Relationship Between Physical Fitness and C-Reactive Protein Level in Adolescent Age (10-18 years) in Bundelkhand Region

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ABSTRACT

Introduction: C-reactive protein (CRP), an acute-phase reactant, is produced in the liver and belongs to the pentraxin family of proteins. Recent data implicate systemic inflammatory factors, including fibrinogen, CRP, and interleukin 6, as important factors for atherosclerosis and cardiovascular disease events. CRP is significantly related to various cardiovascular disease risk factors in children and has been shown to be inversely related to antioxidant concentrations. The presence of early stage atherosclerosis has been documented extensively in children and young adults, but data regarding inflammatory factor in children and adolescents are not so well documented as in adults. Aims and Objectives: To study the relationship between physical fitness and CRP level in the adolescent age group. Methods: The study was conducted from July 2008 to December 2009. Measurement of physical work capacity (PWC) was done by treadmill test according to modified Bruce protocol. We have measured weight, height, resting heart rate, body mass index (BMI), waist-hip ratio (WHR). Measurement of serum CRP level was done by latex agglutination method. Result: In girls mean CRP levels were higher (0.48 mg/L) as compared to boys (0.42 mg/L). In girls mean BMI were higher (19.46%) than boys (18.17%). In girls mean WHR were higher (0.85) than boys (0.84%). In girls mean PWC (3.81) was lower than boys (4.13). CRP level tended to be higher in higher weight children (means of 0.35, 0.40, 0.45, 0.55 for children < 30, 31-40, 41-50 and > 50 kg respectively). Conclusion: We had seen the significant positive correlation of CRP with BMI, weight and height and significant negative correlation with PWC.

Keywords: Body mass index, C-reactive protein, physical fitness

INTRODUCTION

C-reactive protein (CRP), an acute-phase reactant, is produced in the liver and belongs to the pentraxin family of proteins. This protein is very sensitive to inflammation, and its concentration can increase rapidly (1000-fold) in response to a wide range of stimuli. Recent data implicate systemic inflammatory factors, including fibrinogen, CRP, and interleukin 6 (IL-6), as important factors for atherosclerosis and cardiovascular disease events. There is evidence of participation of inflammatory factors in the early stages of atherogenesis, including impairment of endothelial function and formation of fatty streaks and plaque, as well as in the thrombotic events that trigger myocardial infarction and some strokes. CRP and IL-6 levels predict the development of Type 2 diabetes, possibly attributable in part to the established relationship of obesity to IL-6 and CRP levels. Obesity is a strong predictor...
of CRP, and other inflammatory markers. IL-6 which stimulates the hepatic production of fibrinogen and CRP is synthesized in adipose tissue, particularly by visceral adipose tissue. Synthesis of tumor necrosis factor (TNF-α), another proinflammatory cytokine, is also increased in obese subjects. Physical activity and physical fitness levels are inversely correlated with fibrinogen and with CRP levels in adults.

The evidence is now accumulating to suggest that CRP may contribute to inflammation in atheroma and also may be actively involved in early atherogenesis. The protein displays Ca\textsuperscript{2+}-dependent in vitro binding to low density lipoproteins and activates the complement system. Native CRP is deposited in human atherosclerotic lesions. Recently, co-localization of CRP and C5b-9, the terminal complement complex, has been demonstrated in early human atherosclerotic lesions, indicating that CRP is an important complement-activating molecule in the lesion. Co-localization of CRP and foam cells in fatty streaks suggests an interaction of CRP with the cells. Different receptors have been described for CRP. On monocytes, specific CRP binding occurs through FcγRIIa/CD32 with high affinity as well as FcγRIIa/CD32 with high affinity. Very recently, it has been shown that CRP binding to FcγRIIa/CD32 on human monocytes and neutrophils is allele specific. However, further data suggest the existence of an additional “unique” CRP receptor involved in CRP binding and signaling.

