ISSN: 2321-5690
IJOPT
INDIAN JOURNAL OF PHYSICAL THERAPY
AN INTERNATIONAL JOURNAL
INDIAN JOURNAL OF PHYSICAL THERAPY
AN INTERNATIONAL JOURNAL
editor.ijopt@gmail.com

EFFECT OF CORE EXERCISES ON MUSCULOSKELETAL ENDURANCE AMONG PHYSIOTHERAPY INTERNS : A CLINICAL TRIAL

Aditi Shah[1*], Vaishnavi Temghare[2]
[1,2] TMV's Jayantrao Tilak College of Physiotherapy , Minatai Thakre Rd, T.M.V. Colony, Mukund Nagar , Pune 411037

***Corresponding Author:** ptaditi@gmail.com
DOI: https://doi.org/10.63299/ijopt.0701103

ABSTRACT

Background: Despite the recognised role of core stability and strength in functional performance, limited research has focused on the effect of core exercises on functional abilities and physical performance among physiotherapy interns.

Objective: To study the effectiveness of core exercises with relation to endurance.

Methods: 35 Physiotherapy interns (Male = 8, Females = 27) were selected conveniently of mean age 23.12 +_0.061. Pre assessment of the core was done using Mc Gill Endurance test. All the participants underwent 6 weeks of core strengthening protocol, thrice a week. Following the intervention, post data was collected. The data were first tested for normality. The Shapiro–Wilk test (W = 0.916, p = 0.012) and the D'Agostino–Pearson test (DA = 11.42, p = 0.003) both indicated that the distribution of difference scores (Post–Pre) significantly deviated from normality. Therefore, a non-parametric Wilcoxon Signed-Rank Test was applied to compare pre- and post-intervention values.

Results: The median pre-intervention core muscular endurance ratio was 1.15, while the post-intervention median was 1.09. The analysis revealed no statistically significant difference between the two conditions (Z = 0.55, p = 0.589, r = 0.09).

Conclusion: This six-week core exercise programme did not produce a statistically significant improvement in the core muscular endurance ratio among physiotherapy interns. The small reduction observed was not clinically meaningful, suggesting that short-term training may have limited effect in this population. Larger and longer-duration studies are recommended.

Keywords: Physiotherapy, Core, Muscles, Musculoskeletal systems

INTRODUCTION:

The "core" is most commonly known as a muscular box, including the abdominals forming the front, the paraspinal and gluteal muscles in the back.The diaphragm consists as the roof, and the base is made up of pelvic floor and hip girdle muscles.(1)(2)This complex structure provides stability to proximal structures and balance during movement and serves as the central foundation for the motion of distal body parts.(3)(4) Balanced activation of both the stabilising and mobilising muscles of the core is crucial for maintaining posture, generating movement, and preventing musculoskeletal injuries.(5)

Weaknessin the core musculature can cause poor postural control, excessive stress onthe spinal structures, and a greater risk of musculoskeletal disorders, particularly low back pain. Working in sustained poor postures, physical inactivity, and inadequate core strength can also result in decreased endurance and functional efficiency while performing daily tasks.(6,7)

Physiotherapy is a profession that requires frequent manual handling, awkward postures, and repetitive physical activity.(8) Physiotherapy interns engage in physically demanding tasks such as patient transfers, manual therapy, and exercise assistance; ifthese activities are performedwith poor core stability or muscle imbalance, this can increase the risk of fatigue, poor movement control, and injury, ultimately affecting their performance and well-being.(9)

The importance of core stability in posture, injury prevention and improving movement efficiency, strengthening the core is very essential for individuals whose professions demand sustained physical effort, such as physiotherapists.(10)(11) Despite its recognised role in functional performance, limited research has focused on the effect of core exercises on functional abilities and physical performance among physiotherapy interns.(12,13)

This research study contributes to a better understanding of how targeted core interventions can enhance functional performance and reduce the risk of musculoskeletal problems in physically active individuals.

