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Original Article

Physical Medicine and Rehabilitation Section

Effect of Forward Head Posture on Aerobic Fitness of Collegiate Students: A Cross-sectional Observational Study

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ABSTRACT

Introduction: A state of musculoskeletal equilibrium with little to no physical strain or stress is known as proper posture. While poor posture is caused by body parts that are not aligned with gravity, proper alignment with gravity lessens the strain on tissues. Reducing cardiovascular risks, mortality rates, and maintaining extended physical activity all depend on aerobic fitness.

Aim: The current study aimed to investigate the effect of increasing severity of Forward Head Posture (FHP) on aerobic fitness of young adults between 18-25 years of age therefore, depicting their cardiovascular status.

Materials and Methods: The present cross-sectional observational study was carried out over the course of six months from Feb 2020 to August 2020 at the Rehabilitation Centre of Jamia Hamdard, Hamdard Nagar, New Delhi, India. It evaluated the cardiovascular fitness levels of 82 college students over the course of six months using the 3-minute step test and FHP utilising University of Texas Health Science Center at San Antonio, (UTHSCA) 3.0. Healthy adults (Male: 41: Female: 41; Mean BMI: 48.2±5 kg; Mean age: 21.32±5 years for females, 20.58±5 years for males) from a variety of university courses who did not appear to have a history of lower limb injuries, cardiopulmonary disease, congenital malformations, neurological disorders, balance and proprioception issues, or cervical/thoracic spine trauma, were included in the study. The 3-minute step test was used to gauge aerobic fitness by measuring oxygen intake and endurance capacity during resting levels, 15 and 30 seconds post the completion of test, and the photogrammetric method of postural evaluation was used to measure postural misalignment.

Results: The results showed a positive relationship between reduced aerobic fitness and the degree of FHP, especially in female students with a p-value of 0.0525 for the resting pulse rate, p=0.530 for the 15-second post-test, and p=0.039 for the 30-second post-test. According to the findings, bad posture may be associated with a decrease in cardiovascular endurance. It also depicted no statistically significant differences for males with a p-values of 0.325, 0.306 and 0.933 for resting pulse rate, post 15 seconds and 30 seconds of test, respectively for males.

Conclusion: According to the study, maintaining good posture and reaching appropriate fitness levels is crucial, particularly for young people who are more likely to lead sedentary lives. More research is encouraged to examine the wider consequences of FHP on fitness and health, given its detrimental impacts.

Keywords: Cardiovascular endurance, Fitness, Physical activity

INTRODUCTION

A state of musculoskeletal homeostasis involving the body's minimal stress and strain is considered to be correct posture [1,2]. To reduce the strains that gravity places on the body's tissues, it must align with a particular body position in space [3]. Inadequate posture is characterised by misaligned body parts. Insufficient inter-relationships result in tense and shortened muscles, which impede proper joint motions and induce discomfort [3]. Therefore, assessing posture is one of the most important aspects of any clinical examination [4,5]. Poor neck posture has been shown to develop as a result of extended screen usage without muscle strengthening. Adolescents who are recognised to be physically active but who do not meet the requirements for daily activity are classified as having a sedentary lifestyle by the American College of Sports Medicine (ACSM) [5,6]. University students' cardiovascular health is categorised as "below average" or "poor" since their aerobic fitness has significantly decreased [6,7].

The head-neck-shoulder mechanics are affected when teens and young people use smartphones and laptops, leading to a common neck faulty posture known as FHP. Studies have indicated that compared to other age groups, college students had a higher likelihood of having FHP [8].

The level of an individual's aerobic fitness is highly significant [9]. Its ability to effectively meet daily oxygen requirements and lower the risk of cardiovascular diseases which in turn lowers mortality rates-explains why it allows an individual to perform an activity for longer. It is important for everyone to maintain aerobic fitness because sedentary lifestyles are linked to the early onset of lifestyle disorders such obesity, diabetes, hypertension, and cardiovascular disease [10] and because low aerobic fitness is believed to be associated with a higher death rate [10].

Previous research has demonstrated that individuals with a FHP had considerably reduced accessory respiratory muscle activity, Forced Expiratory Volume in one second (FEV1), and Forced Vital Capacity (FVC) when compared to normal individuals [11]. The upper thorax showed a larger forward shift and the lower thorax showed a greater forward and inward shift when the head posture was forward as opposed to neutral [12].

