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Effects of Occupational Exposure to Wood Smoke in *Tandoor* Occupants

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Abstract

Exposure to wood smoke leads to mucosal irritation and physiological and neurological abnormalities in human.Blood samples along with histories were taken from 100(50*Tandoor* occupants and 50 controls) male individualsliving in the same locality. SYSMIX KX-21 (Japan) and Shimadzu Double Beam Spectrophotometer 1700 Pharma (Japan) were used for blood profiling and serum biochemistry. In workers, blood cholesterol was 131 ± 4.8 mg/dl, triglyceride was 125 ± 10mg/dl, and serum glutamate pyruvate transaminase level was 68 ± 2.4IU/L and glucose level was 113 ± 2.1 mg/dl. The total red blood cell count was 5.6 ± 0.035mill/cmm, hemoglobin level was15 ± 0.054mg/dl, hematocrit value was49 ± 0.22 mg/dl, mean corpuscular volume was 86 ± 0.22 fl,mean corpuscular hemoglobin was 31 ± 0.12 pg, mean corpuscular hemoglobin concentration was 35 ± 0.12gm/dl, neutrophils were 77 ± 0.50%, lymphocytes were 45 ± 1.0 %, eosinophilswere6.0 ± 0.14%, monocytes were 7.7 ± 0.19 %, total leukocyte count were 11014 ± 115/cmm, and platelets were235864 ± 5491 /cmm. In control group the blood cholesterol, triglyceride, serum glutamate pyruvate transaminase and glucose level was111 ±2.4mg/dl,97 ±1.5mg/dl, 28 ±1.1IU/L and 101 ±1.2 mg/dl respectively, while thetotal red blood cell count, hemoglobin level, hematocrit value, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobinconcentration, neutrophils, lymphocytes, eosinophils, monocytes, leukocyte, and platelets were4.3 ± 0.027mil/cmm, 12 ±0.064 mg/dl, 38 ±0.11mg/dl, 75 ±0.30fl, 25 ±0.37pg, 31 ±0.11gm/dl, 56 ± 0.82%, 34 ± 1.0, 3.1 ± 0.20%, 4.2 ± 0.12%, 6573 ± 125, and 169162 ± 2454 /cmm respectively.The levels in both groups were statistically compared using *t* test and the p value was determined.The results showed that there was significant increase in blood biochemical parameters as well as in complete blood count in workers as compared to control and are therefore at more risk to heart, lungs and blood diseases.

Keywords: *Tandoor*, Wood smoke, Hematology, Blood biochemical parameters

1. Introduction

A *Tandoor* is a cylindrical clay oven used for cooking and baking in many countries like Pakistan, India, Turkey, Iran, Afghanistan, Burma and Bangladesh (Steven 2011). Burning wood used in Tandoor emits toxic particles in air that contains carbon monoxide (CO),

Nitrogen Oxides (NOx), Volatile Organic Compounds (VOCs), Dioxin, and Inhalable Particulate Matter (PM) (Minnesota Pollution Control Agency 2012) due to which cardiovascular, coronary artery diseases, cerebro-vascularsdiseases and venous thrombo-embolism occurred in people that are exposed (Fraanchini 2011). According to the recent studies, each year, ten of thousands of premature cardiovascular death occurs, the mechanisms of which remain uncertain (Schwartz 2001). Long time exposure also leads to death from coronary heart diseases (Nemmar et al 2006). Air pollutant when inhale, affects blood pressure (Simkhovich et al 2008). The improved stove intervention was associated with 3.7mm Hg lower systolic blood pressure (SBP) after adjusting for age, body mass index, smoking, second hand tobacco smoke, apparent temperature, season, day of week and time of day (Mccracken 2010). Exposure to wood smoke leads to irritation of the mucous as well as physiological and neurological effects in human (Riddervold et al 2011) and they causes reduced lung function in rural Africans (Fullerton et al2011). The particulate matter in kitchen is associated with chronic obstructive pulmonary diseases and lung cancer in women (Perez et al 2010).In Pakistan 94% of households in rural areas and 58% in urban areas depend on biomass fuels (wood, dung, and agricultural waste) due to incomplete combustion of the biomass fuels, the resulting smoke contains a range of health-worseningsubstances that, at varying concentrations, can causea serious threat to human health. Indoor air pollution accounts for 28,000 deaths a year and 40 million cases of acute respiratory illness. It places a significant economic burden on Pakistan with an annual cost of 1% of GDP (Colbeck et al 2010). The present study was conducted to study the general health status of *Tandoor* occupants exposed to wood smoke and its effects on blood biochemical parameters of the occupants and hematological parameters.