The pathogenesis of cardiovascular disease often starts in childhood. Immunologic inflammatory cells are present in early atherosclerotic lesions of the aorta in people as young as 17 years. Risk factors for cardiovascular disease, such as smoking, hypertension, dyslipidemia, obesity, physical activity and diabetes mellitus, also often start in childhood and track into the adulthood for many. Less in known about the distribution and correlates of inflammatory markers that predict cardiovascular disease risk in children and young adults, however. CRP, concentrations in children, are associated with excess weight, as they are in adults. In addition, CRP is significantly related to various cardiovascular disease risk factors in children and has been shown to be inversely related to antioxidant concentrations. The presence of early stage atherosclerosis has been documented extensively in children and young adults, but data regarding inflammatory factor in children and adolescents are not so well developed as in adults. Due to a sedentary lifestyle and bad eating habits there is an increase in the prevalence of obesity worldwide, which contributes to a higher incidence of cardiovascular diseases and Type 2 diabetes mellitus. Results from large prospective cohort studies have generally showed an increased risk of cardiovascular disease - mortality with increasing body mass index (BMI). BMI is the best tool available to determine childhood and adolescent obesity.

The objective of our study was to evaluate the relationship between physical fitness and CRP level in adolescent age.

METHODS
Selection of Cases
The study was conducted from July 2008 to December 2009. Children and adolescent from 10 to 18 years of age of either sex attending “adolescent clinic” in the department of pediatrics or studying in privileged schools of the city. These children were randomly selected irrespective of their socioeconomic status. Children with known cardiac disease and asthmatic patient were not included in the study. A detailed history including television viewing, physical activity, dietary, exercise, indoor and outdoor activities, Family history and clinical examination were taken properly.

Measurement of physical work capacity (PWC) was assessed by using a treadmill test according to modified Bruce protocol. Resting heart rate (RHR) was measured before the exercise test and after 5 min of rest. Height was taken by stadiometer, nearest to the 0.1 cm.

Electronic weighing machine was used. In order to have uniformity in the procedure subject was weighed with minimum possible clothing.

$$BMI = \frac{Wt (kg)}{Ht (m^2)}$$

was calculated. Circumferences at the waist (level of the narrowest part of the torso) and hip (level of the maximum extension of the buttocks) were measured with a tape and the waist to hip ratio was calculated.

CRP level was measured from serum using latex agglutination method. We had used turbidimetric immunoassay for determination of CRP in human serum and were based on the principle of agglutination reaction. The test specimen was mixed with activation buffer (R1), Turbilyte-CRPTM reagent (R2) and allowed to react. The presence of CRP in the test specimen results in the formation of an insoluble complex production a turbidity, which was measured at 546 nm wavelength. The increase in turbidity corresponds to the concentration of CRP in the test specimen. The reaction temperature was at 37°C.

Statistical analyses were performed using SPSS – PC software. Frequencies mean, and standard deviations were calculated for each variable. Pearson’s correlation coefficients were also calculated.

RESULTS
A total of 106 cases were taken between the age group of 10 and 18 years in which 70 (66.04%) were males and 36 (33.96%) were females. There were 46 (43.40%) subject
in the age group of 10-12 years, 56 (52.83%) were in the age group of 13-15 years and 4 (3.77%) in the age group of 16-18 years.

On basis of weight grouped in four categories. In the first category of < 30 kg weight (13 subjects, 12.26%), in the second category of 31-40 kg (38 subject, 35.85%), in the third category of 41-50 kg (32 subjects, 30.19%) and in the last category of more than 50 kg (23 subjects, 21.70%). Height recorded in centimeters and had grouped into four categories, 19 subjects (17.92%) were below 140 cm, 29 subject (27.36%) were in between 141 and 150 cm, 39 subject (36.79%) were in between 151 and 160 cm, and 19 subject (17.92%) were in more than 161 cm. BMI has been grouped four categories of < 14 kg/m² (underweight, 6 subjects, 5.66%), 14-25 kg/m² (normal, 93 subjects, 87.74%), 25-30 kg/m² (overweight, 6 subjects, 5.66%), and 30 kg/m² (obese, 1 subject, 0.94%).

Waist-hip ratio (WHR) grouped into three categories. 19 subject (17.92%) were in the first category of 0.70-0.79, 72 subjects (67.92%) were in second category of 0.80-0.89, and 15 subjects (14.15%) were in between 0.90 and 0.99.

PWC grouped all in five categories according to the stage of modified Bruce protocol, which they had achieved during treadmill test. 7 subjects were not achieved the target heart rate (indeterminate) because they had refused to run over treadmill after few stages.

