https://doi.org/10.35845/kmuj.2026.23559

ORIGINAL ARTICLE

Impact of Diabetes Mellitus on knee pain and quality of life among patients with knee osteoarthritis: a cross-sectional study

Muhammad Sabir [1], Muhammad Waqas Ghauri [1], Mahad Saleem [1], Shabana Rahim [1], Muhammad Aamir [1], Ali Akbar [1]

1: Department of Physical Therapy, Agile Institute of Rehabilitation Sciences Bahawalpur, Bahawalpur, Pakistan

Email ✉ : ghauri12345@gmail.com
Contact #: +92-334-0642093

Date Submitted: December 19, 2023
Date Revised: February 21, 2026
Date Accepted: February 22, 2026

ABSTRACT

Objective: To examine the association between diabetes mellitus (DM) and knee pain severity, as well as health-related quality of life (HRQoL), in adults with knee osteoarthritis (KOA).

Methods: This cross-sectional study was conducted from December 2022 to March 2023 at three healthcare centers in Bahawalpur, Pakistan. A total of 360 patients aged 4580 years diagnosed with KOA, with or without DM, were recruited through convenience sampling. Knee pain intensity was assessed using the Visual Analogue Scale, and HRQoL was evaluated using the Short Form-36 questionnaire. Demographic and clinical data were collected through structured questionnaires. Chi-square tests were applied to examine associations, with statistical significance set at $p < 0.05$.

Results: Among the 360 participants, 215 (59.7%) were females. Most participants were aged 4554 years (38.9%), followed by 5564 years (33.6%), 6574 years (19.7%), and 7580 years (7.8%). Socioeconomic status was predominantly middle-class (159, 44.2%). Knee pain intensity was moderate in 176 (48.9%) participants and severe in 139 (38.6%). Diabetes mellitus was present in 198 (55.0%) participants. HRQoL was reported as severe in 137 (38.0%) and very severe in 36 (10.0%) participants. Chi-square analysis showed a significant association between knee pain intensity and HRQoL ($\chi^2=366.14$, $p=0.001$), while the association between diabetes and HRQoL was not statistically significant ($\chi^2=5.040$, $p=0.283$).

Conclusion: Diabetes mellitus was not significantly associated with knee pain severity or HRQoL in patients with KOA. However, increasing pain severity was strongly linked to worsening HRQoL, highlighting the importance of effective pain management in improving patient outcomes.

Keywords: Diabetes Mellitus (MeSH); Osteoarthritis, Knee (MeSH); Knee Pain (MeSH); Patellofemoral Pain Syndrome (MeSH); Quality of Life (MeSH); SF-36 (Non-MeSH); Visual Analogue Scale (MeSH); Pain (MeSH); Pain Measurement (MeSH); Pain Management (MeSH).

THIS ARTICLE MAY BE CITED AS: Sabir M, Ghuari MW, Saleem M, Rahim S, Aamir M, Akbar A. Impact of Diabetes Mellitus on knee pain and quality of life among patients with knee osteoarthritis: a cross-sectional study. Khyber Med Univ J 2026;18(1):61-6. https://doi.org/10.35845/kmuj.2026.23559

INTRODUCTION

Knee osteoarthritis (KOA) is one of the most widespread health problems across the world, and the condition is noted to be a major cause of chronic pain and limited functionality, especially among the elderly.[1] It is highly prevalent globally with projections showing hundreds of millions of people are affected by it around the world.[2] Indicatively, an in-depth examination of KOA epidemiology based on the data provided by the 2021 Global Burden of Disease Study (GBD) showed that the burden represented by the organism is substantial between 1990 and 2021, whereas it is predicted to rise further by 2035.[1] A second study 1990-2019 also reported the prevalence of KOA in the various regions and countries.[3] This is a degenerative joint disease that greatly affects the quality of life (QoL) and daily physical activity of the patient.[4] Osteoarthritis (OA) pathogenesis is considered to be a complicated mechanism of mechanical damage, biological degradation, and inflammation in the whole organ of the joint, cartilage, bone, and synovium.[2] KOA pain is not primary in the aneural cartilage but occurs in the tissues surrounding and innervated by the cartilage, including the inflamed synovium and the pathologically remodeled subchondral bone. The functional limitation and dependence depend on the severity of knee pain, which has a direct impact on the QoL.[4]

