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Core Muscle Activation Levels Assessed Using a Pressure Biofeedback Unit Among College Students: A Cross-Sectional Study

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ABSTRACT

Background: Core stability, mediated by the transversus abdominis (TrA), is vital for spinal protection and functional movement. Impaired activation of these deep stabilizers is a recognized precursor to musculoskeletal dysfunction and low back pain. While the Pressure Biofeedback Unit (PBU) is a validated tool for assessing TrA recruitment during the abdominal drawing-in maneuver, normative data for healthy young adults is limited.

Objectives: This study sought to quantify transversus abdominis activation using the Pressure Biofeedback Unit (PBU) and categorize the distribution of core stability levels among healthy college students aged 18–22 years.

Methods: A community-based cross-sectional study was conducted at the NAMO College of Allied Health Sciences among 185 participants recruited via purposive sampling. Healthy students aged 18–22 years were included, while those with a history of low back pain, fractures, or neuromuscular disorders were excluded. Core activation was assessed using a Pressure Biofeedback Unit (PBU) in a supine crook-lying position during the Abdominal Drawing-in Maneuver (ADIM) from a 40-mmHg baseline. Participants were categorized into three functional activation patterns based on pressure readings: Optimal TrA Control (40-50 mmHg hold), Compensatory Global Bracing (>50mmHg), and Weak/Insufficient Recruitment (< 40 mmHg).

Results: The mean pressure deviation during the hold phase across the cohort was 41.69 ± 5.62 mmHg. Overall, only 41.1% (n = 76) of participants demonstrated optimal core activation. Suboptimal core control was observed in 58.9% (n = 109) of the sample: 42.7% (n = 79) exhibited compensatory global stabilizer activation (pressure increase > 50 mmHg), and 16.2% (n = 30) demonstrated insufficient recruitment (pressure drop < 40 mmHg or inability to sustain baseline control).

Conclusion: The study identifies a significant prevalence (58.9%) of suboptimal core stabilizer control among college students. The high rate of compensatory global muscle recruitment underscores a critical need for targeted neuromuscular re-education and core stability programming to prevent early-onset postural and musculoskeletal dysfunctions.

Keywords: Core Stability, Pressure Biofeedback Unit, Transversus Abdominis, College Students

INTRODUCTION

Core stability is fundamental to maintaining spinal alignment, optimizing postural

control, and ensuring functional movement efficiency [1]. Central to this stability is the coordinated activation of the deep trunk musculature—specifically the transversus abdominis which serves as a primary stabilizer of the lumbar spine and a safeguard against musculoskeletal dysfunction [1,2]. Current literature suggests that suboptimal neuromuscular control and impaired core muscle activation are significant predictors of reduced physical performance and a heightened risk of chronic low back pain [3].

In clinical settings, the Pressure Biofeedback Unit (PBU) has emerged as a reliable, non-invasive tool for the indirect assessment of transversus abdominis recruitment [1,4]. By monitoring pressure fluctuations during the Abdominal Drawing-in Maneuver (ADIM), the PBU offers a practical alternative to resource-intensive techniques such as rehabilitative ultrasound imaging or electromyography [1,5]. Evidence indicates that PBU-guided interventions not only enhance trunk muscle recruitment but also significantly improve lumbopelvic stability across various functional tasks and postural orientations [3, 6].

While the clinical utility of the PBU is well-documented in symptomatic populations, there is a distinct lack of normative data concerning core muscle activation patterns in healthy young adults. This demographic, particularly college-going individuals, represents a critical group for early intervention due to the increasing prevalence of sedentary behaviors and postural stresses associated with academic environments. Addressing this knowledge gap is essential for establishing baseline functional metrics and developing preventative rehabilitation protocols. Consequently, this study aims to evaluate the distribution of core muscle activation levels using pressure biofeedback among college students aged 18–22 years.

AIMS:

To assess lumbo-pelvic core muscle activation levels using a Pressure Biofeedback Unit (PBU) among healthy college-going students aged 18–22 years.

Objectives:

- To measure core activation pressure values during the Abdominal Drawing-In Maneuver using a PBU.
- To classify participants into Optimal, Compensatory, and Insufficient core activation groups based on pressure criteria.
- To determine the overall percentage distribution of these core activation levels.

MATERIALS AND METHODOLOGY

Study Design and Setting:

A community-based cross-sectional study was conducted at the NAMO College of Allied Health Sciences, Silvassa. The study protocol was approved by the Institutional Ethics Committee, and all participants provided written informed consent prior to data collection.

Participant Recruitment and Selection

A total of 185 participants were recruited using a purposive sampling technique from the student population. The study focused on a healthy young adult demographic to establish baseline core muscle recruitment metrics.

Inclusion Criteria:

- Asymptomatic male and female students aged 18–22 years.
- Voluntary consent to participate in the clinical assessment.

