INFORMATICS JOURNALS

*SHORT COMMUNICATION*

*©2023 The Academy of Environmental Biology, India*

**Journal of Ecophysiology and Occupational Health,** Vol 26(3), *DOI: 10.18311/jeoh/2026/53144, 295-302, September 2026*

*ISSN (Online) : 0972-4397*
*ISSN (Online) : 0974-0805*

# Unveiling the Efficacy of Promis-29 V2.0 in Physical Therapy for Musculoskeletal Patients: An Observational Study

**Anitha Mariappan[1*], Ifthisham[2], Olivia Rose Mary[1], Priya Sharma[1], Sarath S. Kumar[3] and Janani Arul[4]**

[1]College of Physiotherapy, School of Health Sciences, Dayanand Sagar University, Bangalore - 562112, Karnataka, India; mbanitha.26@gmail.com

[2]Srinivas Institute of Physiotherapy, Mangalore - 575001, Karnataka, India

[3]Dr Achanta Lakshmipathi, Regional Ayurveda Research Institute, CCRAS, Ministry of AYUSH, Government of India, New Delhi - 110058, Delhi, India

[4]VYMAK College of Physiotherapy, Whitefield, Bengaluru - 560066, Karnataka, India

## Abstract

**Purpose:** This study aimed to determine the effectiveness of PROMIS-29 v2.0 (Patient-Reported Outcomes Measurement Information System), a tool for measuring health-related quality of life in patients undergoing physical therapy for musculoskeletal conditions. It is also useful in monitoring the progression of physical, mental, and social health outcomes during treatment. **Methods:** Patients aged 18 years and above who have been receiving physiotherapy treatment for musculoskeletal disorders with complaints of pain. Ethical approval and informed consent were obtained from all participants in the study. On days 1, 3, and 5 of physiotherapy treatment, the PROMIS-29 v2.0 questionnaire, including domains such as Physical Functioning, Pain Interference, Fatigue, Emotional Distress, and Social Health, was administered. The data collected was analysed to evaluate its responsiveness and ability to detect changes over time. **Results:** The PROMIS-29 v2.0 detected improvements in patients during physiotherapy with changes in all domains that it measures. There were significant ($p<0.05$) improvements in physical functioning, reduced pain interference, and better quality-of-life indicators among respondents. The tool identified variations and modifications in condition, thereby validating its use for individual care plans and making patient-centred clinical decisions. **Conclusion:** The study concluded that PROMIS-29 v2.0 is a valuable tool for assessing health-related quality of life in musculoskeletal patients undergoing physical therapy. Implementing PROMIS-29 v2.0 in clinical practice can improve rehabilitation outcomes and patient satisfaction.

**Major Findings:** PROMIS-29 v2.0 is a dependable measure of quality of life in musculoskeletal physiotherapy. Significant improvements in function and reductions in pain were observed. Supports personalised care and improves rehabilitation outcomes.

