

Original Article

ASSOCIATION BETWEEN PROLONGED SITTING AND CORE MUSCLE STRENGTH IN SECONDARY SCHOOL STUDENTS

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Abstract

Background: This study was performed to observe the relationship between prolonged sitting and core muscle strength. Core muscle weakness is most common in secondary school students and it may be linked to prolonged sitting.

Objective: The major goal of this study was to modify the posture and sitting duration of students to minimize the negative impact on core muscles strength. And to assess the relationship between posture and core muscle strength.

Study Design: A cross-sectional study was conducted.

Place and duration of study: This study is a cross sectional study, performed on secondary school students of Rawalpindi and Islamabad in time duration of 6 months i.e. May 2025 to January 2026.

Material and Methods: This study is a cross sectional study, performed on secondary school students of Rawalpindi and Islamabad in time duration of 6 months i.e. May 2025 to January 2026. This study used three tests to find out core muscle endurance and strength. These are plank test, Side Bridge and McGill flexion test. The students had to hold the positions and the timing was being noted. After that, statistical analysis was done to observe the relationship of each test's results with sitting duration.

Results: The results of the study showed different patterns. The relationship observed between sitting duration and Side Bridge was negative, which indicated increased sitting duration decreases the strength and endurance of lateral trunk flexors. However, we found a positive relationship of sitting duration with plank and Mc Gill flexion test.

This indicated that there are other factors along with prolonged sitting such as, posture and sedentary behavior, that should be considered. Gender studies show that male students perform better than female in holding plank test. Also BMI statistics show that increase in BMI causes a decrease in core endurance.

Conclusion: The study concludes that almost more than half of the students showed below average holding time. This showed that prolonged sitting is linked to core muscles strength. And to reduce its impact on core there should be short term breaks in between classes.

Keywords: Core endurance, strength, prolonged sitting, plank test, side-bridge endurance, McGill flexion endurance, sedentary behavior.

1. Introduction

The core is defined as the anatomical box which include several muscle groups (such as quadratus lumborum, erector spinae, lumbar multifidus, external and internal oblique, diaphragm, iliopsoas, pelvic and hip girdle [1]. The core is further divided into functional and anatomical core. The term functional core is used in terms of the function such as exercise, mobility and tasks, which the core muscles perform. The anatomical core is defined by the muscles and other soft tissues, including their origins and insertions, which comprise its structure [2].

CORE STRENGTH AND INJURY PREVENTION

For core muscle training, the power chain principle is mostly followed. According to this principle, all body segments act as interconnected links, and the core acts as the significant link to produce momentum among them. A strong core acts as a strong link in the body to produce force and provides stable support for balance and stability. To build such core strength and stability, core training is divided into two main components: (1) core strength and (2) core stability. Core strength

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training focuses on producing maximal force without causing fatigue and injury, while core stability training focuses on maintaining stable support with minimal effort [3].

IMPACT OF SEDENTARY LIFESTYLE ON CORE MUSCLE FUNCTION

Core stability is considered the key to a functional bio-mechanical system, which helps in smooth movements and reduces excessive joint load [4]. Also, rhythmic co-contraction of these muscles increases the efficacy of the movement. Weakness of the core will lead to an increase amount of load on the lumbar spine, which ultimately leads to a faulty posture. According to current literature, prolonged sitting leads to low back pain due to reduced core muscle endurance. Similarly, studies have shown that individuals with standing jobs and minimal breaks also experience various postural problems [3].

SUSTAINED SITTING

Adolescents are increasingly engaged in sedentary behaviors, both during school hours and in their leisure time. On average, they spend approximately 10.58 hours (71% of waking time) sitting on school days and about 7.52 hours (54% of waking time) on weekends [5]. A significant portion of this time is spent seated due to academic demands, contributing to a largely inactive daily routine.

IMPACT OF PROLONGED SITTING ON MUSCLES

Deep trunk muscles show significant reductions in strength and increased fatigue following prolonged sitting. If these habits are maintained long-term, serious musculoskeletal injuries may develop. Muscle activity also decreases with habitual prolonged sitting, leading to a reduced ability to generate sufficient force for stability and balance [6].

IMPACT OF SUSTAINED SITTING ON POSTURE

Spinal alignment is subjected to considerable stress due to prolonged sitting. It has been observed that sitting for even 30 minutes can cause an increase in thoracic kyphosis and lumbar lordosis. The relationship between spinal misalignment and sitting duration is linear, the longer the sitting duration, the greater the risk of increased thoracic kyphosis and lumbar lordosis [7].

