

Short Communication

Passive- and active-cigarette smoking: Effects on the levels of antioxidant vitamins, immunoglobulin classes and acute phase reactants

Arinola O. G^{1*}, Akinosun O. M¹ and Olaniyi J. A²

¹Department of Chemical Pathology and Immunology, College of Medicine, University of Ibadan, Oyo State, Nigeria.

²Department of Haematology, College of Medicine, University of Ibadan, Nigeria.

Accepted 11 April, 2011

The levels of plasma immunoglobulin classes (IgG, A and M) and acute phase proteins (α 2-macroglobulin (A2MG), C-reactive protein (CRP)) were determined using single radial immunodiffusion method. Also, determined in the plasma of the subjects were antioxidant vitamins (vitamins C and E) using spectrophotometric method. The participants were 30 subjects who had never smoked and not exposed to cigarette smoke (non smokers), 30 who had smoked at least 15 cigarettes per day for at least five years (active smokers) and 30 who had been exposed to cigarette smoke at least 2 cigarette/day on ≥ 5 days/wk for at least 5 years (passive smokers). Plasma levels of IgG, IgM, CRP and A2MG were significantly raised ($p < 0.05$), while vitamins C and E ($p < 0.05$) were significantly reduced in active smokers when compared with the controls. The plasma levels of CRP and A2MG were significantly raised ($p < 0.05$), while vitamins C and E were significantly reduced ($p < 0.05$) in passive smokers when compared with the controls. The levels of CRP and antioxidant vitamins were similar in active and passive smokers. This study suggested that, exposure to passive as well as active cigarette smoking cause's inflammation as well as vitamin deficiency.

Key words: Cigarette smoke, inflammation, oxidative stress, acute phase proteins, immunoglobulin classes.

INTRODUCTION

Tobacco smoke contains numerous compounds, many of which are oxidants and prooxidants, capable of producing free radical and enhancing the oxidative stress (Pryor, 1997). The chemical composition of burning tobacco produce more than 4000 chemicals compounds in the form of gases, vapours and particulates. Some of these are carbon mono-oxide (CO), hydrogen cyanide, phenols, ammonia, formaldehyde, benzene (a) pyrene, nitrosoamines, nicotine, tar, heavy metals, radio active products, poisons and at least 48 known cancer-producing substances (Howard et al., 1998). The components of cigarette smoke when blown out by active smokers into the environment are inhaled by passive or involuntary smokers, thus exposing them equally to the harmful effects of tobacco (Alberg, 2002).

Among the harmful effects of cigarette smoke, is

increased risk of atherosclerosis (Nakao and Yasuett, 2000). Maternal smoking has been shown to be a leading cause of pediatric deaths, infant mental retardation, low birth weight, short gestation, respiratory distress syndrome and sudden infant death syndrome (Walsh, 1994; Olds et al., 1994; Koren, 1995; Drews et al., 1996). The frequency of stillbirth was found to be increased with paternal smoking habits (John et al., 1991). Studies have shown that cigarette smoking is one of the important mutagenic factors which cause damage to human genetic material. Other epidemiological studies have reported elevated risk of neoplastic disorders, coronary heart disease and lung cancer in smokers (John et al., 1991; Hecht, 2002).

Few reasons given to explain the basis of the harmful effects of active tobacco smoke are: oxidative damage, increased oxidation of LDLc, raised fibrinogen, C-reactive protein (CRP) and uric acid (Nakao and Yasuett, 2000; Block et al., 2004). Active cigarette smoking has been found to be associated with biochemical predictive features of cardiovascular diseases (CVD) viz: CRP

*Corresponding author. E-mail: drarinolaog64@yahoo.com or arinolaog@doctor.com

elevation, raised lipid peroxidation, inflammation and alteration in antioxidative enzyme activities (Mendall et al., 2000; Ridker et al., 2001). It may be hypothesized that long term involuntary smoking may predispose passive smokers to similar consequences of active smoking. Therefore, this study aims to find out if involuntary smoking has damaging effect or otherwise as active smoking by measuring plasma immunoglobulin classes, acute phase proteins and antioxidant vitamins; secondly, to provide additional information explaining the basis for the harmful effects of cigarette smoking. To the knowledge of the authors, this is the first study that determined the levels of antioxidant vitamins and immunologic factors in Nigerian involuntary smokers.

MATERIALS AND METHODS

The subjects were divided into three groups, viz: 30 (31 to 40 years) who had never smoked before and were not exposed to cigarette smoke (non-smokers), 30 (29 to 42 years) who had smoked at least 15 cigarettes/day for at least five years (active smokers), current smoker and had not quit smoking (active smokers), and 30 (30 to 40 years) who were exposed to indoor environment cigarette smoke of more than 2 cigarettes/day on more than 5 days/week for at least 5 years (passive smokers).

