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Relationship between Core Muscle Endurance and Shoulder Balance Using Upper Quadrant Y Balance Test: An Observational Study

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ABSTRACT

Objectives: To investigate the association between core muscle endurance and shoulder balance in young adults. **Design:** Cross-sectional observational study. **Setting:** University-based laboratory environment. **Participants:** A total of 200 participants (59.5% female, 40.5% male; mean age: 20.18 ± 1.4 years; mean BMI: 21.62 ± 3.9). All reported right-side limb dominance for weight-bearing, with a mean right limb length of 89.5 ± 4.2 cm. **Main Outcome Measures:** Core endurance assessed using the plank test, and shoulder balance evaluated through the Upper Quarter Y Balance Test in anterior, posterolateral, and posteromedial directions. **Results:** Core muscle endurance showed the strongest positive correlation with shoulder balance in the posterolateral direction ($r = 0.379$, $p < 0.05$). Moderate positive associations were also found in the anterior and posteromedial directions. **Conclusions:** Core muscle endurance is positively associated with upper quarter shoulder balance, particularly in the posterolateral direction. Enhancing core endurance may contribute to improved shoulder stability and reduced injury risk in both athletes and sedentary populations.

1.1 INTRODUCTION:

Core stability is the ability to control trunk movement over the pelvis and lower limbs, enabling efficient transfer of force through the kinetic chain.(Akuthota & Nadler, 2004) It relies on coordinated activation of muscles such as the transversus abdominis, obliques, erector spinae, multifidus, and diaphragm, which together provide postural support and intra-abdominal pressure.(Lynders, 2019; Oliva-Lozano & Muyor, 2020) Adequate core function is essential for mobility, stability, and injury prevention.(Huxel Bliven & Anderson, 2013)

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In athletic performance, core stability has been linked to improved upper limb function and reduced injury risk.(Jha et al., 2022; Rodríguez-Perea et al., 2023) Stronger trunk control facilitates efficient energy transfer between the trunk and shoulders, enhancing precision and power.(Jha et al., 2022; Leroux & Lagniaux, n.d.) Conversely, poor core endurance may lead to compensatory movement patterns, suboptimal performance, and increased susceptibility to musculoskeletal injuries.(Abdelraouf & Abdel-aziem, 2016) While the theoretical link between core stability and shoulder function is well recognized, existing evidence remains inconclusive, and core measures alone may not consistently predict upper-limb performance.(Mısırlıoğlu et al., 2018; Nuhmani, 2022; Pontillo et al., 2018; Silfies et al., 2015)

Despite growing emphasis on core endurance and shoulder stability in both sports training and rehabilitation, few studies have directly explored their association, particularly among sedentary athletes.(Dong et al., 2023; Marijančić et al., 2023; Santos et al., 2019; Zemková, 2022) Addressing this gap is clinically important for designing effective training and prevention strategies. Therefore, this study aimed to assess shoulder balance using the Upper Quarter Y Balance Test, evaluate core endurance with the plank test, and determine their relationship in sedentary athletes.

1.2 Methods:

This observational study was conducted in the XXX. Ethical approval was obtained from the Institutional Ethics Committee of XXX. Written informed consent was obtained from all participants prior to recruitment. Eligible participants were males and females aged 18–30 years. Individuals with upper or lower limb injuries (e.g., soft tissue or bone injuries), vascular disease, or infectious conditions were excluded.

1.2.1 Outcome Measures:

Primary outcome: Upper Quarter Y Balance Test (YBT-UQ) — This test assesses dynamic balance and injury risk by requiring participants to maintain support on one hand while reaching with the opposite hand in three directions: anterior, posteromedial, and posterolateral. The composite scores are expressed as a percentage of limb length. Reported reliability of the YBT-UQ is strong, with average composite scores of 81.7–82.3% for men and 80.7% for women, and a validity of 71%.

Secondary outcome: *Core muscle endurance (Plank Test)* — Core endurance was evaluated using the prone plank test. Participants were instructed to maintain a straight body line from head to toe, supported on elbows and toes, for as long as possible. Time was recorded in seconds using a stopwatch. The plank test demonstrates excellent reliability (ICC = 0.99; 95% CI: 0.98–0.99).

