High-Sensitive C-reactive Protein and Atherogenic Lipid Levels in a Group of University Students with Habitual Smoking

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High-Sensitive C-reactive Protein (hs-CRP) is a well-known inflammatory and cardiovascular disease (CVD) marker. Non-HDL cholesterol concentration in blood are strongly associated with long-term risk of atherosclerotic CVD. Hs-CRP and atherogenic lipids are suggested to be a central feature of cardiovascular disease (CVD), particularly among smokers. Smoking for long duration seems to be correlated with high level of hs-CRP, plasma cholesterol, and LDL-C. This study was done to evaluate the plasma levels of hs-CRP, lipid profile, and magnesium in a group of university students with habitual smoking. Eighty current smoker males participated in this cross sectional study. Estimation of plasma hs-CRP was carried out using latex immune turbidimetric method, plasma lipid profile and magnesium by chemical methods using a spectrophotometer (Biosystem 310) and results were computed by using SPSS. Regarding hs-CRP level, 20% (16/80) participants were at high (>3mg/L) risk to CVD; total cholesterol 6.3% (5/80) participants were at an average greater than 240mg/dL; LDL-C 6.3% (5/80) were at an extremely high risk of greater than 190 mg/dL. A test group of students who smokes for ten years or more had a significant increase in means of plasma hs-CRP, total cholesterol, LDL-C P value < 0.05, while there was a significant decrease in means of plasma HDL-C P value <0.05. Study results revealed that cigarette smoke was associated with considerable changes of hs-CRP, and atherogenic lipids that were considered as risk factors for cardiovascular disease among young male smokers.

Keywords: Smoker; hs-CRP; Total cholesterol; LDL-C; CVD; magnesium; Students.

The use of tobacco is increasing and broadly spreading throughout the world. It is a bad human behavior and is practiced by people when addicted to nicotine, which causes many harmful diseases1. Smoking is the highest risk factor in the progress of specific health problems, such as cardiovascular disease and chronic obstructive pulmonary disease2. Cigarette smoke consists of over 4000 components, including toxicants, carcinogens, oxidants, and free radicals components3.

Hs-CRP is one of an acute-phase reactant proteins, an indicator of systemic inflammation4. Hs-CRP is usually related to CVD risk factors, predominantly, with lifestyle features like smoking as well as physical activity behaviors5,6.
Dyslipidaemia in smokers shows a superior risk of atherogenic disorder, which comparably correlates to the number of cigarettes, and smoking duration.7 Magnesium misbalances are associated with many pathological states such as hypertension, CVD and ischemic brain injury, a rising of extracellular and intracellular magnesium levels can control the addiction to nicotine and tobacco smoking.8 Several studies reported the associations between hs-CRP and CVD among adolescents and youth.2-7 In this current study, we targeted the investigation of some CVD risk factors, specifically, hs-CRP, total cholesterol, and LDL-C among Sudanese young adult males aged between 18 and 25 years.

**MATERIALS AND METHODS**

In this cross-sectional comparative study, approved by research committee of Sudan University of Science and Technology, 80 healthy current daily cigarettes smoker male were randomly selected from Sudan university of Science and Technology. The smoker males, age between 18 and 25 years, smokes 10 or less cigarettes per day and at least on smoking for 30 days before participation in this study. Participant with diabetes, diagnosed CVD, cerebrovascular disease, stable hypertension treated by drugs, dyslipidemia, renal problems, and chronic hepatic disease, were excluded from this study. After getting their informed consent, 3ml venous blood samples were taken from participants in the morning in lithium heparin containers after a minimum of 8 hours of overnight fasting. Then specimens were centrifuged at 3000 rpm for 5 minutes, plasma was separated and used for high sensitive hs-CRP which was measured by turbidimetric, and plasma magnesium by chemical method.10 Total cholesterol, triglyceride, and HDL-C by enzymatic methods.11-13 Simultaneously, LDL-C was calculated according to Friede wald formula: LDL cholesterol (mg/dL) = total cholesterol – HDL cholesterol – (triglycerides/5).12

The precision and accuracy of the techniques used in this study were checked each time a batch was analyzed by including commercially prepared control sera.

**Statistical analysis**

A convenient descriptive and analytical, statistical approach was followed using a statistical package SPSS version 20. Descriptive statistic, Pearson’s correlation was used to compare and correlate hs-CRP magnesium, and lipid profile levels with variables in the study group and the level of significance were expressed as P value < 0.05.

**RESULTS**

The study population included 80 non-diabetic, non-hypertensive university student smokers (light smokers: 1 – 10 cigarettes/day), age 18–25 years, 59 out of 80 participants practice sport two times per week, the mean of BMI (22.9 ± 3.9) kg/m².