HEALTH RISKS OF SEDENTARY LIFESTYLE

We choose sitting as our posture, mostly which is not really good for us. It can cause a lot of health problems like problems with how our body handles glucose uptake and blood pressure. These health problems include our body not using insulin properly, problems with our blood vessels, our body burning carbohydrates in a way, changes in the type of muscles we have been using, losing muscle and bone, gaining fat especially around your abdomen and having high VLDLs and LDLs in our blood.[8]

CORE MUSCLES: BODY'S NATURAL BRACE AGAINST LBP

In order to support limb movements and stabilization of spine the core muscles often known as body's power house or natural brace plays a vital role. For the reduction of stress on lumbar spine and intervertebral disc the core muscles acts as segmental stabilizer which serve as muscular corset. The core which is properly functioning serves to maintain proper posture and spinal protection. The risk of musculoskeletal disorders increases due to sedentary lifestyle and poor posture which causes to the weakness of the muscular network. As a result of this weakening of muscular network several other symptoms arises such as reduction of muscle endurance, hip extensors imbalance , instability of lower limb , atrophy of para spinal muscle and stress on lumbar spine [9].

2. Materials & Methods

The study was a cross sectional survey with the sample size of 377. It was extended over the time of 8 months following the consent from the

research panel from May 2025 to January 2026. Non-Probability convenient sampling technique was used. The study was conducted on secondary school students in twin cities of Pakistan i.e. Islamabad and Rawalpindi through three standardized tests. Sample was selected on the basis of inclusion and exclusion criteria. All students both male and female aged between 12-16 years were included in the study. The sitting duration must be of 3-4 hours consecutively. Any student with any musculoskeletal disorder: muscular dystrophy, Fractures, Arthritis, Osteoporosis, Osteoarthritis, Sarcopenia, Myasthenia Gravis etc. or any neurological disability due to which a person cannot walk or is not in ambulatory state. Any student who has Cardiac and respiratory complications leading to inactivity or a participant who is not willing to be included.

TOOLS:

SIDE BRIDGE TEST:

Participants performed the test in a lateral decubitus position, supported on their preferred forearm and elbow, with both the shoulder and elbow flexed at 90°. Their legs were extended and barefoot, maintaining a straight alignment from shoulder to hip to feet. The free arm rested on the opposite shoulder. The objective was to hold this position for as long as possible until exhaustion, with the examiner providing consistent verbal encouragement and feedback on maintaining correct form. Endurance time was measured manually using a digital stopwatch and the test ended when the participant either voluntarily stopped or could not hold the correct posture for more than 3 seconds [10].

MCGILL FLEXION TEST

The McGill Flexion Endurance Test was used to assess the endurance of the trunk flexor muscles. This measures the time, how long a person can hold a curl up position while maintaining body's proper form. This test is simple, cost effective and easy to administer. It shows excellent reliability with intraclass correlation coefficients (ICCs) typically exceeding 0.90. This test is effective tool for assessing core endurance because studies show strong correlation between its outcomes and overall core muscle endurance [11].

PLANK TEST:

Plank test was performed. The body was in a decubitus position with elbow and shoulder in 90 degrees and body in a straight line from head to heels. Their legs were extended and barefoot, maintaining a straight alignment from their shoulders to their hips to their feet. The objective was to hold this position for as long as possible until exhaustion, with the examiner providing consistent verbal encouragement and feedback on maintaining correct form. Endurance time was measured manually using a digital stopwatch, and the test ended when the participant either voluntarily stopped or could not hold the correct posture for more than 3 seconds [12].

DATA COLLECTION PROCEDURE:

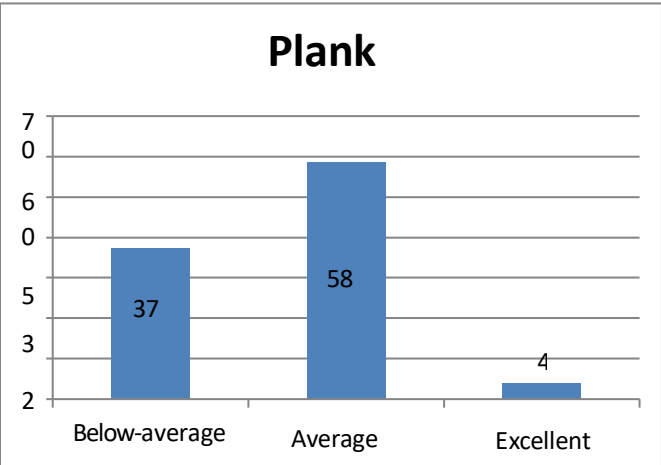
Approval for this research was granted by IRB (Ref no: YIRS/PRIN/25/011) on May 2025. An informed consent was taken from concerned school authorities and from participant's for data collection. Three standardized tests were used to find association between core muscle strength and prolonged sitting namely, the McGill trunk flexion test, side bridge test and plank test, which are reliable and valid measures of core muscle strength. Students of secondary schools who fulfilled the inclusion criteria were selected for

participation. A self-structured questionnaire was used to collect demographic information, including name, age, gender, class level. MC Gill flexion test, side bridge test and plank test were used to assess core muscle strength. All the tests were demonstrated before participants prior to their participation and participants were also clearly explained with the instructions.