Exclusion Criteria:

- History of chronic low back pain, spinal fractures, or major abdominal surgeries.
- Presence of radicular symptoms, including tingling or numbness.
- Diagnosed neuromuscular or vestibular or musculoskeletal disorders affecting trunk stability.
- Inability to comprehend or follow standardized verbal instructions.

Instrumentation

The primary evaluative tool utilized was a Pressure Biofeedback Unit (PBU;

Stabilizer™, Chattanooga Group, Hixson, TN, USA). The PBU is a validated, non-invasive clinical device designed to register pressure fluctuations that indirectly reflect the isolated isometric recruitment of the deep abdominal musculature—specifically the Transversus Abdominis (TrA) and internal obliques. The device comprises a flexible, three-chambered inflatable bladder connected via a rigid tube to a calibrated pressure gauge (range: 0 to 200mmHg), enabling real-time monitoring of lumbopelvic control during specific motor control maneuvers.

Testing Protocol

Standardized procedures were followed to ensure the reliability of the measurements:

1. Familiarization: Participants were coached on the Abdominal Drawing-in Maneuver (ADIM) using standardized verbal cues to facilitate isolated TrA activation without global muscle compensation.
2. Positioning: Subjects were placed in a supine crook-lying position on a firm clinical plinth.
3. Placement & Calibration: The uninflated PBU bladder was positioned horizontally beneath the lumbar spine, centered at the L3–L4 spinal segment. The bladder was inflated to a steady-state baseline pressure of 40 mmHg to comfortably fill the space between the lumbar lordosis and the plinth.
4. Assessment Execution: Participants were instructed to perform the ADIM to contract the deep core muscles while maintaining the pressure gauge reading between 40 mmHg and 50mmHg (representing an elevation of up to +10mmHg above baseline) for a hold duration of 10 seconds.

Upper Cut-off (>50mmHg): Exceeding 50mmHg indicated over-activation of the superficial Rectus Abdominis or excessive posterior pelvic tilting rather than isolated deep core recruitment.

Lower Cut-off (<40mmHg): Dropping below the baseline 40mmHg indicated arching of the lumbar spine (anterior pelvic tilt) or failure to sustain isometric contraction.

Statistical Analysis

Data were analyzed using SPSS Version 26.0. Descriptive statistics (mean, standard deviation, and percentages) were employed to summarize the demographic profile and the distribution of core activation levels. Participants were classified into three functional categories based on their mean Pressure Biofeedback Unit (PBU) readings across three trials:

- **Optimal Activation:** 40-50mmHg.
- **Weak/Compensatory Activation:** > 50mmHg
- **Weak/ Insufficient Recruitment:** < 40mmHg

REULTS AND STATISTICAL ANALYSIS

Participant Characteristics

A total of 185 college-going students aged 18–22 years participated in the study. The demographic profile of the cohort represented a healthy, non-athletic population currently enrolled in academic programs.

Core Muscle Activation Quantification

The primary outcome was the quantification of Transversus Abdominis (TrA) recruitment through pressure deviations from a 40 mmHg baseline during the Abdominal Drawing-in Maneuver (ADIM). The descriptive analysis of the cohort's performance is summarized in Table 1.

Table 1: Descriptive Statistics of Pressure Biofeedback Values (N=185)

Metric	Value (mmHg)
Mean Pressure	41.69
Standard Deviation (SD)	± 5.62
Minimum Recorded Value	8.00
Maximum Recorded Value	48.00
Median	42.00

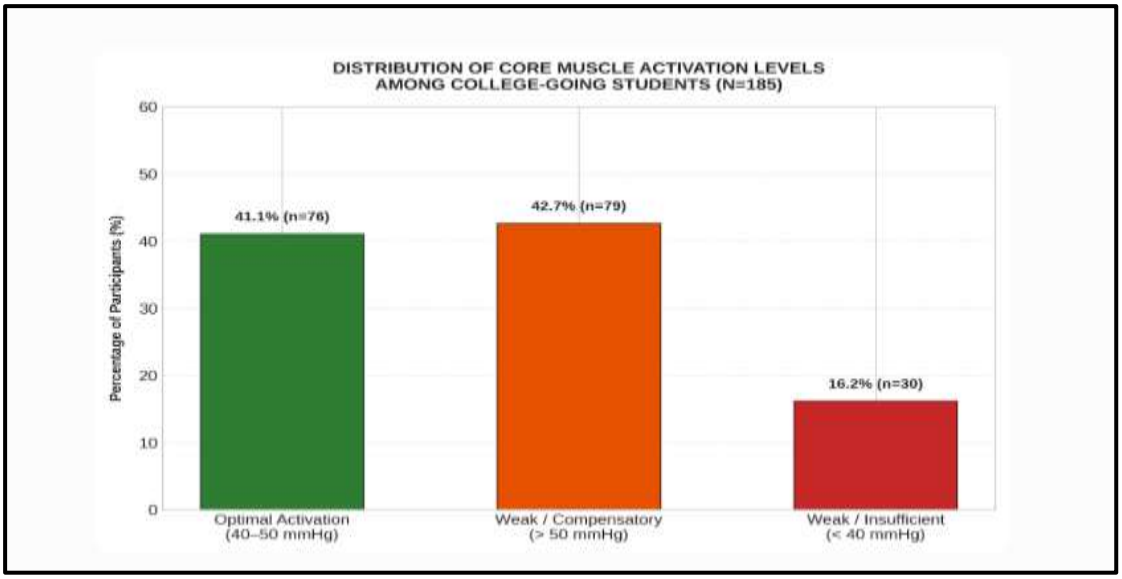
Categorization of Core Muscle Competency

