

## 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 diseases<sup>1</sup>. Smoking is the highest risk factor in the progress of specific health problems, such as cardiovascular disease and chronic obstructive pulmonary disease<sup>2</sup>. Cigarette

smoke consists of over 4000 components, including toxicants, carcinogens, oxidants, and free radicals components<sup>3</sup>.

Hs-CRP is one of an acute-phase reactant proteins, an indicator of systemic inflammation<sup>4</sup>. Hs-CRP is usually related to CVD risk factors, predominantly, with lifestyle features like smoking as well as physical activity behaviors<sup>5,6</sup>.

Dyslipidaemia in smokers shows a superior risk of atherogenic disorder, which comparably correlates to the number of cigarettes, and smoking duration<sup>7</sup>.

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<sup>8</sup>. Several studies reported the associations between hs-CRP and CVD among adolescents and youth<sup>2,7</sup>. 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<sup>9</sup>, and plasma magnesium by chemical method<sup>10</sup>, total cholesterol, triglyceride, and HDL-C by enzymatic methods<sup>11-13</sup>. Simultaneously, LDL-C was calculated according to Friedewald formula:  $LDL\ cholesterol\ (mg/dL) = total\ cholesterol - HDL\ cholesterol - (triglycerides/5)$ <sup>12</sup>

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 statistics, 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 ( $22.9 \pm 3.9$ ) kg/m<sup>2</sup>.

Table 1 shows 16 participants (20%) had >3.0 mg/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 2 shows the statistics of measured hs-CRP, serum magnesium and lipid profile parameters compared according to duration of smoking per year. Results were found to

**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 ( $\geq 240$ )	5	6.3
HDL-C (mg/dL)		
No Risk ( $\geq 40$ )	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 ( $\geq 190$ )	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<sup>13</sup>. CVD referred to as an inflammatory disease<sup>2</sup>. 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<sup>14</sup>.

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 2.** Comparison between means of the biochemical parameter according to the duration of smoking per year

Duration Variables	< 10 years (n = 43) Mean ± SD	≥10 years (n = 37) Mean ± SD	P- value
Plasma hs-CRP (mg/L)	1.41 ± 0.92	2.09 ± 1.85	0.02*
Plasma magnesium (mg/dL)	2.26 ± 0.50	1.97 ± 0.32	0.00**
Plasma T.Cholesterol (mg/dl)	146 ± 30.2	185 ± 64.0	0.00**
Plasma Triglyceride (mg/dL)	83.0 ± 42.4	141 ± 102	0.00**
Plasma HDL-C (mg/dL)	34.0 ± 8.0	30.1 ± 8.1	0.03*
Plasma LDL-C (mg/dL)	95.9 ± 29.1	128 ± 57.4	0.00**

Independent Student's t-test was used to compare between means  
Statistical significance were considered as P value ≤ 0.05

**Table 3.** Comparison between biochemical parameters and sport practice

Variable	Sport practice "YES" n=59 Means ± SD	Sport practice "NO" n=21 Means ± SD	Pvalue
Plasma hs-CRP (mg/L)	1.72 ± 1.3	2.00 ± 1.3	0.07
Plasma magnesium (mg/dL)	2.14 ± 0.37	2.11 ± 0.61	0.83
Plasma T.Cholesterol (mg/dl)	164 ± 58.4	166.9 ± 29.5	0.83
Plasma Triglyceride (mg/dL)	106 ± 68.5	121.7 ± 110.6	0.45
Plasma HDL-C (mg/dL)	34.1 ± 7.3	26.7 ± 8.5	0.00**
Plasma LDL-C (mg/dL)	109 ± 52.9	115 ± 24.7	0.48
BMI (kg/m <sup>2</sup> )	21.8 ± 1.70	26.3 ± 1.80	0.00*

Independent Student's t-test was used to compare between means  
Statistical significance were considered as P value > 0.05

**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/m <sup>2</sup> )	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  $\leq 0.05$  was considered significant.

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

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  $e^{> 10}$  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<sup>6,17-19</sup>. 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<sup>18,19</sup> and most studies showing a dose-response relationship between CRP levels and smoking intensity and/or duration<sup>20,21</sup>. The change in the serum cholesterol and lipoprotein levels became more marked with the number of cigarettes smoked per day and duration of smoking<sup>6</sup>.

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<sup>22</sup>. 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<sup>23</sup>.

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<sup>24</sup>, and disagree with another study; hs-CRP concentration levels were conversely identified with cardiorespiratory fitness<sup>25</sup>. Stewart *et al.* reported exercise training decrease the risk of CVD as defined by a reduction in the concentration of CRP in healthy individuals<sup>26</sup>.

The study revealed that serum magnesium significantly negatively correlated with duration of smoking. This result is in agreement with a previous study<sup>27</sup>; as cigarette smoking causes decreased supply of magnesium due to lesser appetite and reduced absorption due to digestive system disturbances<sup>28</sup>. Experimental evidence indicates that magnesium insufficiency promotes atherosclerosis and that magnesium fortification attenuates atherogenesis<sup>28,29</sup>. 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<sup>30,31</sup>.

## 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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