The precise impact of this prevalent postural problem on aerobic fitness is still mostly unknown, despite the fact that its effects on respiratory function and biomechanics are well-established. This research attempted to bridge this information gap. According to the study, biomechanical malalignments such as FHP may not only affect the musculoskeletal system but also have the potential to affect cardiorespiratory capacity. If a substantial association is discovered the study will emphasise the necessity of treating postural problems in addition to conventional fitness therapies in order to preserve or increase young people' aerobic capacity. This could guide the creation of more comprehensive wellness and health initiatives. Research indicates that FHP can lower lung

capacities and respiratory muscle activity. The present study seeks to determine if these physiological changes associated with FHP translate into measurable deficits in overall aerobic fitness.

The consequences of biomechanical malalignments, such as FHP, on an individual's aerobic fitness are not well documented in the literature. The purpose of the study is to ascertain whether there is any correlation between the FHP of college students and their aerobic fitness. The study intended to highlight the importance of maintaining students' posture in addition to their ideal levels of fitness, since young people already have lower levels of aerobic fitness and are more likely to lead sedentary lifestyles.

Determining the relationship between young college students' levels of cardiovascular fitness and their degree of FHP was the main aim of the study. Its primary objective was to sought to evaluate the association between objectively determined aerobic fitness levels and the craniovertebral angle a marker of FHP. The secondary objectives were to assess the prevalence of FHP among the young college students in the study population, the average aerobic fitness levels of the participating students, any notable variations in aerobic fitness levels among the subgroups of students with different degrees of FHP (minimum, moderate, and severe), and potential influencing factors like screen time habits and physical activity levels in relation to both FHP and aerobic fitness.

MATERIALS AND METHODS

The present cross-sectional observational study, was carried out at the Rehabilitation Centre of Jamia Hamdard, Hamdard Nagar, New Delhi, India over the course of six months from Feb 2020 to August 2020 after seeking approval from Review Board in which the cardiovascular fitness levels of 82 college students using the 3-minute step test and FHP utilising University of Texas Health Science Center at San Antonio, (UTHSCA) 3.0 was evaluated. After seeking a proper informed consent, 82 students (41- M; 42-F), aged 18-25 years were recruited in the study using Convenient sampling techniques.

Inclusion and Exclusion criteria: Students with an observed FHP were included in the study from which the ones having a history of thoracic postural and structural deformities, congenital torticollis, supine surgical disorders, and any history of lung disease were excluded.

Study Procedure

An assessment form was completed by each participant who disclosed information about their level of daily physical activity. The FHP was quantified using photogrammetry. Surface markings were made on the selected subjects' tragus, external corner of the eye, and spinous process of the seventh cervical vertebra. The subjects' FHP was photographed from the side using a digital camera. Using a standing imaging approach, a digital camera (FUJIFILM, 10 MP FINEPIX L30) was positioned 100 cm from a fixed base.

An adjustable camera height and a self-balancing stance were used to standardise the subject's posture. The, participants were instructed to maintain their typical head and neck positions by completely extending and flexing them for a period of time, and then gradually reducing the range of motion until they were unable to move or maintain their posture. The participant's left-side was attached to the predetermined landmarks- the tragus of the ear, the external corner of the eye, and the spinous process of C7 using board pins and double sided tape. A horizontal line that passed through the C7 spinous process and a line that connected the middle of the tragus of the ear to the skin covering it were intersected to establish the craniovertebral angle using the UTHSCSA 3.0 version.

The severity of FHP was assessed using the UTHSCA 3.0 version. It is a software that calculates the degree of FHP when a photograph taken from the lateral view, with all the above three bony landmarks highlighted is uploaded. A greater degree of FHP is associated with increased severity.

After each subject's forward head measurement, a 5-minute warm-up consisting of three 15-second self-stretches for the lower limb muscle groups, three climbs up and down the stepper, and a 5-minute rest to allow the subjects to decompress were all included.

The YMCA 3-minute step test was used to measure aerobic fitness. Following a warm-up, each participant was instructed to complete each stepping cycle for three minutes at a four-step cadence: up, up, down, down. Using a metronome (metronome beats app), the step height for males was 40 cm (16 inches), while for females it was 33 cm (13 inches), with each step occurring at a pace of 22.5 steps per minute. Following the test, the participants stood while the pulse oximeter recorded their pulse rate at 15 and 30 seconds into recovery [13]. The heart is at the highest level of exertion immediately postcessation of the activity. Post 15 seconds, it starts to recover spontaneously and becomes more stable. Another measurement at the 30th second post the activity is used to assess the rate of decline.

STATISTICAL ANALYSIS

The data was analysed using Microsoft excel and Karl Pearson correlation coefficient with $p<0.05$ to find correlation between outcome measures.

