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THE RELATIONSHIP BETWEEN SERUM VITAMIN B12 LEVELS, TIBC, AND AEROBIC FITNESS IN REGULARLY EXERCISING WOMEN.

Physiology

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ABSTRACT

Background: Regular physical activity has become popular among women, increasing interest in how it affects biochemical parameters. Vitamin B12 and Total Iron Binding Capacity (TIBC) are key markers that influence athletic performance and health. This study aimed to explore the relationship between serum Vitamin B12 levels, TIBC, and aerobic fitness in regularly exercising women. **Methodology:** This case-control study was conducted at the Postgraduate Department of Physiology in collaboration with the Department of Biochemistry at Government Medical College, Jammu, from October 2021 over a year. It involved 70 subjects: 35 exercising women (cases) and 35 non-exercising women (controls). The cases were women who engaged in at least 30 minutes of aerobic exercise daily, five days a week, for at least six months. Data collected included personal information and anthropometric measurements (age, height, weight, and body mass index). A blood sample was taken from each participant to assess Vitamin B12 and Total Iron Binding Capacity (TIBC), measured using chemiluminescence immunoassay and photometer methods, respectively. Aerobic fitness was evaluated using the Harvard Step Test. **Results:** The study found a statistically significant difference in vitamin B12 levels (p=0.023) between the cases and controls. The mean vitamin B12 level in controls was significantly higher at 292.20 pg/ml compared to that of the cases. The mean physical fitness index (PFI) was higher in subjects aged 18-28 years than in those aged 29-40 years (P0.001). There was no significant difference in the aerobic fitness index between the controls and cases (P=0.174). **Conclusion:** The present study concludes that the routine estimation of vitamin and Iron profiles are helpful in the detection of any alteration of haematological parameters.

KEYWORDS

Vitamin B12, Total Iron Binding Capacity, Aerobic Fitness.

INTRODUCTION:

The health benefits of regular physical activity /exercise have been recognized since ancient times. Regular exercise controls body weight and prevents obesity, hypertension, diabetes, and cardiovascular diseases. Physical activity maintained throughout life is associated with lower incidence and prevalence of chronic diseases such as cancer, diabetes, and cardiovascular and coronary heart diseases **(1).**

Regular physical activity and exercise have become increasingly popular among women, leading to growing interest in understanding how exercise affects various biochemical parameters (2,3). Vitamin B12 and Total Iron Binding Capacity (TIBC) are particularly important markers that can significantly impact athletic performance and overall health in exercising females.

Vitamin B12 plays a crucial role in exercise metabolism, and athletes with poor B-vitamin status may experience a decreased ability to perform high-intensity exercise. Studies have shown that exercise can alter vitamin B12 levels, leading to recommendations for B-complex vitamin supplementation in physically active individuals (4).

TIBC, which measures the blood's capacity to bind transferrin with iron, is an important marker for iron status (5). TIBC reflects the amount of transferrin, an iron-transport protein, available in the blood. Measuring TIBC can provide valuable insights into iron metabolism and potential deficiencies. This is particularly relevant for female athletes, as they are more susceptible to iron deficiency due to menstrual blood loss, sweating during exercise, and potentially inadequate dietary intake (2,3).

Research has demonstrated that physically active women often show different B12 and iron parameter patterns compared to sedentary individuals (6). Studies have found that active women frequently display lower serum ferritin and mean cell haemoglobin concentrations compared to their sedentary counterparts (7). Additionally, exercise training has been shown to significantly affect vitamin B12 concentrations, with some studies reporting higher levels in exercise training groups compared to non-training groups (8).

The relationship between aerobic fitness and these biochemical parameters is complex and warrants investigation. Previous research has indicated that various fitness levels may correspond to different patterns of vitamin B12 and TIBC measurements. Despite the growing body of research in this area, there remains a significant gap in understanding how different levels of aerobic fitness correlate with vitamin B12 and TIBC levels, particularly in regularly exercising females. This understanding is crucial as both parameters can significantly impact exercise performance and overall health outcomes (4,9).

The present study aims to investigate the relationship between serum vitamin B12 levels, TIBC, and aerobic fitness in regularly exercising females. This research is particularly relevant given that iron deficiency is one of the most prevalent forms of malnutrition worldwide, and female athletes may be at increased risk due to their physical activity levels. Furthermore, understanding these relationships could help inform nutritional and training recommendations for physically active women.

Methodology:

The present case-control study was conducted at the Postgraduate Department of Physiology in collaboration with the Department of Biochemistry, Government Medical College, Jammu. The study period, commencing in October 2021, lasted over one year.

