



The Prevalence of Adaptive Muscles Shortening and Weakness Among University Students in Jordan

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Abstract

Muscle balance, defined as equivalent strength of agonist and antagonist muscle groups to ensure coordinated movement and smooth motor control, is a key factor in maintaining optimal posture and preventing musculoskeletal disorders. Muscle balance is affected by muscle shortening or weakness. University students spend long hours sitting while performing school-related activities, which can impair muscle balance by causing muscle shortening and/or weakness. Therefore, this study aimed to determine the prevalence of adaptive postural muscle shortening and weakness among university students in Jordan.

Two hundred participants were recruited for this study. One participant decided to withdraw. After obtaining informed consent, participants underwent standardized measures, including head position measures, Manual Muscle Testing (MMT), and Muscle Length Tests.

Results indicated a high prevalence of postural muscle weakness and flexibility issues. Results revealed that 15.1% had normal strength of deep neck flexor muscles. Simultaneously, 15.3% had normal strength of right shoulder retractor muscles. Also, 13.6% had normal strength of left shoulder retractor muscles. Right pectoralis muscle flexibility was limited in 65.2% of subjects, and left pectoralis muscle flexibility was limited in 69.3% of subjects. CROM measures showed that the average head position among subjects was 18.07 ± 1.89 cm. The average head retraction of subjects was 16.51 ± 2.11 cm, and the average head protraction was 21.31 ± 2.55 cm. Results revealed that 30.7% of subjects had normal strength in the abdominal muscles, 32.7% had normal strength in the right gluteal muscles, and 29.6% had normal strength in the left gluteal muscles. Right hip flexor muscles had limited flexibility in 63.1% of subjects; however, left hip flexor muscle flexibility was limited in 58.2% of subjects. Right hamstring muscle flexibility was limited in 89.9% of subjects, while left hamstring muscle flexibility was limited in 81.9% of subjects. The average anterior tilt of the right innominate was 11.37 ± 4.2 degrees, and the left innominate was 10.85 ± 4.4 degrees. Adaptive shortening and weakness of postural muscles are predominant among university students. It could be related to their sedentary lifestyle and the hours they spend studying. It is imperative to implement proper interventions to enhance the function of postural muscles and improve body posture among university students.

Keywords: Adaptive Muscle Shortening; Muscle Weakness; University Students; Postural Balance; Jordan

Abbreviation

MMT: Manual Muscle Testing; CROM: Cervical Range of Motion

Introduction

Muscle balance is the equal strength of agonist and antagonist muscle groups to ensure coordinated movement and smooth motor control. It is a key factor in maintaining optimal posture and preventing musculoskeletal disorders [1]. The postural (or tonic) muscles play an important role in sustaining upright posture, stability, and effective body alignment. Proper body posture influences the ability to maintain balance when confronted with static and dynamic stressors [2]. When muscle strength is insufficient or muscles become shortened or tight, posture may be compromised, balance may deteriorate, and musculoskeletal disorders may ensue [3].

Several mechanisms and methods explain how muscle shortening and tightness occur, particularly in populations exposed to sustained postures. Sustained shortening of a muscle can lead to a reduction in muscle fiber length, sarcomere absorption, altered motor unit recruitment, and ultimately reduced flexibility [4]. Muscle imbalance may arise when the agonist muscle becomes overactive or shortened [5]. Over time, such imbalances can lead to altered joint kinematics, changes in spinal alignment (e.g., increased anterior pelvic tilt or forward head posture), and a higher risk of musculoskeletal problems [6].

Postural deviations and muscle imbalances are not limited to adult populations. Research demonstrates a high prevalence of postural changes among adolescents. For example, Centemeri et al. (2024) found that 77% of adolescents exhibited somatic or postural dysfunctions that were closely linked to muscle imbalances and spinal deviations [3]. Similarly, Pacheco et al. (2023) identified substantial rates of musculoskeletal disorders associated with postural changes among the youth population. The early onset of muscle imbalance and postural misalignment is concerning because habits and structural adaptations formed during adolescence often persist into adulthood [6].

In one longitudinal study, Ludwig et al. (2018) reported that adolescents who engaged in targeted neuromuscular performance training (including strength, stretching, and awareness exercises) showed significant improvement in posture indices over 6 years. This finding underlines the importance of early intervention to manage muscle imbalances and promote optimal posture and balance.

