Indoor Air Pollution and the Risk of Cardiovascular Disease

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ABSTRACT

Objective: To measure an association between factors related to indoor air pollution and CVD in the Hail population of Saudi Arabia.

Methodology: A case control study was conducted in King Khalid hospitals. Convenience and random sampling techniques were used to recruit cases and controls. Structured Questionnaire was used to collect data from 302 CVD cases and 300 controls. Data analysis was carried out using SPSS 24.0 statistical software.

Results: The bivariate analysis showed significant association between (i) socio-demographic characteristics (ii) air quality and occupation related variables (iii) ventilation and cooking related factors and (iv) exposure of different types of smoke, and CVD (p<0.001). The independent risk factors of CVD by Multivariate logistic regression analysis with adjusted odds ratios of variables are: age groups (25-50 & >50 years) (2.95&22.84); education level (uneducated & primary) (4.39&2.64); cigarette smoking (1.89); shisha smoking (2.12), exposed to cigarette smoke (2.50); burning scented wood (3.09), burning of mosquito repellent (2.18) and kitchen type (2.83) (p<0.001).

Conclusions: This study shows various sources of air pollutants are associated with CVD. The composition of indoor and outdoor air is same in Hail city but amount of contaminants is high in indoor environments. Future studies longitudinal studies are required to confirm the findings of this study.

Keywords: Air Pollution, Cardiovascular Disease, Particulate Matters, Hail City, Saudi Arabia.

I. INTRODUCTION

Mounting body of clinical and epidemiological evidence has implicated air pollution as an emerging risk factors for human diseases [1]. Presently, major important risk factors for contributing cardiovascular disease (CVD) disability and mortality are documented as air pollution [2]. Initially, Broek et al [3] has announced scientific statement as “Air pollution and CVD” through the evidence provided by American Heart Association (AHA) which has the effects of particulate matter (PM) on CVD health and in 2004, AHA confirmed as PM contributes to cardiovascular morbidity and mortality. Due et al [4] studies confirm as indoor air pollution is an evolving problem for environmental health because PM may be robustly associated with CVD risk. Globally, every annum, air pollution is deemed to be responsible for several million premature deaths. Specifically, ambient air pollution has been documented as fifth largest risk factors [5]. However, indoor air pollution has become an important health issues in developing countries; globally [4], [5] million were register for annual deaths and extensively, studies in subway metros, homes, schools, hospitals, restaurants, and offices6. The indoor air pollution issue has been started since 1960s and concentrated on nitrogen dioxide (NO2), carbon monoxide (CO) and particles to control and reduce the risk of CVDs7.

Since decade and above, magnitude evidence and multiple studies connected outdoor air pollution to CVD has ripen dramatically and an anxious is associated with air borne particles such as (PM10 and PM2.5) with adverse outcomes of CVD are casual as per AHA committee [8]. Arrhythmia, cardiac arrest, heart failure and diseases are connected with long-term exposure of PM2.5, verified to be associated independently for mortality of CVD [9], [10]. Short-term exposure of PM10 incorporate susceptible to in complete CVD mortality. Different global studies have confirmed high ischemic strokes in straight relation to modify in an ambient concentration [11]-[13].

Over the years, researchers have documented evidence identifying biomass fuels as crucial sources of pollutants that increase ill health in humans. In this sense, other indoor pollutants have been associated with increased disease risk [14]. Rokoff et al [15] indicates the particles that are emitted from residential wood burning escape the indoor environment through the chimneys, doors, and windows. Limited studies have been carried out in the Saudi population. Therefore, present study aims to quantify the risk factors related to with indoor air pollution and its association with the prevalence of CVD in the Hail population of Saudi Arabia.
II. METHODS

A. Study Settings

This study was carried out in 2018, at Cardiac center of King Khalid, general and government hospitals in Hail city, Saudi Arabia.

B. Study Subjects

A total of 302 cases and 300 controls constitutes the study subjects of this study. CVD cases were defined as patients diagnosed with the disease in the past year. Eligible cases were identified among those admitted to the coronary care unit with a doctor’s diagnosis confirmed by cardiologist based on clinical presentation and laboratory examinations with: ST /non-ST elevation myocardial infarction, stable/unstable angina, or heart failure. At least one control for each case were recruited from the same hospital, matched by age (±5 years). Controls were recruited from non-CVD-related clinics.

C. Data Collection Methods, Instruments Used, Measurements

A pre-tested questionnaire was used to collect demographics, the perception of indoor air quality, sources of indoor pollutants, outdoor activities, smoking, and other activities. Informed consent was obtained from study participants. Ethical approval was obtained from Institutional review board.

D. Data Analysis

Data were analyzed using SAS statistical software version 9.4 (NC, USA). Descriptive statistics (frequencies, percentages, mean and standard deviation) were used to describe categorical and quantitative variables. Pearson’s Chi-square test and odds rations were used to test and measure an association between categorical study variables and CVD. Binary logistic regression was used to identify the independent risk factors of CVD. A p-value of <0.05 and 95% confidence intervals for OR were used to report significant and precision values.