The frequency distribution of the PWC shows that 7 subjects (6.60%) achieved Stage 2, 25 subject (23.58%) achieved Stage 3, 40 subject (37.74%) achieved Stage 4, 27 subject (25.47%) achieved Stage 5, and 7 subjects (6.60%) achieved Stage 6.

We had grouped CRP level in four groups. The first group had CRP level < 0.30 mg/L (21 subject, 19.81%). The second, third, and fourth groups had a CRP level of 0.31-0.40 mg/L (25 subject, 23.58%), 0.41-0.50 mg/L (23 subject, 21.70%) and more than 0.50 mg/L (37 subject, 34.91%), respectively.

**Mean and Standard Deviation of the Indicators**
The mean and standard deviations of each of the variables have also been calculated and presented in Table 1. Mean value of age was 12.67 years. Mean value of RHR was 100.51/min. The average weight of the respondents was 42.96 kg (range: 23-75). The average height was 151.06 cm (range: 130-180). The mean value of BMI was 18.60 kg/m² (range: 12.58-31.62), which indicates that most of the subjects had a normal BMI level. The mean value of WHR was 0.84 (range: 0.70-0.99) and mean value of CRP was 0.44 mg/L (range: 0.17-0.8). The mean value of PWC was 4.022 (range: 2-6), which indicates that most of the subjects had reached up to level 4.

Table 2 presents the bivariate results of mean and standard deviation together with the P value. Table 2 shows that in girls the mean CRP level was higher (0.48 mg/L) in comparison to boys (0.42 mg/L). In girls mean BMI and WHR were also higher than boys (BMI: 19.46 vs. 18.17 and WHR: 0.85 vs. 0.84). Girls had a lower level of PWC than boys (3.81 vs. 4.13). Girls had lower mean RHR than boys (100.33 vs. 100.60).

CRP level tended to be higher in the older children (means of 0.41, 0.46, 0.54 for children 10-12, 13-15, and 16-18 years respectively). CRP level was also higher for subjects with more weight in comparison to the lesser weight subjects. The P value of the result is 0.031, which shows that it is also significant at 0.05 level of significance.

Table 3 presents the result of Pearson’s correlation coefficient.

In Pearson’s correlation (Table 3), we had seen very significant positive correlation of CRP with BMI, age, weight, height, and negative correlation of CRP with PWC.

**DISCUSSION**

In our study we had found that 6 subjects (28.57%) who had weight less than 30 kg, their CRP level were below 0.30 mg/L (P = 0.000) (Table 3). There was very strong positive correlation between weight and CRP (0.471) (Table 4). Mean height was 151.06 cm in our sample there was also positive correlation between height and CRP (0.280) (Table 4).

We had found very strong positive correlation in between BMI and CRP (0.447) (Table 4) and P value 0.044 (Table 3). There was no significant correlation between waist hip ratio and CRP level (0.073) (Tables 3 and 4).
In our study we had found very significant inverse correlation in between PWC and CRP level ($-0.785$) (Table 4).

Cook et al.\(^{17}\) found higher mean level of C-reactive protein in children in the top quintile of the ponderal index. These investigators used a questionnaire to assess physical activity and found an inverse relationship with CRP level in bivariate analysis and after adjustment for the ponderal index. Physical fitness was inversely related to several established cardiovascular disease risk factors, including high cholesterol, blood pressure, and obesity in both adults and children.

Mattush et al.\(^{21}\) reported a decrease in CRP level after a 9 month endurance training programme in adults.

Acevedo et al.\(^{22}\) studied on children in 2007 and found significant direct relationship between the CRP concentration and measures of adiposity, particularly body mass index. The CRP concentrations of the children in their study were significantly lower than those seen in adults.\(^{23}\) In their study in healthy children the median CRP concentration ranges from 0.2 to 0.5 mg/L.

Yudkin et al.\(^{1}\) studied over 107 subjects aged 40-75 years in UK, they found that subjects with high concentrations of CRP were more obese than those with lower levels, and had higher levels of blood pressure, triglyceride, Vonwillebrand factor, cellular fibronectin, PAI-1, tPA, and of the proinflammatory cytokines TNF-α and IL-6.