2. Materials and Methods

Questionnaire

For the present study,a standard questionnaire was formulated for collecting specific information from *Tandoor* occupants and control group regarding their age, marital status, type of fuel, addiction, health status, exposure time to smoke and other particulars. The study was approved by the ethical board of University of Malakand.

Data collection

The study was approved by the ethical board of University of Malakand. During sampling, 100 (50 workers irrespective to their age and working hours in *Tandoor* and 50 controls) maleindividuals were selected. A written consent was signed from all individuals before taking interviews.The blood samples from *Tandoor* occupants and healthy individuals (Control) were collected from (Chakdara, Gulabad and Tazagram), at Dir (Lower), Khyber Pakhtunkhwa, Pakistan, that was made in October, 2011 till April,2012.

Blood sampling from *Tandoor* occupants

Blood sample (5 ml) was taken from the workers and 3 ml of the blood was transferred to heparinized test tube for blood profiling. Blood sample (2 ml) was transferred to other test tube having no any anticoagulant for isolation of serum that was used for biochemical tests. The

samples were immediately analyzed and those which were kept pending, transferred to -20 ℃ refrigerator for storage.

Blood sampling from control

The people living all around the area near *Tandoor* shops were kept as control. A total of 50 people were randomly selected from those areas. Same procedure was adopted for collection of blood and isolation of serum as that of workers.

Serum isolation

Test tubes were kept in slant position. Serum oozed out, and transferred to the other sterilized test tubes. Serum was used for analysis of different chemicals (Cholesterol, Glucose, Serum Glutamate Pyruvate Transaminase (SGPT) and Triglycerides (TG) in blood.

Equipment used

SYSMIX KX-21(Japan) was used for the determination of complete blood profile and Shimadzu Double Beam Spectrophotometer 1700 Pharma (Japan) was used for blood biochemistry.

Statistical analysis

The data obtained was statistically analyzed. Mean, standard deviation, column statistics/row statistics and*t* test were used for the comparison of both the groups (control and workers) were performed for each parameter using Graphpad Prism, Demo version 05 (www.graphpad.com).

3. Results and Discussions

The present study is based on studying the effects of *Tandoor* smoke on health status of the occupants. The adverse effects of the toxicants in wood smoke are a common phenomenon in all the developing countries. The awareness about this problem is lacking in Pakistan, particularly in Khyber Pakhtunkhwa. To collect the specific information from workers as well as control, a questionnaire was formulated regarding their age and health status. The information collected was summarized (Table.1).The results of biochemical parameters such as Cholesterol, Triglycerides, Glucose, SGPT and complete blood profile of both workers and control are listed(Table.2).

History of workers and control

In the present study, both workers and control group were divided into different age groups. Control group was mostly normal (Table. 1) while workers, who were frequently exposed to wood smoke, had hypertension, lungs abnormalities, chest pain and physical weakness (Table. 1). These problems were correlated with age and thus more prominent in elder people than young ones.Kodgule and Salvi 2012 stated that increased mortality and morbidity is associated with exposure to biomass smoke. Minnesota Pollution Control Agency2012 have also given same report that irritation of eyes, lungs, throat and sinuses, increases severity of existing lung diseases such as asthma, emphysema, pneumonia and bronchitis, and chronic obstructive lung disease and chronic bronchitis are associated with short term and long term exposure to wood smoke.Kunzliet al2006studied exposure to heavy smoke of wildfires and concluded thatthe nose, eyes, and throat irritations, cough, bronchitis, cold, wheezing, asthma attacks were associated with

individually reported exposure differences within communities.Rajpandey 1984 found that wood smoke inhalation causes chronic bronchitis in adults; chronic interstitial pneumonitis andfibrosis (Ramage et al 1988), interstitial lung disease, pulmonary arterial hypertension (Sandoval et al 1993), and altered pulmonary immune defense mechanisms (Demarest et al 1979 and Ramage et al 1988).

