The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 10, 2025

VMO STRENGTH IN WOMEN WITH AND WITHOUT KNEE OSTEOARTHRITIS

Dr. M. Hassan Waseem PT[*1], Dr. Haris Raza PT[2], Dr. Zara Abbasi PT[3], Dr. Shifa Abbasi PT[4], Dr. Nisha PT[5]

[*1]*Assistant Professor of Physiotherapy Iqra University, North Campus, Karachi*
[2]*Incharge Physiotherapist Dua physiotherapy and chiropractic clinic, Hyderabad*
[3]*Vice Principal Simrah Institute of Medical & Health Sciences*
[4]*Physiotherapist, IPRS Liaquat University of Medical & Health Sciences*
[5]*HOD Health Sciences DIHE, Karachi, Pakistan*

[*1]hassan.waseem@iqra.edu.pk, [2]harisraza504@gmail.com, [3]zaraabbasi83@gmail.com, [4]shifa.abbasi21@gmail.com, [5]nisha.lohana@yahoo.com

DOI: https://doi.org/10.5281/zenodo.17615203

Keywords
Knee osteoarthritis, Vastus medialis oblique, muscle weakness, manual muscle testing, rehabilitation

Article History
Received: 21September 2025
Accepted: 31 October 2025
Published: 04 November 2025

Copyright @Author
Corresponding Author: *
Dr. M. Hassan Waseem PT

Abstract

Background: *Knee osteoarthritis (OA) is a leading cause of disability, particularly affecting women over 50 years. . Weakness of the VMO has been implicated in the development and progression of knee disorders, yet its specific relationship with osteoarthritis remains under-explored.*

Objective: *To assess and compare VMO strength in females with and without knee osteoarthritis, establishing the association between VMO weakness and OA presence.*

Methods: *A cross-sectional observational study was conducted involving 112 female participants aged 40 years or older: 56 with clinically diagnosed knee osteoarthritis and 56 healthy controls. Data were analyzed using SPSS version 16, employing frequencies, cross-tabulation, and chi-square tests with significance set at $p<0.05$.*

Results: *Participants with osteoarthritis predominantly exhibited Grade 3 Fair+ VMO strength (42.9% of the OA group), while healthy controls most commonly demonstrated Grade 4 Good strength (44.6% of the control group). No osteoarthritic participants achieved Grades 4+ or 5. Chi-square analysis revealed a highly significant association between reduced VMO strength and osteoarthritis (χ^2 105.286, $p<0.001$).*

Conclusion: *VMO weakness is significantly associated with knee osteoarthritis in women above 40 years. These findings support the implementation of VMO-specific assessment and targeted strengthening protocols in both preventive and therapeutic approaches to knee osteoarthritis management.*

INTRODUCTION

Osteoarthritis (OA) represents one of the most prevalent degenerative joint diseases worldwide, characterized by progressive destruction of articular cartilage, subchondral bone changes, osteophyte formation, and resultant joint space narrowing (1,2,3). The knee joint, due to its complex biomechanical demands and weight-bearing function, is particularly susceptible to osteoarthritic changes. Epidemiological data indicate that knee OA affects approximately 10% of men and 13% of women over 60 years of age, with women showing disproportionately higher prevalence after menopause. (3,20).

The etiology of knee OA is multifactorial, involving both non-modifiable risk factors (age, gender, genetics)

and modifiable factors (obesity, trauma, occupational demands, and muscle strength) (6,20,21). Recent research has increasingly focused on the role of muscular factors, particularly quadriceps weakness, in both the initiation and progression of knee OA (7,9,10). Among the quadriceps muscle group, the vastus medialis oblique VMO) holds unique anatomical and functional significance.

The VMO originates from the adductor magnus tendon and medial intermuscular septum, with its distinctive oblique fiber orientation making it the primary dynamic medial stabilizer of the patella (13-17). This muscle is crucial for maintaining proper patellar tracking during knee extension and preventing excessive lateral patellar displacement (14,15,17). The VMO's role extends beyond simple force generation; it provides essential medial stability that counteracts the natural lateral pull of the vastus lateralis, ensuring optimal patellofemoral joint mechanics (14,16).

