ORIGINAL ARTICLE

Correlation between Low Back Pain with Core Muscles Endurances Among Undergraduate Students: A Cross Sectional Study

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ABSTRACT

Introduction: Low back pain (LBP) is a prevalent musculoskeletal complaint in Malaysian healthcare and is increasingly common among undergraduate students. This study aimed to examine the relationship between functional status related to LBP and core muscle endurance, as well as evaluate their levels among undergraduates. **Materials and Methods**: A total of 297 students from various academic disciplines participated in this cross-sectional study. They completed a self-administered questionnaire that included demographic information and the Back Pain Functional Scale (BPFS). Core muscle endurance was assessed using McGill's Core Muscle Endurance Test. Spearman's rank correlation was used to analyze the relationship between BPFS scores and endurance levels. **Results**: The majority of participants were aged 20–21 years, with a nearly equal gender distribution. Most students were from health sciences disciplines and were in their second or third year of study. The most challenging functional tasks reported were sleeping and putting on shoes or socks. Among endurance measures, trunk flexors showed the highest median endurance, followed by extensors, with lower values observed for lateral trunk muscles. Significant positive correlations were found between BPFS scores and trunk flexor endurance ($\rho = 0.426$, $p < .001$), extensor endurance ($\rho = 0.394$, $p < .001$), and lateral trunk endurance ($\rho = 0.379–0.403$, $p < .001$). **Conclusion**: Core muscle endurance is positively associated with functional ability among undergraduates with LBP. These findings support integrating core-strengthening exercises into student wellness initiatives to reduce LBP-related limitations and promote spinal health.
Malaysian Journal of Medicine and Health Sciences (2026) 22(3): 1-9.doi:10.47836/mjmhs.v22i3.1577

Keywords: Low Back Pain, Muscle Fatigue, Postural Balance, Students, Cross-Sectional Studies

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INTRODUCTION

Low back pain (LBP) is defined as pain, muscle tension, or stiffness localized below the costal margin and above the inferior gluteal folds, with or without leg pain, and is one of the leading causes of disability worldwide (1). It imposes a significant global health issue with substantial implications for individuals' physical, psychological, and academic well-being, particularly among adolescents and young adults, including undergraduate students (2-4). Recent studies have reported a high prevalence of LBP among undergraduates, with contributing factors including sedentary behavior, prolonged sitting during lectures and study sessions, poor ergonomic postures, and low levels of physical activity (5,6). Inadequate endurance of core muscles, particularly the deep stabilizers such as the transversus abdominis and multifidus, has been identified as a contributing mechanism for LBP. Weak core endurance can impair spinal motor control by reducing the ability to stabilize the lumbar spine during movement or prolonged static postures. This may result in either excessive or insufficient trunk stiffness, both of which can increase mechanical loading on spinal tissues, promote muscle fatigue, impair proprioception, and ultimately contribute to the onset or persistence of LBP (7).

In Malaysia, LBP prevalence was reported at 12%, ranking as the ninth most reported complaint in public primary healthcare clinics and fifth in private clinics, highlighting its public health relevance (2,8). Despite its widespread impact, there is limited research focusing on LBP among Malaysian undergraduates, a group with unique lifestyle characteristics and vulnerability to LBP due to prolonged sitting and insufficient awareness of ergonomic principles (9-11).

Core muscles refers to the group of muscles that support the lumbar spine stability during both rest and movements (12-13). Decreased activation of multifidus and tranversus abdominis reduces the core muscle endurance which is essentials for maintaining spinal stability through sustained contractions at rest and during precise movement over time (14). This reduction in endurance increases stress and load on the joints and ligaments of lumbar spine, contributing to development of low back pain to occur. Therefore, training core muscle endurance is important for the prevention and management of low back pain, as it enhance spinal stability, reduces recurrence, and improve functional performance (13).