METHODOLOGY

This Pre-post Experimental study was conducted over a period of six weeks(3 alternate days/week) on 35 physiotherapy interns aged between 22 and 28 years, including both males and females. CTRI Registration was done prior to the start of the study with reference no. CTRI/2025/09/094410. The study was carried out in the Out Patient Department in Pune. Individuals with a history of spine injury, musculoskeletal fracture, or dysfunction, as well as those demonstrating irregular participation, were excluded to maintain the consistency of the subjects and intervention process. During the intervention period there were no dropouts from the study.Ethical approval for the study was obtained from the Institutional Ethics Committee of Tilak Maharashtra Vidyapeeth with reference Number R&D/2025/50.Written informed consent was obtained from all participants after providing detailed information about the study, including consent for photography and video recording; also the Helsinki guidelines for Ethical concerns were followed. Baseline data were collected through an endurance test in which each intern performed a Mc GillEndurance test using torso flexor endurance test(Figure 1) and torso extensor endurance test(Figure 2), their hold timewas recorded using a stopwatch and their ratio was taken. Normal average values for Mc GillEnduranceRatio is 0.84 and 0.72 for healthy adult men and women respectively. The exercise intervention included core stability and strengthening exercises such as prone bridge, side bridge, bird dog and limb loading exercises- 1A, 1B, 1C; 2A, 2B, 2C; 3A, 3B, 3C (Figure 3) performed in a progressive manner (by volume) as illustrated in Table 1. After the completion of six weeks intervention, post assessment was done using Mc Gill Endurance test using the same procedure. Data obtained pre and post study were organized in an excel sheet. Statistical analysis was performed using Advanced Microsoft Excel. The Wilcoxon signed-rank test was used to compare pre- and post-intervention values.

35 Physiotherapy interns were selected conveniently for this study.Participant characteristics (age and gender) were collected. Statistical analysis was performed using Advanced Microsoft Excel(Version 10). Wilcoxon signed-rank test was employed to compare pre and post-intervention values. All data were presented as median, with a significance level set at $p< 0.05$ and a 95% confidence interval.

Week 1& 2				
EXERCISE	**PROGRESSION**	**REPETITION**	**SETS**	**WEIGHTS**
PRONE BRIDGE	VOLUME	30* SEC HOLD	2	NONE
SIDE BRIDGE	VOLUME	30* SEC HOLD	2	NONE
BIRD DOG	VOLUME	10	3	NONE
LIMB LOADING1A	VOLUME	10	3	NONE
LIMB LOADING 2A	VOLUME	10	3	NONE
LIMB LOADING 3A	VOLUME	10	3	NONE
Week 3 &4				
PRONE BRIDGE	VOLUME	60* SEC HOLD	2	NONE

SIDE BRIDGE	VOLUME	60* SEC HOLD	2	NONE
BIRD DOG	VOLUME	15	3	NONE
LIMB LOADING1B	VOLUME	15	3	NONE
LIMB LOADING2B	VOLUME	15	3	NONE
LIMB LOADING 3B	VOLUME	15	3	NONE
Week 5 & 6				
PRONE BRIDGE	VOLUME	60* SEC HOLD	3	NONE
SIDE BRIDGE	VOLUME	60* SEC HOLD	3	NONE
BIRD DOG	VOLUME	20	3	NONE
LIMB LOADING1C	VOLUME	20	3	NONE
LIMB LOADING 2C	VOLUME	20	3	NONE
LIMB LOADING 3C	VOLUME	20	3	NONE

Table 1: Showing core exercise intervention protocol of 6 weeks with progression.

Figure.1 Shows Torso Extensor Endurance Test

Figure.2 Shows torso Flexor Endurance Test

a. Prone Bridge

b. Side Bridge

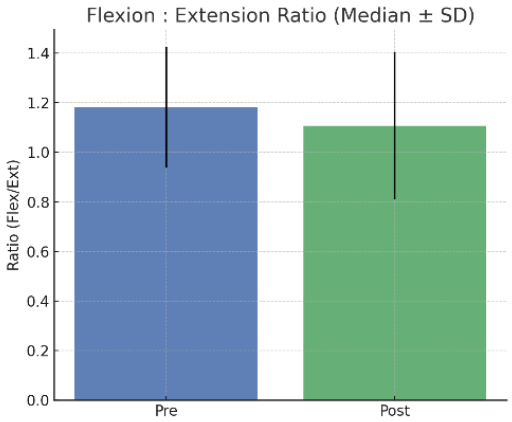
c. Bird Dog

d. Limb Loading 1 C

Figure.3. It shows core exercise Intervention Protocol

RESULTS

A total of 35 subjects, comprising 8 males and 27 females with mean age 23.13 ± 0.061 years participated in this clinical trial. The data were first tested for normality. The Shapiro–Wilk test (W = 0.916, p = 0.012) and the D'Agostino–Pearson test (DA = 11.42, p = 0.003) both indicated that the distribution of difference scores (Post–Pre) significantly deviated from normality. Therefore, a non-parametric Wilcoxon Signed-Rank Test was applied to compare pre- and post-intervention values. The median pre-intervention core muscular endurance ratio was 1.15, while the post-intervention median was 1.09. The analysis revealed no statistically significant difference between the two conditions (Z = 0.55, p = 0.589, r = 0.09). These findings suggest that the given core intervention did not produce a significant improvement in core muscular endurance among physiotherapy interns.