Informed consent was taken from the participants of the study. A questionnaire on age, sex, occupation, cigarette smoking, alcohol use, and drug consumption was completed for every subject. Based on clinical examinations, history and laboratory tests when necessary, individuals detected to be suffering from the following diseases and conditions were excluded from the study, viz: infectious diseases, inflammatory and connective tissue diseases, diabetes, cancer, gout, nephrotic syndrome, cirrhosis, acute hepatitis, cholestatic diseases, pre-eclampsia and primary hypertension. Individuals taking vitamin supplements and compulsory medication were also excluded. Also, exclusion criteria included self-reported consumption of more than 4 servings/day of fruits and vegetables, more than 2/day alcoholic drinks or history of alcohol abuse within the past 6 months, current pregnancy, history of kidney stones or other kidney diseases, cancer, stroke and human immunodeficiency virus infection.

Between 6 and 10 ml of whole blood were collected by venipuncture without stasis from each subject into sample tubes containing lithium heparin. Blood samples were centrifuged at 3,000 rpm for 5 min in an MSE centrifuge in a working area with low intensity light.

The plasma levels of immunoglobulin classes and acute phase proteins were measured in the subjects using immunoplates (Arinola and Ezech, 2007). Radial immunodiffusion involves radial diffusion of a specific antigen through an agarose gel containing the appropriate mono-specific antibody. During radial diffusion, stable antigen-antibody complexes are formed at equilibrium which appears as a visible ring. The diameter of the ring is proportional to the concentration of the antigen.

Vitamin C was determined using colorimetric method of Halliwell and Gutteridge (1995). To 2 ml plasma in a centrifuge tube, 2 ml of colour reagent was slowly added, mixed thoroughly, allowed to stand for 30 min at room temperature and centrifuged at 3,000 rpm for 15 min. The blank (distilled water in place of plasma) and standard were treated similarly as the plasma samples. For each batch of samples analyzed, a fresh blank and standard were prepared. Absorbance was read at 700 nm wavelength using the blank to set zero. Concentrations of samples were extrapolated from standard calibration curve. Vitamin E was also estimated using

colorimetric method of Halliwell and Gutteridge (1995).

Statistical analysis

The data were presented as mean and standard deviation. Student's t-test was used to determine significant difference between the means. The 5% ($p < 0.05$) level of significance was used to compare the means and S.D.

RESULTS

The mean ages (years) of active smokers, passive smokers and non-smokers were 32.6 ± 7.9 , 26.8 ± 9.4 and 28.6 ± 8.5 years, respectively. There were no significant differences between the three groups ($p > 0.05$). Mean body mass index (BMI) of active smokers, passive smokers and non-smokers was 24.1 ± 4.7 , 25.2 ± 4.4 , and 26.7 ± 4.9 , respectively. There were no significant differences between the three groups ($p > 0.05$). In Table 1, the result shows that the plasma levels of IgG, IgM and CRP were significantly raised ($p < 0.05$), while vitamin E ($p < 0.05$) was significantly reduced in active smokers when compared with the controls. The plasma levels of CRP and A2MG were significantly raised ($p < 0.05$), while vitamin C was significantly reduced ($p < 0.05$) in passive smokers when compared with the controls. The levels of CRP, A2MG and antioxidant vitamins were similar in active and passive smokers.

DISCUSSION

Cigarette smoking has been implicated in the pathogenesis of many diseases. *In vitro* prolonged exposure of plasma to gas-phase cigarette smoke was reported to cause depletion of antioxidants, including vitamins C and E (Alberg, 2002). This is similar to this study. Reduced levels of vitamins E and C in passive- and active-cigarette smoker might be due to the presence of a large variety of compounds in cigarettes that could initiate or amplify oxidative damage. Apart from these antioxidant vitamins, enzymatic antioxidant defence systems such as superoxide dismutase (SOD), catalase and glutathione peroxidase (GSH-Px) have been reported to be altered by tobacco smoke (Alberg, 2002; Block et al., 2004). It is the opinion of the present authors that public health preventive action toward smoking should aim not only at suppressing tobacco use, but also at promoting better nutritional habits. The observation that active and involuntary smokers have lower circulating levels of vitamins C and E raises concern of such a need. Therefore, passive smokers may have a necessity of taking supplementary vitamins as much as active smokers.

Previous studies (Devaraj and Jialal, 2000; Upritchard et al., 2000) reported that low level of vitamin E induces release of pro-inflammatory cytokines, thus reduced

Table 1. The level (mean±S.D) of Ig classes, acute phase proteins and antioxidant vitamins in active and passive-smokers when compared with non-smokers.

Smoker	IgG (g/L)	IgA (g/L)	IgM (g/L)	CRP (g/L)	A2MG (g/L)	Vitamin C (mg/L)	Vitamin E (mg/L)
Control (n=30)	17.5±8.6	2.14±1.5	1.52±1.2	0.8 ± 0.5	2.0 ± 0.9	0.7 ± 0.2	0.8 ± 0.3
Active smokers (n=30)	28.9±4.0*	2.68±3.0	3.44±2.2*	1.4± 0.4*	2.2 ± 0.8	0.6 ± 0.3	0.7 ± 0.2*
Passive smokers (n=30)	18.0± 0.0 [#]	2.2± 1.0 [#]	2.0± 1.9 [#]	1.2± 0.5*	2.2 ± 0.3*	0.6 ± 0.2*	0.7 ± 0.1

*Significantly different from control (p<0.05); [#]significantly different from active smokers (p<0.05).

levels of vitamin E in our cigarette smokers might explain raised levels of acute phase proteins in them. C-reactive protein and α -2-macroglobulin are acute phase proteins produced primarily by the liver in response to inflammatory cytokines such as interleukin-6 (Libby, 2000). Prospective epidemiologic studies among asymptomatic individuals have related plasma CRP to risk of cardiovascular diseases (Ridker et al., 2001, Mendall et al., 2000). Based on the high levels of CRP in the two groups of smokers, our study reinforces the view that cigarette smokers are at risk of cardiovascular disease due to an ongoing inflammatory response.