The interrelationships among muscle balance (strength/flexibility), posture, and balance ability have been increasingly investigated. For instance, posture and movement-pattern quality interact to influence injury risk; a study of young amateur athletes demonstrated that those with better posture and higher-quality movement patterns experienced fewer injuries [7]. While this study did not focus exclusively on muscle shortening, it provides important evidence that posture (which may reflect underlying muscle imbalance) influences functional outcomes.

In younger populations, Baccouch et al. (2024) assessed postural control and neuromuscular activation in 11 to 13-year-old children and found that those engaged in regular athletic activity (swimming) had superior postural control and neuromuscular activation compared to non-athletic peers. The authors suggested that improved neuromuscular coordination, possibly mediated by better muscle balance and flexibility, contributed to enhanced postural stability.

Even though many studies focus on children and adolescents, the college-age group of 18–24 remains understudied concerning detailed muscle balance, flexibility, and strength of postural muscle groups, and the resultant posture and balance outcomes. Given that the age range 18–24 often corresponds to university years and early adulthood, which are characterized by increased sedentary behavior and sustained postures from studying or smart device use, the potential for muscle shortening and imbalance is considerable. For example, lengthy sitting and forward-head posture while studying predispose to pectoralis shortening and deep neck flexor weakness, which may then manifest as forward head posture,

scapular protraction, or thoraco-lumbar misalignment [6]. These postural deviations may, in turn, compromise balance control systems and predispose individuals to musculoskeletal disorders later in life.

The current cross-sectional observational study of healthy youth aged 18–24 in Jordan is timely and important, as we expect an increase in postural muscle shortening and weakness due to lifestyle. By measuring flexibility and strength in a selection of muscle groups, including deep neck flexors, pectoralis, shoulder retractors, gluteals, hip flexors, and abdominal muscles, the study addresses a gap in the literature concerning youth in the 18–24 age range and could be an early indicator of expected postural changes in future generations. Moreover, given that muscle shortening and imbalance are modifiable risk factors, early detection in youth offers the opportunity for preventive exercise-based interventions, as supported by the longitudinal findings of Ludwig et al. (2018). Therefore, the purpose of this study was to determine the prevalence of adaptive postural muscle shortening and weakness among university students in Jordan.

Materials and Methods

Subjects

Two hundred subjects were recruited from different universities in Jordan. One subject decided not to continue the study. Subjects were included if they were healthy, had no musculoskeletal pathologies or systemic diseases, and were aged between 18 and 24 years. Subjects were excluded if they had a congenital musculoskeletal deformity, a history of spine injury or disorders, musculoskeletal surgeries, or were diagnosed with disorders that affect normal growth. All protocols and procedures were approved by the Institutional Review Board at the Hashemite University. The demographic data of subjects are shown in Table 1.

Sample size (N)	Age (Av. ± SD)	Weight (Av. ± SD) Kg	Height (Av. ± SD) Cm
199 subjects	21.2 ± 1.3	64.6 ± 15.7	166.2 ± 9.3

Table 1: Demographic data of subjects.

Study design

A cross-sectional observational study.

Methods

Measurement of deep neck flexor strength

The test was performed in a supine position, where subjects were asked to tuck their chin and lift their head off the table simultaneously. Verbal cues included, “Make a double chin. Lift your head up to get your chin as close as possible to your chest, and do not let me push you down.” Manual resistance was applied by the assessor to determine the strength [8].

Measurement of pectoralis flexibility

The test was performed in a supine position with the Glenohumeral joint line at the edge of the table. The examined shoulder was placed in 90 degrees of abduction and external rotation. The examined shoulder was then taken into horizontal shoulder abduction until resistance (R1) was noted or discomfort was reported by the patient. Horizontal shoulder abduction ROM was measured using a universal goniometer [8]. Pectoralis muscle flexibility was determined, where limited ROM indicates limited flexibility.

Measurement of the strength of the shoulder retractor muscles strength

This test was performed in a prone position with the shoulder at 90 degrees of abduction, neutral rotation, and the elbow at 90 degrees of flexion. Instructions to the subject were, “Lift your elbow toward the ceiling. Hold it. Do not let me push it down”. Manual resistance will be applied by the examiner to determine the level of strength [9].

Measurement of gluteus strength

The subject will be in a prone position. The subject will be asked to bend their knee and lift their lower limb off the table. The strength will be determined based on the resistance applied by a therapist [9].

Shortening of the hip flexor muscles

The subject will be in a supine position toward the edge of the examination table. The subject will be asked to bend their knee toward their chest. Flexion of the other hip will be measured using a simple goniometer to determine limitations in muscle flexibility.

