RESEARCH PAPER

Academic Discipline, but Not Medical versus Non-Medical Stream, Predicts Core Muscular Endurance in University Students: A Cross-Sectional Study

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ABSTRACT

Background: Core muscular endurance underlies spinal stability and injury prevention. Studies in student populations have commonly compared broad groupings such as health-science versus non-health-science streams, but whether core endurance varies at the level of specific academic discipline and whether broad stream classification captures such variation at all has received little attention.
Methods: In this cross-sectional study, 435 university students from eight academic disciplines (medical stream: Nursing, Pharmacy, Dentistry, Physiotherapy; non-medical stream: Education, Computer Applications, Business Administration, Law) underwent standardized assessment of core muscular endurance using the Biering-Sorensen test, prone plank test, and bilateral side-bridge tests, alongside a structured postural and behavioural questionnaire. Multivariable linear regression with heteroscedasticity-robust standard errors, adjusted for gender, age, and body mass index (BMI), compared both stream and individual discipline, with Holm correction for multiple comparisons.
Results: Medical and non-medical stream did not differ significantly on any of the four endurance measures (all Holm-corrected $p > 0.22$). By contrast, academic discipline significantly predicted prone plank endurance (robust $F = 28.94$, Holm-corrected $p = 0.0006$). Male students demonstrated greater endurance than female students across all four measures (all $p < 0.0001$; Cohen's d 0.44–0.80). Higher BMI was associated with reduced lateral trunk endurance on both side-bridge tests (Holm-corrected $p = 0.016$ and 0.015) but not with posterior or anterior endurance. None of the seven self-reported postural or study-behaviour items predicted endurance on any measure after adjustment (0 of 28 comparisons significant).
Conclusions: Broad stream classification did not predict core muscular endurance, whereas specific academic discipline did, indicating that aggregating students into health-science and non-health-science categories may obscure meaningful variation. Gender and BMI emerged as consistent physiological correlates, while self-reported postural behaviour did not predict measured endurance.
Trial registration: Clinical Trials Registry – India, CTRI/2024/11/077463 (reference REF/2024/10/093927).
Keywords: core stability; trunk muscle endurance; university students; academic discipline; cross-sectional study.
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INTRODUCTION

Core muscular endurance the capacity of the trunk musculature to sustain submaximal contractions over time underlies spinal stability, postural control, and injury prevention in both athletic and everyday contexts [1, 2]. Reduced core endurance has been associated with increased risk of low back pain and impaired functional performance, particularly among sedentary populations who spend prolonged periods in static postures [3]
University students, who typically spend several hours daily in seated study or clinical postures, represent a
population at particular risk of reduced core endurance [8, 12]. The Biering-Sorensen test, prone plank test, and side-bridge tests are validated field measures widely used to characterize posterior, anterior, and lateral trunk endurance respectively in student populations [4, 5, 6, 18, 19, 20].
Where student populations have been compared, the literature has generally relied on broad categorical groupings most commonly health-science versus non-health-science students on the assumption that curricular exposure to health content, or the physical demands of clinical training, produce systematic differences in physical status [10, 11]. Findings from this literature have been mixed, with health-science students shown to differ from their peers in activity and lifestyle patterns, though not consistently in a favourable direction [11]. Comparatively little attention has been paid to whether such broad groupings are the appropriate unit of comparison at all, or whether variation between individual disciplines within those groupings is greater than variation between them.
This distinction has practical consequences. If broad stream classification captures the relevant variation, then interventions and screening may reasonably be targeted at the stream level. If, however, meaningful differences exist between individual disciplines that aggregate categories conceal, then stream-level analyses may report null findings while masking substantial discipline-level variation.

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The present study therefore examined core muscular endurance across eight academic disciplines, testing both the conventional medical versus non-medical stream comparison and discipline-level variation within the same sample, with adjustment for gender, age, and BMI. Sex differences, the relationship between BMI and endurance across muscle groups, and the contribution of self-reported postural and study behaviour were examined as secondary objectives.

MATERIAL AND METHODS

Design and ethical aspect of the study

This cross-sectional observational study was conducted in accordance with the Declaration of Helsinki and is reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [7]. Ethical approval was obtained from the KLE Institute of Physiotherapy Ethical Committee (Reference No. 837), and the study was registered with the Clinical Trials Registry – India (CTRI/2024/11/077463; reference REF/2024/10/093927). The study was conducted among university students from selected medical- and non-medical-stream colleges in North Karnataka, India.

Participants and sampling

A cluster sampling method was used to select participating colleges. Eight colleges were randomly selected from a list of eligible institutions, comprising four medical-stream disciplines (Nursing, Pharmacy, Dentistry, and Physiotherapy) and four non-medical-stream disciplines (Bachelor of Education, Bachelor of Computer Applications, Master of Business Administration, and Bachelor of Laws). Following institutional permission, students were invited to participate through classroom announcements and direct interaction, and written informed consent was obtained from all participants prior to data collection.