At the same time, one of the most widespread comorbidities is diabetes mellitus (DM), particularly type 2 diabetes (T2D), often co-occurring with KOA and having common pathophysiological processes.[2,5] These common pathways are low-grade systemic inflammation, oxidative stress, advanced glycation end-products (AGEs) accretion, and aberrant adipokine signaling.[2] The epidemiological studies have always shown that the prevalence and severity of KOA among patients with DM is higher than it is among non-diabetes patients.[6] In addition, diabetes has been also associated with increased rate of cartilage degeneration and reduced response to conservative therapies in patients with OA.[2] The KOA and DM combination are linked to poorer symptoms, diminished physical performance, lower levels of physical activity, and a much poor QoL.[7,8] Certain studies have been conducted on the relationship between DM and the severity of knee pain, and pain distribution in people with KOA.[9] An example is a cross sectional study that established that DM was linked to more

osteoarthritic knee pain, which was not affected by possible confounding factors such as adiposity or even disease status.[9] More than that, DM has been demonstrated to influence physical activity in KOA patients, which leads to a loop of decreased mobility and the deterioration of health conditions.[7] Knee functional scores and glycemic control have improved in T2D patients using interventions like continuous care with carbohydrate restriction.[10]

Although the coexistence of diabetes mellitus and KOA is well recognized, important gaps remain in understanding their interaction. While comorbidity between the two conditions is established, the independent contribution of diabetes to knee pain severity and specific domains of QoL has not been adequately quantified, particularly across diverse populations and in relation to confounding factors such as age, body mass index, and radiographic severity.[5] Moreover, many previous studies have relied on generic QoL instruments that may not sufficiently capture knee-specific functional impairment and associated psychosocial consequences. The influence of glycemic control, duration of diabetes, and diabetes-related complications on symptom burden in KOA also remains insufficiently explored, limiting the development of integrated musculoskeletal and metabolic management strategies.

To address these gaps, the present study was conducted to investigate the association between diabetes status and knee pain severity, as well as knee-related QoL, among adults with KOA. It was also designed to examine whether glycemic parameters and diabetes-related complications independently influenced these outcomes. By clarifying these relationships, the study sought to generate evidence to support comprehensive clinical management and improve patient-centered outcomes in individuals with KOA and diabetes.

METHODS

Ethical approval for the study was obtained from the Institutional Research Committee of Agile Institute of Rehabilitation Sciences Bahawalpur (Reference #: AIRS/IRC/17-07, dated: December 19, 2022). A cross-sectional study design was employed, and data were collected over four months (December 2022 to March 2023) from Bahawal Victoria Hospital, Nawab Sir Sadiq Muhammad Khan Abbasi Hospital, and Agile Physical Therapy and Rehabilitation Center, Bahawalpur. Eligible participants were informed about the study objectives and procedures, and written informed consent was obtained prior to enrollment. A convenience sampling technique was adopted due to feasibility considerations, including the limited study duration and high patient turnover in outpatient departments. The sample size of 360 participants was determined using the Raosoft sample size calculator.[11]

Both male and female patients aged 45-80 years diagnosed with knee osteoarthritis of any grade, with or without diabetes mellitus, were included in the study. Patients with systemic inflammatory or metabolic conditions such as rheumatoid arthritis, psoriatic arthritis, multiple myeloma, or osteoporosis, those with a history of recent knee injury or trauma, and individuals who had received intra-articular knee injections within the previous six months were excluded. Demographic data, including name, gender, marital status, and socio-economic status, were collected using a structured questionnaire completed by the participants. Knee pain intensity was assessed using the Visual Analogue Scale (VAS), which is widely used to assess pain severity, monitor changes in pain over time, and compare pain levels under similar conditions. The VAS has been extensively utilized in cancer-related pain, chronic pain, and rheumatic diseases.[12] Participants were asked to indicate the numerical value on the segmented scale that best represented the intensity of their knee pain. Previous studies have demonstrated good test-retest reliability of the VAS, with higher reliability observed among literate patients ($r=0.94$, $p=0.001$) compared to illiterate patients ($r=0.71$, $p=0.001$).[13] Health-related quality of life (HRQoL) was assessed using the Short Form-36 (SF-36) questionnaire, which comprises 36 items divided into eight domains: general health, limitation of activities, physical health problems, emotional health problems, social activities, pain, energy, and emotional well-being. These domains contribute to the Physical Component Summary and Mental Component Summary scores, allowing comprehensive assessment while reducing the number of required measurements.[14] The SF-36 que-stionnaire has demonstrated acceptable internal consistency, with a reported Cronbach's alpha coefficient of 0.791.[15] All collected data were coded, entered, and analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0. Descriptive statistics were used to summarize demographic and clinical characteristics, and the chi-square test was applied to examine associations between diabetes mellitus, knee pain intensity, and quality-of-life variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The univariate analysis of demographic and health-related variables of the study participants is presented in Table I. A total of 360 patients with knee osteoarthritis were included in the analysis.