Previous research has demonstrated that there is significant associations between reduced core muscle endurance and increased LBP in various populations. For example, studies involving sedentary office works, athletes and adults from general population have shown that lower endurance of trunk flexors, extensors, and lateral muscle is correlated with higher incidence and severity of LBP (15-18)

Considering the limited local research and the critical role of core muscle endurance in maintaining spinal health, this study aims to address this gap by assessing core muscle endurance levels and examining the impact of low back pain on functional status among Malaysian undergraduate students. In addition, the study will explore the relationship between LBP and core endurance using McGill's core endurance tests, which offer a standardized and reliable approach for evaluating spinal stabilizing muscle function (16). Findings from this study may provide valuable insights into the underlying biomechanical factors contributing to LBP in this population and support the development of targeted intervention strategies aimed at reducing LBP and enhancing students' overall well-being.

MATERIALS AND METHODS

This study was an observational cross-sectional study conducted to examine the relationship between core muscle endurance and functional status in individuals with low back pain (LBP) among undergraduate students. The research was carried out at Universiti Tunku Abdul Rahman (UTAR), Sungai Long Campus, Malaysia.

A priori power analysis using G*Power (version 3.1) was conducted to estimate the required sample size for detecting a statistically significant correlation between core muscle endurance and low back pain functional status. With a significance level (α) of 0.05, statistical power ($1-\beta$) of 0.80, and an anticipated small-to-moderate effect size ($r = 0.16$), the required sample size was calculated to be 301 participants. However, due to constraints in recruitment and participant availability, 297 participants were included in the final analysis. This represents a 1.3% shortfall, which is within an acceptable margin for observational studies and is unlikely to meaningfully affect the statistical power or interpretation of results.

This study employed a convenience sampling method, recruiting participants who were readily accessible and willing to participate, such as students from a specific academic program. While this approach facilitated efficient data collection, it introduces certain limitations that warrant consideration.

One primary concern is selection bias, as the sample may not adequately represent the broader population of young adults or university graduates. Participants selected through convenience sampling may differ in characteristics such as fitness level, motivation or health awareness, potentially influencing the study outcomes (19). Consequently, the generalizability of the findings is limited. The results pertaining to core muscle endurance and its relationship with low back pain may not be directly applicable to other demographic or occupational groups, such as older adults, individuals with sedentary lifestyles, or clinical populations (20).

Undergraduate students aged 18 to 25 years, of both sexes, who were enrolled in degree programs at Universiti Tunku Abdul Rahman, Sungai Long Campus, were eligible to participate in the study. Exclusion criteria included a documented history of lumbar or sacral spine fractures, prior diagnosis or history of Prolapsed Intervertebral Disk (PID), and recent injuries occurring within the week prior to study initiation. The study protocol received approval from the UTAR Scientific and Ethical Review Committee (Approval No. U/SERC/248/2023, Date: 26 September 2023). Informed consent was obtained from all participants, who were assured of confidentiality and their right to withdraw from the study at any time without penalty.

Data collection involved a structured questionnaire distributed through online platforms, including WhatsApp, Facebook, Microsoft Teams, and Telegram. The questionnaire was divided into two sections:

1. Demographic Data: Included information on age, gender, year of study, and other relevant demographic details.
2. Back Pain Functional Scale (BPFS): The BPFS is a self-reported questionnaire designed to assess functional limitations related to back pain. It consists of 12 items, each representing a common daily activity, such as bending, lifting, walking, or climbing stairs. Respondents rate their current level of function for each activity on a scale from 0 to 5, where 0 indicates inability to perform the activity and 5 reflects the same level of function as before the onset of back pain. The total score ranges from 0 to 60, with higher scores indicating better functional status. The BPFS has demonstrated good internal consistency, with a Cronbach's alpha of 0.82, and strong construct validity, showing significant negative correlations with the Roland-Morris Disability

Questionnaire (r = –0.693) and the Oswestry Disability Index (r = –0.794) (20), supporting its use in assessing back-related functional impairment.

