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Evaluation of Trunk Endurance in Female Physiotherapy Students Using McGill Core Endurance Test

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ABSTRACT

This cross-sectional study evaluates trunk endurance using the McGill Core Endurance Test among female physiotherapy students. Results indicate significantly lower endurance compared to normative values ($p<0.001$), suggesting implications for musculoskeletal health and professional performance. Trunk endurance, critical for maintaining posture, injury prevention, and task performance, warrants emphasis in physiotherapy training. Studies, including Hanney et al. (2016), highlight its importance for professional efficacy and health outcomes. Further research is recommended to explore targeted interventions.

1. INTRODUCTION

Endurance, the ability to sustain effort over extended periods, is crucial for various physical activities, especially in healthcare professions. Physiotherapists, for instance, require strong trunk endurance to maintain proper posture, perform physically demanding tasks, and prevent musculoskeletal injuries. Beyond physiotherapy students, trunk endurance impacts other healthcare workers, such as nurses, who also face risks related to prolonged standing and patient handling [2][4]. However, inadequate trunk endurance among physiotherapy students could lead to musculoskeletal issues and suboptimal professional performance.

Strong trunk endurance is also critical for injury prevention. Reference [5] provide evidence linking lumbar extension strength with balance and reduced pain risk. Furthermore, studies such as [13] suggest a strong association between BMI and trunk endurance, emphasizing the need to address this factor in physiotherapy training programs. This study aims to evaluate trunk endurance levels among female physiotherapy students using the McGill Core Endurance Test, a reliable tool to measure the endurance of various core muscle groups, and compare the results with the established normative data.

2. LITERATURE REVIEW

2.1 Anatomy of Trunk Muscle

According to [59], core muscles form a box-like structure in the body. This includes:

- Rectus abdominis (front),
- Rectus spinae (back),
- Quadratus lumborum (dorsal side),
- Internal and external obliques (sides),

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- Diaphragm (top),
- Pelvic girdle and Psoas (bottom).

These core muscles are central to the body, helping transmit force to the limbs. They are crucial for upper and lower body movements, linking with major muscles like the latissimus dorsi, pectoralis major, hamstrings, and quadriceps. Core stability, strength, and endurance are key factors to measure. Reference [8] found that those with higher core endurance have better balance and posture. A good balance between trunk extensor and flexor endurance can prevent back pain and improve mood [28][29].

2.2 Level of Trunk Muscle Endurance

Different trunk muscles have varying endurance levels based on factors like muscle type and fitness. Reference [18] noted that flexor muscles generally have the longest endurance, followed by extensor and side flexors. When testing endurance, some muscles compensate to hold certain positions, which can affect the results. Reference [9] suggested that additional muscle activation may increase endurance times during testing. Plus, comparative studies, such as [57], provide insights into variations across populations, offering a benchmark for healthcare workers and athletes.

2.3 Impact of BMI on Trunk Endurance

Higher body mass and BMI can negatively impact trunk muscle endurance. Reference [41] found that students with higher BMI had lower core endurance. Similarly, [13] noted that women with larger waist circumferences performed worse in endurance tests. Reference [13] and others highlight the detrimental effects of excess body weight on endurance, further supporting the focus on normal BMI ranges in this study. This study focuses on participants with normal BMI to avoid skewed results.

2.4 Physiotherapy in Malaysia

According to the Ministry of Health Malaysia, the ratio of physiotherapists to patients is 1:21,260, indicating a shortage of physiotherapists. Most physiotherapists are female, requiring them to exert more effort in handling patients due to the shortage of male physiotherapists.

2.5 Work-Related Musculoskeletal Disorders (WMSDs) in Physiotherapy

Reference [30] reported that lower back pain is the most common WMSD among physiotherapy students due to clinical training involving physical tasks. These tasks include prolonged standing, lifting patients, and awkward postures, which increase the risk of WMSDs.

2.6 Risk Factors for Imbalance in Trunk Muscle

Low physical activity, prolonged sitting, and poor posture can lead to muscle imbalances. References [29] and [22] highlighted that extended sitting impacts posture and trunk muscle balance, contributing to lower back pain.