Measurement of abdominal muscle strength

The subject will be in a supine position with both hips and knees flexed. The subject will be asked to clasp their hands behind their head (for Grade V), keep arms crossed over the chest (for Grade IV), or keep arms outstretched in full extension above the plane of the body (for Grade III). Following that, subjects will be asked to flex the trunk through a full range of motion. A therapist will be standing on the right side of the subject to check the scapula clearance [9].

Statistical analysis

The Statistical Package for Social Sciences (SPSS, version 30) was used to analyze data. Frequencies and percentages were used to summarize the findings of categorical variables. Mean and standard deviation were used to summarize the findings of quantitative variables.

Results and Discussion

Results revealed that 47.7% of subjects had fair strength, 37.2% had good strength, and 15.1% had normal strength of deep neck flexor muscles. At the same time, 38.5% had fair strength, 46.3%

had good strength, and 15.3% had normal strength of right shoulder retractor muscles. Additionally, 40.2% had fair strength, 46.2% had good strength, and 13.6% had normal strength of left shoulder retractor muscles. Right pectoralis muscle flexibility was limited in 65.2% of subjects, and left pectoralis muscle flexibility was limited in 69.3% of subjects.

CROM measures showed that the average head position among subjects was 18.07 ± 1.89 cm. The average head retraction of subjects was 16.51 ± 2.11 cm, and the average head protraction was 21.31 ± 2.55 cm. The average difference between protraction and retraction among subjects was 4.80 ± 2.67 cm. Most subjects had fair strength of abdominal muscles. 43.7% of subjects had fair strength, 25.6% had good strength, and 30.7% of subjects had normal strength of abdominal muscles. The findings related to right gluteal muscle strength were different: 29.6% had fair strength, 37.8% had good strength, and 32.7% had normal strength of right gluteal muscles. On the other hand, 34.7% of subjects had fair strength, 35.7% had good strength, and 29.6% had normal strength of left gluteal muscles.

Right hip flexor muscles had limited flexibility in 63.1% of subjects. However, the left hip flexor muscles' flexibility was limited in 58.2% of subjects. Right hamstring muscle flexibility was limited in 89.9% of subjects. However, left hamstring muscle flexibility was limited in 81.9% of subjects. The average anterior tilt of the right innominate was 11.37 ± 4.2 degrees, and for the left innominate, it was 10.85 ± 4.4 degrees.

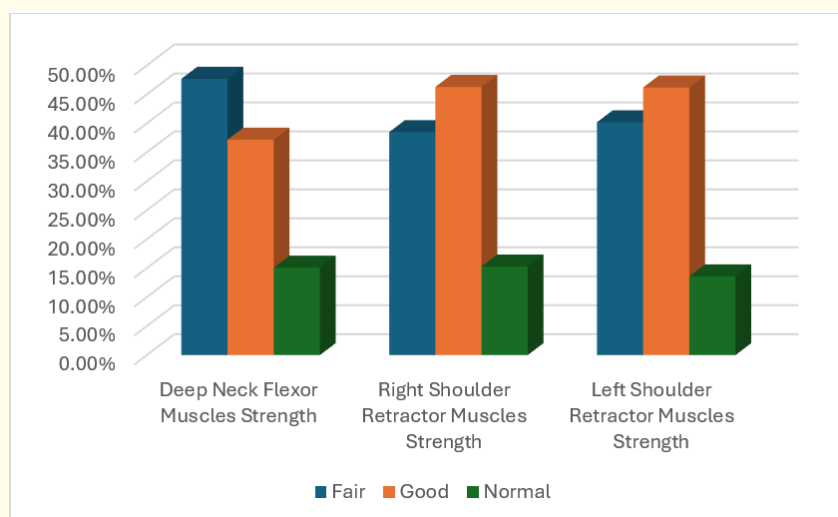


Figure 1: Muscle strength of the deep neck flexor and shoulder retractor muscles.