Upon completing the questionnaire, participants scheduled appointments for the McGill Torso Muscle Endurance Test (Fig.1). This test assessed core muscle endurance through four specific positions: trunk flexor endurance, trunk lateral endurance (right and left), and trunk extensor endurance (23). All assessments were conducted by the same trained physiotherapist, who underwent a calibration session prior to data collection to ensure consistency in test administration. Prior to testing, participants received a clear explanation and physical demonstration of all positions. They were then given a brief trial attempt to familiarize themselves with the posture requirements and ensure correct alignment before the actual measurement began. Participants were closely guided into the correct test position and monitored for adherence throughout the test.

Fig. 1: McGills Torso Endurance Test. A. Trunk Flexor Endurance Test. B. Trunk Lateral Endurance Test. C. Trunk Extensor Endurance Test

1. For the trunk flexor test (Fig. 1A) – Participants sat against a wedge set at a 60-degree incline, with knees and hips flexed at 90-degrees and arms crossed over the chest. The wedge was then pulled back, and timing began once the participant maintained the position without support.
2. For the side bridge test (Fig. 1B) – Participants lay on their side with legs extended and the top foot placed in front of the lower. They supported their body with the forearm directly beneath the shoulder and lifted the hips off the floor to form a straight line. The test was performed on both left and right sides.
3. For the trunk extensor test (Fig. 1C) – Participants lay prone with the upper body hanging over the edge of a bench, pelvis and legs secured. They were asked to lift and hold the upper body horizontal to the floor while arms were crossed over the chest.

Time was recorded in seconds using a digital stopwatch, starting from the moment the participant achieved the required position until the participant either lost the posture, experienced fatigue, or voluntarily stopped. Verbal encouragement was provided throughout the test. Each component was separated by a 5-minute rest to minimize fatigue carryover. All tests were conducted by the same investigator in a controlled university laboratory setting to ensure consistency. Data were securely stored in a password-protected database accessible only to the research team. Accuracy was maintained through double data entry and validation checks to minimize errors.

Data analysis was performed using IBM SPSS version 29.0. Descriptive statistics, including means, standard deviations, frequencies, and percentages, summarized the demographic data and BPFS scores. Due to non-normal distribution of the data, Spearman's rank correlation coefficient (ρ) was used to examine the relationship between core muscle endurance and back pain-related functional status.

RESULTS

Demographic Data

The demographic data of the participants are reported in Table I. 297 participants are reported to have low back pain with majority being 21 years old (30.3%), followed by 20 years old (28.3%). Gender distribution was 52.5% for male and 47.5% for female. Participants were distributed across faculties: M.Kandiah Faculty of Medicine and Health Sciences (40.4%), Faculty of Arts and Management (23.2%), Faculty of Computing and Informatics (19.2%), and Lee Kong Chean Faculty of Engineering (17.2%) Year of study varied, with the highest representation in Year 2 (35.7%) and Year 3 (30.3%).

Table I: Demographic Data

Demographic data		Frequency (%)
N		297
Age		
	18	4 (1.3)
	19	16 (5.4)
	20	84 (28.3)
	21	90 (30.3)
	22	64 (21.5)
	23	27 (9.1)
	24	10 (3.4)
	25	2 (0.7)
Gender		
	Male	156 (52.5)
	Female	141 (47.5)
Faculty		
	MK FMHS	120 (40.4)
	FAM	69 (23.2)
	FCI	57 (19.2)
	LKC FES	51 (17.2)
Year of Study		
	Year 1	75 (25.3)
	Year 2	106 (35.7)
	Year 3	90 (30.3)
	Year 4	21 (7.1)
	Year 5	5 (1.7)

Note. N = 297. MK FMHS = Faculty of Medicine and Health Sciences; FAM = Faculty of Accountancy and Management; FCI = Faculty of Creative Industries; LKC FES = Lee Kong Chian Faculty of Engineering and Science.