Graph 1: Shows changes in Medianof Mc Gill Flexion Extension ratio,pre and post Intervention

DISCUSSION

As the participants were physiotherapy interns, this study was conducted during their internship phase. The intervention consisted of a structured core exercise protocol conducted three days per week over a period of six weeks at scheduled timings. The results of the study indicated that the core exercise program did not lead to a statisticalimprovement in core muscular endurance among the physiotherapy interns(p=0.589).

Several studies (14)(15)in the medical field support the findings of the present study and show that core exercises can improve muscular endurance. Nurses who completed a four-week core training program showed better muscle fatigue resistance after the intervention.(16) Similarly, in another studydone by Gopika S et al,

an eight-week core exercise plan led to increased plank time and back extensor endurance in staff nurses.(14) University-level students also demonstrated improvements in core endurance following structured core training.(17) These positive results are likely due to improved activation and control of deep stabilising muscles developed through repeated core engagement. In this study, mean flexion extension ratio was found to be 1.178 before the start of the intervention while it improved to 1.14 at the end of the study. Further analysis of the data revealed that 21 out of 35 participants(~60%) had an increase in flexion-extension ratio (mean=0.09).

However, not all studies have shown consistent improvements. In one study, nurses reported feeling less tired after training, but their core endurance did not significantly improve when tested objectively.(18) Another study found that gains in core endurance were not always linked with improvements in core strength or stability, suggesting that different aspects of the core respond differently to training.(19) These mixed findings indicate that the success of core exercise programs may depend on program duration, exercise intensity, and the participant's baseline fitness level.

As there was decline in core muscle endurance among 40 % physiotherapy interns; this might be due to long standing hours, working in awkward postures during internship at various hospitals leading to physical fatigue and most of them preparing for competitive exams requiring prolonged sitting hours might have led to mental fatigue. Earlier studies have also reported that heavy workload, stress, and fatigue can reduce the effect of training and delay recovery.(20)(21) In addition, research shows that when exercise is done under high stress or lack of proper rest and proper balance of protein, carbohydrates, and essential vitamins and minerals in diet(22), muscle adaptation becomes slower and results are not easily visible .(23)

Fatigue is defined as a reversible decline in muscle performance or central drive resulting from physical exertion.(24) Among physiotherapy interns, fatigue arises from both peripheral musculararand central mechanisms. Peripheral fatigue occurs due to metabolic changes in the muscle, such as depletion of ATP, accumulation of lactate, hydrogen ions, and inorganic phosphate, which impair cross-bridge cycling and reduce force production.(25) Central or neuromuscular fatigue is influenced by prolonged clinical hours, high patient loads, emotional strain, and documentation pressure, which reduce motivation and central nervous system activation, leading to less effective recruitment of stabilizing muscles such as the transversus abdominis and multifidus, essential for core stability(26)(27) which likely explains the phenomena that there was no improvement in few participantsin flexion extension ratio post intervention .

Fatigue also impairs proprioceptive feedback, disrupting timing, coordination, and endurance during core exercises, which diminishes adaptive responses to strengthening programs.(25) Moreover, long duty shifts elevate cortisol levels and reduce anabolic recovery, which impairs muscle protein synthesis and limits strength gains.(28) Sleep deprivation, common in interns, further reduces neuromuscular recovery, while mental fatigue decreases voluntary muscle activation and overall performance during core training program.(29)(30) Collectively, these factors demonstrate that both physical and mental fatigue significantly limit the effectiveness of core-strengthening programs among physiotherapy interns, focusing the need for structured rest, recovery strategies, and optimized scheduling to ensure maximal training benefits.

