

## Evaluation of the effect of smoking on complete blood counts, serum C-reactive protein and magnesium levels in healthy adult male smokers

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### Abstract

**Objective:** To examine the effect of smoking on complete blood count, serum C-reactive protein and magnesium levels in male smokers.

**Methods:** The prospective case-control study was conducted in two villages of Matiari district in rural Sindh, Pakistan, from July to December 2013, and comprised healthy adult male smokers and an equal number of matching non-smokers as controls. The complete blood count, serum C-reactive protein and magnesium levels in all the subjects were measured to assess the effect of smoking on these parameters.

**Results:** The two groups had 48 subjects each with an overall age range of 20-40 years. The results of complete blood count were comparable except for lymphocyte, which was significantly higher ( $p < 0.001$ ), and neutrophil, which was lower ( $p < 0.001$ ) in smokers than in the non-smokers. Serum C-reactive protein concentrations among the cases ( $14.62 \pm 0.16 \text{ mg/L}$ ) compared to the controls ( $4.81 \pm 0.38 \text{ mg/L}$ ) were significantly higher ( $p < 0.001$ ). However, reverse was true for serum magnesium levels which were significantly higher ( $p < 0.001$ ) in the controls ( $2.52 \pm 0.18 \text{ mg/L}$ ) as against the cases ( $1.09 \pm 0.38 \text{ mg/dl}$ ). Serum C-reactive protein-to-magnesium ratio was significantly higher ( $p < 0.001$ ) in smokers than in the non-smokers.

**Conclusion:** Lymphocyte count was higher while neutrophil count was lower in smokers. Smoking also caused significant increase in serum C-reactive protein concentration concomitant to decrease in magnesium concentration in the smokers.

**Keywords:** Smoking, Complete blood counts, C-reactive protein, Magnesium. (JPMA 65: 59; 2015)

### Introduction

Cigarette smoking is a major risk factor involved in the pathogenesis of several diseases with an inflammatory component, such as cardiovascular disease (CVD) and chronic obstructive pulmonary disease (COPD).<sup>1,2</sup> Smoking triggers inflammation which is manifested by raised plasma levels of inflammatory markers like C-reactive protein (CRP) and white blood cell (WBC) counts.<sup>3,4</sup> CRP synthesis increases dramatically in the liver in response to cytokines released by adipocytes<sup>5</sup> and macrophages.<sup>6</sup> In a recent study it has been observed that adult males who were current smokers had elevated levels of serum CRP compared to non-smokers.<sup>7</sup> It has also been noted that people with high basal levels of CRP are at increased risk of developing obesity, diabetes, hypertension and CVD.<sup>8,9</sup> Healthy smokers compared to non-smokers have been found to have more insulin resistance (a characteristic of metabolic syndrome that is caused by lower cellular magnesium), increased glucose levels, much raised insulin levels, almost twice more very low-density lipoprotein (VLDL) cholesterol and 30 percent

lower high-density lipoprotein (HDL) cholesterol. Although these variables are not direct measures of magnesium status in smokers, but they clearly point out that smoking lowers cellular magnesium levels.<sup>10</sup> There seems to be a link between hypomagnesaemia and elevated plasma levels of CRP in cellular processes that affect vascular endothelial function<sup>11</sup> in people with obesity<sup>12</sup> and in people with blood pressure (BP) alterations.<sup>13</sup>

The current study was planned to find out the effect of smoking on complete blood count (CBC) and serum levels of CRP and magnesium in healthy adult male smokers. To our knowledge no study has concurrently examined the effect of smoking on CBC and blood levels of magnesium and CRP in healthy adult male smokers residing in rural areas.

### Subjects and Methods

The prospective case-control study was conducted in two villages of Matiari district in rural Sindh, Pakistan, from July to December 2013, and comprised healthy adult male smokers and an equal number of matching non-smokers as controls. The two villages were selected on the grounds that majority of the male inhabitants of one village were either active or passive smokers, whereas it was the opposite in the other village. The size of population in our

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study was initially 125 and with a 0.5 margin of error, the needed sample size calculated by using simplified formula for proportions<sup>14</sup> was 95.24.

Both the cases and the controls were randomly recruited from respective villages and were matched for age, height, weight and socioeconomic background. Individuals suffering from any inflammatory diseases or using any medication were excluded. Healthy smokers were defined as those who were smoking 10 or more cigarettes per day for three or more years without indication of the exclusion criteria, The non-smokers were those who had never smoked. CBC along with serum CRP and magnesium levels in all the subjects were measured to assess the effect of smoking on these parameters. Before blood sampling, informed written consent was obtained from each subject, while the approval was obtained from the Ethical Committee of Isra University, Hyderabad. CBC was analysed using Sysmex Haematology Analyser, while serum CRP and magnesium levels were determined by standard methods using Nyocard and Diasys kits respectively.