2.7 Role of Core Stability in Health Professions

Core stability underpins physical performance and injury prevention in healthcare workers. Reference [48] demonstrate that core stability exercises improve endurance and reduce pain, which is critical for physiotherapists who perform repetitive and physically demanding tasks.

2.8 Assessment Techniques for Core Endurance

The McGill Core Endurance Test is commonly used to assess core endurance and widely recognized for its reliability in evaluating trunk muscle endurance [58]. Reference [10] measured core endurance using the Flexors Endurance Test, Biering-Sorensen Test, and Lateral Bridge Test. These methods provide reliable measures of trunk muscle strength and endurance [55].

2.9 Normative Values for the McGill Core Endurance Test

The McGill Test sets average times for holding isometric positions to gauge trunk muscle endurance. For example, [4] reported a normative value of 149 seconds for the Trunk Flexor Endurance Test in young female nurses. This study will use these normative values due to similarities in sample demographics.

2.10 Interventions to Improve Trunk Muscle Endurance

Various exercises, including Pilates, core bracing, and even kinesiology taping, have been shown to improve core endurance [26][54]. Daily physical activities like walking can also enhance endurance, benefiting overall health [29].

3. METHODOLOGY

This cross-sectional observational study was conducted at Universiti Kuala Lumpur Royal College of Medicine Perak (UniKL RCMP). The research included 80 female physiotherapy students, both from the Bachelor and Diploma programs. Data collection occurred at the Manual Lab on Level 2 of the New Building at UniKL RCMP, from March to September 2024.

Participants were selected using a convenience sampling method. Convenience sampling, while practical for this study's time constraints and accessibility, limits the generalizability of the findings to broader populations [15]. To minimize biases, strict inclusion and exclusion criteria were applied. Participants were required to fill out a screening form and the Oswestry Low Back Pain Disability Questionnaire to ensure they met the study criteria. The inclusion criteria were female physiotherapy students, aged 18 to 29, with a normal BMI (18.5-24.9), and willing to participate. Students with low back pain, recent spinal injuries, or other medical conditions were excluded.

The sample size was determined using G-Power software, resulting in 80 participants. With a projected 20% dropout rate, the initial target was 96 students. The final sample included 80 students who met all criteria and participated in the study.

Data collection involved demographic information and trunk muscle endurance tests. The McGill Core Endurance Test, consisting of three specific assessments—Modified Biering-Sorensen Test, Trunk Flexor Endurance Test, and Side Bridge Test—was used to evaluate the students' trunk endurance. No warm-ups were conducted before testing to avoid introducing fatigue that could skew results. This decision aligns with findings by [12], which suggest that pre-test fatigue can negatively impact performance, leading to unreliable endurance measurements. To ensure proper recovery, each test was followed by a 3-minute rest period.

Participants completed the Modified Biering-Sorensen Test first, followed by the Trunk Flexor Test, and ended with the Side Bridge Test for both sides. The total duration for each participant was around 20-25 minutes. The McGill Core

Endurance Test was chosen due to its established standards and proven reliability in evaluating trunk endurance. It effectively measures back extensors, abdominal muscles, and lateral trunk stability, making it ideal for this population.

Data were collected in one session, recording the holding time in seconds for each test. The McGill Core Endurance Test was chosen due to its proven reliability in evaluating trunk endurance, measuring back extensors, abdominal muscles, and lateral trunk stability. Outcome measures focused on the duration participants could hold specific postures, with times compared against normative values [4].

Statistical analysis was performed using SPSS version 29.0. A one-sample t-test assessed the difference between the obtained data and the normative values, with significance set at $p < 0.05$. The data showed normal distribution based on histogram analysis. The Oswestry Low Back Pain Disability Questionnaire was used as a screening tool to exclude students with significant low back pain, ensuring a focus on core endurance levels among otherwise healthy participants.