Low Back Pain Functional Status and Core Muscle Endurance

Table II shows the results on Back Pain Functional Scale (BPFS) that was used to assess the functional limitations of participants in performing daily activities. Scores are reported as Median (IQR) to reflect the non-normal distribution of the data. Participants reported the greatest difficulty with activities such as "Putting your shoes or socks" (4.0 (2.0–5.0)) and "Sleeping" (4.0 (3.0–5.0)). Relatively lower difficulty levels were noted for "Performing heavy activities around your home" (3.0 (2.0–4.0)) and "Standing for 1 hour" (3.0 (2.0–4.25)). Other activities, such as "Driving for 1 hour" (3.0 (2.0–5.0)) and "Walking 1 mile" (4.0 (2.0–5.0)), showed moderate levels of limitation. The total BPFS score had a median of 44.0 (IQR 29.0–53.0) out of a maximum of 60, indicating a moderate level of overall functional ability among participants.

Table II: Distribution of Function Based on Back Pain Functional Scale and McGill's Core Endurance Test Values

	Items	(N=297) Median (IQR)
Back Pain Functional Scale items	Any of your usual work housework or school activities	3.0 (3.00 -5.00)
	Your usual hobbies recreational or sporting activities	3.0 (2.00 – 4.00)
	Bending or stooping	3.0 (2.00 – 4.00)
	Putting your shoes or socks (or stockings or pantyhose)	4.0 (2.00 – 5.00)
	Lifting a box of groceries from the floor	4.0 (2.00 – 5.00)
	Sleeping	4.0 (3.00 – 5.00)
	Standing for 1 hour	3.0 (2.00 – 4.25)
	Walking 1 mile	4.0 (2.00 – 5.00)
	Going up or down 2 flights of stairs (about 20 steps)	4.0 (2.00 – 5.00)
	Sitting for 1 hour	4.0 (2.00 – 5.00)
	Driving for 1 hour	3.0 (3.00 -5.00)
	Performing heavy activities around your home	3.0 (2.00 – 4.00)
	Total BPFS Score (out of 60)	**44.0 (29.0 – 53.0)**
McGill's Core Endurance Test (seconds)	Trunk Flexor	69.0 (49.0–110.0)
	Trunk Extensor	67.0 (51.0–88.5)
	Left Lateral Trunk Endurance	44.8 (31.0–55.0)
	Right Lateral Trunk Endurance	45.3 (34.5–56.4)

Note. Values are presented as Median (IQR). Non-parametric descriptive statistics were used due to non-normal distribution of the data. N = 297 participants. *Significant at p<0.05.
BPFS = Back Pain Functional Scale; TFE = Trunk Flexor Endurance; TEE = Trunk Extensor Endurance; LLTE = Left Lateral Trunk Endurance; RLTE = Right Lateral Trunk Endurance.

The endurance of the core muscles was assessed using McGill's Torso Endurance Test, with results also expressed as Median (IQR). Participants demonstrated higher endurance in the trunk flexor muscles (69.0 seconds (49.0–110.0)) and trunk extensor muscles (67.0 seconds (51.0–88.5)), compared to the right lateral trunk (45.3 seconds (34.5–56.4)) and left lateral trunk (44.8 seconds (31.0–55.0)) muscles.

Correlation Between BPFS and McGill's Core Endurance

Prior to conducting the correlation analysis, the assumption of normality was assessed using both the Shapiro-Wilk test and Q-Q plot visual inspection. As presented in Table III, the Shapiro-Wilk test indicated that all key variables, namely the BPFS total scores and McGill's torso endurance test components (TFE, TEE, LLTE, and RLTE), were not normally distributed, with all p-values below 0.05. Complementing these statistical results, Fig. 2 displays the Q-Q plots for the same variables, which demonstrate visible deviations from the expected diagonal line, particularly at the distribution tails. These patterns indicate clear violations of normality assumptions. In light of these findings, the use of Spearman's rank order correlation was deemed appropriate for examining the monotonic relationships between functional outcomes and core endurance performance.