RESULTS

The study examined the correlation between college students' severity of FHP and aerobic fitness, paying particular attention to the variations between male and female participants. Significant variations in significance levels were found in the statistical analysis of pulse rate values. The resting pulse rate for female participants had a r- value of 0.322 and p-value of 0.0525, which is somewhat higher than the standard level of statistical significance (0.05) and suggests a tendency towards significance but not a clear difference as depicted in [Table/Fig-1]. The r values for 15 seconds and 30 seconds post-test were -0.042 and 0.266 with p-value of 0.530 and 0.039, respectively and did not depict any satisfactory statistical differences. The results also revealed no statistically significant differences for male participants with r values of -0.157, -0.163 and -0.013 for resting pulse rate, 15 seconds and 30 seconds post-test with p-value 0.325,0.306,0.933, respectively as depicted in [Table/Fig-2]. These results imply that men' pulse rate responses to FHP and aerobic fitness did not differ significantly.

According to [Table/Fig-1], Pearson correlation of Aerobic fitness of resting pulse rate for both males and females showed r value of 0.322 and p-value is 0.0525 which indicates moderate positive correlation but not quite statistically significant ($p>0.05$).This suggests that as aerobic fitness changes resting pulse rate shows a moderate tendency to increase or decrease alongside the degree of FHP.

Parameters	Degree of FHP	Resting Pulse Rate (r value, p-value)	Pulse Rate Post 15 seconds (r value, p-value)	Pulse Rate Post 30 seconds (r value, p-values)
Degree of FHP	1	0.05, 0.31	-0.111, -0.08	0.141, 0.26
Resting pulse rate	0.05	1, 1.00	0.267, 0.10	0.393, 0.32
Pulse rate post 15 seconds	-0.111	0.267. 0.10	1, 1.00	0.447, 0.36
Pulse rate post 30 seconds	0.141	0.393, 0.32	0.447, 0.36	1, 1.00

[Table/Fig-1]: Depicts the severity of Forward Head Posture (FHP) and aerobic fitness for both males and females.

Pulse rate post 15 seconds showed r value of -0.042 and p-value 0.530 which indicates very weak negative correlation essentially no linear relationship. The p-value >0.05 confirms that it is not statistically

Degree of Forward Head Posture (FHP)	r-values	p-values
Aerobic fitness- resting pulse rate	-0.157	0.325
Pulse rate post 15 seconds	-0.163	0.306
Pulse rate post 30 seconds	-0.0136	0.933

[Table/Fig-2]: Severity of Forward Head Posture (FHP) and aerobic fitness for males.

significant, indicating no meaningful association between pulse rate at 15 seconds and degree of freedom. Pulse rate post 30 seconds shows r value of 0.026 and p-value of 0.039 which indicates very weak positive correlation, but statistically significant ($p<0.05$).This means there is a slight tendency for the pulse rate at 30 seconds to increase with FHP degree though the association is very weak. FHP and aerobic fitness as determined by resting pulse rate have largely weak to moderate positive correlation, according to [Table/Fig-1]. There is not much of a linear relationship between the pulse rate measures and the degree of FHP as shown in [Table/Fig-1]. As it is typical of physiological reactions to activity, there is a more pronounced positive correlation between the pulse rate measures itself. According to [Table/Fig-3], the degree of FHP and the pulse rate post 15 seconds measurements seem to have a negative correlation The degree of FHP and resting pulse rate and pulse rate post 30 seconds had somewhat stronger, positive correlation. According to [Table/Fig-3] which indicates females, aerobic fitness for resting pulse the r value is 0.322 and p-value is 0.525. It shows a moderate positive correlation suggests higher FHP is somewhat related to resting pulse rate, and p-value is just 0.05 and hence indicate not conventionally significant.

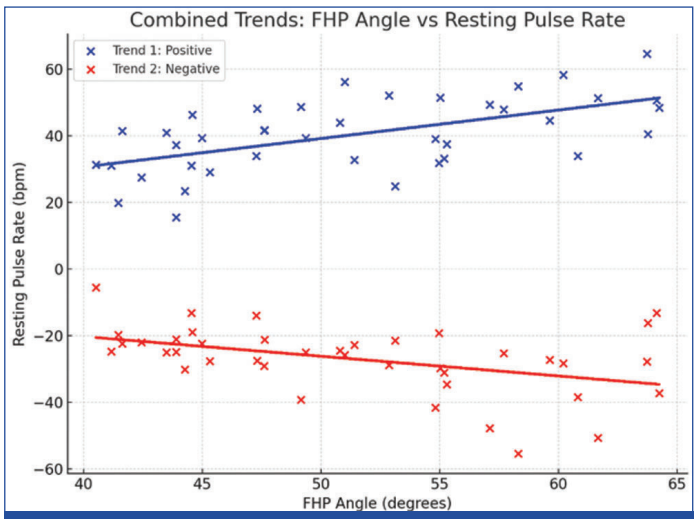
Degree of Forward Head Posture (FHP)	r- values	p-values
Aerobic fitness- resting pulse rate	0.3222	0.0525
Pulse rate post 15 seconds	- 0.042	0.530
Pulse rate post 30 seconds	0.026	0.039

[Table/Fig-3]: Severity of Forward Head Posture (FHP) and aerobic fitness for females.