Data was presented as mean  $\pm$  standard deviation (SD). Comparison of mean values between the cases and the controls was done using student's t- test. Differences were considered significant at  $p < 0.001$ .

## Results

Of the total 96 subjects in the study, 48(50%) each represented the two groups. The overall age range was 20-40 years. CBC values for each group were comparable except for neutrophils, which were significantly higher ( $p < 0.001$ ), and lymphocytes, which were significantly raised ( $p < 0.001$ ), in smokers than in non-smokers (Table-1).

**Table-1:** Blood CP values compared between healthy adult male smokers and non-smokers.

Blood CP	Smokers (n=48)	Non-Smokers (n=48)	P value
Hb g/dl	12.89 $\pm$ 2.09	12.70 $\pm$ 2.17	0.400
HCT %	40.34 $\pm$ 5.94	41.49 $\pm$ 4.78	0.342
MCV fl	83.05 $\pm$ 9.27	83.07 $\pm$ 11.82	0.226
MCH pg	26.55 $\pm$ 4.23	25.37 $\pm$ 5.09	0.137
MCHC g/dl	31.94 $\pm$ 2.19	30.50 $\pm$ 2.65	0.315
WBC %	8.38 $\pm$ 2.45	8.90 $\pm$ 2.62	0.294
Neutrophils %	45.74 $\pm$ 1.14	56.65 $\pm$ 9.80	<0.001
Lymphocytes %	48.39 $\pm$ 1.30	31.10 $\pm$ 7.14	<0.001
Platelets x103/ $\mu$ l	273.73 $\pm$ 9.01	322.85 $\pm$ 9.52	0.223

Hb: Haemoglobin

HCT: Hematocrit

MCV: Mean corpuscular volume

MCH: Mean corpuscular haemoglobin

MCHC: Mean corpuscular haemoglobin concentration

WBC: White blood cell

Results are presented as Mean  $\pm$  S.D.

**Table-2:** Comparison of serum C-reactive protein and magnesium levels between healthy adult male smokers and non-smokers.

Serum variable	Smokers (n=48)	Non-Smokers (n=48)	P value
C- reactive protein			
Normal range			
(<5mg/L)	14.62 $\pm$ 0.16	4.81 $\pm$ 0.16	<0.001
Magnesium			
Normal range			
(1.8-2.6mg/dl)	1.09 $\pm$ 0.38	2.52 $\pm$ 0.18	<0.001

Results are presented as Mean  $\pm$  S.D.

The mean serum CRP concentration in smokers (14.62 $\pm$ 0.16mg/L) was significantly higher ( $p < 0.001$ ) compared to non-smokers (4.81 $\pm$ 0.38mg/L). The mean serum magnesium concentration in non-smokers (2.52 $\pm$ 0.18mg/L) compared to smokers (1.09 $\pm$ 0.38mg/L) was significantly higher ( $p < 0.001$ ) (Table-2).

Serum magnesium level in all smokers was found to be less than 1.8mg/dl, while serum CRP level higher than 10mg/l. On the contrary, all non-smokers had their serum magnesium concentration greater than 2.0mg/dl and serum CRP less than 7.5 mg/L.

The mean CRP-to-magnesium ratio in serum samples of the smokers was 1.63 $\pm$ 1.02 against 0.20 $\pm$ 0.04 in non-smokers ( $p < 0.001$ ).

## Discussion

The finding of the present study that male smokers had significantly higher lymphocytes count and lower counts of neutrophils compared to healthy adult male non-smokers is in full agreement with earlier findings.<sup>15</sup>

In the present study it was noted that serum magnesium levels were significantly decreased in smokers. This could be due to increased demand for magnesium by smokers owing to increased release of adrenaline and thermogenic effect of nicotine, which is the main constituent of tobacco. Also, smokers may get less magnesium than non-smokers because they tend to eat less.

A study<sup>7</sup> reported raised levels of serum CRP in smokers. This is supported by the finding of the present study.

A study carried out on magnesium-deficient rats<sup>16</sup> observed that inflammatory response was an early outcome of magnesium deficiency in rats. This is supported by the notion that magnesium inhibits inflammation and decreases CRP levels in chronic diseases.<sup>17</sup>

According to a study,<sup>18</sup> which is supported by a meta-analysis and systemic review,<sup>17</sup> individuals with less intake

of magnesium were more likely to have had raised serum CRP. The independent relationship between the low serum magnesium levels and raised CRP concentrations in smokers in the present study as well as by an earlier one<sup>5</sup> in non-diabetic, non-hypertensive obese subjects suggest that hypomagnesaemia might be responsible for the activated state of immune cells. In order to clarify the role of plasma magnesium deficiency in the aetiology of the inflammatory processes, interventional prospective studies are needed to be carried out to examine the effects of magnesium supplementation on serum magnesium and CRP levels in healthy adult male smokers.