Table 1. History of workers and control

Age Group (Years)	No. of Workers	Economic status	Marital Status	Type of Fuel used	Exposure Time (Months)	Addiction (%)	Use of Mask	Health status (Before Job) (%)	Health status (After Job) (%)
Workers 18-25	20	Poor	15 Unmarried 05 married	Wood	72-90	09 Snuff 00 Cigarettes	No	No Specific	06 RTI*, 03 Rhinitis, 08 Eye discharge, 02 Hypertension
26-33	15	Poor	06Unmarried 09 married	Wood	120-140	10 Snuff 01Cigarettes	No	02 GIT* disorders.	05 RTI*, 03 Rhinitis, 02 Eye discharge, 05 Hypertension
34-41	10	Poor	02Unmarried 08 married	Wood	110-120	10 Snuff 00 Cigarettes	No	01 G.B.A*.	10 RTI*, 05Rhinitis, 05 Eye discharge 00 Hypertension
42-49	5	Poor	00 unmarried 05 Married	Wood	140-160	07 Snuff 02 Cigarettes	No	05 Physical weakness	03RTI*, 03Rhinitis, 02 Eye discharge, 01Hypertension, 02 Lumbago, 04 Chest pain
Control 18-25	22	Poor	17 Unmarried 05 Married	No	00	03 Snuff 00Cigarettes	No	00	00
26-33	13	Poor	01 Unmarried 12 Married	No	00	06 Snuff 00 Cigarettes	No	00	00
34-41	8	Poor	00 Unmarried 08 Married	No	00	03 Snuff 00 Cigarettes	No	00	00
42-49	7	Poor	00 Unmarried	No	00	00 Snuff 00	No	00	00

			07 Married			Cigarettes			

*RTI: Respiratory Tract Infection, *GIT: Gastro Intestinal Tract, *GBA: General Body Aches,

Blood Cholesterol

The mean and standard deviation of workers was high (131 ±4.8mg/dl) as compared to control (111 ±2.4 mg/dl) for cholesterol (Table2).Particulate matter coming from fossil fuel can cause atherosclerosis, thrombosis (Nemmar et al 2006),affects blood pressure(Simkhovich et al 2008) and increases risk of coronary events(Bareegard et al 2006). It may be concluded that wood smoke has an ill effect on health by raising the blood cholesterol level.

Blood Triglycerides

Blood triglyceride level in workers was high (125 ± 10 mg/dl) as compared to control (97 ± 1.5mg/dl) (Table 2).The smoking raises triglyceride level (American Heart Association 1983)and raises the Low Density Lipid (Mikhailidi 1998).

Serum Glutamate Pyruvate Transaminase (SGPT)

SGPT level of workers and control was 68 ±2.4 IU/L and 28 ±1.1 IU/L (Table 2). Workers have high SGPT level. The serum alanine aminotransferase (ALT) about 1.5 fold the normal limit is caused by the inhalation of smoke having high concentration of Hydrocarbons and Chlorinated vapors (Loh et al 2006). Among HCV seropositive subjects smoking and alcohol consumption significantly elevated ALT level (Wang et al 2002).

Blood Glucose

There was a significant increase in blood glucose level of workers (113 ±2.1 mg/dl) as compared to control group (101 ±1.2mg/dl) (Table 2). Same results have also been given byBornemisza and Suciu 1980 after smoke inhalation and blood glucose level raised as compared to control group.

Blood profile

Total Red Blood Cells (TRBC) count

The TRBC in workers was5.6 ±0.035 mil/cmm and in control was 4.3 ±0.027 mil/cmm(Table 2). Workers have high TRBC than control. Smoking at high altitude further increases RBC count(Ramirez et al 1991). Roethig et al2010stated that by stopping smoke cigarette, a significant decrease up to 9% in RBC is reported within three days. It has been concluded that wood smoke increases total red blood cell count.

Hemoglobin

The hemoglobin level in workers was 15 ±0.054mg/dl and in control was 12 ±0.064mg/dl(Table 2). The smoking increases the hemoglobinlevel both in men and women (Nordenberg et al1990 andBinkin et al 1993).

Hematocrit Value

The Hematocrit level in workers was 49 ±0.22mg/dl while in control was 38 ±0.11mg/dl(Table 2).

The present study is also in correlation with Goldbourt and Medalie1977,who determined that current smokers have high hematocrit level than non smokers.

Mean corpuscular Volume

The MCV in workers was 86 ±0.22fl and in control was 75 ±0.30fl(Table 2). Same results have been reported by Kondo et al1993.

Mean Corpuscular Hemoglobin

The MCH for workers was 31 ±0.12pg and for control, was 25 ±0.37pg(Table 2).The results are in agreement with Kondo et al1993, who found that in smokers MCH level is high. It has beenconcluded that MCH level is raised when compared to control.

Mean Corpuscular Hemoglobin Concentration

The MCHC was high in workers (35 ±0.12gm/dl) as compared to control (31 ±0.11gm/dl)(Table 2). Similar resulthas also been reported by Kondo et al1993,who found that individual chronically exposed to smoke has higher level of MCHC.