1.2.2 Procedure

Following informed consent, participants completed a demographic questionnaire and underwent anthropometric assessment. Height was measured using a portable stadiometer, and weight using a calibrated scale; body mass index (BMI) was calculated as weight (kg)/height (m^2). Upper limb length was measured from the acromion process to the third metacarpal.

The YBT-UQ was then administered. Participants began in a push-up position with feet shoulder-width apart and hands directly beneath the shoulders. With shoes removed, the right thumb was placed just behind and parallel to the starting line. Each participant reached maximally in the anterior, posteromedial, and posterolateral directions (Figures 1.1–1.3), with reach distances measured in centimeters at the furthest point reached by the fingertip. Three successful trials were recorded per direction for each arm. If a participant failed more than four times, a score of zero was assigned for that trial; up to six attempts were permitted per direction.

Figure_1 Upper Quarter Y Balance Test – *Anterior reach position*

Figure_2 Upper Quarter Y Balance Test – *Posteromedial reach position*

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Figure_3. Upper Quarter Y Balance Test – *Posterolateral reach position*

Core muscle endurance was measured using the plank test. Participants assumed a prone position with elbows and forearms on the ground, lifting the trunk and hips to maintain a straight alignment. Timing commenced once the correct position was achieved and ended when participants could no longer maintain a straight back or when the hips dropped.

1.2.3Data Analysis:

Descriptive statistics (mean and standard deviation) were calculated for baseline variables, including age, gender, height, weight, and BMI. All data were entered into Microsoft Excel and analyzed using SPSS software (version 21.0; IBM Corp., Armonk, NY, USA). To test the hypothesis regarding the relationship between core muscle endurance and shoulder balance, Pearson's correlation coefficient was applied. A significance level of $p < 0.05$ was considered statistically significant.

1.3 RESULTS:

A total of 200 participants were recruited. The sample consisted of 59.5% females and 40.5% males, with a mean age of 20.18 ± 1.4 years. The mean BMI was 20.83 ± 3.91, and the mean height was 163.62 ± 9.3 cm. All participants reported right-side limb dominance (Table 1).

Upper limb length measurements showed a mean of 72.48 ± 4.47 cm on the right and 71.61 ± 4.54 cm on the left, with no statistically significant differences between sides. Performance on the Upper Quarter Y Balance Test (YBT-UQ) demonstrated the highest reach in the posterolateral direction on both right (83.14 ± 11.32 cm) and left (82.67 ± 10.71 cm) sides (Table 1).

Table 1. Descriptive statistics of participant characteristics and outcome measures

Parameter	Mean ± SD (n- 200)	Notes / % Distribution
Demographic variables		
Age (years)	20.18 ± 1.40	—
Gender	—	Male: 40.5% Female: 59.5%
Preferred weight-bearing limb	—	Right: 100%
Height (cm)	163.62 ± 9.30	—
BMI (kg/m²)	20.83 ± 3.91	—
Right limb length (cm)	72.48 ± 4.47	—
Left limb length (cm)	71.61 ± 4.54	—
Upper Quarter Y Balance Test (cm)		
Anterior (Right)	49.33 ± 11.72	—
Anterior (Left)	47.85 ± 11.89	—
Posteromedial (Right)	56.45 ± 10.99	—
Posteromedial (Left)	54.85 ± 11.05	—
Posterolateral (Right)	83.14 ± 11.32	—
Posterolateral (Left)	82.67 ± 10.71	—
Core muscle endurance		
Prone plank (sec)	41.36 ± 23.90	—

Sl. No.	**Parameter**	**Mean**	**Standard Deviation**
1	Age (years)	20.18	1.4
2	Gender	Male: 40.5% Female: 59.5%	—
3	Preferred weight-bearing limb	Right: 100%	—

Footnotes:

1. Values are presented as *mean ± standard deviation (SD)* unless otherwise specified.
2. Gender and limb dominance are presented as percentages.
3. BMI = Body Mass Index; calculated as weight (kg) ÷ height (m²).
4. Y Balance Test values represent maximum reach distance in each direction, expressed in centimetres.
5. Core muscle endurance was assessed using the prone plank test, measured in seconds.