4. RESULTS

80 physiotherapy students from UniKL RCMP participated in this study, with an average age of 21.26 years based on Table 1. The majority were Bachelor of Physiotherapy students (68.8%), while 31.3% were enrolled in the Diploma of Physiotherapy program. The study aimed to compare the trunk muscle endurance of these female physiotherapy students to standard norms [4].

Table 1. Demographic Data of Subject

Variables	Frequency (n)	Percentage (%)	Mean
Age (years)			21.26
Course	Bachelor of Physiotherapy	55	68.80
	Diploma in Physiotherapy	25	31.30

For trunk extensor endurance as presented in Table 2 and Figure 2, the average time for normal individuals was 189 seconds, while the female students had an average time of 80 seconds. The mean difference was -109.14 seconds, with a 95% confidence interval of -119.52 to -98.76, indicating a statistically significant result ($p < 0.001$). This highlights a substantial deficit in their core endurance compared to healthy individuals.

Table 2. Comparison of normative and obtained data of trunk extensor muscle endurance in seconds.

Data	Mean (Trunk Extensor)	Mean Difference	95% CI for Mean Difference	P value
Normative	189s			
Obtained	80s	-109.14s	[-119.52, -98.76]	<0.001

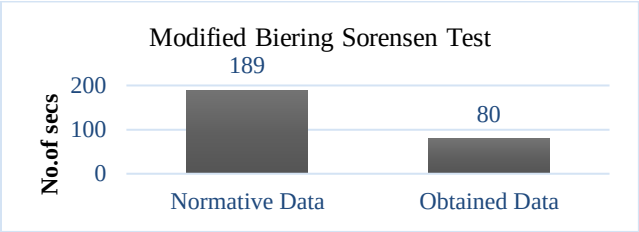

Fig. 2. Graph for the comparison mean of obtained data with the normative values for trunk extensor muscle endurance in seconds

In trunk flexor endurance based on Table 3 and Figure 3, the normative average was 149 seconds, but the students averaged 67 seconds. The mean difference was -82.48 seconds, with 95% confidence interval of -91.70 to -73.26, and p-value was less than 0.001, indicating strong significance. Female physiotherapy students had considerably lower trunk flexor muscle endurance than the general population

Table 3. Comparison of normative and obtained data of trunk flexor muscle endurance in seconds

Data	Mean (Trunk Flexor)	Mean Difference	95% CI for Mean Difference	P value
Normative	149s			
Obtained	67s	-82.48s	[-91.70, -73.26]	<0.001

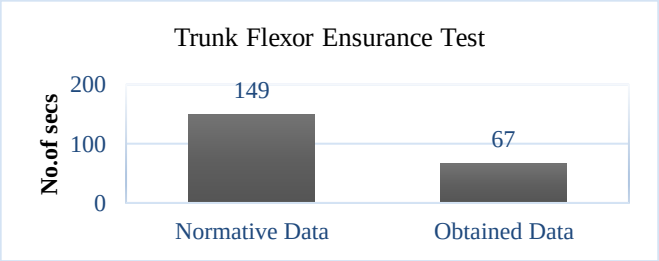

Fig. 3. Graph for the comparison mean of obtained data with the normative values for trunk flexor muscle endurance in seconds

The Right-Side Bridge Test also revealed lower endurance among the students, with a mean time of 39 seconds compared to the normative 72 seconds. The mean difference was -33.18 seconds, with 95% confidence interval of -37.91 to -28.45, and p-value was less than 0.001, indicating strong significance. Female physiotherapy students had considerably lower endurance in the Right Trunk lateral flexor muscles compared to normal persons. The graph below indicates a substantial difference in female physiotherapy students' right trunk lateral flexor muscle endurance compared to normative values. The result can be seen below in Table 4 and Figure 4.