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boys 1.4 mg/L and in girls 1.3 mg/L. They found that age was inversely correlated with CRP whereas BMI, WHR and sum of skin fold thickness were positively correlated.

In our study we had found CRP ranges from 0.17 to 0.80 mg/L, mean 0.42 mg/L, standard deviation 0.15, in age group 10-18 years. In boys mean value 0.42 mg/L, and in girls mean value 0.48 mg/L (Table 2).

In our study mean BMI level were higher among girls than boys, however physical work capacity was higher in boys as compared to girls (Table 2). These finding are consistent with Isasi et al.\textsuperscript{25}

CRP level tended to be higher in older children (means of 0.41, 0.46 and 0.54 mg/L for children 10-12, 13-15 and 16-18 years respectively) as shown in Table 2.

CRP level was positively correlated with age, weight, height (Tables 2 and 4).

CRP level was also positively correlated with BMI and this correlation was very significant (Table 4).

However, study conducted by Ford et al.\textsuperscript{26} in United States in 2003 over 3348 children and young adults 3-19 years of age, who participated in National Health and Nutrition Examination Survey. They found that CRP concentrations increased with age, and females 16-19 years of age had higher concentrations than males in this age group. In their study, CRP concentrations ranged from 0.1 to 90.8 mg/L. They found that almost 33% of participants had a CRP concentration of 0.1 mg/L.

They found that geometric mean concentration of CRP increased gradually with age among both male and female

