

# Effect of Prolong Sitting for Continuous Three Hours on Neuromuscular and Cardio-respiratory System in College Students: An Observational Study

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## ABSTRACT

**Background:** Prolonged sitting has adverse effects on the body's physical fitness. Since the students sit in college during lecture hours, their physical fitness is compromised. Some studies have proved that inactivity can affect various systems.

**Method:** The study included 50 students randomly whose ages ranged between 18-22 years of college going. The students were then assessed for flexibility with the Sit and Reach test, aerobic capacity with the Harward Step Test, and Balance with One Leg Standing. The values of each outcome measure were noted and assessed again after 15 days when they completed sitting for 3 hours each day.

**Result:** The analysis shows a statistically significant difference between the outcome measures' pre and post-values. The Paired sample t-test was used to compare the data for which the Z value was negative, which confirms the post value was higher. The p-value was significant ( $p < 0.05$ ) at a 95% confidence interval.

**Conclusion:** Prolonged sitting for 3 hours for 15 days resulted in a reduction in the physical fitness of the students. All three systems were compromised when assessed after 15 days, which says that due to prolonged sitting, flexibility, aerobic capacity, and balance are compromised, ultimately reducing the student's performance.

**Clinical Implication:** The study says that the student's lecture shouldn't continue for prolonged periods, and intermittent break is needed. As this affects the physical fitness of the students in upcoming years till they complete the degree, overall performance can be compromised to a greater extent. Self-awareness should be advised, and intermittent breaks with various stretches and exercises should be taught.

**Keywords:** Prolong Sitting, Sit and Reach Test, Harvard Step Test, One leg standing.

## INTRODUCTION

Activities of daily living (ADLs) are essential and routine tasks that most young, healthy individuals can perform without assistance. The inability to accomplish essential activities of daily living may lead to unsafe conditions and poor quality of life [1]. Conditions affecting the musculoskeletal system, the nervous system, the circulatory system, or the sense of sight can reduce physical performance and impair ADLs.

A student's daily schedule is typically jam-packed with classes, study time, on-campus jobs or internships, hanging out with friends, meals, extracurricular activities, and more in many institutions and colleges. Prolonged sitting has been linked to several health issues, including an increased risk of obesity, cardiovascular and metabolic disorders, as well as low back pain [2]. Postural abnormalities like rounded shoulders, kyphosis, a forward-facing head, and altered Proprioception in the spine may also be predisposed by poor postural habits [3]. Understanding the connection between extended sitting and discomfort or pain in university students is crucial to getting funding for creating physiotherapeutic therapies [4].

Instead of referring to a lack of physical activity, "sedentary behavior" has started to describe prolonged sitting. Sedentary activities involve little energy consumption (typically less than 1.5 METs, multiples of the basal metabolic rate) [5]. The risk of dying from cardiovascular disease and cancer appears to be increased by excessive sitting overall and by sitting for extended periods. Sitting requires less energy than standing or moving around. Sitting for extended periods without getting up causes a large rise in systolic blood pressure and mean arterial pressure, especially in younger age groups. Flexibility is an essential part of fitness needed for the best possible musculoskeletal functioning and to perform physical activities to their fullest potential [6].

To maintain equilibrium under various circumstances, balance ability is the capacity to minimize and stabilize the movement of the center of gravity on a basal surface. This is necessary for daily living activities to be performed as effectively as possible. Integration of sensory data, neurological functions, and biomechanical elements are necessary for balance abilities. The musculoskeletal system also has components for visual, vestibular sensory, and proprioceptive sensory integration [7-9]. So, to assess the components such as flexibility, VO<sub>2</sub> max and balance the outcome measures used are 1. Sit and reach test, 2. Harvard step test, 3. One leg standing.

**Sit and Reach Test-** The sit-and-reach test is most frequently used to evaluate low back and hamstring flexibility. It is frequently utilized in many fitness tests, including the Physical Best test from the American Alliance for Health, Physical Education, Recreation, and Dance (AAHPERD) (AAHPERD, 1988).

**Harvard Step Test** -The best measure of aerobic fitness is maximum oxygen uptake or Vo<sub>2</sub>max. However, for some people, measuring Vo<sub>2</sub>max is frequently neither convenient nor secure due to the strenuous effort required of the participant. One such test is the step test, regarded as a real-world field test for determining people's aerobic fitness [10].

**One-leg standing-** The OLS test can evaluate postural steadiness in a static position in clinical settings. OLS is valid and reliable because it measures how long a person can hold the OLS position [11]. Maintaining balance requires the central nervous system to combine visual, vestibular, and proprioceptive information while modulating commands to the neuromuscular system.

So, it is necessary to know the effects of prolonged sitting on all these systems and to understand

the relationship between them to acquire subsidies for the development of physio-therapeutic interventions that allow the adaption of furniture for the modifications and comfort along with the same measures to change the techniques of teaching which only include prolonging sitting.

## METHODOLOGY

A cross-sectional observational study was conducted on college-going students of Parul University, both male and female, with ages ranging between 18 and 22 years. Students having any medical conditions that affect their physical fitness, going to the gym regularly, and having any addiction were excluded.