**Keywords:** Musculoskeletal Condition, Pain Interference, Physical Function, Physiotherapy, PROMIS 29 v2.0

Article Received on: 11.11.2025 Revised on: 03.06.2026 Accepted on: 11.06.2026

**Author for correspondence*

# 1. Introduction

"PROMIS, short for Patient Reported Outcomes Measurement Information System, was developed by the National Institutes of Health (NIH). PROMIS enhances communication between clinicians and patients and is relevant across all conditions to assess clinical symptoms, functioning, and quality of life across diverse conditions. PROMIS aims to provide reliable measurements of physical, mental, and social health domains crucial to patient outcomes, using rigorous psychometric techniques like Item Response Theory (IRT) for validity and reliability testing. The "PROMIS-29 v2.0" is a powerful tool in Patient-Reported Outcomes (PROs), mainly designed to assess Health-Related Quality of Life (HRQOL) across multiple domains with precision. Through IRT, it offers detailed measurements beneficial for individual patient care, enhancing clinical practice, research, and healthcare decision-making[1]. PROMIS item banks for physical function, pain interference, and pain behaviour have differential item functioning among diverse groups, including patients with specific musculoskeletal conditions, compared to the general population. This is aimed at making the PROMIS assessments fairer and more valid by giving directions to personal interventions and monitoring of patient progress. The use of PROMIS measures in both general and musculoskeletal populations with pain, such as osteoarthritis of the knee, frozen shoulder, low back pain, ankylosing spondylitis, tennis elbow, ACL injury, patellar tendonitis, supraspinatus tendinitis, etc., facilitates standardised reporting that encourages worldwide comparisons, which in turn improve health outcomes for people with musculoskeletal problems[2]. The "PROMIS-29 v2.0" is a widely utilised tool designed within the field of Patient-reported Outcomes (PROs) to assess physical and mental health across various populations. This instrument merges patient-reported outcomes into a brief profile, providing comprehensive insight into individuals' health status[3]. "PROMIS-29 v2.0" specifically consists of 29 items across several domains: physical function, anxiety, depression, fatigue, sleep disturbance, ability to participate in social roles and activities, and pain interference. Each domain is carefully constructed to capture the multidimensional nature of HRQOL, enabling healthcare providers and researchers to obtain a comprehensive understanding of a patient's well-being from their perspectives[4]. In musculoskeletal patients, these outcomes are hence very relevant as they directly impact daily functioning and quality of life. "PROMIS-29 v2.0" offers an advantage over the earlier measures in terms of accuracy and efficiency for the assessment of musculoskeletal health, both for clinical practice and for research. Several developments and validations of the "PROMIS-29 v2.0" have been observed across various populations, including adaptations for musculoskeletal disorders. This lays the ground for the focus of the study, which is to contribute to the understanding of pain in patients and eventually to enable better-targeted pain management strategies[5]. Accurate assessment of PROs is essential for evaluating treatment effectiveness and guiding clinical decisions[6]. "PROMIS-29 v2.0" is designed to capture the multifaceted nature of HRQOL, and it fully represents the diverse experiences among individuals[7]. The tool creates precise, reliable measures of PRO status across various domains, making it a valuable tool for understanding patient experiences[8]. This study aims to assess how the patient-reported outcome measure "PROMIS-29 v2.0" enhances treatment outcomes for individuals undergoing physical therapy for musculoskeletal conditions. It seeks to provide valuable insights into the tool's effectiveness in improving patient care, contributing to the growing evidence supporting its application in clinical practice[9]. The objective is to evaluate how well "PROMIS-29 v2.0" detects changes in physical, mental, and social health outcomes during physical therapy for musculoskeletal patients, which can aid in the comprehensive assessment of HRQOL, functioning, and symptoms in this specific population.

# 2. Materials and Methods

## 2.1 Participants

An observational design was conducted over 3 months at the Srinivas Institute of Physiotherapy OPD department in Mangalore, employing purposive sampling with a recruited sample size of 75 participants, 40 males and 35 females. The study includes adults aged 18 and older of both genders receiving physiotherapy treatment for musculoskeletal conditions with primary complaints of pain, while excluding individuals with conditions other than musculoskeletal disorders, painless conditions, and those who are unable to read or write in English.

## 2.2 Procedure

The "PROMIS-29 v2.0" scale is a standardised tool for evaluating different facets of health-related quality of life.

The procedure was given specifically to patients who fit the required inclusion criteria, i.e. to confirm the patient is 18 years of age or older, is of any gender, and has a diagnosis of a musculoskeletal disorder that is causing pain and also to verify the patient's literacy to ensure they can comprehend and respond to the questionnaire. Once the ethical clearance from the institutional ethical board was received and informed consent was taken, the patient was handed over the questionnaire sheet and was informed about the purpose of the "PROMIS-29 v2.0" to the patient after starting physiotherapy, provided information on the voluntary nature of participation and assured the patient's confidentiality. Explaining the instructions clearly that they will be answering questions about their health-related quality of life in the "PROMIS-29 v2.0" consists of 29 items that assess various domains such as physical function, pain interference, fatigue, emotional distress, and social health, ensuring the patient understands and answers based on their experiences. Ensure patients read and respond to each item without skipping any items unless they choose not to answer specific questions, and also inform them that during physiotherapy treatment, periodically the PROMIS scale is re-administered on day 3rd and day 5th during physiotherapy treatment to monitor changes in the patient's health status and the effectiveness of physiotherapy on musculoskeletal conditions. Collect the completed questionnaires on days 1, 3, and 5th consequently from the patient and verify that all items are adequately answered and legible.