Of 600 records originally collected, 164 were excluded following data verification (duplicate entries and internally inconsistent records), and one further record was excluded for an implausible age value inconsistent with the study's eligibility criteria. The final analytic sample comprised 435 participants (303 female, 132 male).

Outcome measures

Core muscular endurance was assessed using four validated field tests: the Biering-Sorensen test for posterior chain (lumbar extensor) endurance [4, 18], the prone plank test for anterior and global core endurance [5, 19], and left and right side-bridge tests for lateral trunk flexor endurance [6, 20]. All tests were timed to the point of task failure by trained assessors using a standardized protocol.

A structured, face-validated questionnaire captured seven dichotomous (yes/no) items relating to postural and study-related behaviour: prolonged sitting or standing (more than four hours), maintenance of upright posture, slouched sitting posture, use of back support, prolonged study in a single position, studying for more than two hours without a break, and low back pain in the preceding six months.

Anthropometric measures (height and weight) were recorded using standard procedures, and BMI was calculated as weight in kilograms divided by height in metres squared.

Statistical analysis

Descriptive statistics are reported as mean ± standard deviation. Normality (Shapiro-Wilk test) and homogeneity of variance (Levene's test) were assessed for each outcome across groups, given evidence of non-normality and heteroscedasticity in the majority of comparisons, all regression models used heteroscedasticity-consistent (HC3) standard errors. Multivariable linear regression modelled each endurance measure as a function of gender, age, BMI, and either stream or academic discipline. The overall contribution of discipline was tested using a robust Wald test comparing models with and without the discipline term. All families of tests the four stream comparisons, the four discipline omnibus tests, the four BMI coefficients, and the 28 questionnaire comparisons were corrected within family using the Holm-Bonferroni method. Effect sizes are reported as Cohen's d with 95% confidence intervals presented alongside adjusted mean differences. Quantile (median) regression and Kruskal-Wallis tests were used as non-parametric sensitivity analyses. Descriptive statistics were computed using IBM SPSS Statistics (version [24]; IBM Corp., Armonk, NY, USA). Regression modelling, robust standard error estimation, and multiplicity correction were performed using Python (stats models' version 0.14).

RESULTS

Participant characteristics

The final analytic sample comprised 435 university students (303 female, 132 males; mean age 21.2 ± 1.7 years), of whom 222 were enrolled in medical-stream and 213 in non-medical-stream disciplines. Baseline characteristics by gender are presented in Table 1.

Table 1 Baseline characteristics by gender (N = 435)

Characteristic	Female (n = 303)	Male (n = 132)
Age (years)	21.0 ± 1.8	21.8 ± 1.4
Height (cm)	157.7 ± 7.0	168.0 ± 8.0
Weight (kg)	55.4 ± 10.5	63.5 ± 9.7
BMI (kg/m²)	22.3 ± 3.9	22.5 ± 3.1

Values are presented as mean ± standard deviation. BMI, body mass index.

Core endurance by discipline

Mean endurance values for each of the four tests, stratified by academic discipline, are presented in Table 2.

Table 2 Core muscular endurance by academic discipline (mean ± SD, seconds)

Discipline	n	Biering-Sorensen	Prone Plank	Side Bridge R	Side Bridge L
B.Ed	61	20.0 ± 8.9	58.6 ± 25.4	28.9 ± 14.9	28.7 ± 15.5
BCA	26	18.8 ± 8.7	77.7 ± 38.5	33.2 ± 17.2	34.7 ± 20.0
BDS	75	18.4 ± 7.8	68.3 ± 24.7	27.9 ± 16.5	29.5 ± 16.6
BPT	30	15.0 ± 10.7	53.0 ± 33.9	23.3 ± 18.7	23.5 ± 19.6
LLB	75	20.5 ± 9.3	55.6 ± 24.1	25.0 ± 14.9	24.7 ± 15.8

MBA	51	19.2 ± 8.6	59.0 ± 30.5	31.4 ± 16.4	32.0 ± 16.5
Nursing	59	20.4 ± 12.5	59.5 ± 37.5	29.8 ± 18.5	31.1 ± 20.0
Pharmacy	58	18.0 ± 10.7	64.9 ± 33.3	29.8 ± 23.5	30.7 ± 23.7

B.Ed, Bachelor of Education; BCA, Bachelor of Computer Applications; BDS, Bachelor of Dental Surgery; BPT, Bachelor of Physiotherapy; LLB, Bachelor of Laws; MBA, Master of Business Administration; SD, standard deviation.

Stream comparison: medical versus non-medical

Adjusted differences between medical- and non-medical-stream students are presented in Table 3. No significant difference was observed on any of the four endurance measures, either before or after correction for multiple comparisons, and all effect sizes were small (Cohen's $d \leq 0.18$).