The students were randomly selected, and consent was obtained for the study. A total of 50 students were included in the study for which the baseline data was taken.

The students were then assessed to know their flexibility by the Sit and Reach Test, their Aerobic Capacity by the Harvard step Test, and their Balance by the One Leg standing test.

The outcome measures used to assess the cardiorespiratory and neuromuscular systems were: - the sit-and reach test, the Harvard step test, and one-leg standing.

**Sit and Reach Test:** The participants were seated with legs extended at an angle to the floor's taped line. Feet should be spaced about 10 to 12 inches apart and with heels that meet the taped line. The participant should slowly stretch their arms forward and stack their hands, palms facing down, as far forward as they can. They should keep this position for at most two seconds. The score is the distance in centimeters or inches that can be reached with the fingertips. It is best to keep track of the top trials out of three [12].



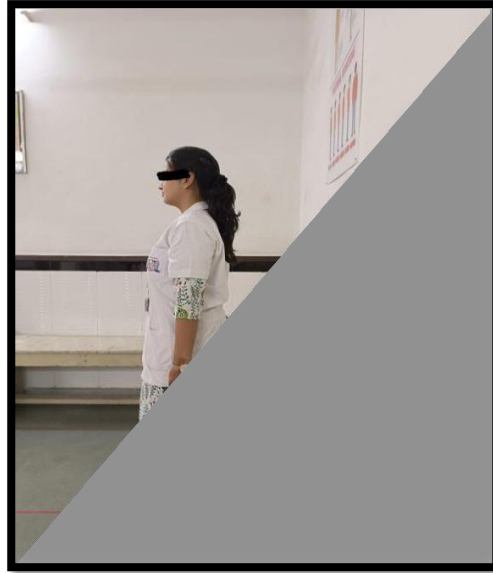
**Fig. 1:** Sit and Reach Test

**Harvard Step Test:** The equipment needed for this test is modest and easy to perform. Participants take thirty steps per minute for 3 minutes or until they are completely out of breath. So, for five minutes or until they become exhausted, the client ascends the step and descends it at a rate of 30 steps per minute (one second up, one second down). When the participant cannot keep up their stepping pace for a continuous 15 seconds, they are exhausted. After the test is finished, the client sits down, and the total number of heartbeats is counted from 1 to 1.5 minutes later, then from 2 to 2.5 minutes later, and lastly, from 3 to 3.5 minutes later. The participant's pulse at their wrist is felt to determine the number of heartbeats [13].



**Fig. 2:** Harvard Step Test

**One Leg Standing** This test was performed with hands on hips, eyes open. The participant must stand unsupported on one leg for the duration of the timed interval between when the second foot first leaves the ground and when it returns or when the arms are raised above the hips. Participants who can't stand for more than five seconds are likely to suffer fall injury [14-16].

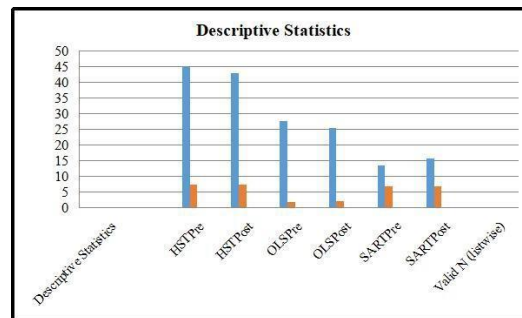


**Fig. 3:** One Leg Standing Test.

The students were then observed for 15 days as they had a schedule of lectures for three continuous hours on a hard bench with a 90-90 position. After 15 days, i.e., after 45 hours of sitting, they were again assessed for all these three outcome measures.

## RESULT:

Descriptive statistical analysis was accomplished in the present study for the age of the participants and values of flexibility test, aerobic capacity, and balance of the participants, i.e., for both males and females. The outcome measures used in the study were the Sit and Reach test, Harvard Step test, and one-leg standing test. Significance was assessed at the 5% significance level with  $p < 0.05$  (2 tailed hypothesis test was considered). As the data doesn't follow the normality, non-parametric tests were used.



**Graph 1:** Shows the descriptive statistics of the pre and post-observation assessment of the data of the study

The Graph shows the graphical presentation of the data, including histogram presentation, which clearly shows that significant differences are seen between the pre and post-values of the

outcome measures used in the study.

**The Table shows the comparison between the pre and post-data**

Test Statistics <sup>c</sup>					
		HarvardStep Test	One Leg StandingTest	Sit and Reach Test	
		Pre-Post	Pre-Post	Pre-Post	
Z		-4.213 <sup>b</sup>	-5.376 <sup>b</sup>	-5.923 <sup>d</sup>	
Asymp. Sig. (2-tailed)		.000	.000	.000	
Monte Carlo Sig. (2-tailed)	Sig.		.000	.000	.000
	% ConfidenceInterval	Lower Bound	.000	.000	.000
		Upper Bound	.058	.058	.058

The table shows the Wilcoxon signed-rank test was used to compare the pre-and post-analysis data. The pre and post-value of the Z test of the Harvard step test are -4.21 and for One Leg standing is -5.37, and for the Sit and Reach Test is -5.92, respectively. The negative Z value suggests that the post-data is higher than the data. Significant differences exist between pre and post-data with  $p < 0.05$  for all three outcome measures. The confidence interval was set at 95%.