Pulse rate post 15 seconds has r value of -0.042 and p value of 0.530, it indicates very weak/virtually no negative correlation. This means there is almost no relationship between FHP and pulse rate 15 seconds post activity. p-value is not significant. Pulse rate post 30 seconds has r value of 0.026 and p value of 0.039 which indicates very weak positive correlation. There is a very small tendency for a higher FHP to be associated with a higher pulse rate after 30 seconds but the relationship is almost negligible. The p-value does indicate statistical significance. According to [Table/Fig-2], the degree of FHP and the pulse rate readings both at rest and after activity, have a very weak or negative correlation. Although these tendencies are very slight, the negative signs show a slight tendency for pulse rates to be lower with increased FHP.

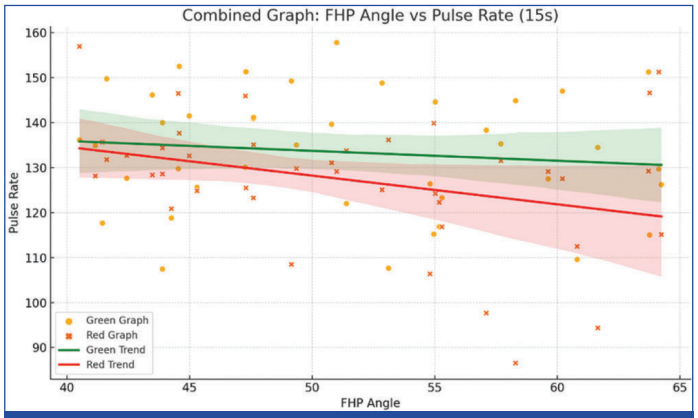
[Table/Fig-2] which indicates males there aerobic fitness- resting pulse rate has r value of -0.157 and p-value of 0.325 which indicates very weak negative correlation. As FHP increases, resting pulse rate very slightly tends to decrease, but this relationship is so weak it is essentially negligible. The p-value (>0.05) indicates this finding isn't statistically significant. Pulse rate post 15 seconds is -0.163 and p-value is 0.306 which indicates very weak negative correlation. Slight tendency for more FHP to go with lower pulse rate at 15 seconds, but again, the correlation is so close to zero it's practically no relationship. Not statistically significant (p-value >0.05). Pulse rate post 30 seconds has r value of 0.0136 and p-value of 0.933 which indicates No real correlation. This value is almost zero, meaning there is no linear relationship present. The very high p-value supports that there is no significant association. The findings of the severity of FHP and aerobic fitness for both males and females [Table/Fig-1], for females [Table/Fig-3] and males [Table/Fig-2], respectively have been depicted in the graphs below.

[Table/Fig-4] shows how FHP, which is determined by the craniovertebral angle in degrees, and resting pulse rate are correlated.



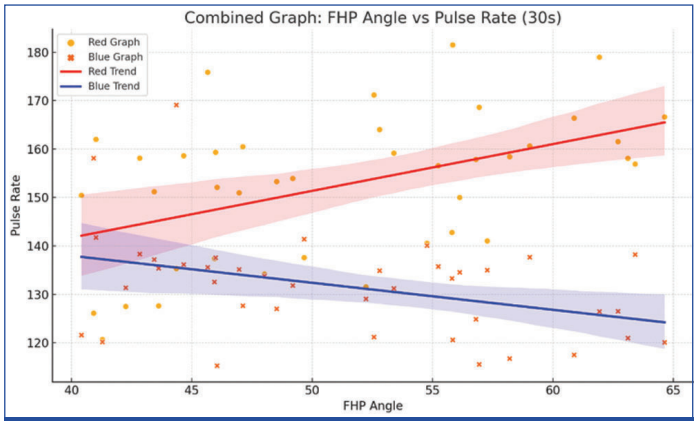
[Table/Fig-4]: FHP angle vs resting pulse rate.