The study population comprised healthy females between 18 to 40 years of age. For data collection, local gymnasiums near GMC, Jammu were visited. A total of 70 subjects participated in the study, with 35 cases (regularly exercising females) and 35 controls (non-exercising females). The cases included women who had been performing regular aerobic exercise for at least 30 minutes daily, five days per week, for a minimum of six months.

The study excluded individuals who were smokers, alcoholics, pregnant, or breastfeeding. Additionally, those with a history of chronic diseases or who were outside the age range of 18-40 years were not included. The purpose of the study was thoroughly explained to all eligible subjects, and written consent was obtained from those who volunteered to participate.

Data collection involved personal data and Anthropometric measurements such as Age, Height, Weight, and Body Mass Index. Clinical histories were carefully documented for all participants. A Blood Sample was collected from each subject to evaluate Vitamin B12 and Total Iron Binding Capacity. Vitamin B12 was measured by chemiluminescence immunoassay, and Total Iron Binding Capacity was measured by photometer method. Aerobic fitness was measured by the Harvard Step test.

Statistical Analysis:

The statistical analysis was done using SPSS (Statistical Package for the Social Sciences, SPSS Inc., v.16). The descriptive statistics were calculated as mean and standard deviation. The comparison of study parameters between cases and controls was done using an independent t-test. Correlation between quantitative variables was assessed using Pearson's correlation analysis. The comparison of study parameters among participants with various fitness levels was done using Analysis of Variance, followed by Turkey's post- hoc test for multiple comparisons. The level of significance for the present study was set at a P value of less than 0.05.

RESULTS AND OBSERVATIONS:

The current study aimed to measure plasma Vitamin B12 levels, evaluate Total Iron Binding Capacity, and assess aerobic fitness in regularly exercising females. Seventy participants took part in the study, consisting of 35 cases (women who regularly exercise) and 35 controls (women who do not exercise). The cases included women who had been engaging in aerobic exercise for at least 30 minutes a day, five days a week, for a minimum of six months.

In our study, we found that the mean age of the cases was 27.65 ± 6.24 years, while the mean age of the controls was 29.88 ± 6.61 years. The mean height of the cases was 1.60 ± 0.59 meters, compared to the mean height of the controls, which was 1.62 ± 0.06 meters. The mean weight of the cases was 62.82 ± 9.77 kg, and the mean weight of the controls was 63.11 ± 7.72 kg. Lastly, the mean BMI of the cases was 24.09 ± 3.70 kg/m², whereas the mean BMI of the controls was 24.20 ± 3.82 kg/m².

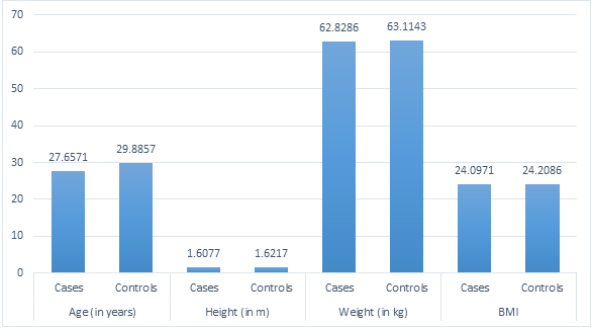

Figure 4.1: Age and Baseline Anthropometric parameters of cases and controls

Table 1: Biochemical Parameters Of Cases And Controls

	Group	Mean	Std. Deviation	P value
Vitamin B12 Levels	Cases	221.68	140.76	0.02*
	Controls	292.20	110.87	
Total Iron Binding Capacity	Cases	347.68	126.03	0.50
	Controls	365.42	94.72	

*Statistically significant (P<0.05, Independent t-test)

Table-1 depicts the Vitamin B12 and TIBC levels among cases and controls. In our study, we found a statistically significant difference in vitamin B12 levels (p=0.023) between the cases and controls. However, there was no statistically significant difference in total iron-binding capacity (TIBC) between the two groups (p=0.508). The mean vitamin B12 level in controls was significantly higher at 292.20 pg/ml compared to that of the cases.