III. RESULTS

The comparison of socio-demographic characteristics between cases and controls shows high statistically significant association of the variables: gender, age group, level of education, family income, current house, type of building and sports activity with CVD. For gender higher proportion of female (57.7%) were suffering with CVD when compared with male subjects (46%) which is statistically significant (p=0.006). In relation to the age group, about 87.5% of them who were >50 years of age suffer with CVD when compared with only 10.6% with < 25 years of age and 32.2% between 25 to 50 years of age which is highly statistically significant (p<0.0001). For level of education about 81.7% of subjects who were suffering with CVD, 52.3% of subjects with primary education level and only 23.6% of subjects with university degree were suffering with CVD which is highly statistically significant (p<0.0001). In relation to the monthly family income, lower income (<5000) subjects and those with income of 5000-15000 were suffering with CVD (54.7% & 49.4%) when compared with the subjects whose income is >15000 (32.8%), which indicates statistically significant difference (p=0.009). Also, the variables “current house” and “type of building” are highly statistically significantly associated with CVD. That those subjects who were residing (61.6%) in village and those who were residing in Villa (58.9%) were suffering with CVD when compared with those subjects who were residing in coastal city & in Inland city and those who were in apartment, shows highly statistically significant (p<0.0001; p<0.0001). Also, the higher proportion (59.3%) of those subjects who were not performing sports activity suffering with CVD when compared with those who perform sports activity (41.4%) which is highly statistically significant (p<0.0001). The corresponding odds ratios also shows statistically significant association (Table 1).

| Table 1: Association between socio-demographic characteristics, sport activity and CVD |
|---|
| Characteristics | Cases No.(%) | Controls No.(%) | Total No.(%) | p-value | Odds ratio (95% CI) |
| Gender | | | | | |
| Male | 179(46) | 210(54) | 389(100) | 0.006 | 1.0 |
| Female | 123(57.7) | 90(42.3) | 213(100) | 1.60 (1.14,2.25) |
| Age group(in years) | | | | | |
| <25 | 10(10.6) | 84(89.4) | 94(100) | <0.0001 | 1.0 |
| 25-50 | 89(32.2) | 187(67.8) | 276(100) | 3.99 (1.98,8.07) |
| >50 | 203(87.5) | 29(12.5) | 232(100) | 58.80 (27.43,126.03) |
| Level of Education | | | | | |
| Uneducated | 147(81.7) | 33(18.3) | 180(100) | <0.0001 | 14.44 (8.88,23.46) |
| Primary education | 101(52.3) | 92(47.7) | 193(100) | 3.56 (2.34,5.39) |
| University degree | 54(23.6) | 173(76.4) | 229(100) | 1.0 |
| Family Income(in SR) | | | | | |
| <5000 | 157(54.7) | 130(45.3) | 287(100) | 0.009 | 2.48 (1.37,4.49) |
| 5000-15000 | 126(49.4) | 129(50.6) | 255(100) | 2.00 (1.10,3.66) |
| >15000 | 19(32.8) | 39(67.2) | 58(100) | 1.0 |
| Current house | | | | | |
| Inland city | 210(50.1) | 209(49.9) | 419(100) | <0.0001 | 1.0 |
| Coastal city | 25(5.6) | 34(94.4) | 36(100) | 0.06 (0.01,0.25) |
| Village | 90(61.6) | 56(38.4) | 146(100) | 1.60 (1.09,2.35) |
| Type of building | | | | | |
| Apartment | 63(32.1) | 133(67.9) | 196(100) | <0.0001 | 1.0 |
| Villa | 238(58.9) | 166(41.1) | 404(100) | 3.03 (2.11,4.34) |
| Sports activity | | | | | |
| Yes | 125(41.4) | 177(58.6) | 302(100) | <0.0001 | 2.06 (1.49,2.85) |
| No | 176(58.6) | 121(40.7) | 297(100) | |

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The comparison of variables related to the ventilation factors and cooking factors shows highly statistically significant association between type of kitchen in house, ventilation area between walls and roof in kitchen, cooking source type & use of Chimney and CVD. Higher proportion of subjects who were used connected kitchen (56.6%), no ventilation area between walls and roof in the kitchen (58.1%), those who were using wood burning stove (66.7%), those who were not using Chimney (55.5%) were suffering with CVD when compared with those who were using isolated type of kitchen in house (34.1%), had ventilation area between walls and roof in kitchen (43.4%), those who use electric/gas stove (49.2%) and those who use Chimney (35.5%). All these comparison shows highly statistically significant difference with low p-values of <0.0001 also its corresponding odds ratios indicates highly statistically significant association (Table 2).