Table 4. Comparison of normative and obtained data of Right Side Bridge Test in seconds

Data	Mean (Right Side Bridge Test)	Mean Difference	95% CI for Mean Difference	P value
Normative	72s			
Obtained	39s	-33.18s	[-37.91, -28.45]	<0.001

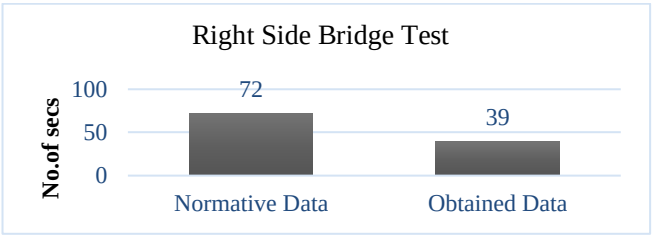

Fig. 4. Graph for the comparison mean of obtained data with the normative values for Right Side Bridge Test in seconds

Similarly, for the Left-Side Bridge Test that can be seen in Table 5 and Figure 5 below, the students had an average of 38 seconds, significantly lower than the normative 77 seconds. The mean difference was -39.54 seconds, with 95% confidence interval of -43.33 to -35.75, and p-value was less than 0.001, indicating strong significance. This highlights considerably lower endurance in these students, as confirmed by the graph showing a substantial difference.

Table 5. Comparison of normative and obtained data of Left Side Bridge Test in seconds

Data	Mean (Left Side Bridge Test)	Mean Difference	95% CI for Mean Difference	P value
Normative	77s			
Obtained	38s	-39.54s	[-43.33, -35.75]	<0.001

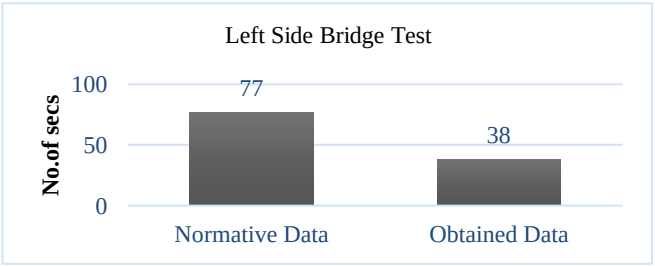

Fig. 5. Graph for the comparison mean of obtained data with the normative values for Leftt Side Bridge Test in seconds

Overall, the findings showed that female physiotherapy students had considerably lower trunk muscle endurance in all measured categories compared to standard values from the established data [4].

5. DISCUSSIONS

This study found that female physiotherapy students had lower trunk muscular endurance than normative data, indicating potential health and occupational risks linked to weak core endurance in healthcare workers. The McGill Core Endurance Test was used to assess core endurance among 80 nulliparous female physiotherapy students aged 18 to 29 with normal BMI from UniKL RCMP.

This study's findings are consistent with [4], who also reported reduced trunk endurance in nurses involved in physically demanding tasks. Both studies underscore the importance of adequate core endurance in healthcare professions, as weak core muscles can lead to musculoskeletal issues such as lower back pain. Nurses frequently perform physically demanding tasks like lifting and prolonged standing, which require core stability to prevent injury. Repetitive manual tasks and awkward postures further increase the risk of muscle fatigue, chronic pain, and reduced endurance over time. Similar risks may affect physiotherapy students, who experience prolonged sitting, limited physical activity, and a lack of core training, leading to muscle imbalances. Comparing these results with international studies highlights the universal nature of this issue and the importance of targeted interventions across different regions and educational systems. Research by [51] and [36] highlights that physiotherapy students often adopt sedentary habits due to academic pressures, contributing to muscle atrophy, poor posture, and potential lower back pain. This study's findings are also consistent with research conducted on Malaysian physiotherapy students by [30], which also reported low trunk endurance among students due to limited physical activity and poor ergonomics training.

Low trunk endurance in physiotherapists can significantly increase the risk of low back pain (LBP), especially given the physical demands of the profession. Reference [11] report that LBP is prevalent in healthcare workers due to prolonged standing, lifting, and awkward postures during patient handling.