Table 1 shows 16 participants (20%) had >3.0mg/L of hs-CRP, 5 (6.3%) high level of total cholesterol, 5 (6.3%) had very high level of LDL-C, while 45 (58.2%) had low level of HDL-C.

### Table 1. Biomarkers frequency among young smokers

| Parameters       | Frequency | Percentage (%) |
|------------------|-----------|----------------|
| hs-CRP (mg/L)    |           |                |
| Low Risk (< 1.0) | 48        | 60             |
| Moderate Risk (1.0 – 3.0) | 16 | 20.0          |
| High Risk (>3.0) | 16        | 20.0           |
| TC (mg/dL)       |           |                |
| Optimal (<200)   | 66        | 82.0           |
| Border line high (200 – 239) | 9 | 11.0          |
| High (>240)      | 5         | 6.3            |
| HDL-C (mg/dL)    |           |                |
| No Risk (>40)    | 16        | 20.0           |
| Moderate Risk (35 – 39) | 19 | 23.8          |
| High Risk (<35)  | 45        | 58.2           |
| LDL-C (mg/dL)    |           |                |
| Optimal (<100)   | 40        | 50             |
| Near Optimum (100 – 129) | 23 | 28.8          |
| Border Line High (130 – 159) | 11 | 13.7          |
| High (160 – 189) | 1         | 1.3            |
| Very high (>190) | 5         | 6.3            |

TC: Total cholesterol. HDL-C: high density lipoprotein-cholesterol, LDL-C, low density lipoprotein cholesterol, hs-CRP: high sensitive C-reactive protein.
be significantly increased for hs-CRP, total cholesterol, triglycerides, LDL-C and significantly decreased for HDL-C, and magnesium in male smokers more than 10 years when compared with smokers less than 10 years (P<0.05).

Table 3 shows a comparison between biochemical parameters according to sport practice (two times per week, for at least 30 minutes) among smokers. The results reflect that there was a significant increase in means of HDL-C level, and decrease in body mass index, while total cholesterol, triglycerides, LDL-C and magnesium, there were no statistical difference in the means according to sport practices.

Table 4 shows Pearson’s correlation between hs-CRP, lipid profile, magnesium levels and duration of smoking per year. The results reflect statistically significant, positive correlation between the hs-CRP, total cholesterol, triglycerides, LDL-C with duration of smoking per year.

**DISCUSSION**

Cigarette smoking is a classical and a major risk factor in the development of several diseases with an inflammatory component, including the development of cardiovascular disease (CVD) and atherosclerosis. CVD referred to as an inflammatory disease. Cigarette smoking alters plasma lipid and lipoprotein levels, nicotine stimulates sympathetic adrenal system leading to increased secretion of catecholamines resulting in increased lipolysis and increased concentration of plasma free fatty acids (FFA) which further result in increased secretion of hepatic FFAs and hepatic triglycerides along with VLDL in the blood stream.

In the present study, although the factors that affect the hs-CRP, lipid profile and magnesium were excluded, we found that 20.0% (16/80) of the studied group had high level of hs-CRP (hs-CRP...
Table 4. Pearson’s correlation of BMI, hs-CRP, lipid profile, and magnesium with the duration of the smoking per year

| Parameters                  | Duration of smoking/year | R value | P value |
|-----------------------------|--------------------------|---------|---------|
| BMI (kg/m2)                 | 0.229                    | 0.041*  |
| Plasma hs-CRP (mg/L)        | 0.339                    | 0.002*  |
| Plasma T.Cholesterol (mg/dl)| 0.314                    | 0.005*  |
| Plasma Triglyceride (mg/dL) | 0.206                    | 0.067   |
| Plasma HDL-C (mg/dL)        | -0.258                   | 0.021*  |
| Plasma LDL-C (mg/dL)        | 0.338                    | 0.002*  |
| Plasma magnesium (mg/dL)    | -0.303                   | 0.006*  |

Pearson’s correlation R-value, P-value ≤ 0.05 was considered significant.