After interviewing the participants following the study, it was noticed that some interns were involved in fitness related activities (e.g. calisthenics, gym, etc.). So they might already have had a good level of core strength and fitness. Previous studies have shown that people who are already trained show less improvement compared to untrained individuals.(31)

One of the main strengths of this study is that none of the participants dropped out, which kept the study findings more reliable. Also, as the study was done on physiotherapy interns who already had some knowledge of exercises, the chances of doing the protocol incorrectly were very low. These features are known to improve the quality of exercise-related research.(32,33)

The sample size of 35 participants was suitable for a small trial but still limited, small samples also make it difficult to apply results to a larger population.(34) Earlier research suggests that core strengthening should

include progressive intensity, a variety of exercises, and sometimes a longer training period of 8 - 12 weeks to show significant improvements.(35)(36)This core strengthening program did not lead to significant improvements in quite a few participants on core muscular endurance .So this study contributes valuable evidence for designing future interventions and highlights the need for longer duration programs with broader outcome measures.

References

1. k K. Prevalence Of Core Muscle Weakness In 18-25 Years College Going Students–A Cross-Sectional Study. African J Biol Sci. 2024 Jul 20;6:5764–83.
2. Parkar M, Saini RK. Assessment of upper limb and core muscle strength in physiotherapy student aged 20-25 years. Int J Community Med Public Heal [Internet]. 2022;9(10):3835–3840. Available from: https://www.ijcmph.com/index.php/ijcmph/article/view/10121
3. Rad ZM, Norasteh AA. Research Paper: The Effect of a Six-week Core Stability Exercises on Balance, Strength, and Endurance in Female Students With Trunk Defects. Phys Treat. 2020;10(4):231–8.
4. Aly S, ElMohsen A, Elhafez S. Effect of Six Weeks of Core Stability Exercises on Trunk and Hip Muscles' Strength in College Students. Int J Ther Rehabil Res. 2017 Jan 1;6:9.
5. Kisner C, Colby LA. Therapeutic Exercise: Foundations and Techniques [Internet]. F.A. Davis; 2007. (Therapeutic Exercise: Foundations and Techniques (Kisner) Series). Available from: https://books.google.co.in/books?id=phtnQgAACAAJ
6. Multani N, Singh A. Level of Physical Fitness among Physiotherapy Students a Study of Punjab and Haryana. 2013 Jan 1;21:1136–40.
7. Shetkar P, Retharekar S, Allen BK, Porcari JP. Are We Physiotherapists Really Fit ? 2019;8(5):1415–8.
8. Gorce P, Jacquier-Bret J. Global prevalence of musculoskeletal disorders among physiotherapists: a systematic review and meta-analysis. BMC Musculoskelet Disord [Internet]. 2023;24(1):265. Available from: https://doi.org/10.1186/s12891-023-06345-6
9. Johnson DL, Mair SD. Clinical Sports Medicine. Clinical Sports Medicine. 2006. 1–764 p.
10. Desai M, Jain S. Prevalence of Musculoskeletal Problems in Physiotherapy Students. 2020 Apr 1;10:59–64.
11. Dsouza S, Mathew A, Kumar D. Work Related Musculoskeletal Disorders in Physiotherapist; Prevalence and Associated Factors: A Review of Literature. Int J Heal Sci Res [Internet]. 2016;6(6):344. Available from: www.ijhsr.org
12. Alqhtani RS, Ahmed H, Ghulam HSH, Alyami AM, Hassan H, Sharyah A, et al. Efficacy of Core-Strengthening and Intensive Dynamic Back Exercises on Pain , Core Muscle Endurance , and Functional Disability in Patients with Chronic Non-Specific Low Back Pain : A Randomized Comparative Study. 2024;
13. Hlaing SS, Puntumetakul R, Khine EE, Boucaut R. Effects of core stabilization exercise and strengthening exercise on proprioception, balance, muscle thickness and pain related outcomes in patients with subacute nonspecific low back pain: a randomized controlled trial. BMC Musculoskelet Disord [Internet]. 2021;22(1):1–13. Available from: https://doi.org/10.1186/s12891-021-04858-6
14. S G, Dinakaran R. Effect of eight-week core stabilization program on core muscle endurance and function in female staff nurses. Natl J Physiol Pharm Pharmacol. 2017;8(5):1.
15. Firouzjah EMAN, Daneshmandi H, Norasteh AA. Effect of Core Stability Training on the Endurance and Strength of Core in Basketball Players with Trunk Dysfunction. J Rehabil Sci Res. 2020;7(2):80–6.
16. Zou CJ, Li JH, Wu FC, Li YZ, Pan HY, Wu T. The effects of core stability training in nurses with nonspecific low back pain. Med (United States). 2021;100(25):E26357.
17. Hung KC, Chung HW, Yu CCW, Lai HC, Sun FH. Effects of 8-week core training on core endurance and running economy. PLoS One. 2019;14(3):e0213158.
18. Moghadam SH, Ganji J. Evaluation of the nursing process utilization in a teaching hospital, Ogun State,

Nigeria. J Nurs Midwifery Sci. 2019;6(3):149–55.