Dysfunction or selective atrophy of the VMO can disrupt the delicate balance of patellar forces, leading to abnormal tracking patterns, increased joint stress, pain, and accelerated cartilage degeneration (14,17,25). Despite this critical function, the VMO's specific relationship with knee OA has received limited attention in clinical research and practice. Most assessments and interventions target the quadriceps as a whole rather than addressing the VMO's unique contribution to knee stability (7,14). The concept of VMO weakness as a contributing factor to knee disorders is supported by several biomechanical studies demonstrating that patients with various knee pathologies consistently show preferential VMO atrophy and delayed activation patterns (13,16). This selective weakness can initiate a cascade of biomechanical alterations that may predispose individuals to or exacerbate existing osteoarthritic changes. Current rehabilitation approaches for knee OA often emphasize general quadriceps strengthening without specific attention to VMO activation and strengthening (18).

This gap in targeted intervention may explain the persistent symptoms and functional limitations observed in many patients following conventional rehabilitation programs. Understanding the specific relationship between VMO strength and knee OA could inform more effective, targeted therapeutic strategies. This study aims to objectively assess VMO strength in females with and without knee osteoarthritis, quantify the association between VMO weakness and disease presence, and provide evidence to support the integration of VMO-specific assessment and interventions in clinical practice.

METHODS:

Study Design and Setting

A cross-sectional observational study was conducted from September to November 2016 across multiple healthcare facilities, including the Institute of Physiotherapy and Rehabilitation Sciences IPRS) at Liaquat University of Medical and Health Sciences LUMHS, the Orthopedic Ward at LUMHS, ISRA University Hyderabad, and several private orthopedic and physiotherapy clinics.

Participants

The study included 112 female participants aged above 40 years, comprising two groups: 56 participants with clinically diagnosed knee osteoarthritis (meeting American College of Rheumatology criteria) and 56 age-matched healthy controls without knee complaints. The age criterion was selected as osteoarthritis prevalence increases significantly after age 40, particularly in women.

Inclusion Criteria:

Female gender
Age above 40 years
Clinical diagnosis of knee osteoarthritis OA group) or absence of knee problems (control group)
Ability to perform the straight leg raise maneuver.

Exclusion Criteria:

- Male gender
- Age below 40 years
- History of knee trauma or surgery • Inflammatory joint diseases

Neurological disorders affecting lower extremities • Other chronic musculoskeletal conditions

VMO Strength Assessment:

VMO strength was evaluated using manual muscle testing MMT) following standardized protocols. Participants were positioned either supine or sitting and asked to perform straight leg raises with external hip rotation and foot inversion - a position specifically designed to isolate and preferentially activate the VMO (14,27).

The assessment was performed by trained physiotherapists using the Medical Research Council MRC) grading scale:

- Grade 5 Normal Maintains position against maximum resistance
- Grade 4 Good+ Maintains position against moderate to strong resistance
- Grade 4 Good Maintains position against moderate resistance
- Grade 4 Good- Maintains position against slight to moderate resistance
- Grade 3 Fair+ Maintains position against slight resistance
- Grade 3 Fair Maintains position against gravity only
- Grade 3 Fair- Gradual release from test position
- Grade 2 Poor+ Partial range of motion against gravity
- Grade 2 Poor Full range of motion with gravity eliminated
- Grades 1 and below: Minimal or no voluntary contraction

Data Analysis

Data were entered and analyzed using SPSS version 16.0. Descriptive statistics included frequencies and percentages for categorical variables. Cross-tabulation was performed to examine the relationship between disease status and VMO strength grades. Chi-square test was applied to determine statistical significance of the association, with significance level set at $p<0.05$.

RESULTS:

A total of 112 female participants were enrolled in the study. The mean age of the osteoarthritic group was 55.8 7.1 years, while the control group had a mean age of 54.2 6.8 years, with no statistically significant difference between groups.