Neutrophil

In control, neutrophils count was 56 ±0.82%, while in workers it was77 ±0.50%(Table 2).Human exposure to diesel particles for 1 hour at 300 microgram/cubic meter resulted in increased level of peripheral neutrophils(Schwartz 2001).

Eosinophils

For workers, the mean value of eosinophil was 6.0 ±0.14% and for control was 3.1 ±0.20%(Table 2).Lal et al1993obtained similar results by exposing rats to wood smoke for 30 and 45 days and found increased number of esosinophils in the blood.

Lymphocytes

There was a significant increase in lymphocyte count of workers (45 ± 1.0 %) as compared to control (34 ± 1.0 %)(Table 2).Lymphocyte percentage is associated with smoking and is therefore higher in smokers (Huang et al 2001 and Rutgerz et al 2000).

Monocytes

The mean count of monocyte for workers was 7.7 ± 0.19% while for control was 4.2 ± 0.12% (Table 2). Present results are in agreement with the finding of Adams et al1997and Huang et al2001. They found that smoke increases monocyte count. Ray et al2006found that biomass smoke exposure causes activation of monocyte.

Total Leukocytes Count

The TLC was high in workers (11014 ±115/cmm) as compared to control (6573 ±125/cmm)(Table 2).Thesmoke exposure increase white blood cells count (Yanbaeva et al 2007 and Megan 2003). Kondo et al1993studied the relationship of cigarette smoke and hematological parameters and analyzed that smoking increases TLC.

Platelets

The mean value of platelets for workers was 235864 ± 5491/cmm and for control were169162 ± 2454 /cmm(Table 2).Milton and Cuyler1956, Reed et al2006,Ray et al2006and Sithu et al2010havestated same results.

Table 2. Comparative analysis of the blood biochemical parameters of the control and *Tandoor* occupants.

Parameters	Control	Workers	95% C.I	P value
	Mean ±SD	Mean ±SD		
Glucose	101 ± 1.2	113 ± 2.1	-16 to -6.7	< 0.0001
Lymphocytes	34 ± 1.0	45 ± 1.0	-14 to -8.5	< 0.0001
Platelets	169162 ± 2454	235864 ± 5491	54749 to 78654	< 0.0001
SGPT	28 ± 1.1	68 ± 2.4	-45 to -34	< 0.0001
Hb%	12 ± 0.064	15 ± 0.054	2.8 to 3.1	< 0.0001
HCT	38 ± 0.11	49 ± 0.22	10 to 11	< 0.0001
Cholesterol	111 ± 2.4	131 ± 4.8	-31 to -9.3	.0003
MCH	25 ± 0.37	31 ± 0.12	5.5 to 7.1	< 0.0001
MCHC	31 ± 0.11	35 ± 0.12	3.2 to 3.8	< 0.0001
MCV	75 ± 0.30	86 ± 0.22	10 to 12	< 0.0001
Neutrophil	56 ± 0.82	77 ± 0.50	-23 to -19	< 0.0001
Eusinophils	3.1 ± 0.20	6.0 ± 0.14	-3.4 to -2.4	< 0.0001
Monocytes	4.2 ± 0.12	7.7 ± 0.19	-3.9 to -3.0	< 0.0001
TG	97 ± 1.5	125 ± 10	-48 to -8.0	0.0066
TLC	6573 ± 125	11014 ± 115	-4778 to -4104	< 0.0001
TRBC	4.3 ± 0.027	5.6 ± 0.035	1.2 to 1.4	< 0.0001

SD= Standard Deviation, C.I= Confidence Interval

4. Conclusion

From the present study, it is concluded that wood smoke has harmful effects on the persistently exposed people. In workers,wood smoke exposure leads to hypertension, lungs infection, dry cough, chest pain and physical weakness. In adults such problems were more severe as compared to young ones. It has been concluded that workers are at more risk to heart and liver diseases because the biochemical parameters such as SGPT, blood cholesterol, blood triglyceride and blood glucose level were found high as compared to control group. Such workers are also at more risk of getting lungs infections/abnormalities as compared to control group.

Recommendations

To check the effects of chronic exposure to wood smoke and its toxicants; a study on large population should be performed, and a work on female *Tandoor* occupants will also be necessary in the same locality. The printed as well as electronic media should aware the people from the hazardous effects of wood smoke generating during cooking and baking process.

Limitations

In present study, a small number of population sizeand only the male individuals were considered. The toxicants inindoor environment of work place were not measured due to unavailability of facilities.Toxicants were not measured in blood, it is recommended to check the toxicants in indoor environment as well as in blood to co-relate the results and to boost the validity of the results.

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