>3mg/L), These results are comparable with the findings of several studies.15,16

Our study reveals that there were significant increase in means of hs-CRP, total cholesterol, triglycerides and LDL-C and significant decrease in HDL-C, and magnesium in participants smokes for ≥ 10 years, also there was significant positive correlation between duration of smoking and hs-CRP, total cholesterol and LDL-C. Our findings are in accordance with the findings of many research workers.6,17-19. A direct association between elevated levels of hs-CRP, as well as other markers of inflammation, and cigarette smoking has been reported in several investigations, and most studies showing a dose-response relationship between CRP levels and smoking intensity and/or duration.20,21. The change in the serum cholesterol and lipoprotein levels became more marked with the number of cigarettes smoked per day and duration of smoking.6

Nicotine and other toxic substances from tobacco smoke increases the amount of bad fats (total cholesterol (TC), LDL-C, and triglycerides (TG) circulating in the blood vessels and decreases the amount of good cholesterol HDL-C availability.22 Nicotine induces oxidative stress, generates free radicals that attack on the membrane lipids resulting in the formation of malondialdehyde (MDA), which causes peroxidative tissue damage.23

In this study, there was an insignificant difference between means of hs-CRP among the smoker who practice sport when compared with the smoker not practice sports. Only 21 out of the 80 participants practiced sport twice in a week. Our results were similar to Mazurek et al., who reported that no relationship between hs-CRP concentration and the physical activity,24 and disagree with another study; hs-CRP concentration levels were conversely identified with cardiorespiratory fitness.25 Stewart et al. reported exercise training decrease the risk of CVD as defined by a reduction in the concentration of CRP in healthy individuals.26

The study revealed that serum magnesium significantly negatively correlated with duration of smoking.27 This result is in agreement with a previous study; as cigarette smoking causes decreased supply of magnesium due to lesser appetite and reduced absorption due to digestive system disturbances.28 Experimental evidence indicates that magnesium insufficiency promotes atherosclerosis and that magnesium fortification attenuates atherogenesis.29 Evidence from observational studies indicates that high circulating magnesium levels and magnesium intake are associated with a modest reduction in risk of cardiovascular disease, including coronary heart disease.30,31

CONCLUSION

Study results revealed that smoker status was associated with substantial changes in hs-CRP, atherogenic lipid profile, and magnesium that considered risk factors for cardiovascular disease among young adults smoker. Consistent advice for young men considers a healthy lifestyle rich in physical activity and free of smoking.

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REFERENCES

1. Leone A, Landini L and Leone A. What is Tobacco Smoke? Socio cultural Dimensions of the Association with Cardiovascular Risk. Curr. Pharm. Des., 16: 2510-2517 (2010).

2. Tonstad S and Cowan J.L. C-reactive protein as a predictor of disease in smokers and former smokers. Int. J. Clin. Pract., 63: 1634-1641 (2009).
3. de Heens G. L, Kikkert R, Aarden, L. A, Van der Velden U and Loos, B. G. Effects of smoking on the ex vivo cytokine production in periodontitis. *J. Periodontal. Res.*, **44**: 28-34 (2009)

4. Zakynthinos E, and Pappa N. Inflammatory biomarkers in coronary artery disease. *J.Cardio.*, **53**: 317–333 (2009).

5. Lowe G. Circulating inflammatory markers and risks of cardiovascular and non-cardiovascular disease. *J. Thrombo. Haemos.*, **3**: 1618–1627 (2005).

6. Raitakari M, Mansikkaniemi K, Marniemi J, Viikari J, and Raitakari O. Distribution and determinants of serum high-sensitive C-reactive protein in a population of young adults. The Cardiovascular Risk in Young Finns Study. *J. Int. Med.*, **258**:428–434 (2005).

7. Ega J. K. Comparative study of lipid profile in young smokers and non-smokers. *J. Chem. Pharm. Res.*, **8**: 513-525 (2016).

8. Larsson S. C, Burgess  S and Michaëlsson  K. Serum magnesium levels and risk of coronary artery disease: Mendelian randomisation study. *BMC. Med.*, **16**: 68 (2018).

9. PriceC.P, Trull A.K, Berry D and Gorman E.G. development and validation of a particle - enhanced turbidimetric immunoassay for c-reactive protein. *J. Immuo. meit.*, **99**: 205-211 (1987).

10. FossatiP and Prenciple L. Serum triglyceride determination colorimetrically with an enzyme that produce hydrogen peroxide. *Clin. Chem.*, **28**: 2077-2080 (1982).

11. AllainC.C, PoonL.S, Chan C.S.G, RichmodW and FuP.C. Enzymetic determination of total serum cholesterol. *Clin. Chem.*, **20**: 470-475 (1974).

12. BishopM. L, Fody E.P and Schoeff L. E.Clinical Chemistry Techniques Principles, Correlations. 6th ed,Philadelphia, (2010).

13. Smith C.J and Fischer T. H. Particulate and Vapor Phase Constituents of Cigarette Mainstream Smoke and Risk of Myocardial Infarction. *Atheroscl.*, **158**: 257–267 (2001).