### 3.1 Data Analysis

The analysis will be done using descriptive statistics. Comparison among the different timings will be analysed by using ANOVA and BONFERRONI t-test. A statistical package, SPSS version 24.0, was used to do the statistical analysis. T less than 0.05 will be considered significant.

## 3. Results

The collected data were summarised by using Descriptive Statistics: frequency, percentage, mean, and S.D. The independent-samples t-test was used to compare age and PROMIS v2.0 between males and females. The repeated-measures ANOVA was used to compare PROMIS-29 v2.0 from day 1 to day 5. The BONFERRONI test was used for the pairwise comparisons. To find the relation between PROMIS-29 v2.0 and age, the Pearson correlation coefficient ("r") was used. A p-value <0.05 was considered significant. Data were analysed using the SPSS software (SPSS Inc., Chicago, IL) version 29.0.10.

An independent sample t-test was used to compare PROMIS-29 v2.0 according to gender. There was no

**Table 1.** Descriptive statistics for age

| (n=75) | Range | Mean | S. D |
|---|---|---|---|
| Age (Years) | 20 to 82 | 38.6 | 16.7 |

**Table 2.** Distribution of gender

| Gender | Frequency | % |
|---|---|---|
| Male | 40 | 53.3 |
| Female | 35 | 46.7 |

**Table 3.** Comparison of PROMIS-29 v2.0 according to gender

| PROMIS v2.0 | Gender | Mean | S. D | "t" | P value |
|---|---|---|---|---|---|
| Day 1 | Male | 95.3 | 9.3 | 0.66 | 0.514 |
| | Female | 93.8 | 10.2 | | |
| Day 3 | Male | 89.6 | 9.1 | 0.62 | 0.536 |
| | Female | 88.3 | 10.0 | | |
| Day 5 | Male | 83.5 | 9.9 | 0.46 | 0.651 |
| | Female | 82.4 | 10.7 | | |

**Table 4.** Comparison of PROMIS-29 v2.0

| PROMIS v2.0 | Mean | S. D | "F" | P value |
|---|---|---|---|---|
| Day 1 | 94.6 | 9.7 | 234.77 | <0.001* |
| Day 3 | 89.0 | 9.5 | | |
| Day 5 | 83.0 | 10.2 | | |

**Table 5.** Pairwise comparison of PROMIS-29 v2.0

| Pairwise Comparisons | Mean Difference | p-value |
|---|---|---|
| Day 1 vs. Day 3 | 5.57 | < 0.001* |
| Day 1 vs. Day 5 | 11.61 | < 0.001* |
| Day 3 vs. Day 5 | 6.04 | < 0.001* |

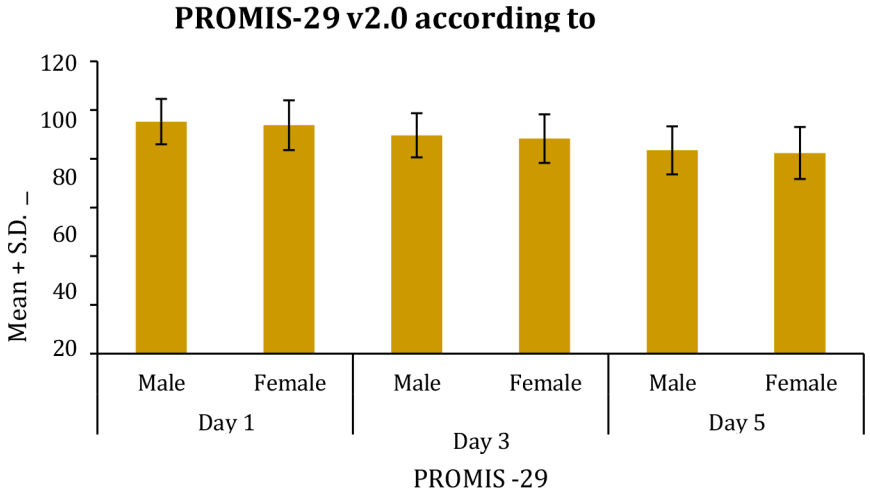
**Table 6.** Correlation between PROMIS-29 v2.0 and age

| PROMIS-29 v2.0 | | Age (Years) |
|---|---|---|
| | "r" | P value |
| Day 1 | -0.218 | 0.060 |
| Day 3 | -0.163 | 0.162 |
| Day 5 | -0.085 | 0.471 |