As shown in Table I, females constituted most of the study population (n=215, 59.7%), while males accounted for 145 (40.3%) participants. The largest proportion of patients belonged to the 45-54 years age group (n=140, 38.9%). Regarding socioeconomic status, most participants were from the middle class (n=159, 44.2%). Assessment of knee pain intensity using the VAS revealed that nearly half of the participants reported moderate pain (n=176, 48.9%), while a substantial proportion experienced severe pain (n=139, 38.6%). Systemic evaluation showed that more than half of the participants were diabetic (n=198, 55.0%). Evaluation of HRQoL indicated that severe impairment was reported by 137 (38.0%) participants, whereas varying degrees of impairment were observed in the remaining population.

As shown in Table II, the association between QoL changes and diabetes

Table I: Univariate analysis of demographic and health-related variables (n=360)

Variables	Category	Frequency (%)
Gender	Male	145 (40.3)
	Female	215 (59.7)
Age (years)	45-54	140 (38.9)
	55-64	121 (33.6)
	65-74	71 (19.7)
	75-85	28 (7.8)
Socioeconomic status	Upper class	95 (26.4)
	Middle class	159 (44.2)
	Lower class	106 (29.4)
Visual analogue scale for Knee pain	No pain	4 (1.1)
	Mild pain	34 (9.4)
	Moderate pain	176 (48.9)
	Severe pain	139 (38.6)
	Worst pain	7 (1.9)
Systemic condition	Diabetic	198 (55.0)
	Non-diabetic	162 (45.0)
Health-related quality of Life	Mildly affected	57 (16.0)
	Moderately affected	119 (33.0)
	Severely affected	137 (38.0)
	Very severely affected	36 (10.0)
	Not affected	11 (3.0)

Table II: Association between quality of life changes and diabetes mellitus (n=360)

Quality of Life Changes	Diabetes Mellitus (n=198)	No Diabetes Mellitus (n=162)	Chi-square (χ^2)	p-value
Non-affected	7 (3.5%)	4 (2.5%)	5.040	0.283
Mildly affected	17 (8.6%)	19 (11.7%)		
Moderately affected	68 (34.3%)	69 (42.6%)		
Severely affected	70 (35.4%)	49 (30.2%)		
Very severely affected	36 (18.2%)	21 (13%)		

mellitus was evaluated using the Chi-square test. The analysis revealed that the association between diabetes status and QoL changes was not statistically significant at the conventional significance level of 0.05. Therefore, there was insufficient evidence to reject the null hypothesis, suggesting no significant relationship between diabetes mellitus and QoL changes in the studied population.

knee pain ranging from mild to severe; however, the association between diabetes status and knee pain intensity was not statistically significant (χ^2 = 6.37, p = 0.41). In contrast, a strong and statistically significant association was observed between QoL changes and knee pain intensity. Participants who were not affected in terms of QoL predominantly reported no knee pain, whereas those with mild to moderate QoL impairment reported corresponding increases in pain severity. Individuals with severe and very severe QoL impairment predominantly experienced severe knee pain. The Chi-square analysis confirmed this strong association (χ^2 = 366.14, p = 0.001).

DISCUSSION

The results of the study demonstrate the strong interaction between diabetes mellitus, knee pains, and QoL in patients with KOA. The high number of female participants is consistent with other past epidemiological studies that show high prevalence rates of KOA among the women. Most of the participants were 45-54 years of age, which is the age at which knee OA normally manifests among middle-aged adults. These population tendencies eliminate the need to overlook sex-specific and age-related factors in the management of KOA and its comorbidities.

