its solubility ensures that lung penetration is restricted to the upper respiratory tract and the physiological response of the lungs to sulphur dioxide as reflected by measurements of pulmonary flow resistance (Frank, 1964). In addition to having a bad odour, high concentrations of sulphur dioxide can affect breathing, cause respiratory illness and aggravate existing respiratory and cardiovascular diseases.

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