For physiotherapists, tasks such as lifting and transferring patients require consistent core stability. Incorrect posture and repetitive movements over time can contribute to muscle fatigue and decreased trunk endurance, which, in turn, can heighten the risk of musculoskeletal issues like LBP. A systematic review and meta-analysis by [47] emphasize the relationship between lumbar spine flexion during lifting tasks and the onset of low back pain. This highlights the critical role of trunk endurance in maintaining proper posture and preventing LBP, especially for physiotherapists who perform frequent patient-handling tasks. These findings further support the inclusion of core stability training in physiotherapy programs to mitigate risks associated with musculoskeletal disorders. This fatigue reduces spinal support and increases mechanical stress, further impairing muscle function [5]. Over time, the loss of endurance in the trunk muscles can lead to chronic low back pain, which is prevalent among healthcare workers, including physiotherapists. The diminished ability to maintain proper posture and movement patterns can affect job performance and increase the risk of injury and musculoskeletal disorders, reducing career longevity and job satisfaction. Reference [2] highlights the multifaceted challenges physiotherapists face, including psychosocial risks such as stress and low self-esteem due to the work musculoskeletal disorder that they have. These pressures lead to emotional exhaustion, explaining why a significant portion of the participants expressed a desire for a career change. The findings align with similar conditions in developing countries, where

stress and job dissatisfaction are prevalent in healthcare professions.

Broader implications the findings of this study align with global trends indicating low levels of physical activity among healthcare students. Reference [33] report that physiotherapy students often face barriers to maintaining fitness due to academic demands, which contributes to reduced endurance and increased health risks. Highlighting these trends underscores the need for institutional support and integration of physical activity into healthcare training programs to enhance overall well-being and professional capabilities.

Given the observed deficiency in trunk endurance among female physiotherapy students, it is essential to recommend interventions that can improve their endurance levels and educate the students about the importance of trunk endurance. Incorporating core-strengthening exercises into both the physiotherapy curriculum and personal fitness routines could help address this issue. A study by [31] demonstrated that core stability exercises significantly improve balance, strength, and endurance in female students with trunk defects. Additionally, [54] found that online Pilates programs effectively enhance core endurance and proprioception, offering a flexible intervention method that could be integrated into physiotherapy education. Plus, [21] found that female students who participated in total-body resistance exercises exhibited marked improvements in muscle endurance. This suggests that targeted core-strengthening interventions could potentially improve the trunk endurance of physiotherapy students, mitigating the risk of developing musculoskeletal issues such as low back pain. Incorporating core stability and resistance exercises into the daily routines of physiotherapy students have long-term benefits on their professional performance by enhancing their physical resilience. Workshops on ergonomics, body mechanics, and proper lifting techniques would also better prepare students for the physical demands of their profession. A systematic review and meta-analysis by [47] highlighted that lumbar spine flexion during lifting is significantly associated with the onset of low back pain. This finding underscores the importance of maintaining adequate trunk endurance to support proper lifting mechanics and reduce the likelihood of injury. Implementing all the suggestions into the student life, especially in their curriculum can further encourage students to maintain their physical health, reducing the likelihood of developing lower back pain and related issues during their studies and future practice.

In conclusion, addressing the lower trunk endurance observed in this study through targeted interventions, lifestyle changes, and curricular improvements can significantly impact physiotherapy students' physical health and professional capabilities. By enhancing their endurance and awareness of proper body mechanics, students can improve their well-being and perform more effectively in their future careers as physiotherapists. Plus, future research could explore the longitudinal effects of curriculum-integrated core-strengthening programs on trunk endurance and track the impact of improved endurance on career satisfaction and physical resilience in practicing physiotherapists.