Table III: Shapiro-Wilk Test for Normality of Study Variables

Variable	Shapiro-Wilk Statistic (W)	p-value	Normality Assumption
Back Pain Functional Scale (BPFS)	0.942	0.003	Not Normally Distributed
Trunk Flexor Endurance (TFE)	0.935	0.001	Not Normally Distributed
Trunk Extensor Endurance (TEE)	0.948	0.006	Not Normally Distributed
Right Lateral Trunk Endurance (RLTE)	0.923	0.002	Not Normally Distributed
Left Lateral Trunk Endurance (LLTE)	0.929	0.004	Not Normally Distributed

Note. p<0.05 shows variable violate normal assumptions

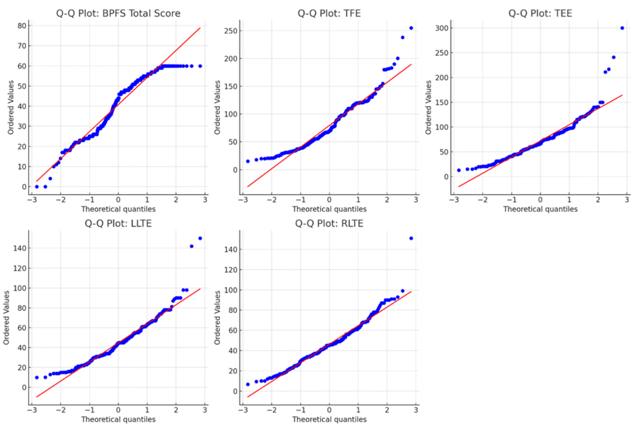

Figure 2: Q–Q plots assessing the normality of distribution for outcome variables. The plots display the quantile-quantile relationships for (A) BPFS Total Score, (B) Trunk Flexor Endurance (TFE), (C) Trunk Extensor Endurance (TEE), (D) Left Lateral Trunk Endurance (LLTE), and (E) Right Lateral Trunk Endurance (RLTE). The blue dots represent the observed values, while the red diagonal line indicates the theoretical normal distribution. Deviations from the line suggest departures from normality.

Table IV shows significant positive correlations between the Back Pain Functional Scale (BPFS) and McGill's Torso Endurance Test. Fig. 3 is visualizing the presentation between the relationship between them. BPFS scores demonstrated positive correlations with Trunk Flexor Endurance (TFE) (ρ = 0.426, p < .001), Trunk Extensor Endurance (TEE) (ρ = 0.394, p < .001), Right Lateral Trunk Endurance (RLTE) (ρ = 0.379, p < .001), and Left Lateral Trunk Endurance (LLTE) (ρ = 0.403, p < .001).

Table IV: Correlation between McGill's Torso Endurances Tests and Back Pain Functional Scale

	Median (IQR)	1	2	3	4	5
1. BPFS	44.0 (29-0 – 53.0)	--				
2. TFE	69.0 (49.0 – 110.0)	ρ = .426**	--			
3. LLTE	44.8 (31.0 – 55.0)	ρ = .403**	ρ = .579**	--		
4. RLTE	45.3 (34.5 – 56.4)	ρ = .379**	ρ = .539**	ρ = .831**	--	
5. TEE	67.0 (51.0 – 88.5)	ρ = .394**	ρ = .415**	ρ = .445**	ρ = .463**	-

Note. ρ = Spearman's rank correlation coefficient.

**Correlation is significant at the 0.01 level (2-tailed). N=297

BPSF: Back Pain Functional Scale, TFE: Trunk Flexor Endurance, LLTE: Left Lateral Trunk Endurance, RLTE: Right Lateral Trunk Endurance, TEE: Trunk Extensor Endurance