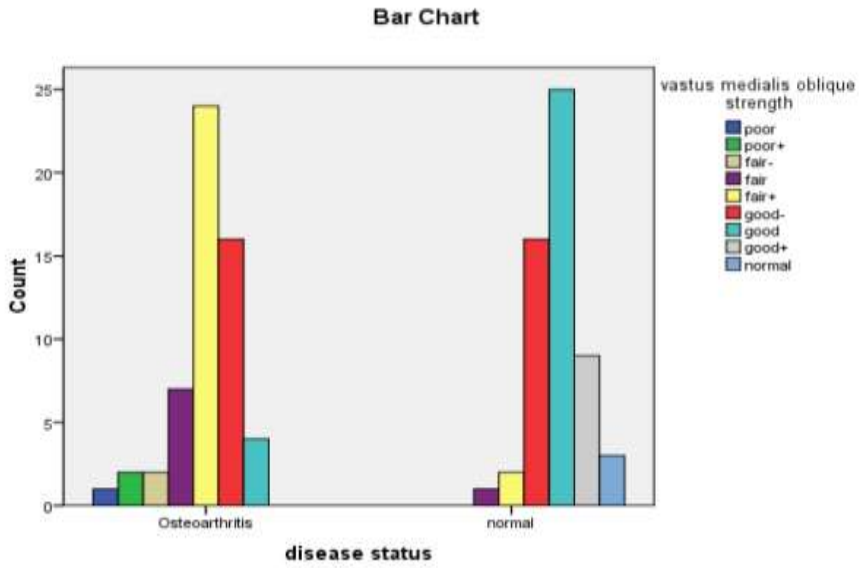


Figure 1. Bar chart of normal and osteoarthritic participants according to VMO muscle grading.

VMO Strength Distribution

Osteoarthritic Group (n=56):

The distribution of VMO strength grades in participants with knee osteoarthritis revealed a predominance of lower strength grades:

- Grade 2 Poor 1 participant 1.8%
- Grade 2 Poor+ 2 participants 3.6%
- Grade 3 Fair- 2 participants 3.6%
- Grade 3 Fair 7 participants 12.5%
- Grade 3 Fair+ 24 participants 42.9% - *most frequent grade*
- Grade 4 Good- 16 participants 28.6%

- Grade 4 Good 4 participants 7.1%
- Grade 4 Good + 0 participants 0%
- Grade 5 Normal 0 participants 0%

Control Group (n=56):

The healthy control participants demonstrated significantly higher VMO strength grades:

- Grade 3 Fair 1 participant 1.8%
- Grade 3 Fair + 2 participants 3.6%
- Grade 4 Good- 16 participants 28.6%
- Grade 4 Good 25 participants 44.6% *- most frequent grade*
- Grade 4 Good + 9 participants 16.1%
- Grade 5 Normal 3 participants 5.4%

Statistical Analysis

Cross-tabulation analysis revealed distinct differences in VMO strength distribution between the two groups. The chi-square test yielded highly significant results:

- **Chi-square value:** 105.286
- **Degrees of freedom:** 8
- **p-value:** 0.001

The results demonstrate a statistically significant association between knee osteoarthritis and reduced VMO strength. Participants with osteoarthritis were significantly more likely to exhibit lower VMO strength grades

Grade 3+ and below), while healthy controls predominantly demonstrated higher strength grades Grade 4 and above).

Chi-square test

	Disease status	Vastus medialis oblique strength
Chi-Square	.000[a]	105.286[b]
Df	1	8
Asymptotic Significance	1.000	.000

Conclusion of chi-square test: This data is significant as the p-value is 0.00, because when the p-value is less than 0.05, the data is significant.

Key Findings

- No osteoarthritic participant achieved Grade 4+ or 5 strength
- Over 60% of osteoarthritic participants had Grade 3+ or lower strength
- Over 65% of control participants had Grade 4 or higher strength
- The association between VMO weakness and osteoarthritis was highly significant ($p<0.001$)

DISCUSSION:

The findings of this study provide compelling evidence for a significant association between vastus medialis oblique VMO) weakness and knee osteoarthritis in women above 40 years of age. These results support the growing body of literature emphasizing the critical role of specific muscle groups, particularly the VMO, in the pathophysiology and progression of knee osteoarthritis (7,13,14,16,17).

The predominance of Grade 3 Fair+ strength in the osteoarthritic group, compared to Grade 4 Good strength in healthy controls, underscores the clinical relevance of VMO assessment in knee OA evaluation. The complete absence of participants with Grade 4+ or 5 strengths in the osteoarthritic group is particularly noteworthy, suggesting that significant VMO weakness may be a universal feature of knee OA in this population. The VMO's role as the primary medial dynamic stabilizer of the patella makes its weakness particularly consequential for knee joint health (14,15,17). When the VMO is weak, the natural lateral pull of the vastus lateralis becomes unopposed, leading to patellar maltracking, increased patellofemoral joint stress, and accelerated cartilage degradation (14,16,25). This biomechanical disruption can initiate or exacerbate the osteoarthritic process, creating a cycle of progressive joint deterioration.