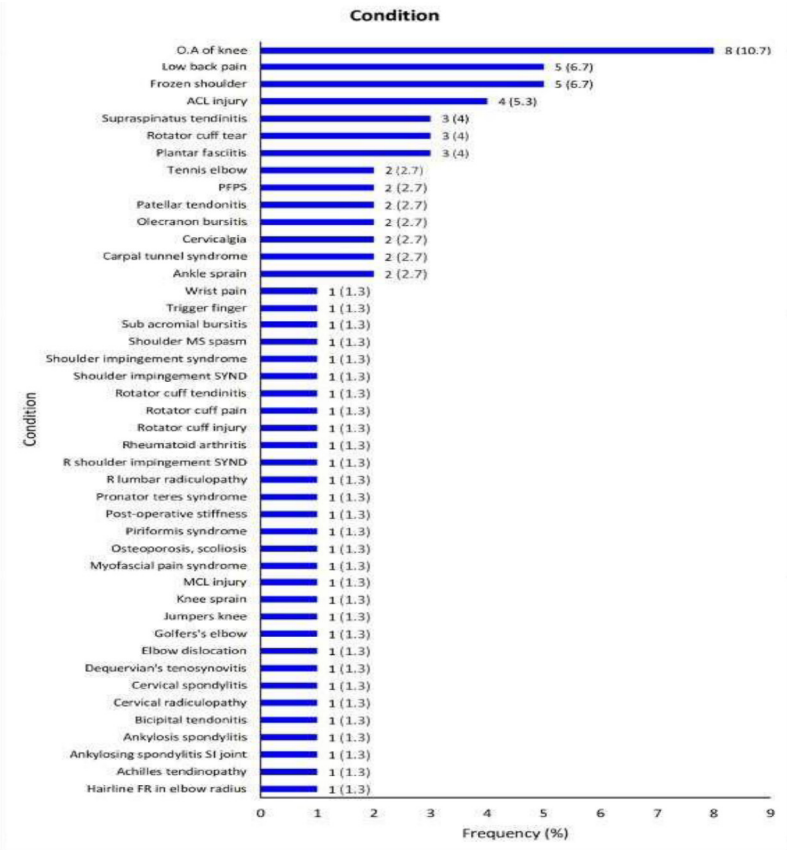
difference ($p > 0.05$) in PROMIS-29 v2.0 between males and females during day 1, day 3, and day 5.

The repeated-measures ANOVA was used to compare PROMIS v2.0. There was a difference ($p < 0.05$) in PROMIS-29 v2.0 from day 1 to day 5.

The BONFERRONI test was used for the pairwise comparisons of PROMIS-29 v2.0. There was a difference ($p < 0.05$) in PROMIS-29 v2.0 between Day 1 vs. Day 3; Day 1 vs. Day 5; as well as Day 3 vs. Day 5.




**Graph 1.** Indicates the Mean and S.D. of PROMIS-29 v2.0 according to gender.




**Graph 2.** Shows the frequency of musculoskeletal conditions.

The Pearson correlation coefficient ("r") was used to find the relation between PROMIS-29 v2.0 and age. There was no correlation ($p > 0.05$) between age and PROMIS-29 v2.0 during day 1, day 3, and day 5.

## 4. Discussions

The present study resulted in the responsiveness of PROMIS-29 v2.0 among patients receiving physiotherapy for various musculoskeletal conditions. A significant improvement in PROMIS-29 scores was observed over the treatment period, with mean scores decreasing from 94.6±9.7 at baseline to 83.0±10.2 by Day 5. Repeated-measures ANOVA demonstrated a highly significant change across assessment periods ($F = 234.77$, $p < 0.001$), indicating that PROMIS-29 v2.0 was sensitive to changes occurring during physiotherapy. These findings suggest that it helps to observe short-term improvements in patients' health-related quality of life and functional status.