Participants were categorized into three functional groups based on their ability to isolate the TrA and maintain lumbar stability.

- Optimal Activation: 76 participants (41.1%) demonstrated the ability to maintain baseline pressure within the target range, indicating successful deep muscle isolation.
- Weak/ Compensatory Activation: 79 participants (42.7%) exhibited pressure values exceeding 42 mmHg. This indicates a "bracing" strategy characterized by the compensatory recruitment of global stabilizers such as the rectus abdominis and external obliques or excessive posterior pelvic tilting.
- Weak/ Insufficient Recruitment: 30 participants (16.2%) demonstrated pressure values below 40 mmHg, indicating delayed deep core engagement, abdominal bulging, or lumbar spine arching (anterior pelvic tilt).

Distribution of Activation Levels:

The findings indicate that a majority (58.9%, n = 109) of the college-going population (N = 185) lacks isolated control of the deep core stabilizers, exhibiting a significant tendency toward compensatory global muscle recruitment.



DISCUSSION

The primary objective of this study was to evaluate core muscle activation levels among college students using a Pressure Biofeedback Unit (PBU). Our findings revealed that only 41.1% of the participants demonstrated optimal transversus abdominis (TrA) isolation, while the majority (58.9%) exhibited dysfunctional activation patterns. The PBU is established as a reliable, non-invasive clinical method for monitoring these pressure fluctuations, which indirectly reflect the recruitment of the TrA during stabilization maneuvers. [1,2]

A significant finding was that 42.7% of participants showed pressure increases exceeding 50 mmHg. While often misinterpreted as "strength," this pressure rise during the Abdominal Drawing-in Maneuver (ADIM) typically indicates a "bracing" strategy, where global stabilizers like the rectus abdominis and external obliques override the deep local system.[3,4] This is consistent with established theories suggesting that healthy young adults should ideally demonstrate anticipatory, isolated TrA activation to stiffen the spine without global compensatory torque.[1,4]

Conversely, 16.2% of participants registered pressure values below the 40mmHg baseline, reflecting an inability to build or sustain lumbopelvic pressure against the inflatable cell. This insufficient recruitment pattern suggests poor local neuromuscular endurance, delayed motor unit activation, or a fundamental lack of proprioceptive awareness regarding deep core contraction. (2,5) Because the local core system serves as the foundational kinetic link for proximal stability and dynamic force transfer between the upper and lower extremities, the high prevalence (58.9%) of sub-optimal activation in an asymptomatic population aged 18–22 years may predispose these individuals to future musculoskeletal overload, postural dysfunctions, or chronic low back pain. (3,6)

Prior research emphasizes that targeted restoration of deep core stability yields tangible reductions in lower back injury rates. (1,5) Understanding the distinct roles of local versus global stabilizers during motor tasks facilitates the design of precise, functional exercise programs, ensuring a more effective translation into dynamic athletic performance and injury prevention. (3,6) Furthermore, timely correction of deep core recruitment deficits is essential for preserving optimal spinal alignment and mitigating long-term degenerative back pathology. (4)

CONCLUSION

This study demonstrates a high prevalence (58.9\%) of sub-optimal lumbopelvic core muscle activation among healthy, asymptomatic college-going students aged 18–22 years (N = 185). Although the cohort exhibited a mean pressure reading of 41.69 ± 5.62 mmHg, only 41.1% (n = 76) achieved optimal, isolated recruitment of the Transversus Abdominis (TrA) within the target 40-50mmHg range.

The majority of participants displayed dysfunctional motor control strategies, characterized predominantly by compensatory global muscle bracing (>50mmHg; 42.7%, n=79) or insufficient deep muscle recruitment (<40 mmHg; 16.2%, n=30). These results highlight a critical need for targeted neuromuscular re-education and core stability programs within student health initiatives to prevent early-onset postural and musculoskeletal dysfunctions.

Declaration by Authors

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