The relationship between VMO weakness and knee OA likely represents both a cause and a consequence of the disease process. Initially, VMO weakness may predispose individuals to abnormal knee mechanics and increased joint stress, contributing to the initiation of osteoarthritic changes. As the disease progresses, pain, swelling, and joint dysfunction can further compromise muscle function through several mechanisms, including arthrogenic muscle inhibition, disuse atrophy, and altered movement patterns (5,21,22). This creates a "vicious cycle" where VMO weakness contributes to joint degeneration, which in turn leads to further muscle weakness and functional decline (5). Breaking this cycle requires targeted interventions that address both the underlying muscle weakness and the biomechanical consequences of that weakness.

Current rehabilitation approaches for knee OA often emphasize general quadriceps strengthening without specific attention to VMO activation and recruitment (7,14). The findings of this study suggest that such approaches may be insufficient, as they may not adequately address the specific deficits in VMO function that appear to be characteristic of knee OA. VMO-specific strengthening exercises, such as straight leg raises with external hip rotation, terminal knee extension with medial glide, and closed-chain exercises with emphasis on medial quadriceps activation, may be more effective in addressing the underlying biomechanical deficits associated with knee OA (17,18,27). These exercises are designed to preferentially recruit the VMO and restore the balance between medial and lateral patellar forces.

The significant association between VMO weakness and knee OA identified in this study supports the inclusion of specific VMO assessment in routine clinical evaluation of patients with knee complaints. Manual muscle testing, while having inherent limitations in terms of objectivity and sensitivity, provides a practical and accessible means of identifying VMO weakness in clinical settings. Healthcare providers should consider incorporating VMO assessment into their standard examination protocols for patients with knee pain or suspected osteoarthritis. Early identification of VMO weakness may allow for timely intervention that could potentially slow or prevent the progression of osteoarthritic changes.

Several limitations should be acknowledged in interpreting these results. The study population was limited to women, which may limit the generalizability of findings to men with knee OA. Manual muscle testing, while clinically relevant, is somewhat subjective and may not detect subtle strength differences that might be identified through more sophisticated testing methods such as isokinetic dynamometry or electromyographic analysis.

The cross-sectional design of the study precludes the determination of causality; it cannot be definitively established whether VMO weakness precedes the development of OA or results from it. Longitudinal studies would be needed to clarify the temporal relationship between VMO weakness and OA development. Additionally, the study did not control for other potential confounding factors such as activity level, body mass index, or duration of symptoms, which could influence both VMO strength and OA severity.

Future Research Directions

Future research should explore the relationship between VMO strength and knee OA in more diverse populations, including men and different age groups. Longitudinal studies are needed to determine whether VMO weakness precedes OA development or results from it. Investigation of the effectiveness of VMO-specific strengthening interventions in preventing or slowing OA progression would be particularly valuable.

More sophisticated assessment methods, including electromyographic analysis and imaging studies, could provide deeper insights into the specific patterns of VMO dysfunction in knee OA. Additionally, research into the optimal exercise protocols for VMO strengthening in individuals with varying degrees of knee OA would inform evidence-based clinical practice.

CONCLUSION:

This study demonstrates a strong and statistically significant association between vastus medialis oblique VMO) weakness and knee osteoarthritis in women above 40 years of age. The findings reveal that women with knee OA consistently exhibit weaker VMO strength compared to healthy controls, with the majority of osteoarthritic participants showing Grade 3 Fair+ strength or below, while healthy participants

predominantly demonstrated Grade 4 Good strength or better.

These results highlight the critical importance of VMO function in knee joint health and suggest that VMO weakness may play a significant role in the development and progression of knee osteoarthritis. The complete absence of participants with normal or good+ VMO strength in the osteoarthritic group underscores the clinical relevance of this muscle group in knee pathology.

REFERENCES:

Hoeltzel DA, et al. Automedica Vol. 10, p. 201. New York: Gordon and Breach Science; 1989.

Bhatia D, Bejarano T, Novo M. Current interventions in the management of knee osteoarthritis.

J Pharm Bioallied Sci. 2013;5 1 .

Woolf A, Pfleger B. Burden of major musculoskeletal conditions. Bull World Health Organ.

2004;81 9 646 56.

Mukta S, Akther S. Outcome of Physiotherapy management for osteoarthritis of knee joint: A retrospective survey. Bangladesh Health Professions Institute, CRP. 2012.