In relation to the correlation of diabetes mellitus and knee pain intensity, the findings in this study did not reveal a statistically significant correlation. Nevertheless, the existing literature confirms that diabetes mellitus correlates with an increase in pain intensity and it can be possible that poor glycemic control further contributes to the observed discrepancies and should be investigated further.[21] In particular, type 2 diabetes mellitus (T2DM) has been suggested to correlate with increased pain intensity in individuals with localized OA, and that poor glycemic control might be the cause of the observed differences and the subject of further studies. In the present study, it is established that knee osteoarthritis adversely affects the QoL

Table III: Association between quality of life changes and knee pain intensity measured by the visual analogue scale (n=360)

Variables	Categories	Mild Pain (n)	Moderate Pain (n)	Severe Pain (n)	Chi-square (χ^2)	p-value
Systemic Condition	Diabetic	16	90	92	6.37	0.41
	Non-diabetic	22	84	56		
Quality of Life Changes	Non-affected	11	0	0	366.14	0.001
	Mildly affected	14	22	0		
	Moderately affected	12	122	3		
	Severely affected	0	28	91		
	Very severely affected	1	2	54		

especially in the areas of role limitation because of physical health and emotional well-being, which causes limited physical activity. The results are in line with the existing evidence that KOA has a significant influence on functional status and overall QoL.[16, 17] This study results are in contrast to another study on diabetes mellitus Impact on Knee pain stated that diabetes mellitus has a direct correlation with greater pain intensity and the distribution of unilateral or bilateral knee pain.[22] Another study showed the same results and stated that type 2 diabetes is associated with increased pain intensity in individuals with localized osteoarthritis, while poor-glycaemic control affects the amount of pain in people with localized osteoarthritis and type 2 diabetes.[23]

This study was conducted on knee osteoarthritis and QoL and result showed that knee osteoarthritis affects quality of life. It concluded that role limitation due to physical health and emotional well-being was more effected due to Knee osteoarthritis and it limits physical activity. These results are similar to another study on Knee osteoarthritis and quality of life stated that the role limitation due to physical health and general health were more effected due to knee osteoarthritis and it limits physical activity and disturbs mental health status.[24] These results are similar to another study on diabetes mellitus Impact on knee osteoarthritis and quality of life stated that more than a quarter of patients had severe-extreme health states in some or all domains, as indicated by the study's median index score of 0.808, indicated a moderate health-related QoL.[16] This demonstrates the additive negative impact of comorbid diabetes mellitus and KOA on patient well-being. In spite of these revelations, the research has a number of limitations. It was only carried out in two centers of one city, which limits the generalizability. Also, the challenges in clarifying the study to potential participants led to the rejection of some potential subjects because of ethical issues, which introduced the possibility of selection bias. These considerations put issues on the recruitment of a representative sample of this group of patients.

Future research needs to be of multi-centric nature and represent wider geographical areas to increase generalizability. Accessible and understandable patient information and patient navigators could enhance the recruitment and decrease the selection bias. Longitudinal study designs would provide them with an opportunity to evaluate the progression of knee pain and changes in QoL through time in patients with comorbid diabetes mellitus and KOA, which cannot be observed in a cross-sectional study. To sum up, this research confirms the serious role of knee OA on the QoL and the aggravating influences of comorbidity of diabetes mellitus. It is important to address the physical and emotional health of these patients. The future research should aim at clarifying how pain is increased in diabetic KOA[21,22] creating integrated methods of managing the two disorders[18,19] and utilizing patient-centered research to better recruit and collect data that would eventually improve clinical outcomes and quality of life in this population.

Limitations of the study

This study has several limitations. The cross-sectional design provides only a snapshot of the relationships between diabetes mellitus, knee pain, and QoL, limiting causal inferences. The use of a convenience sampling technique introduces potential selection bias. The sample size of 360 participants may not fully represent the larger population of KOA patients. Furthermore, the exclusion criteria, including patients who received intra-articular injections, restrict the generalizability of the findings to all osteoarthritis patients.