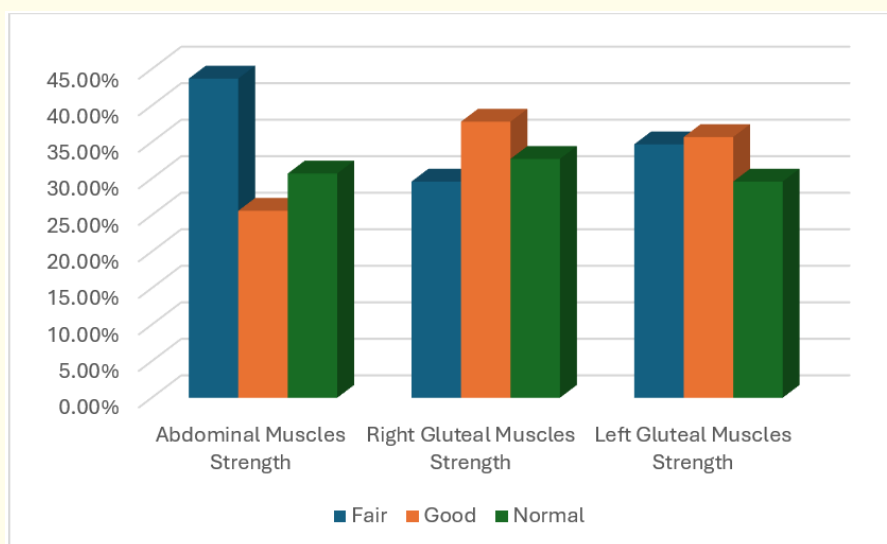


Figure 2: Muscle strength of the abdominal and gluteal muscles.

The findings of this study demonstrated notable asymmetries between right and left sides in several muscle groups, consistent with previously reported postural and functional dominance patterns [10,11]. As shown previously, a large proportion of subjects exhibited fair to good strength in the deep neck flexor muscles, with only 15.1% achieving normal levels. This pattern is consistent with previous studies linking deep neck flexor weakness to forward head posture (FHP) and altered cervical alignment [12,13]. The CROM findings in this study, showing an average head position of 18.07 ± 1.89 cm and a protraction–retraction difference of 4.80 ± 2.67 cm, further suggest a predominance of anterior head positioning, indicative of FHP. Such posture increases the demand on posterior cervical musculature and may lead to adaptive shortening of anterior cervical and pectoral muscles [14].

Interestingly, while both right and left pectoralis muscles exhibited considerable tightness (65.2% and 69.3%, respectively), the right shoulder retractors were slightly stronger than the left. This finding supports the typical agonist–antagonist relationship where shortened agonists are accompanied by weakened antagonists [15]. One possible explanation is the dominance of the right upper extremity in daily activities, leading to compensatory strengthen-

ing of right posterior shoulder stabilizers despite pectoralis tightness. Previous research supports that unilateral habitual use can result in side-specific adaptations in muscle tone and strength [16].

In the lower quarter, tightness in the right hip flexors (63.1%) and right hamstrings (89.9%) was more prevalent than on the left side (58.2% and 81.9%, respectively). Despite this, the right gluteal muscles showed slightly better strength profiles than the left. The average anterior tilt of the right innominate was more ($11.37 \pm 4.2^\circ$) compared to the left ($10.85 \pm 4.4^\circ$), suggesting a stronger influence of right hip flexor shortening on pelvic alignment. This supports the idea that dominant-side hip flexor activity can contribute to anterior pelvic tilt, thereby affecting lumbopelvic rhythm and postural control [17].

Prior evidence indicates that chronic hip flexor tightness often coexists with gluteal inhibition or weakness due to reciprocal inhibition mechanisms [5]. However, the present data suggest that such a relationship may vary depending on activity level and functional dominance. The relatively higher right gluteal strength found in this study might reflect compensatory adaptation to maintain postural symmetry during standing or gait tasks.

The coexistence of anterior head posture, pectoral tightness, and mild pelvic asymmetry underscores the interrelation of regional postural adaptations. Alterations in one segment often propagate biomechanical changes throughout the kinetic chain [18]. For example, increased anterior pelvic tilt may enhance lumbar lordosis, indirectly influencing thoracic and cervical curvature, leading to FHP [17].

The observed prevalence of fair to good strength rather than normal strength across most muscle groups suggests suboptimal neuromuscular control in postural stabilizers. This aligns with contemporary views emphasizing endurance and activation timing over maximal strength for maintaining optimal posture [12,19].

Future research should explore the relationship between segmental alignment, muscle flexibility, and strength asymmetries using longitudinal designs. Additionally, investigating the efficacy of corrective interventions, such as targeted stretching of shortened muscles and activation training for weak antagonists, could provide valuable clinical insights.

Conclusion

Adaptive shortening and weakness of postural muscles are predominant among university students. This could be related to their sedentary lifestyle and hours spent studying. It is imperative to have proper interventions to enhance postural muscles' function and improve body posture among university students.

Conflict of Interest

No conflict of interest exists.

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