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**Table 4: Cross tabulation of CRP with other variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>&lt;0.30 mg/L</th>
<th>0.31-0.40 mg/L</th>
<th>0.41-0.50 mg/L</th>
<th>&gt;0.50 mg/L</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>18 (85.71)</td>
<td>16 (64.00)</td>
<td>15 (65.22)</td>
<td>21 (56.76)</td>
<td>70 (66.04)</td>
<td>P=0.165</td>
</tr>
<tr>
<td>Female</td>
<td>3 (14.29)</td>
<td>9 (36.00)</td>
<td>8 (34.78)</td>
<td>16 (43.24)</td>
<td>36 (33.96)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-12 years</td>
<td>13 (61.90)</td>
<td>11 (44.00)</td>
<td>7 (30.43)</td>
<td>15 (40.54)</td>
<td>46 (43.40)</td>
<td>P=0.513</td>
</tr>
<tr>
<td>13-15 years</td>
<td>8 (38.10)</td>
<td>13 (52.00)</td>
<td>15 (65.22)</td>
<td>20 (54.05)</td>
<td>56 (52.83)</td>
<td></td>
</tr>
<tr>
<td>16-18 years</td>
<td>0 (0.00)</td>
<td>1 (4.00)</td>
<td>1 (4.35)</td>
<td>2 (5.41)</td>
<td>4 (3.77)</td>
<td></td>
</tr>
<tr>
<td>PWC (AXB) stage**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 2</td>
<td>0 (0.00)</td>
<td>1 (4.00)</td>
<td>0 (0.00)</td>
<td>6 (16.22)</td>
<td>7 (6.60)</td>
<td>P=0.000</td>
</tr>
<tr>
<td>Stage 3</td>
<td>1 (4.76)</td>
<td>1 (4.00)</td>
<td>1 (4.35)</td>
<td>22 (59.46)</td>
<td>25 (23.58)</td>
<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>3 (14.29)</td>
<td>6 (24.00)</td>
<td>22 (95.65)</td>
<td>9 (24.32)</td>
<td>40 (37.74)</td>
<td></td>
</tr>
<tr>
<td>Stage 5</td>
<td>12 (57.14)</td>
<td>15 (60.00)</td>
<td>9 (39.13)</td>
<td>9 (24.32)</td>
<td>32 (30.19)</td>
<td></td>
</tr>
<tr>
<td>Stage 6</td>
<td>5 (23.81)</td>
<td>2 (8.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>7 (6.60)</td>
<td></td>
</tr>
<tr>
<td>Weight**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30 kg</td>
<td>6 (28.57)</td>
<td>1 (4.00)</td>
<td>5 (21.74)</td>
<td>1 (2.70)</td>
<td>13 (12.26)</td>
<td>P=0.000</td>
</tr>
<tr>
<td>31-40 kg</td>
<td>12 (57.14)</td>
<td>9 (36.00)</td>
<td>6 (26.09)</td>
<td>11 (29.73)</td>
<td>38 (35.85)</td>
<td></td>
</tr>
<tr>
<td>41-50 kg</td>
<td>3 (14.29)</td>
<td>11 (44.00)</td>
<td>9 (39.13)</td>
<td>9 (24.32)</td>
<td>32 (30.19)</td>
<td></td>
</tr>
<tr>
<td>&gt;50 kg</td>
<td>0 (0.00)</td>
<td>4 (16.00)</td>
<td>3 (13.04)</td>
<td>16 (43.24)</td>
<td>23 (21.70)</td>
<td></td>
</tr>
<tr>
<td>Height**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;140 cm</td>
<td>10 (47.62)</td>
<td>2 (8.00)</td>
<td>5 (21.74)</td>
<td>1 (2.70)</td>
<td>19 (17.92)</td>
<td>P=0.009</td>
</tr>
<tr>
<td>141-150 cm</td>
<td>6 (28.57)</td>
<td>8 (32.00)</td>
<td>6 (26.09)</td>
<td>9 (24.32)</td>
<td>31 (28.57)</td>
<td></td>
</tr>
<tr>
<td>151-160 cm</td>
<td>2 (9.52)</td>
<td>10 (40.00)</td>
<td>9 (39.13)</td>
<td>18 (48.65)</td>
<td>39 (36.79)</td>
<td></td>
</tr>
<tr>
<td>&gt;161 cm</td>
<td>3 (14.29)</td>
<td>5 (20.00)</td>
<td>3 (13.04)</td>
<td>8 (21.62)</td>
<td>19 (17.92)</td>
<td></td>
</tr>
<tr>
<td>BMI*</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>&lt;14 kg/m\textsuperscript{2}</td>
<td>3 (14.29)</td>
<td>1 (4.00)</td>
<td>1 (4.35)</td>
<td>1 (2.70)</td>
<td>6 (5.66)</td>
<td>P=0.044</td>
</tr>
<tr>
<td>14-25 kg/m\textsuperscript{2}</td>
<td>18 (85.71)</td>
<td>24 (96.00)</td>
<td>22 (95.65)</td>
<td>29 (78.38)</td>
<td>93 (87.74)</td>
<td></td>
</tr>
<tr>
<td>25-30 kg/m\textsuperscript{2}</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>6 (16.22)</td>
<td>6 (5.66)</td>
<td></td>
</tr>
<tr>
<td>&gt;30 kg/m\textsuperscript{2}</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (2.70)</td>
<td>1 (0.94)</td>
<td></td>
</tr>
<tr>
<td>WHR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.70-0.79</td>
<td>3 (14.29)</td>
<td>3 (12.00)</td>
<td>5 (21.74)</td>
<td>8 (21.62)</td>
<td>19 (17.92)</td>
<td>P=0.683</td>
</tr>
<tr>
<td>0.80-0.89</td>
<td>17 (80.95)</td>
<td>17 (68.00)</td>
<td>14 (60.87)</td>
<td>24 (64.86)</td>
<td>72 (67.92)</td>
<td></td>
</tr>
<tr>
<td>0.90-0.99</td>
<td>1 (4.76)</td>
<td>5 (20.00)</td>
<td>4 (17.39)</td>
<td>5 (13.51)</td>
<td>15 (14.15)</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at 0.05 level of significance, **Significant at 0.01 level of significance, PWC: Physical work capacity, CRP: C-reactive protein, BMI: Body mass index, WHR: Waist hip ratio.
participants. Geometric mean CRP concentrations were similar among male and female participants through ~15 years of age (age 3-9 years, P = 0.304, age 10-15 years, P = 0.407), after which female participants tended to have higher geometric mean concentration than male participants 16-19 years of age.

CONCLUSION

CRP level tended to be higher in older children and positively correlated with age. We had seen very significant positive correlation of CRP with BMI, weight and height. We had seen no significant correlation with WHR.

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I am thankful to all the Children who were the very basic of this study

PEER REVIEW

Nil

CONFLICTS OF INTEREST

Nil

FUNDING

Nil

REFERENCES