A few limitations should be acknowledged in this study. First, a small sample size, like the 80 participants in this study, can limit how widely the findings can be applied. Reference [7] explain that a larger sample size improves the reliability of results and helps better represent the overall population. When too few participants are included, it can lead to misleading conclusions because the sample may not accurately reflect the diversity of the broader group. Reference [19] emphasize that choosing an adequate sample size is critical for reliable statistical results. Without enough participants, the findings may not accurately represent all physiotherapy students, raising concerns about the study's generalizability. Additionally, since participants were involved in other research before this assessment, fatigue might have impacted their performance on the McGill Core Endurance Test. Reference [6] discuss how fatigue can diminish physical performance, particularly in athletes, highlighting that prior exertion can compromise endurance levels. Furthermore, [12] emphasize the link between physical fatigue and cognitive performance, suggesting that fatigue can impact both physical and mental capabilities. Additionally, factors like sleep deprivation and stress, which were not controlled in this study, can also significantly influence endurance. Reference [44] note that altered sleep patterns can adversely affect physical performance, while [17] detail how stress can further impair performance by affecting focus and motivation. These unmeasured variables, therefore, pose limitations to the validity of the findings regarding trunk endurance. Furthermore, the study did not account for the participants' recreational activities, which could be a key factor, as more physically active individuals may exhibit greater trunk endurance compared to those with more sedentary lifestyles. In addition, factors such as muscle mass, fat distribution, and overall body composition likely play a more significant role in determining trunk endurance than BMI alone.

However, besides all the limitations, the strength of this study lies in the use of a validated and widely recognized tool, the McGill Core Endurance Test, which is considered a gold standard for assessing trunk endurance. Numerous tests and measurements exist for evaluating different components of core stability [43]. Among these, core endurance tests, like the McGill tests, are considered the most reliable for assessing core stability [35][50][58]. By utilizing a well-established and reliable measurement tool, this research ensures high credibility and allows for better comparability with other studies, such as [4]. Additionally, focusing on a specific group, such as female, nulliparous physiotherapy students with normal BMI, helps improve the accuracy of research findings. By reducing differences related to age, pregnancy, or body composition, this approach makes results more reliable [46][52]. A more homogeneous sample allows researchers to gain clearer insights and strengthens the validity of the study by minimizing the impact of outside variables [15]. Furthermore, the study's emphasis on a profession with physical demands (physiotherapy) enhances its practical significance. The findings directly affect core endurance, which is crucial for the physical health and future job performance of physiotherapy students, potentially reducing their risk of low back pain and other musculoskeletal issues. In healthcare, understanding the unique experiences of specific populations can lead to better-targeted interventions that are crucial for their physical health and well-being [42]. Overall, studying these defined groups not only sharpens research focus but also aids in developing effective strategies for future healthcare professionals [52].

6. CONCLUSION

The study found that female physiotherapy students' trunk extensors, flexors, and lateral flexors have worse endurance than normative data as there is a significant difference in trunk muscle endurance ($p<0.001$). Lower trunk endurance could impact the health of physiotherapy students and their future professional performance. It is important to address this issue in physiotherapy education and training programs.

Clinical implications include enhancing trunk muscular endurance through exercises that the students may implement into their daily routines. Interventions (such as specific core-strengthening programs) should be explored more to enhance trunk endurance in physiotherapy students. Reference [21] demonstrated the effectiveness of resistance exercises in improving endurance, suggesting that integrating such programs into the curriculum could yield significant benefits. Plus, longitudinal studies to track changes in trunk endurance throughout their education or as they enter the workforce must be proposed. Awareness in the community, among various physiotherapy students' colleges about the reason for diminished trunk muscular endurance among physiotherapy students and its bad effects by providing seminars and lectures on good handling practices, thereby decreasing stress over the spine. Lastly, the implementation of ergonomics can be incorporated into the student's daily life.

Future research should aim to improve upon the limitations of this study by increasing the sample size to enhance the statistical significance of the findings and expand the generalizability of the results. Additionally, future studies should include parous females and males to gain a more comprehensive understanding of how pregnancy, childbirth, and gender influence trunk endurance. Furthermore, researchers should consider incorporating more detailed assessments of physical activity levels, body composition, sleep, and stress to identify potential contributing factors to trunk endurance. By utilizing more comprehensive body composition measurements, such as body fat percentage and muscle mass analysis, researchers can gain a deeper insight into the relationship between body composition and trunk endurance. Lastly, experimental studies that introduce specific interventions, such as core strengthening programs, can provide valuable evidence on how to improve trunk endurance among physiotherapy students. Incorporating qualitative research methodologies, as suggested by [42], could provide deeper insights into these influences.

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