| Risk factor | Adjusted odds ratios (95% CI) |
|-------------|-----------------------------|
| Age group (in years) |                         |
| <25 | 1.0 |
| 25-50 | 2.95 (1.37, 6.38) |
| >50 | 22.84 (9.43, 55.33) |
| Level of Education |             |
| Uneducated | 4.39 (2.22, 8.68) |
| Primary education | 2.64 (1.52, 4.59) |
| University degree | 1.0 |
| Current cigarette smoker (YES) | 1.89 (1.22, 3.38) |
| Current Sisha smoker (YES) | 2.12 (1.89, 5.53) |
| Exposed regularly to other people’s cigarette smoke at work (YES) | 2.50 (1.24, 5.03) |
| Do burn scented wood at home (YES) | 3.09 (1.82, 5.24) |
| Do apply burning mosquito repellent (YES) | 2.18 (1.64, 4.90) |
| Type of kitchen in house (Connected) | 2.83 (1.64, 4.90) |

Table 4: Independent risk factors associated with CVD using binary logistic regression.
Cardiovascular disease is a widespread ailment associated with inhalation of contaminated air. The World Health Organization shows particulate matter in air causes more than 800,000 premature deaths each year around the world. Thus, air contamination is a major health risk to humans [16]. Individuals exposed to polluted air are at a high risk of cardiovascular disease, which can result in mortality.

The study has established that the risk of CVD varies in the community based on different socio-demographics factors. In a sample of 300 individuals with CVD, more women (57%) stated that they suffered from CVD. About 46% of men stated that they suffered from the disease. The results confirm the findings from literature, which show that women and children are at a higher risk of CVD compared to men because they spend more time in the home preparing food in highly polluted environments [17]. The results imply that combustion of biomass such as wood and charcoal in open spaces in homes is a significant risk factor for CVD among women. The earlier study indicates that organic carbon consists about 50% of particulate matter generated through biomass combustion [18]. Therefore, women and children are exposed to contaminated indoor air as they spend much of their time in the kitchen. The results indicate that 87% of the research subjects aged above 50 years are affected by CVD. The results suggest that aging increases the risk of CVD as a result of inadequate physical activity in addition to exposure to harmful indoor environment. As shown in the literature review, adults living in homes with increased concentration of particulate matter are at a high risk of CVD and other related ailments [19]. Strategies for alleviating CVD should target the elderly in contaminated areas to reduce the prevalence of the disease in the group. It is also essential to encourage regular exercise among aged individuals to minimize the spread of CVD. Individuals aged between 25 and 50 years also exhibit a high prevalence of CVD. In the research, about 32% of the subjects with the disease were aged between 25 and 50 years. Even though individuals in the age group are highly likely to lead an active lifestyle, they are exposed to polluted indoor air conditions that increase the prevalence of CVD [20].

Based on educational level, uneducated individuals had higher cases of CVD (81.7%) compared to people with primary (52.3%) and university education (23.6%). The findings show that literacy levels are associated with people’s knowledge of risk factors for CVD. People with university education experience the lowest percentage of CVD cases because a majority are aware of conditions that cause the disease. Health promotion programs should target uneducated groups to create awareness of the main causes of CVD and ways of minimizing the risk of developing the disease. The level of education also determines individuals’ socio-economic status, which influences living conditions [21]. Lee et al [21] carried out a study at 6 residential buildings in Hongkong to check the indoor air quality and the study results confirm indoor air quality at residential areas should be constantly monitored and improved.

Family income is equally associated to the occurrence of CVD where the findings support results of literature, which show that individuals in low-income areas are at a higher risk of CVD compared to those in high-income neighborhoods [22]. Studies shows that rural and low-income areas bear the greatest burden of CVD due to increased dependence on inefficient energy sources. Since highly efficient sources of power are expensive, low-income households rely on biomass combustion to generate heat. Even in developed regions, an increase in energy costs compels some individuals to use inefficient energy sources.
Cooking materials used in homes also determine the risk of developing CVD. The results indicate that a high proportion of CVD patients (66.7%) utilized wood stoves, which supports findings of the literature review showing that biomass combustion emits particulate matter that contaminates indoor air. About 49.2% of research participants who utilized electric or gas stoves suffered from the ailment. The findings imply that the use of efficient energy sources such as gas and electricity is not a sufficient measure for preventing CVD. Other factors such as inadequate physical activity and exposure to contaminated air in the environment increases the risk of the disease [24]. While a majority of the participants utilized electricity as a source of energy, 58.4% of the population suffered from CVD. The findings imply that other factors such as air quality in the environment have a significant influence on the occurrence of CVD.

V. CONCLUSION

This study shows that particulate matter in the air is detrimental to human health regardless of the source. While the composition of indoor and outdoor air is nearly the same, the amount of some contaminants is high in indoor environments. In rural and low-income communities, the high prevalence of cardiovascular disease is associated with burning biomass in open spaces where emission of gasses such as carbon dioxide increase due to incomplete combustion of carbon.

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