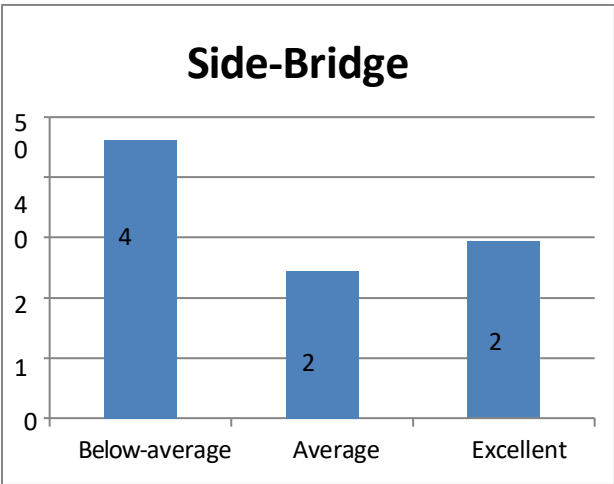
3. Results

This study investigated the correlation of gender, BMI and sitting duration with holding time of plank, Side Bridge and McGill’s flexion using Spearman’s rank correlation. The correlation coefficient between gender and plank hold time was 0.357 with a p-value < 0.001 (Table 4.x). A value of 0.357 indicates a moderate positive correlation, suggesting a meaningful association between gender and plank hold performance.

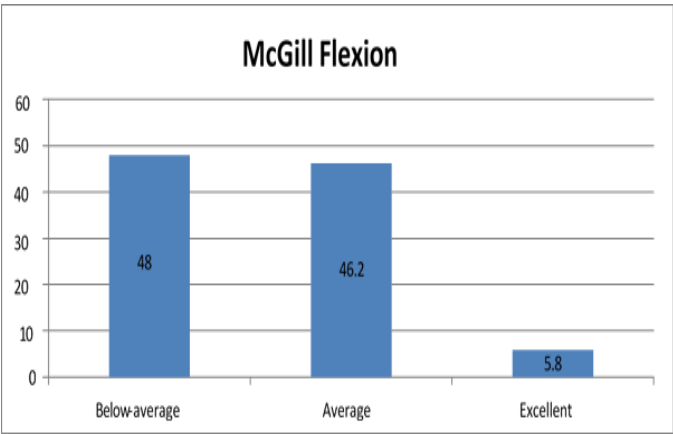
Based on the plank test performance, core muscle strength/endurance among the 377 secondary school students was categorized into three levels. Below-average plank strength was observed in 141 students (37.4%), while the majority of participants, 221 students (58.6%), demonstrated average plank strength. Only 15 students (4.0%) exhibited excellent plank strength.



Based on the side-bridge test performance, core muscle strength/endurance among the 377 secondary school students was categorized into three levels. Below-average side-bridge strength was observed in 174 students (46.2%), 92 students (24.4%), demonstrated average plank strength. 111 students (29.4%) exhibited excellent side-bridge strength.



Based on the McGill Flexion test performance, core muscle strength/endurance among the 377 secondary school students was categorized into three levels. Below-average McGill Flexion strength was observed in 181 students (48.0%), 174 students (46.2%), demonstrated average McGill Flexion strength. 22 students (5.8%) exhibited excellent McGill Flexion strength.



The correlation coefficient between gender and flexion hold time was 0.154 and the p-value was 0.003 (Table 4.x). A correlation value of 0.154 is close to zero, indicating a weak positive correlation between gender and flexion hold duration. Although the relationship is weak, the statistically significant p-value suggests that gender has a small but significant association with flexion hold time. The correlation coefficient between gender and side bridge hold time was -0.161 with a p-value of 0.002. This negative value indicates a weak inverse correlation between gender and side bridge endurance. The p-value is below 0.05, confirming that the result is statistically significant, and suggesting that gender is associated with side bridge hold performance.

Spearman's rank-order correlation was performed to assess the relationship between body mass index (BMI) and core endurance measures. The analysis revealed a statistically significant weak negative correlation between BMI and plank hold time ($\rho = -0.183$, $p < 0.001$), indicating that an increase in BMI was associated with a decrease in plank endurance. There was no statistically significant correlation between BMI and side bridge hold time ($\rho = -0.011$, $p = 0.830$), suggesting that BMI did not influence side bridge performance. A significant weak negative correlation was also found between BMI and flexion hold time ($\rho = -0.117$, $p = 0.023$), indicating that higher BMI was associated with reduced flexion endurance.