CONCLUSION

The findings of this study provide important insights into the relationship between knee osteoarthritis, diabetes mellitus, pain intensity, and QoL. Diabetes mellitus was not independently associated with knee pain severity or QoL among patients with KOA. In contrast, pain intensity demonstrated a strong and significant association with worsening QoL, highlighting its central role in shaping functional and psychosocial outcomes. These results emphasize the need to prioritize effective pain management within integrated, patient-centered care models for individuals with KOA, regardless of diabetic status.

Recommendations

Future studies should explore additional biological, behavioral, and psychosocial determinants that influence well-being in patients with knee osteoarthritis.

Longitudinal research designs are recommended to better understand changes in pain and quality of life over time and to clarify potential causal relationships. Broader demographic and geographic sampling would enhance the external validity of findings. Incorporating objective assessments of physical function, evaluating structured intervention strategies, and examining factors such as psychological health and physical activity levels may provide deeper insights into patient outcomes. Such approaches would strengthen the evidence base and inform the development of targeted, patient-centered clinical and public health strategies.

REFERENCES

1. Chen J, Chen X, Wang T, Li M, Dai H, Shang S, et al. Global burden of knee osteoarthritis from 1990 to 2021: Trends, inequalities, and projections to 2035. PLoS One 2025;20(6):e0320115.https://doi.org/10.1371/journal.pone.0320115
2. Zhang B, Liu D. Integrated bioinformatic analysis of the molecular mechanisms between type 2 diabetes mellitus and osteoarthritis. Medicine (Baltimore) 2024;103(35):e39469. https://doi.org/10.1097/MD.0000000000039469
3. Kang Y, Liu C, Ji Y, Zhang H, Wang Y, Bi W, et al. The burden of knee osteoarthritis worldwide, regionally, and nationally from 1990 to 2019, along with an analysis of cross-national inequalities. Arch Orthop Trauma Surg 2024;144(5):2155-66. https://doi.org/10.1007/s00402-024-05250-4
4. Khired Z, Albeladi F, Abudeyah M, Alluli M, Al Faqih A, Suwaydi A, et al. Knee pain and its influence on quality of life and physical function in Jazan adult population: a cross sectional study. Clin Epidemiol Glob Health 2023;22:101346. https://doi.org/10.1016/j.cegh.2023.101346
5. Almodahka A, Weisman A, Shah BR, Watson T, Stanaitis I, Parikh A, et al. Association between symptomatic knee osteoarthritis and health-related quality of life in individuals with type 2 diabetes: a cross-sectional study. Osteoarthr Cartil Open 2026;8:100742. https://doi.org/10.1016/j.ocarto.2025.100742
6. Zonova EV, Lykov AP, Trifonova EP, Sazonova OV. Characterization of osteoarthritis in patients with diabetes mellitus type 2. Integr Mol Med 2016;3(3):649-53. https://doi.org/10.15761/IMM.1000217
7. Hart HF, White DK, Reichert SM, Stefanik JJ. Associations of physical activity, sedentary behaviour, pain, function and quality of life with diabetes and knee osteoarthritis: data from the osteoarthritis initiative. Musculoskelet Care 2025;23(2):e70128.https://doi.org/10.1002/msc.70128
8. King LK, Waugh E, MacKay C, Stanaitis I, Stretton J, Weisman A, et al. 'Its a dance between managing both: a qualitative study exploring perspectives of persons with knee osteoarthritis and type 2 diabetes mellitus on the impact of osteoarthritis on diabetes management and daily life. BMJ Open 2022;12(11):e061472. https://doi.org/10.1136/bmjopen-2022-061472
9. Eitner A, Culvenor AG, Wirth W, Schaible H-G, Eckstein F. Impact of diabetes mellitus on knee osteoarthritis pain and physical and mental status: data from the osteoarthritis initiative. Arthritis Care Res 2021;73(3):392-402. https://doi.org/10.1002/acr.24173
10. Lyman KS, Athinarayanan SJ, McKenzie AL, Pearson CL, Adams RN, Hallberg SJ, et al. Continuous care intervention with carbohydrate restriction improves physical function of the knees among patients with type 2 diabetes: a non-randomized study. BMC Musculoskelet Disord 2022;23(1):285.https://doi.org/10.1186/s12891-022-05258-0
11. Raosoft Inc. Sample size calculator [Internet]. Seattle (WA): Raosoft Inc.; 2004 [Accessed On: December 10, 2022]. Available fromURL:http://www.raosoft.com/samplesize
12. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. J Pain Symptom Manage 2011;41(6):1073-93. https://doi.org/10.1016/j.jpainsymman.2010.08.016
13. Tański W, Dudek K, Tomasiewicz A, Świątoniowska-Lonc N. Sexual dysfunction and quality of life in patients with rheumatoid arthritis. Int J Environ Res Public Health 2022;19(5):3088.https://doi.org/10.3390/ijerph19053088
14. Açma A, Carrat F, Hejblum G. Comparing SF-36 scores collected through web-based questionnaire self-completions and telephone interviews: an ancillary study of the SENTIPAT multicenter randomized controlled trial. J Med Internet Res 2022;24(3):e29009.https://doi.org/10.2196/29009
15. Zhang Y, Qu B, Lun SS, Guo Y, Liu J. The 36-item short form health survey: reliability and validity in Chinese medical students. Int J Med Sci 2012;9(7):521-6. https://doi.org/10.7150/ijms.4503
16. Hammami N, Jdidi H, Khezami MA, Ghidaoui L, Talbi A, Hannachi C, et al. Isokinetic strengthening and neuromuscular electrical stimulation protocol impact on physical performances, functional status and quality of life in knee osteoarthritis overweight/obese women. Knee 2022;39:106-15. https://doi.org/10.1016/j.knee.2022.09.004
17. Pereira D, Peleteiro B, Araujo J, Branco J, Santos RA, Ramos E. The effect of osteoarthritis definition on prevalence and incidence estimates: a systematic review. Osteoarthr Cartil 2011;19(11):1270-85. https://doi.org/10.1016/j.joca.2011.08.009