14. Libby P, Ridker P.M and Maseria.A. Inflammation and atherosclerosis. *Circul.*, **105**: 1135–1143 (2002).

15. Shanahan L, Copeland W. E. Worthman C.M.A, Erkanli A. A, Angold A and Costello E. J. Sex-differentiatedchangesinC-reactiveproteinfromages9to21:the contributions of BMI and physical/sexual maturation. *Psycho. Neuro. end.*, **38**: 2209–2217 (2013).

16. Zarzour W, Dehneh N and Rajab M. High-Sensitive C-Reactive Protein Levels in a Group of Syrian University Male Students and Its Associations with Smoking, Physical Activity, Anthropometric Measurements, and Some Hematologic Inflammation Biomarkers. *Inter. J. Inû.,* 11-22 (2017).

17. Elhashimi E. H, Haala M. G, Zakya A. A and Abdalla E. A. Effect of Cigarette Smoking on Lipid Profile In Male at Collage of Police and Low Khartoum, *Sudan. J. Biom. Pharm.Sc. Asian.*, 2013:28-31 (2013).

18. KhuranaM, Sharma D and Khandelwal P.D. Lipid profile in smokers and tobacco chewers – a comparative study. *J. Assoc. Physic. India.*, **48**: 895–897 (2000).

19. Kaptoge S, Angelantonio E.D, Lowe G, Pepsy M.B, Thompson S.G, Collins R, et al. C-reactive protein concentration and risk of coronary heart disease, stroke, and mortality: an individual participant meta-analysis. *Lanc.*, **375**:132–140 (2010).

20. Kawada T. Relationships between the smoking status and plasma fibrinogen, white blood cell count and serum C-reactive protein in Japanese workers. *Diabetes. Metab. Syndr.*, **9**: 180–182 (2015).

21. Lowe G. D, Yarnell J. W, Rumley A, Bainton D andSweetnam P. M. C-reactive protein, fibrin D-dimer, and incident ischemic heart disease in the Speedwell study: are inflammation and fibrin turnover linked in pathogenesis?. *Arteriosclier: Thromb. Vasc. Biol.*, **21**:603-610 (2001).

22. McEvoy J.W, Nasir K, DeFilippis A.P, Lima J.A, Bluemke D.A, Hundley W.G, et al. Relationship of cigarette smoking with inflammation and subclinical vascular disease: the Multi-Ethnic Study of Atherosclerosis. *Arterioscler. Thromb. Vasc. Biol.*, **35**: 1002–1010 (2015).

23. Venkatesan A, Hemalatha A, Bobby Z, Selvaraj N and Sathiyapriya V. Effect of smoking on lipid profile and lipid peroxidation in normal subjects. *Indian. J. Physiol. Pharmacol.*, **50**: 273–278 (2006).

24. MazurekK , Zmiweski P,Czajkowska A andLutos³awskaG. High-sensitivity C-reactive protein (hsCRP) in young adults: relation to aerobic capacity, physical activity and risk factors for cardiovascular diseases. *Biology of Sport.*, **28**: 227– 232 (2011).

25. Kuoh H.K, Yen C.J, Chen J.H, Yu Y.H, and Bean J.F. Association of cardio respiratory fitness and levels of C-reactive protein ;data from the National Health and Nutrition Examination Survey 1999–2002. *Int. J. Cardio.,* **114**: 28–33 (2007).

26. Stewart L.K, Flynn M.G and Campbel W.W. The influence of exercise training on inflammatory cytokines and C-reactive protein. *Medicine and
27. Niemela J.E, Cecco S.A, Rehak N.N and Elin, RJ. The effect of smoking on the serum ionized magnesium concentration is method-dependent. *Arch. Pathol. Lab. Med.*, **121**:1087-1092 (1997).

28. Kolte D, Vijayaraghavan K, Khera S, Sica D.A and Frishman WH. Role of magnesium in cardiovascular diseases. *Cardiol. Rev.*, **22**:182–92 (2014).

29. Morais J.B, Severo J.S, Santos L.R, de Sousa Melo S.R, de Oliveira S.R, *et al*. Role of magnesium in oxidative stress in individuals with obesity. *Biol. Trace. Elem. Res.*, **176**: 20–26 (2017).

30. Del Gobbo LC, Imamura F, Wu JH, de Oliveira Otto MC, Chiuve SE, Mozaffarian D. Circulating and dietary magnesium and risk of cardiovascular disease: a systematic review and meta-analysis of prospective studies. *Am J Clin Nutr.*, **98**: 160–173 (2013).

31. Fang X, Liang C, Li M, Montgomery S, Fall K, Aaseth J, *et al*. Dose-response relationship between dietary magnesium intake and cardiovascular mortality: a systematic review and dose-based meta-regression analysis of prospective studies. *J. Trace. Elem. Med. Biol.*, **38**: 64–73 (2016).