Table 2: Comparison Of Biochemical Parameters And Aerobic Fitness Among The Cases And Controls

Age Group (in years)	Number (%)	Mean Vitamin B12 Levels	Mean TIBC	Aerobic Fitness			
				Excellent	Good	Average	Below Average
18-28 years	33 (47.16 %)	270.96	352.48	11 (33.33 %)	7 (21.21 %)	11 (33.33 %)	4 (12.12%)
29- 40 years	37 (52.84 %)	244.43	408.83	9 (24.32 %)	10 (27.02 %)	5 (13.51 %)	13 (35.13%)

Table 2 compares biochemical parameters and aerobic fitness between cases and controls. Our results show that average Vitamin B12 levels were higher in those aged 18 to 28 years (270.96 pg/ml) than in the 29 to 40 age group (244.43 pg/ml). Conversely, Total Iron-Binding Capacity (TIBC) was greater in the 29 to 40 age group (408.83 µg/dl) compared to the younger group (352.48 µg/dl).

In the 18 to 28 age group, 33.33% rated excellent on the Physical Fitness Index, while 21.21% rated good. For the 29 to 40 age group, 24.32% were rated excellent, and 27.02% rated good.

In our study on comparison of physical fitness index, it was observed that most of the cases (48.6%) had excellent physical fitness index and most (48.6%) had low average physical fitness index found among the control group. There was a statistically significant difference in PFI between cases and controls (P<0.001).

The present study shows a statistically significant positive correlation between BMI and vitamin B12 levels (r =0.300, P=0.012). No statistically significant correlation was observed between BMI and TIBC (r =0.174, P=0.149).

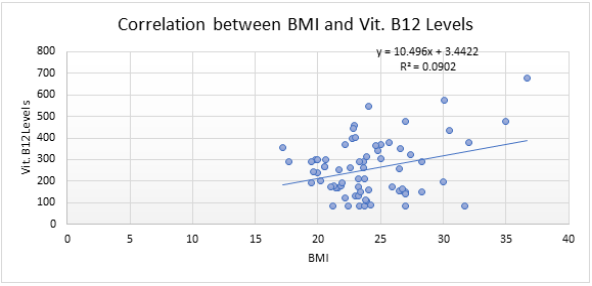

Figure 4.5: Correlation between BMI and Vitamin B12 Levels

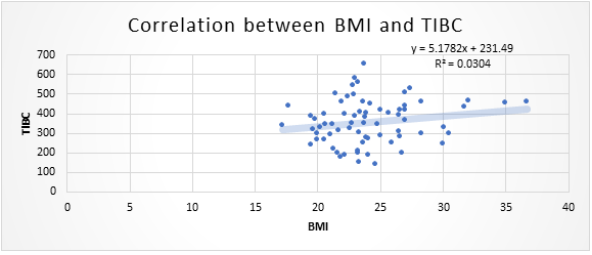

Figure 4.6: Correlation between BMI and TIBC Levels

In our study, participants with Excellent Aerobic Fitness (N=20) had a mean BMI of 22.05 ± 2.01115. Those with Good Aerobic Fitness (N=17) had a mean BMI of 23.42 ± 3.54863, while participants with Average Aerobic Fitness (N=16) had a mean BMI of 24.76 ± 4.26691. Participants with Low Average Fitness (N=17) had a mean BMI of 26.79 ± 3.46408. We found a significant difference in BMI among fitness levels (P=0.001), particularly between Excellent and Low Average fitness (P<0.001) and between Good and Low Average fitness (P=0.024).

The study assessed Vitamin B12 levels and TIBC across different aerobic fitness levels. Participants with Excellent Aerobic Fitness had mean vitamin B12 levels of 181.05±86.12 pg/ml and TIBC of 352.80±132.25 µg/dl. Those with Good Aerobic Fitness had B12 levels of 266.17±111.49 pg/ml and TIBC of 343.23±111.89 µg/dl. Participants with Average Aerobic Fitness showed B12 levels of 282.00±172.00 pg/ml and TIBC of 357.56±92.69 µg/dl, while those with Low Average Fitness had B12 levels of 313.41±115.69 pg/ml and TIBC of 373.35±106.35 µg/dl.

The Statistical analysis showed that there was a significant difference in Vitamin B12 levels but no statistical difference in TIBC levels across various fitness levels.

DISCUSSION:

The body requires several nutrients to respond properly to physical exercise. Physical activity of any bout duration is associated with improved health outcomes, including all-cause mortality **(10).** The World Health Organization (WHO) guidelines recommend that children and young females engage in at least 60 minutes of vigorous-intensity training daily. Adult and older females should aim for 150-300 minutes of moderate-intensity or 75-150 minutes of vigorous-intensity exercise weekly. Pregnant and postpartum women are advised to do at least 150 minutes of moderate-intensity weekly activity. Adults and older females with chronic illnesses should strive for the same duration of moderate-intensity or 75-100 minutes of

vigorous-intensity exercise weekly. Lastly, children and adolescents with disabilities should engage in at least 60 minutes of moderate to vigorous-intensity aerobic activity daily (11).