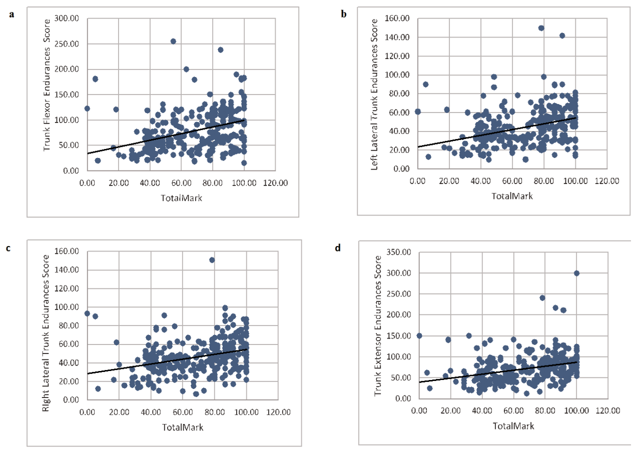

Figure 3: Correlation between Back Pain Functional Scale (BPFS) and McGill's Torso Endurance Test. The correlation was calculated using Spearman Correlation Analysis (p<0.001). a. There is positive correlation between the total score of BPFS and Trunk Flexor Endurance score (ρ = 0.426). b. The total score of BPFS and Left Lateral Trunk Endurance shown positive correlation with ρ = 0.403. c. Positive correlation seen between the total score of BPFS with ρ = 0.379. d. Positive correlation was observed between total score of BPFS and Trunk Extensor Endurance with ρ = 0.394.

These findings suggest moderate to strong relationships between the BPFS and the various torso endurance tests, all of which were statistically significant at the 0.0 level (2-tailed). The highest correlation was found between BPFS and TEE (ρ = 0.463), indicating the strongest association between BPFS and trunk extensor endurance. Similarly, BPFS was moderately correlated with other endurance test: TFE (ρ = 0.426), LLTE (ρ = 0.403), and RLTE (ρ = 0.379).

All correlation coefficients were positive, indicating that better performance in torso endurance test was associated with better functional outcomes on the BPFS. The significance of these correlations was confirmed by their p-values, which were all below 0.01, suggesting that these relationships are unlikely to have occurred by chance.

DISCUSSION

Low Back Pain Among Young Adults

The first objective of this study was to determine the presence of low back pain (LBP) among university graduates. A high proportion of participants reported experiencing LBP, with the majority between the ages of 20 and 21 years. This supports previous findings that LBP is common among young adults, particularly university students, due to sedentary lifestyles, academic stress, and poor posture (2,21). Notably, students in their second and third years of study reported the highest rates of LBP, which is likely associated with increased academic workload psychosocial stress during these periods (22).

In line with earlier research, LBP prevalence was higher among students from health science-related programs (4). These students often spend long hours in clinical training and studying, both of which have been identified as significant contributors to musculoskeletal discomfort. Several studies have also highlighted that prolonged sitting during lectures and extended screen time are important environmental and behavioral factors contributing to LBP in student populations (5-6, 8). These findings suggest a clear need for preventive measures that include ergonomic education, promotion of physical activity, and strategies to manage psychological stress in university settings.

Correlation Between BPFS and McGill's Core Endurance

The second objective of the study was to find out the correlation between the low back pain functional status and the core muscle endurance. Spearman correlation test revealed that there is significant correlation between affected physical function measured by BPFS and core muscles endurance measured by McGill's Torso Endurance Test, particularly the trunk flexor and extensor muscles. This indicates that individuals with better core muscle endurance tend to report fewer limitations in daily functional activities. These findings are consistent with the study by (15,18), who observed similar associations in collegiate athletes with nonspecific LBP.

The BPFS results also provided insight into specific functional limitations experienced by participants. The greatest challenges were reported in tasks such as sleeping and putting on shoes or socks, which require spinal mobility and postural adjustment. These findings are supported by studies indicating that sleep disturbances, difficulty initiating sleep, and poor sleep quality are common in individuals with LBP and are associated with increased pain severity (23-24). A study involving military recruits also found that a significant portion of participants experienced their most intense spinal pain during sleep (25).

Moderate difficulty was also reported for tasks such as walking one mile and driving for one hour, both of which require prolonged isometric contraction of the trunk muscles. These activities place sustained demand on core muscle endurance, particularly the deeper stabilizers that maintain spinal alignment (13,17). In contrast, tasks like standing for one hour or performing heavy activities around the home were perceived as less difficult, possibly due to the more static nature of these activities. This pattern aligns with previous findings that dynamic trunk stabilization poses a greater challenge to individuals with reduced core function compared to static postures (26).