Core muscle endurance, assessed using the plank test, had a mean hold time of 41.36 ± 23.90 seconds (Table 1). Correlation analysis revealed a positive association between core endurance and YBT-UQ performance in all directions (Table 2). The strongest correlation was observed for the posteromedial left reach ($r = 0.379$, $p < 0.01$), followed by anterior left ($r = 0.344$, $p < 0.01$) and posteromedial right ($r = 0.332$, $p < 0.01$). Moderate correlations were found for anterior right ($r = 0.306$, $p < 0.01$), posterolateral left ($r = 0.245$, $p < 0.01$), and posterolateral right ($r = 0.217$, $p < 0.01$).

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Table 2. Correlation analysis of core muscle endurance and Upper Quarter Y Balance Test performance

Parameter	Anterior Left	Anterior Right	Posterolateral Right	Posterolateral Left	Posteromedial Right	Posteromedial Left
Pearson correlation	0.344**	0.306**	0.217**	0.245**	0.332**	0.379**
Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000
N	200	200	200	200	200	200

Footnotes:
1. Correlation assessed using Pearson's correlation coefficient.
2. Correlation is significant at the 0.01 level (2-tailed).
3. *Correlation is significant at the 0.05 level (2-tailed).*
4. N = number of participants.

1.4 DISCUSSION:

This study examined the relationship between core muscle endurance and shoulder balance in sedentary athletes using the Upper Quarter Y Balance Test (YBT-UQ) and the plank test. The results demonstrated a positive association between core endurance and shoulder balance across all test directions, with the strongest correlation observed in the posteromedial and anterior reaches. These findings suggest that trunk stability contributes meaningfully to upper limb control, even in non-athletic populations.

Our results are consistent with previous studies reporting that optimal core stability enhances upper limb performance and reduces injury risk(Kibler et al., 2006; Nuhmani, 2022) The posteromedial and anterior directions are particularly demanding in terms of trunk stabilization and shoulder control, which may explain the stronger correlations observed in these directions. This reinforces the concept that the core serves as a kinetic link, facilitating efficient force transfer between the trunk and upper extremities.

While prior work in professional athletes has shown mixed evidence regarding the predictive value of core endurance for upper limb function (Silfies et al., 2015), our findings highlight that even in sedentary athletes, improved core endurance is associated with enhanced shoulder balance. This expands the clinical relevance of core training beyond elite performance, suggesting potential benefits for injury prevention and rehabilitation in less active populations as well.

The implications for physiotherapy practice are notable. Incorporating core endurance training alongside traditional shoulder rehabilitation or preventive programs may help reduce the risk of musculoskeletal injuries, particularly in populations prone to poor postural control and sedentary lifestyles. Furthermore, the YBT-UQ, being simple and reliable, may serve as a useful clinical tool for screening upper quarter balance deficits and monitoring progress during training or rehabilitation. This study is not without limitations. The cross-sectional design restricts causal inferences, and the sample was limited to young sedentary athletes, which may limit generalizability. Future longitudinal studies should explore whether targeted core strengthening directly improves upper limb function and reduces injury incidence across different populations, including competitive athletes and older adults.

Core muscle endurance demonstrated a positive association with upper quarter shoulder balance across all directions of the YBT-UQ, with the strongest relationship observed in the posteromedial reach. These findings underscore the importance of integrating core endurance training into preventive and rehabilitative strategies for shoulder function. For the physiotherapy community, this study highlights that even in sedentary athletes, strengthening the core may improve upper limb balance and reduce injury risk, offering practical implications for clinical care, sports training, and community health promotion.

1.5 Funding Statement:

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1.6 Declaration of Interest Statement:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

1.7 Ethical Statement:

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of Sri Devaraj Urs Medical College, Sri Devaraj Urs Academy of Higher Education and Research (Approval No. DMC/KLR/IEC/69/2022-23, dated 06/05/2022). Written informed consent was obtained from all participants prior to inclusion in the study.

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