## DISCUSSION

Since the university students studied full-time, it makes sense that most of their sitting time was spent studying in class. Over 15 days, morning sitting time was generally greater than afternoon sitting time, which was noted in the study as the physiotherapy students were posted in clinics in the afternoon.

The study included 50 physiotherapy students who were assessed for various systems. As the students were sitting for prolonged periods for lectures, their overall physical health was compromised, which was also supported by Moro et al., who did a study on ergonomics [17]. The overall goal of sitting posture is the same as the goal of standing posture: to achieve a stable alignment of the body that can be maintained with the least energy expenditure and stress on body structures. But prolonged sitting is affecting the overall fitness of the body. The prolonged sitting leads to decreased participation in physical activity since it becomes sedentary to sit for a prolonged period [18]. We have already discussed the effect of prolonged sitting on the neuromuscular and cardiorespiratory systems. So, to evaluate these components and outcome measures, we used the Sit and Reach flexibility test, the Harvard Step Test for VO<sub>2</sub> max, and One Leg Standing for Balance. We assessed the students with ages ranging from 18 to 22 years.

**Reduction in Aerobic Capacity:** There was one group with 50 participants on which the study was done. The pre and post-values were recorded. On comparing between pre and post values, the Harvard step test shows a significant difference with  $p$ -value  $< 0.05$  with a negative Z value, which says that post values were more compared to pre. The average value for Males is 51ml

oxygen/kg, and for females is 45ml oxygen/kg. This statement says that aerobic capacity observed 15 days prior was a mean of 44.84, whereas post-15 days of sitting was 42.90. Sedentary behavior and the risk of cardio-metabolic disease are closely related. According to the results of this study and other studies, changing the physical surroundings of colleges and workplaces can significantly affect both the health of students and employees. Increasing standing time may be a simple but effective way to lessen the cumulatively harmful health effects of prolonged sitting as more and more time each day is devoted to low MET activities (1.5 METs) for productivity and/or entertainment.

**Reduced Flexibility:** One of the most essential tools to maintain healthy joints and muscles is flexibility. The flexibility in the study was tested using the Sit and Reach Test, for which the mean value was 13.53 pre and 15.52 post values with negative Z values. The typical values are 16-30 cm. Sitting for long periods puts pressure on the back, legs, and glutes in the buttocks and hips, which will cause reduced flexibility. Long periods of sitting have been found to fundamentally alter the flexibility of the hamstring muscles [19]. Therefore, sitting decreases the knee angle, the angle between the trunk and the thighs, and the lumbar lordosis while increasing disc pressure and muscular effort. Numerous health problems, such as an increased risk of obesity, cardiovascular and metabolic disorders, as well as low back pain, have been linked to prolonged sitting.

The nervous system plays a significant role in the whole body's coordination. ADLs can be hampered, and physical performance can be decreased by ailments affecting the nervous system, the musculoskeletal system, the circulatory system, or the sense of sight. So, the result that we got by also supported this result.

**Reduced Neuromuscular performance (Balance):** The other system that was assessed was neuromuscular for assessing the balance of the students for which one leg standing test was used, for which the mean value was 27.5 pre and 25.4 post with negative Z value, which confirms that the post values are reduced. The test shows significant differences between the two values. This states that the balance was significantly reduced after 15 days of prolonged sitting. The reasons can be muscle tightness, like hip and knee flexors, which affect the whole limb's proprioception. Muscle tightness affects the muscle relationships of length-tension, which serve as the limb's capacity to absorb shock. Reduced range of motion leads to a never-ending cycle of decreased flexibility, which causes various musculoskeletal problems. A decrease in ideal performance is also brought on by tight muscles that pack the veins [20]. Hence, prolonged sitting for 15 days for a continuous 3 hours affected the cardiorespiratory and neuromuscular systems of the physiotherapy students.

## CONCLUSION

The study concluded that prolonged sitting for 3 hours continuously for 15 days significantly affected the cardiorespiratory system, in which the VO<sub>2</sub> max was calculated, and there was a significant increase in the consumption of O<sub>2</sub>.

Similarly, the flexibility assessed by the sit and reach test was also affected as the post values were higher. Lastly, the balance was assessed by a leg standing test, which also showed that they

could not stand for adequate time. balance was significant.

Hence, all three systems were affected due to prolonged sitting in classrooms without changing their position, which ultimately affected the students' physical fitness.

**Limitations of the study:** The study didn't include the reasons for the discomfort and factors affecting these systems. Also, the study didn't include the break between the 3-hour lectures.

**Future recommendations:** The study can be done on a larger population by assessing the reasons and comparing between males and females. Also, various factors along with more time can be assessed in detail, and various variables should be considered.

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