Shukla DM, Sarkar DA, Bansal DN, Sharma MR. Effectiveness of different quadriceps strengthening protocols in knee osteoarthritis. Int J Drug Dev Res. 2016.

Felson DT, Lawrence RC. Osteoarthritis: New insights. Part 1 The disease and its risk factors.

Ann Intern Med. 2000;133 8 635 46.

Alnahdi AH, Zeni JA, Snyder-Mackler L. Muscle Impairments in patients with knee osteoarthritis. Sports Health. 2012;4 4 .

Glass NA, Law LAF, Segal NA. The relationship between quadriceps muscle weakness and worsening of knee pain in the MOST cohort: A 5-year longitudinal study. Osteoarthritis Cartilage. 2013;21 9 .

Anwer S, Alghadir A. Effect of isometric quadriceps exercise on muscle strength, pain, and function in patients with knee osteoarthritis: A randomized controlled study. J Phys Ther Sci. 2014;26 5 .

Amin S, Baker K, Niu J, Clancy M, Felson D. Quadriceps strength and the risk of cartilage loss and symptom progression in knee osteoarthritis. Arthritis Rheum. 2009;60 1 189 98.

Unver B, Kalkan S, Yuksel E. Reliability of the 50-foot walk test and 30-sec chair stand test in total knee arthroplasty. Acta Ortop. 2015;23 184 7.

Segal NA, Glass NA, Nevitt M, Torner JC. The effect of quadriceps strength and proprioception on risk for knee osteoarthritis. Med Sci Sports Exerc. 2011;42 11 2081 8.

Livecchi N, Armstrong C, Cordova M. Vastus lateralis and vastus medialis obliquus activity during a straight-leg raise and knee extension with lateral hip rotation. J Sport Rehabilitation 2002;11 2 120 6.

Bhatt A, Khan MH. Preferential vastus medialis oblique activation and its effectiveness in patellofemoral pain syndrome: A review of literature—An update. Saudi J Sports Med.

2015;15 2 117.

Nozic M, Mitchell J, de Klerk D. A comparison of the proximal and distal parts of the vastus medialis muscle. Aust J Physiother. 1997;43 4 277 81.

Engelina S, Antonios T, Robertson C, Killingback A, Adds P. Ultrasound investigation of vastus medialis oblique muscle architecture: An in vivo study. Clin Anat. 2014;27 7 1076 84.

Hyong IH, Kang JH. Activities of the vastus lateralis and vastus medialis oblique muscles during squats on different surfaces. J Phys Ther Sci. 2013;25 8 915 7.

Christou E. Patellar taping increases vastus medialis oblique activity in the presence of patellofemoral pain. J Electromyogr Kinesiol. 2004;14 4 495 504.

Kang JY, Kim TG, Kim KY. The effects of closed kinetic chain exercise using EMG biofeedback on PFPS patients' pain and muscle functions. Int J Bio-Sci Bio-Technol. 2014;6 3 55 62.

Zhang Y, Jordan JM. Epidemiology of osteoarthritis. Clin Geriatr Med. 2011;26 3 355 69.

Heidari B. Knee osteoarthritis prevalence, risk factors, pathogenesis and features: Part I. Caspian J Intern Med. 2011;2 2 205 12.

Tonge DP, Bardsley RG, Parr T, Maciewicz RA, Jones SW. Evidence of changes to skeletal muscle contractile properties during the initiation of disease in the ageing guinea pig model of osteoarthritis. Longev Healthspan. 2013;2 15.

Hinman RS, Crossley KM. Patellofemoral joint osteoarthritis: an important subgroup of knee

osteoarthritis. Rheumatology Oxford . 2007;46 7 1057 62.

Juneau C, Paine R, Chicas E, Gardner E, Bailey L, McDermott J. Current concepts in treatment of patellofemoral osteochondritis dissecans. Int J Sports Phys Ther. 2016;11 6 903 25.

Elias JJ, Kilambi S, Goerke DR, Cosgarea AJ. Improving vastus medialis obliquus function reduces pressure applied to lateral patellofemoral cartilage. J Orthop Res. 2009;27 5 578 83.

Srikanth V, Fryer J, Zhai G, Winzenberg T, Hosmer D, Jones G. A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. Osteoarthritis Cartilage. 2005;13 9 769 81.

Mikesky AE, Meyer A, Thompson KL. Relationship between quadriceps strength and rate of loading during gait in women. J Orthop Res. 2000;18 2 171