Table 3 Medical versus non-medical stream, adjusted for gender, age, and BMI

Outcome	Adj. diff (s)	95% CI	Raw p	Holm p	Cohen's d
Biering-Sorensen	+1.2	[−0.6, 2.9]	0.199	0.598	0.12
Prone Plank	−5.6	[−11.3, 0.1]	0.055	0.221	−0.18
Side Bridge R	−0.2	[−3.8, 3.3]	0.896	0.903	−0.01
Side Bridge L	−1.4	[−5.0, 2.2]	0.452	0.903	−0.08

Positive values indicate higher endurance in non-medical-stream students. CI, confidence interval.

Discipline comparison

In contrast to the stream-level analysis, academic discipline contributed significantly to the prediction of prone plank endurance after adjustment and correction for testing across the four outcomes (Table 4). The discipline effect did not reach significance for the remaining three measures.

Table 4 Omnibus test for discipline effect (robust Wald F-test, Holm-corrected across four outcomes)

Outcome	Robust F	Raw p	Holm p	Significant
Prone Plank	28.94	0.0001	0.0006	Yes
Side Bridge L	16.69	0.0195	0.0584	No
Side Bridge R	12.52	0.0846	0.1693	No
Biering-Sorensen	9.31	0.2313	0.2313	No

Inspection of the discipline-level means (Table 2) indicated that relative ordering was not stable across the four tests. Law students ranked highest on the Biering-Sorensen test but seventh of eight on the remaining three measures, while Computer Applications students ranked highest on prone plank and both side-bridge tests. Mean pairwise rank correlation between the four tests was moderate (Spearman $\rho = 0.42$), indicating that no single discipline performed consistently well across all measures. Physiotherapy students ranked lowest of the eight disciplines on all four tests, this observation was not pre-specified and is considered post hoc.

Gender

Male students demonstrated significantly greater endurance than female students across all four measures, independent of discipline, age, and BMI (Table 5).

Table 5 Gender effect, adjusted for age, BMI, and discipline

Outcome	Adj. diff M − F (s)	95% CI	p	Cohen's d
Prone Plank	+24.5	[18.7, 30.3]	<0.0001	0.80
Biering-Sorensen	+6.5	[4.8, 8.2]	<0.0001	0.67
Side Bridge L	+9.5	[6.0, 13.0]	<0.0001	0.52
Side Bridge R	+7.8	[4.4, 11.1]	<0.0001	0.44

Body mass index

Higher BMI was associated with significantly reduced endurance on both side-bridge tests after correction, but not on the Biering-Sorensen or prone plank tests (Table 6). This pattern indicates that the association between body mass and trunk endurance in this sample was specific to lateral trunk musculature rather than generalized across all muscle groups.

Table 6 BMI effect per unit (kg/m²), adjusted for gender, age, and discipline

Outcome	Adj. diff per unit (s)	95% CI	Raw p	Holm p	Significant
Side Bridge L	−0.76	[−1.27, −0.24]	0.0038	0.0150	Yes
Side Bridge R	−0.71	[−1.21, −0.21]	0.0054	0.0161	Yes
Prone Plank	−0.84	[−1.64, −0.04]	0.0397	0.0795	No

Biering-Sorensen	−0.08	[−0.34, 0.19]	0.5561	0.5561	No

Postural and study behaviour

None of the seven self-reported postural or study-behaviour items predicted endurance on any of the four measures after adjustment for gender, age, BMI, and discipline, of 28 comparisons, none reached significance even before correction for multiple testing. Reported differences were small in magnitude, for example, students reporting more than four hours of continuous sitting or standing differed from those who did not by between 1.3 and 2.9 seconds across the four tests (all $p \geq 0.19$). In unadjusted analysis, this item was associated with lower Biering-Sorensen endurance (17.8 ± 10.3 s versus 19.8 ± 9.6 s, $p = 0.045$), but the association did not persist after adjustment, indicating confounding by gender, discipline, and BMI

DISCUSSION

This study compared core muscular endurance in university students using two levels of grouping within the same sample. The conventional medical versus non-medical stream comparison produced no significant difference on any of the four endurance measures, with uniformly small effect sizes. By contrast, comparison at the level of individual academic discipline identified significant variation in prone plank endurance. Taken together, these results suggest that broad stream classification may be too coarse a grouping to detect variation in physical status among student populations, and that null findings reported at the stream level should not be interpreted as evidence that student groups do not differ.

This interpretation is consistent with the mixed findings of the existing literature comparing health-science and non-health-science students [10, 11]. If disciplines within each stream differ substantially from one another, aggregation into two categories would tend to average out those differences and produce inconsistent results across studies with differing disciplinary composition. The present data support this possibility directly, within the medical stream, mean prone plank endurance ranged from 53.0 seconds to 68.3 seconds across the four constituent disciplines, a spread larger than the difference observed between the two streams overall.