The difference in the mean CRP-to-magnesium ratio in the two groups in the current study clearly indicates that smoking increased inflammation (manifested by raised levels of CRP in serum and decreased serum magnesium concentration in the smokers. However, it will be interesting to see whether the ratio could be used to examine additive effects of smoking on severity and prognosis of diseases with inflammatory component.

## Conclusion

Smoking significantly decreased serum magnesium concentration and increased serum CRP concentration, resulting in an inverse relationship between the two in healthy adult male smokers.

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## References

1. Das SK. Harmful health effects of cigarette smoking. *Mol Cell Biochem* 2003; 253: 159-65.
2. Wannamethee SG, Lowe GD, Shaper AG, Rumley A, Lennon L, Whincup PH. Associations between cigarette smoking, pipe/ cigar smoking, and smoking cessation, and haemostatic and inflammatory markers for cardiovascular disease. *Eur Heart J* 2005; 26: 1765-73.
3. Libby P. Inflammation in atherosclerosis. *Nature* 2002; 420: 868-74.
4. Lao XQ, Jiang CQ, Zhang WS, Adab P, Lam TH, Cheng KK, et al. Smoking, smoking cessation and inflammatory markers in older Chinese men-The Guangzhou Biobank Cohort Study. *Atherosclerosis* 2009; 203: 304-10.
5. Lau DC, Dhillon B, Yan H, Szmitko PE, Verma S. Adipokines: molecular links between obesity and atherosclerosis. *Am J Physiol Heart Circ Physiol* 2005; 288: H2031-41.
6. Pepys M, Hirschfield GM. C-reactive protein: a critical update. *J Clin Invest* 2003; 111: 1805-12.
7. Yamada S, Gotoh T, Nakashima Y, Kayaba K, Ishikawa S, Nago N, et al., Distribution of serum C-reactive protein and its association with atherosclerotic risk factors in a Japanese population- Jichi Medical School Cohort Study. *Am J Epidemiol* 2001; 153: 1183-90.
8. Lopez-Garcia E, Schulze MB, Meigs JB, Manson JE, Rifai N, Stampfer MJ, et al. Consumption of trans fatty acids is related to plasma biomarkers of inflammation and endothelial dysfunction. *J.Nutr* 2005; 135: 562-6.
9. Dehghan A, Kardys I, Demaat MP, Uitterlinden AG, Sijbrands EJ, Bootsma AH, et al. Genetic variation, C-reactive protein levels, and incidence of diabetes. *Diabetes* 2007; 56: 872-8.
10. Volpe SL. Magnesium, the metabolic syndrome, insulin resistance, and type 2 diabetes mellitus. *Crit Rev Food Sci Nutr* 2008; 48: 293-300.
11. Talukder MAH, Johnson WM, Varadharaj S, Lian J, Kearns PN, EL-Mahdy MA, et al. Chronic cigarette smoking causes hypertension, increased oxidative stress, impaired NO bioavailability, endothelial dysfunction, and cardiac remodeling in mice. *Am J Physiol Heart Circ Physiol* 2011; 300: H 388-96.
12. Guerrero-Romero F, Rodriguez-Moran M. Relationship between serum magnesium levels and C-reactive protein concentration, in non-diabetic, non-hypertensive obese subjects. *Int J Obes Relat Metab Disord* 2002; 26: 469-74.
13. King DE, Egan BM, Mainous AG, Geesey ME. Elevation of C-reactive protein in people with prehypertension". *J Clin Hypertension* 2004; 6: 562-8.
14. Taro Y. *Statistics: An introductory analysis*. 2nd ed. New York: Harper & Row; 1967.
15. Lyer RA, Joshi AR, Esmaeil H. Effect of cigarette smoking on leukocytes count in human adult males. *Int J Physiol* 2014; 2: 107-11.
16. Malpuech-Brugère C, Nowacki W, Daveau M, Gueux E, Linard C, Rock E, et al. Inflammatory response following acute magnesium deficiency in the rat. *Biochim Biophys Acta* 2000; 1501: 91-8.
17. Dibaba DT, Xun P, He K. Dietary magnesium intake is inversely associated with serum C-reactive protein levels: meta-analysis and systematic review. *European Journal Clinical Nutrition* 2014; 68: 510-6.
18. King DE, Mainous AG III, Geesey ME and Woolson RF. Dietary Magnesium and C-reactive protein levels. *J. Am Col of Nutr* 2005; 24: 166-71.