18. Wallis JA, Webster KE, Levinger P, Taylor NF. What proportion of people with hip and knee osteoarthritis meet physical activity guidelines? A systematic review and meta-analysis. Osteoarthr Cartil 2013;21(11):1648-59. https://doi.org/10.1016/j.joca.2013.08.003

19. Lee J, Chang RW, Ehrlich-Jones L, Kwoh CK, Nevitt M, Semanik PA, Sharma L, Sohn MW, Song J, Dunlop DD. Sedentary behavior and physical function: objective evidence from the Osteoarthritis Initiative. Arthritis Care Res 2015;67(3):366-73. https://doi.org/10.1002/acr.22432

20. Pereira D, Branco J, Sae A, Ramos E. Osteoartrite. Acta Med Port 2014;27(5):1-8.

21. Alenazi AM, Alshehri MM, Alothman S, Alqahtani BA, Rucker J, Sharma N, et al. The association of diabetes with knee pain severity and distribution in people with knee osteoarthritis using data from the osteoarthritis initiative. Sci Rep 2020;10(1):3985.https://doi.org/10.1038/s41598-020-60989-1

22. Alenazi AM, Obaidat SM, Alshehri MM, Alothman S, Gray C, Rucker J, et al. Type 2 diabetes affects joint pain severity in people with localized osteoarthritis: a retrospective study. Pain Med 2020;21(5):1025-31. https://doi.org/10.1093/pm/pnz299

23. Saeed A, Zulfiqar T, Kaleem M, Hafeez M, Ghauri MW. Health related quality of life in patients with grade III knee osteoarthritis. Rawal Med J 2021;46(3):580-4.

24. Mechal A, Worku T, Oljira L, Amare E, Ezo E, Abate H, et al. Health-related quality of life and risk factors among type II diabetic mellitus patients attending public hospitals in harari regional state, ethiopia. Clin Nurs Perspect 2024;1(1):11-21. https://doi.org/10.26855/cnp.2024.12.002

AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

MS & AA: Conception and study design, acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

MWG, MS, SR & MA: Acquisition, analysis and interpretation of data, drafting the manuscript, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

GRANT SUPPORT AND FINANCIAL DISCLOSURE

Authors declared no specific grant for this research from any funding agency in the public, commercial or non-profit sectors.

DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

KMUJ web address: www.kmuj.kmu.edu.pk
Email address: kmuj@kmu.edu.pk