The McGill Torso Endurance Test results showed variation in endurance capacity across different core muscle groups. Participants generally demonstrated higher endurance in trunk flexors and extensors, while the endurance of lateral trunk muscles was comparatively lower. This imbalance may suggest a weakness or undertraining of the lateral stabilizers, which are critical for controlling movement in the frontal plane and preventing rotational instability (27-28).

Lateral trunk muscle endurance in this study averaged approximately 46 seconds on the right and 44 seconds on the left. Weakness in these muscles can impair lateral bending and rotation, contributing to instability and functional difficulty. A recent study by (29) found that during endurance testing, the iliocostalis lumborum demonstrated the highest activity and was most closely linked to how long a person could hold the endurance position. In contrast, the longissimus thoracis showed weaker correlations, possibly due to its more complex architecture. These findings highlight the role of lateral muscle groups in spinal endurance. In this study, reduced endurance in these muscles may explain the greater difficulty experienced by participants during side bending or twisting tasks.

Collectively, these findings underscore the significance of core muscle endurance in maintaining function and reducing LBP. Rehabilitation strategies should include comprehensive core strengthening programs that not only target the trunk flexors and extensors but also emphasize the lateral stabilizers. Improving endurance across all planes of motion may reduce functional limitations and enhance quality of life among young adults with LBP (12,13).

Limitation

Although the study provides valuable insights into the relationship between core endurance and LBP, several limitations must be considered when interpreting these results. Firstly, the use of self-reported data introduces the possibility of bias, as participants may not always accurately report their pain levels or functional limitations due to subjective perceptions and memory recall issue (30). The reliance on self-report questionnaires may have led to overestimation or underestimation of LBP severity and its impact on daily activities. Secondly, the cross-sectional design of the study restricts our ability to establish causal relationships between core endurance and LBP. Since both the core endurance levels and LBP functional status were measured at a single point in time, it is impossible to determine whether poor core endurance leads to the development of LBP, or whether chronic LBP cause a decline in core endurance. This limitation underscores the need for future longitudinal studies that track changes in core endurance and LBP severity over time, allowing for more accurate understanding of their temporal relationship. Besides, the study's use of a continuous outcome measure (BPFS) could be enhanced with categorical classifications, and the convenience sampling method may have introduced selection bias, indicating the need for more robust sampling techniques in future research.

Future studies should build on the current research’s findings by exploring the mechanisms underlying the observed correlations in greater detail. For instance, longitudinal studies are needed to investigate how variations in core muscle endurance affect the development and progression of LBP over extended periods. Such studies could help clarify whether improving core endurance through exercise interventions can prevent or alleviate LBP symptoms. Intervention studies targeting stress management and ergonomic improvements could help researchers to develop more comprehensive approaches to prevent and manage LBP. Besides, future research could delve into specific reasons why trunk flexors and extensors display higher endurance than lateral trunk muscles. Understanding the underlying biomechanics and muscle activation patterns could help refine rehabilitation program, targeting the most functionally important muscles to improve LBP outcomes.

CONCLUSION

In conclusion, this study highlights a significant relationship between core muscle endurance and functional status among undergraduate students, as assessed by McGill’s Torso Endurance Test and the Back Pain Functional Scale. Students with greater trunk muscle endurance demonstrated better functional performance, suggesting a potential role for core-strengthening exercises in managing and preventing low back pain. Low back pain was most reported among second- and third-year students, particularly within healthcare and technology faculties, emphasizing the need for targeted ergonomic education and posture correction strategies tailored to their academic demands.

While the findings provide valuable insights, the cross-sectional nature of the study limits causal interpretation. Future research employing longitudinal or experimental designs is recommended to establish causal links and explore the underlying mechanisms connecting core endurance and low back pain.

ACKNOWLEDGEMENT

The authors thank Universiti Tunku Abdul Rahman (UTAR) and all study participants.

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