A modest negative correlation between FHP angle and pulse rate is suggested by the trendline's negative slope in red, which shows that the pulse rate marginally drops as the FHP angle rises in males whereas positive correlation is seen between FHP Angle and resting pulse rate in females indicated in blue. [Table/Fig-5] Depicts how FHP, which is determined by the craniovertebral angle in degrees, and resting pulse rate post 15 seconds of the three minute step test are correlated in females in blue and red in males. It shows a slight negative correlation between FHP and pulse rate at 15 seconds.



[Table/Fig-5]: FHP angle vs Pulse rate (15 seconds).

[Table/Fig-6] illustrates the relationship between FHP and pulse rate measured over 30 seconds with red for males and blue for females shows a weakly positive correlation at 30 seconds for females.



[Table/Fig-6]: FHP angle vs Pulse rate (30 seconds).

DISCUSSION

A variety of factors can be blamed for the postulated relationship between neck pain and reduced respiratory capacity. In the present study, a strong correlation between FHP and diminished aerobic fitness was established, which can be attributed to changes in respiratory mechanics, neuromuscular coordination, and proprioception. It has been previously demonstrated that cervical and upper thoracic stability is crucial for optimal respiratory musculature function. Mechanical alterations of the rib cage from cervical instability can compromise thoracic expansion, compromising respiratory efficiency and, therefore, aerobic fitness [12,14-16]. Koseki et al., also proved that FHP individuals exhibit compromised thoracic mobility and lower FVC and FEV1, which are directly related to compromised respiratory performance [16].

In FHP individuals, the diaphragm, intercostals, and abdominal muscles have an altered length-tension relationship, which results in maladaptive contraction patterns and decreased inspiratory and expiratory forces. This results in decreased oxygen intake and impaired aerobic capacity. Szczygieł E et al., also reported similar findings, indicating that pathological head and neck posture changes the recruitment of the accessory muscles of respiration, i.e., sternocleidomastoid and scalene muscles [17]. The propensity to fatigue of these muscles, particularly in poorly postured individuals, results in compensatory overuse and abnormal rib cage motion during breathing [9,10,14]. In addition, restricted cervical range of motion enhances the dysfunction of these accessory muscles, further impairing breathing patterns and decreasing aerobic capacity.

Changes in proprioceptive input are also an important mechanism to be responsible for impaired respiratory function in patients with neck pain. Deficits in proprioception can lead to changed afferent signals to the central nervous system and, as a result, to the inhibition of motor neuron activity at the spinal or central reorganisation level [11,14]. This will inhibit voluntary and reflexive activity of the muscles, leading to instability of the joints and impaired muscular activity. The current study also revealed gender-specific differences. In women, a positive correlation was found between reduced cardiovascular fitness and higher levels of FHP, whereas in men, the correlation was negative. These results are consistent with previous studies that show women are more susceptible to neck and shoulder pain as a result of chronic poor sitting postures, especially during adolescence [12,15]. Additionally, women generally exhibit more severe FHP, leading to increased respiratory dysfunction.

There are also reported gender differences in aerobic fitness, with women typically measuring 15% to 30% lower in VO_2 max than men because of lower levels of haemoglobin and variations in muscle mass and body composition [14-16,18]. A study also added that even among elite athletes, women have 10-20% lower VO_2 max than men [19]. These physiological differences add to the results of postural deviations in women, causing further degradation in aerobic fitness. The findings emphasise the need for early diagnosis and correction of FHP, particularly in females. The integration of cervical stabilisation, posture correction exercises, and respiratory muscle training into physiotherapeutic programs may restore efficient breathing mechanics and enhance aerobic capacity. Also, ergonomic interventions in schools and workplaces may prevent the onset of FHP in adolescents.

Limitation(s)

The research also had its limitations. First, the sample population was relatively small and not representative of the general population. Second, VO_2 max was estimated rather than directly measured, and this could have an effect on its accuracy. Third, the cross-sectional study limits causal inferences. Future studies ought to target larger, more diverse populations as well as direct spirometric and metabolic measurements.

CONCLUSION(S)

The findings of the present study will stimulate further research because FHP is one of the most common positions that are known to have several negative impacts. Findings of the current study, demonstrate one of these effects a decrease in aerobic fitness. Future research could group participants according to the severity of their FHP in order to examine the effects with escalating severity. Maintaining proper posture and avoiding a number of musculoskeletal conditions need regular stretching and muscle strengthening. Prospective research should investigate longitudinal designs that study the outcomes of corrective exercise regimens for posture and cardiorespiratory function. Electromyographic and advanced imaging instrumentation can quantify structural and functional respiratory musculature changes as a function of time in populations presenting with postural abnormalities.

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