Discipline rankings were not stable across the four tests, with moderate rank correlation between measures. This suggests that discipline-related variation in trunk endurance is not a single general fitness dimension but may differ by muscle group, and that studies employing a single endurance test may reach different conclusions from those using a battery. Physiotherapy students ranked lowest on all four measures, while this observation was not pre-specified and did not reach significance in pairwise comparison at the available subgroup size, it is notable given that this is the discipline receiving the most direct curricular exposure to musculoskeletal and core-stabilization content, and warrants examination in an adequately powered, prospectively designed study.

The sex-based difference observed here male students outperforming female students across all four endurance measures, independent of discipline, age, and BMI replicates a well-established pattern in the physical-performance literature [15, 16, 17], and is plausibly attributable in part to established differences in lean muscle mass and cross-sectional area between sexes [15]. Its consistency across all four measures and every sensitivity analysis performed provides a useful internal reference against which the more modest discipline-level effects can be judged.

The association between BMI and endurance was specific to lateral trunk musculature, reaching significance on both side-bridge tests but not on anterior or posterior measures.

This muscle-group specificity is broadly consistent with prior work linking body composition to trunk muscular performance and postural control [13, 14], and may reflect the mechanical demand placed on the lateral trunk musculature when supporting body mass in the side-bridge position. This finding was not anticipated and merits replication.

Notably, none of the seven self-reported postural and study-behaviour items predicted measured endurance after adjustment. This null result is informative rather than merely negative, it suggests that self-reported postural habit, as captured by brief questionnaire items of the kind commonly used in student health surveys, may be a poor proxy for objectively measured trunk endurance. The observation that one item appeared significant in unadjusted analysis but not after adjustment further illustrates the risk of drawing conclusions about postural behaviour without controlling for demographic and anthropometric confounders.

Strengths and limitations

This study's strengths include STROBE-compliant reporting, direct comparison of two grouping levels within a single sample, multivariable adjustment for key confounders, use of heteroscedasticity-robust and non-parametric sensitivity analyses, formal correction for multiple comparisons within each family of tests, transparent reporting of null findings, and a documented data-verification process applied prior to analysis.

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference. Second, postural and behavioural data were self-reported and may be subject to recall or social-desirability bias; the null findings for these items should be interpreted in that light, as measurement error would tend to attenuate any true association. Third, data verification identified and excluded several duplicate and inconsistent records, resulting in unequal group sizes across disciplines, this limited statistical power for discipline-level pairwise comparisons and for the smaller subgroups in particular. Fourth, cluster sampling by college may introduce a design effect not fully captured by the current analysis, and discipline is necessarily confounded with institution in this design. Fifth, no direct measure of physical activity or exercise participation was collected, which limits interpretation of the mechanisms underlying discipline-level differences. Finally, findings are drawn from a single geographic region and may not generalize to other populations or educational systems.

CONCLUSION

Medical versus non-medical stream classification did not predict core muscular endurance in this sample of university students, whereas comparison at the level of individual academic discipline identified significant variation in anterior core endurance. This suggests that broad stream groupings may obscure meaningful differences between student populations and should be used with caution as the unit of comparison in student health research. Gender and BMI emerged as consistent physiological correlates of endurance, with the BMI association specific to lateral trunk musculature, while self-reported postural and study behaviour did not predict measured endurance on any test. Future studies employing prospectively defined discipline-level hypotheses, direct measurement of physical activity, and adequately powered disciplinary subgroups are needed to clarify the determinants of the discipline-level variation observed here.

DATA AVAILABILITY

The de-identified dataset generated and analysed during the current study is available from the corresponding author upon

reasonable request, in accordance with institutional ethical requirements and participant confidentiality considerations.

ABBREVIATIONS

BMI: Body mass index, B.Ed.: Bachelor of Education, BCA: Bachelor of Computer Applications, BDS: Bachelor of Dental Surgery, BPT: Bachelor of Physiotherapy, CI: Confidence interval, CTRI: Clinical Trials Registry – India, HC3: Heteroscedasticity-consistent standard errors (type 3), LLB: Bachelor of Laws, MBA: Master of Business Administration, SD: Standard deviation, STROBE: Strengthening the Reporting of Observational Studies in Epidemiology.

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Ethics declarations

Ethics approval and consent to participate

The study protocol was approved by the KLE Institute of Physiotherapy Ethical Committee (Reference No. 837) and adhered to the principles of the Declaration of Helsinki. The study was registered with the Clinical Trials Registry – India (CTRI/2024/11/077463; reference REF/2024/10/093927). Written informed consent was obtained from all participants prior to data collection, after they were fully informed about the study's aims and procedures.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.