There is a weak but statistically significant positive correlation between sitting duration and plank hold time ($r = 0.115$, $p = 0.026$). This indicates that participants with longer sitting duration tended to demonstrate slightly greater plank hold endurance. A weak but statistically significant negative correlation was observed between sitting duration

and side bridge hold time ($r = -0.229$, $p < 0.001$). This finding suggests that increased sitting duration was associated with reduced side bridge hold endurance among participants. Sitting duration showed a weak yet statistically significant positive correlation with flexion hold time ($r = 0.178$, $p = 0.001$), indicating that participants who reported longer sitting duration tended to have slightly higher flexion hold times.

4. Discussion

This study shows indirect relationship between prolonged sitting and core muscle strength in secondary school students. Three reliable tools have been used in this study, i.e. plank test, McGill Flexion test, and side bridge test. The study shows how sitting duration affects core muscle strength and endurance in students aged 12-16. Overall, a lot of students demonstrated below-average endurance on all the three tools used, which shows a general decrease in the strength in the young population. Furthermore the study showed that the lateral trunk flexors are more affected by the increase in sitting duration.

There was a weak negative correlation between prolonged sitting and duration of side bridge test performed by the students, which suggests that there is an impact of prolonged sitting on lateral trunk stabilizers. Pauwels S. and Willmaerts et al. conducted a study in which the trunk muscles especially the flexors and extensors had weak endurance among university students of first year due to their sedentary lifestyle. The study shows deterioration of core muscles lead to poor posture and decreased support for spine because students without any physical activity spend long hours sitting. Back pain and other musculoskeletal issues are increased because of this increased muscle deterioration. This study highlighted the importance of regular physical activity and core

muscle exercises in maintaining muscle endurance.[13]

The association of prolonged sitting with core was also assessed in relation to Body Mass Index (BMI), showing the relationship between different physical and lifestyle factors and their interaction with muscular performance. The results regarding BMI have showed that increased BMI results in decreased core strength and endurance. The subjects with greater BMI displayed greater difficulty in maintaining core stability resulting in poor performance in plank and McGill tests mainly, however their performance in side bridge test was not affected this can be explained by understanding the effect of increased BMI on fat and muscle composition [14].

Another study conducted by N. Reid et al in 2018 concluded that increased sitting time can affect muscle composition, which leads to reduced strength. Although the study was done primarily on older adults who are naturally prone to age-related sarcopenia but still increased sitting duration further deteriorates their muscular health due to effect of lower metabolism which causes greater fat deposition and reduced muscle mass. The study emphasized that aging individuals are significantly affected by sedentary behavior as it accelerates the muscle loss.[15]

The findings coincide with a study conducted by M.Abid et al in 2022, which studied differences in core strength in male and female population. The study showed that males show greater core strength than females, these findings coincides with our results. The study also suggests that males show increase strength in prone position while in supine positions there is no significant difference between males and females.[16]

Alexander R.Kett performed a research in order to determine the effect of posture sitting and posture activity on lumbar muscles rigidity. There stiffness of muscles was observed during both conditions of sitting duration such as before and after. All this analysis is monitored by an eight camera movement system to observe lower back kinematics in order to measure posture and levels of postural activity. The results of the study showed increase lordosis due to prolonged sitting. These results suggest that increased muscle stiffness may be associated with the

Commonly preferred slumped posture during extended sitting, which can cause a negative effect on core muscles strength.

Overall, the results of our study concluded that there existed an indirect relationship between prolong sitting and core strength in secondary school students. The correlation found in results was weak to moderate which shows that prolong sitting is not the only cause of decrease core strength.

Conclusion

This study concluded that there is an indirect relationship between prolonged sitting and core muscle strength in secondary school students. There is a high prevalence of below average core strength in secondary school students. The findings also show weak to moderate correlations which suggest that there are some other causative factors along with prolong sitting that affects musculoskeletal function in students.

Limitations

Cross-sectional design limits causal interpretation, preventing determination of whether prolonged sitting directly causes reduced core strength. Self-reported sitting duration may be prone to recall bias, reducing accuracy of sedentary time

estimation. Convenience sampling restricts generalizability, as the results may not represent all schools or socioeconomic groups. Core strength assessment was limited to three endurance tests, which may not fully capture dynamic core stability, daily activity level, or overall physical fitness.

Absence of imaging or electromyography data limits understanding of underlying muscle activation and structural adaptations.

Disclosure /Conflict of interest:

No conflict of interest disclose by authors.

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