Further analysis revealed significant differences between all assessment intervals. The mean score improved by 5.57 points between Day 1 and Day 3, by 11.61 points between Day 1 and Day 5, and by 6.04 points between Day 3 and Day 5 (all $p < 0.001$). This progressive decrease in PROMIS-29 scores reflects continuous improvement throughout the treatment period. As PROMIS-29 assesses multiple domains, including physical function, pain interference, fatigue, emotional well-being, and social participation, the observed changes likely represent overall improvement in patients' health status rather than improvement in a single symptom alone.

The findings of the present study are in alignment with previous research evaluating the responsiveness of PROMIS-29 in musculoskeletal populations. Khutok *et al.* reported that PROMIS-29 was highly responsive in individuals with chronic low back pain and was capable of detecting meaningful changes over time[10]. Likewise, *Moya et al.* demonstrated strong reliability, validity, and responsiveness of PROMIS-29 among individuals with chronic musculoskeletal pain. The consistency between these studies and the present findings further supports the usefulness of PROMIS-29 as an outcome measure for monitoring rehabilitation progress[11].

One of the major strengths of PROMIS-29 is its ability to evaluate multiple dimensions of health and physical function simultaneously. Musculoskeletal disorders are known to affect not only physical function and pain levels but also psychological well-being, sleep quality, fatigue, and social participation. Therefore, assessment tools that capture these broader aspects of health are increasingly important in patient-centred rehabilitation[12]. *Gibson et al.* highlighted the value of PROMIS-29 in assessing physical, mental, and social health domains in patients with rheumatologic conditions. Similarly, the improvements observed in the present study suggest that physiotherapy may have contributed to positive changes across several aspects of health-related quality of life[13].

*Hwang et al.*[14] demonstrated strong construct validity of PROMIS-29 v2.0 among patients undergoing lumbar spine surgery, while Karlsson *et al.* reported significant improvements in PROMIS-29 outcomes following treatment for lumbar radicular pain. These studies, together with the present study's findings, indicate that PROMIS-29 can detect treatment-related changes across a broad range of musculoskeletal conditions and clinical settings.

The current study did not identify any significant differences in PROMIS-29 scores between male and female participants at any assessment point ($p>0.05$). The finding suggests that gender did not substantially influence patient-reported outcomes within the study population. Similar observations have been reported in previous validation studies, which have shown that PROMIS instruments perform consistently across different demographic groups[15-17].

Similarly, no significant relationship was found between age and PROMIS-29 scores during the study period. Although increasing age is often associated with greater functional limitations and symptom burden, the absence of a significant correlation in the present study suggests that PROMIS-29 may be equally applicable across a wide adult age range. This is particularly important for routine clinical practice, where patients with musculoskeletal conditions often represent diverse age groups[18-20].

The clinical relevance of these findings should also be considered. PROMIS-29 v2.0 offers clinicians a practical and comprehensive method of evaluating treatment outcomes from the patient's perspective. The ability to detect significant improvements within a short period of physiotherapy highlights its potential value for monitoring recovery, guiding individualized treatment planning, and supporting evidence-based clinical decision-making.

Despite these positive findings, several limitations should be acknowledged. The study included patients

with a variety of musculoskeletal conditions, which may have introduced variability in the observed outcomes. Different conditions may respond differently to physiotherapy, and condition-specific analyses were not performed. In addition, the age range of participants was relatively broad, which may have contributed to differences in baseline health status and recovery patterns. The short duration of follow-up also limits conclusions regarding long-term responsiveness and sustained clinical improvement. Future studies should focus on specific musculoskeletal subgroups, include larger multicentre samples, and evaluate PROMIS-29 outcomes over longer follow-up periods.

The findings of our study support SDG 3: Good Health and Well-Being[21], specifically through the promotion of effective rehabilitation strategies and comprehensive patient-reported outcome assessment in individuals with musculoskeletal conditions.