Our study assessed serum Vitamin B12 levels, Total Iron Binding Capacity, and aerobic fitness in regularly exercising females, comparing cases (those who exercise) and controls (those who do not). The mean age of cases was 27.65 ± 6.24 years and for controls, 29.88 ± 6.61 years. The mean height for cases was 1.60 ± 0.59 meters, while controls were 1.62 ± 0.06 meters. The mean weight for cases was 62.82 ± 9.77 kg and for controls, 63.11 ± 7.72 kg. The mean Body Mass Index (BMI) was 24.09 ± 3.70 kg/m² for cases and 24.20 ± 3.82 kg/m² for controls. Our findings aligned with the studies by ***Schumacher YO et al.*** and ***Krzywanski J et al.*** **(12,13).**

Vitamin B12 is crucial for various health aspects, including bone health, red blood cell formation, and mood regulation. It is vital for nerve function, DNA synthesis, and memory improvement. In this study, the mean vitamin B12 levels were 221.68 ± 140.76 pg/ml for the case group and 292.20 ± 110.87 pg/ml for the control group, showing a significant difference (P = 0.023). However, total iron binding capacity (TIBC) levels were similar between the two groups (case: 347.68 ± 126.03 µg/dl; control: 365.42 ± 94.72 µg/dl; P = 0.508). The control group's vitamin B12 level was significantly higher, consistent with findings from ***Kim YN et al.*** and ***Habte K et al.*** (14,15).

The study found that the mean Vitamin B12 level was higher in subjects aged 18-28 years (270.96 pg/ml) compared to those aged 29-40 years (244.43 pg/ml). In contrast, the mean Total Iron Binding Capacity (TIBC) was greater in the 29-40 age group (408.83 µ/dl) than in the 18-28 group (352.48 µ/dl). In terms of aerobic fitness, 33.33% of the 18-28 age group had excellent fitness, while 21.21% were rated as good, 33.33% as average, and 12.12% as below average. For the 29-40 age group, 24.32% had excellent fitness, 27.02% were good, 13.33% were average, and 35.13% were below average. These findings are consistent with the research conducted by ***Nabeyama T et al.*** (16).

Physical fitness is the ability to perform daily tasks with energy and alertness, without fatigue, and to manage unexpected situations (17). The Physical Fitness Index (PFI) is key for evaluating cardiopulmonary efficiency.

A comparison of the physical fitness index shows that 48.6% of participants had an excellent index, while the control group had 48.6% with a low average index. There was a statistically significant difference in the physical fitness index (PFI) between cases and controls (P<0.001). This aligns with the study by ***Puchala-Sarna A et al.***, which also found significant differences in PFI between the study and control groups (18).

The present study shows a statistically significant positive correlation between BMI and vitamin B12 levels (r =0.300, P=0.012). The findings are similar to the studies conducted by ***Krzywański J et al.*** and ***Alomari MA et al.*** **(13,19).**

In our study, participants with Excellent Aerobic Fitness (N=20) had a mean BMI of 22.05 ± 2.01115, while those with Good Aerobic Fitness (N=17) had a mean BMI of 23.42 ± 3.54863. Participants with Average Aerobic Fitness (N=16) had a mean BMI of 24.76 ± 4.26691, and those with Low Average Fitness (N=17) had a mean BMI of 26.79 ± 3.46408. Statistical analysis indicated significant differences in BMI between fitness levels (P=0.001), specifically between Excellent and Low Average Fitness (P<0.001) and Good and Low Average Fitness (P=0.024). These results align with studies by ***Puchala-Sarna et al***. (18).

The study evaluated vitamin B12 levels and Total Iron Binding Capacity (TIBC) in women with different aerobic fitness levels. Participants with Excellent Aerobic Fitness had a mean vitamin B12 level of 181.05 pg/ml and TIBC of 352.80 µg/dl, while those with Good Aerobic Fitness had levels of 266.17 pg/ml and 343.23 µg/dl, respectively. Women with Average Aerobic Fitness had mean levels of 282.00 pg/ml and TIBC of 357.56 µg/dl, and those with Low Average Fitness had 313.41 pg/ml and 373.35 µg/dl. The analysis revealed a significant difference in vitamin B12 levels but no significant difference in TIBC levels among the groups.

CONCLUSION:

The present study concludes that the routine estimation of vitamin B12 and Iron profile are helpful in the detection of any alteration of hematological parameters.

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