In this study, the mean serum IgG and IgM levels in active cigarette smokers were raised when compared with the controls. IgG and IgM activate complement system is necessary for phagocytosis, lysis of microorganisms and neutralization of toxins (Arinola and Ezeh, 2007). Components of cigarette smoke are known to be toxic with long half life (Pryor, 1997; Howard et al., 1998; Alberg, 2002). The raised levels of IgG and IgM in cigarette smokers might be one of the mechanisms to neutralize components of cigarette tobacco via complement activation.

Conclusion

It can be suggested from our results that exposure to passive cigarette smoke might cause vitamin deficiency and inflammatory responses as in active smoking.

RECOMMENDATION

Individuals that must smoke cigarette or are exposed to cigarette smoke are advised to take antioxidant supplements and CRP chelators.

ACKNOWLEDGEMENT

The authors thank Prof C. P. Muller, Institute of Immunology, Luxembourg for the gift of antisera.

REFERENCES

Alberg A (2002). The influence of cigarette smoking on circulating con-

- centrations of antioxidant micronutrients. *Toxicology*, 15: 180(2): 121-137.
- Arinola OG, Ezeh CC (2007). C1 inhibitor, C3 activator and IgA, IgG and IgM titers in Nigerian HbSS patients with *Plasmodium falciparum*. *Iranian J. Immunol.*, 4: 44-49.
- Block G, Jensen C, Dietrich M, Norkus E, Hudes M and Packer L (2004). Plasma C-reactive protein concentration in smokers: Influence of antioxidant supplementation. *J. Am. Coll. Nutr.*, 23(2): 141-147.
- Devaraj S, Jialal I (2000). Alpha tocopherol supplementation decreases serum C-reactive protein and monocyte interleukin-6 levels in normal volunteers and type 2 diabetic patients. *Free Radical Biol. Med.*, 29: 790-792.
- Dreus CD, Murphy CC, Yeargin-Allsopp M, Decoufle P (1996). The relationship between idiopathic mental retardation and maternal smoking during pregnancy. *Pediatrics*, 97: 547-553.
- Halliwell B, Gutteridge JMC (1995). The definition and measurement of antioxidants in biological systems. *Free Rad. Biol. Med.*, 18: 125-128.
- Howard G, Wagenknecht LE, Burke GL, Dies-Roux A, Evans GW (1998). Cigarette smoking and progression of Atherosclerosis. *JAMA*, 279(2): 119-129.
- Hecht A (2002). Cigarette smoking and lung cancer: chemical mechanisms and approaches to prevention. *Lancet Oncol.*, 3: 461-469.
- John EM, Savitz DA, Sandler DP (1991). Prenatal exposure to parent's smoking and childhood cancer. *Am. J. Epidemiol.*, 133: 123-132.
- Koren G (1995). Fetal toxicology of environmental tobacco smoke. *Curr. Opin. Pediatr.*, 7: 128-131.
- Libby P (2000). Inflammation in atherosclerosis. *Nature*, 420: 868-874.
- Mendall MA, Strachan DP, Butland BK, Ballam L, Morris J, Sweetnam PM, Elwood PC (2000). C-reactive protein: relation to total mortality, cardiovascular mortality, and cardiovascular risk factors in men. *Eur. Heart J.*, 21: 1584-1590.
- Nakao K, Yasuett T (2000). Insulin resistance and endothelial dysfunction in smokers, effects of Vitamin C. *Am. J. Physiol., Heart Circul. Physiol.*, 279(3): 1172-1178.
- Pryor WA (1997). Cigarette smoke radicals and role of free radicals in chemical carcinogenicity. *Environ. Health Perspect.*, 105(suppl14): 875-882.
- Ridker PM, Stampfer MJ, Rifai N (2001). Novel risk factors for systemic atherosclerosis: a comparison of C-reactive protein, fibrinogen, homocysteine, lipoprotein(a), and standard cholesterol screening as predictors of peripheral arterial disease. *J. Am. Med. Assoc.*, 285: 2481-2485.
- Walsh RD (1994). Effects of maternal smoking on adverse pregnancy outcomes: Examination of the criteria of causation. *Hum. Biol.*, 66: 1059-1092.
- Uprichard JE, Sutherland WHF, Mann JI (2000). Effect of supplementation with tomato juice, vitamin E, and vitamin C on LDL oxidation and products of inflammatory activity in type 2 diabetes. *Diabetes Care*, 23: 733-738.