19. Saeterbakken A. Muscle Activity, and the Association between Core Strength, Core Endurance and Core Stability. J Nov Physiother Phys Rehabil. 2015;(July):028–34.
20. Kellmann M. Preventing overtraining in athletes in high-intensity sports and stress/recovery monitoring. Scand J Med \& Sci Sport [Internet]. 2010;20(s2):95–102. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1600-0838.2010.01192.x
21. Santos MS, Behm DG, Barbado D, DeSantana JM, Da Silva-Grigoletto ME. Core Endurance Relationships With Athletic and Functional Performance in Inactive People. Front Physiol [Internet]. 2019;Volume 10. Available from: https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2019.01490
22. Tipton KD, Wolfe RR. Protein and amino acids for athletes. J Sports Sci [Internet]. 2004 Jan 1;22(1):65–79. Available from: https://doi.org/10.1080/0264041031000140554
23. SONNENTAG S, FRITZ C. Recovery from job stress. J Organ Behav [Internet]. 2015 Oct 12;36(S1):S72–103. Available from: https://www.jstor.org/stable/26610962
24. Enoka RM, Duchateau J. Translating Fatigue to Human Performance. Med Sci Sports Exerc. 2016 Nov;48(11):2228–38.
25. Proske U, Gandevia SC. The proprioceptive senses: Their roles in signaling body shape, body position and movement, and muscle force. Physiol Rev. 2012;92(4):1651–97.
26. Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis. Spine (Phila Pa 1976). 1996 Nov;21(22):2640–50.
27. Meeusen R, Duclos M, Foster C, Fry A, Gleeson M, Nieman D, et al. Prevention, diagnosis, and treatment of the overtraining syndrome: joint consensus statement of the European College of Sport Science and the American College of Sports Medicine. Med Sci Sports Exerc. 2013 Jan;45(1):186–205.
28. Hackney AC, Walz EA. Hormonal adaptation and the stress of exercise training: the role of glucocorticoids. Trends Sport Sci. 2013;20(4):165–71.
29. Fullagar HHK, Skorski S, Duffield R, Hammes D, Coutts AJ, Meyer T. Sleep and Athletic Performance: The Effects of Sleep Loss on Exercise Performance, and Physiological and Cognitive Responses to Exercise. Sport Med [Internet]. 2015;45(2):161–86. Available from: https://doi.org/10.1007/s40279-014-0260-0
30. Marcora SM, Staiano W, Manning V. Mental fatigue impairs physical performance in humans. J Appl Physiol. 2009 Mar;106(3):857–64.
31. Rhea MR, Alvar BA, Burkett LN, Ball SD. A meta-analysis to determine the dose response for strength development. Med Sci Sports Exerc. 2003 Mar;35(3):456–64.
32. Boutron I, Moher D, Altman DG, Schulz KF, Ravaud P. Extending the CONSORT statement to randomized trials of nonpharmacologic treatment: explanation and elaboration. Ann Intern Med. 2008 Feb;148(4):295–309.
33. Schulz KF, Altman DG, Moher D, Group the C. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. BMC Med [Internet]. 2010;8(1):18. Available from: https://doi.org/10.1186/1741-7015-8-18
34. Hackshaw A. Small studies: strengths and limitations. Eur Respir J [Internet]. 32(5):1141–3. Available from: http://erj.ersjournals.com/content/erj/32/5/1141.abstract
35. Hibbs AE, Thompson KG, French D, Wrigley A, Spears I. Optimizing performance by improving core stability and core strength. Sports Med. 2008;38(12):995–1008.
36. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Heal Care [Internet]. 2007;19(6):349–57. Available from: https://doi.org/10.1093/intqhc/mzm042

Acknowledgement
Would like to thank Dr. Ganesh Joshi sir for guiding through the initial process of the research. Also grateful to my colleague Mr. Sampanna Shelar for helping throughout this research.