# 5. Conclusion

The study concluded that the PROMIS-29 v2.0 is a reliable outcome measure for patients receiving physiotherapy. It is more effective in their roles and ensures the benefit from optimised rehabilitation interventions aimed at improving quality of life.

# 6. Declaration

## 6.1 Acknowledgments

The authors would like to acknowledge the subjects of the study and request their cooperation. The graphical abstract for this manuscript was developed with the assistance of *Napkin AI* and Canva to enhance visual presentation and clarity. All AI-assisted elements were thoroughly reviewed and refined by the authors to ensure accuracy, relevance, and alignment with the study's objectives.

## 6.2 Ethics Approval

The SUIP/UG22/151/2024 research protocol was reviewed and approved by the Ethical Committee at Srinivas Institute of Physiotherapy, Mangalore.

## 6.3 Consent to Participate

Informed consent was obtained from all subjects involved in the study.

## 6.4 Data Availability

The data on which this research is based are available to the corresponding author upon request.

## 6.5 Statements and Declarations

The research work was supported by the Institute of Physiotherapy, Srinivas University. The authors declare that they did not receive any funds, grants, or other support during the preparation of this manuscript.

# 7. References

1. Health Measures. PROMIS. River Forest (IL): Health Measures. Available from: https://www.healthmeasures.net/explore-measurement-systems/promis.
2. Cook CE, Rethorn ZD, Chiarotto A, Garcia AN, Gottfried O. Construct validity and item response theory analysis of the PROMIS-29 v2.0 in recipients of lumbar spine surgery. Spine 2021; 46(24):1721-1728. https://doi.org/10.1097/BRS.0000000000004085. PMid:34818268.
3. Vaughan B, Chase B, Hickey J, Tassoulas M, Weston H, Fitzgerald K, Fleischmann M, Mulcahy J, Austin P. PROMIS neuropathic and nociceptive pain quality in musculoskeletal pain presentations. Clin J Pain. 2021; 37(9):639-647. https://doi.org/10.1097/AJP.0000000000000955. PMid:34183533.
4. Gibson KA, Kaplan RM, Pincus T, Li T, Luta G. PROMIS-29 in rheumatoid arthritis patients who screen positive or negative for fibromyalgia on MDHAQ FAST4 (fibromyalgia assessment screening tool) or 2011 fibromyalgia criteria. Semin Arthritis Rheum. 2024; 66:152361. https://doi.org/10.1016/j.semarthrit.2024.152361 PMid:38360468.
5. Dunbar MS, Rodriguez A, Edelen MO, Hays RD, Coulter ID, Siconolfi D, Herman PM. Longitudinal associations of PROMIS-29 anxiety and depression symptoms with low back pain impact in a sample of U.S. Military service members. Mil Med. 2023; 188(3-4):630-636. https://doi.org/10.1093/milmed/usab339 PMid:34417805 PMCid:PMC10226420.
6. Pennings JS, Khan I, Davidson CA, Freitag R, Bydon M, Asher AL, Devin CJ, Archer KR. Using PROMIS-29 to predict Neck Disability Index (NDI) scores using a national sample of cervical spine surgery patients. Spine J. 2020; 20(8):1305-1315. https://doi.org/10.1016/j.spinee.2020.04.028 PMid:32413486.
7. Leeuwen VLM, Tamminga SJ, Ravinskaya M, de Wind A, Hahn EA, Terwee CB, Beckerman H, Boezeman EJ, Hoving JL, Huysmans MA, Nieuwenhuijsen K, de Boer AGEM, van der Beek AJ. Proposal to extend the PROMIS®

item bank v2.0 'Ability to Participate in Social Roles and Activities': item generation and content validity. Qual Life Res. 2020; 29(10):2851-2861.https://psycnet.apa.org/doi/10.1007/s11136-020-02540-3 PMid:32488684 PMCid:PMC7561593.

8. Hays RD, Orlando Edelen M, Rodriguez A, Herman P. Support for the reliability and validity of the National Institutes of Health impact stratification score in a sample of active-duty U.S. Military personnel with low back pain. Pain Med. 2021; 22(10):2185-2190. https://doi.org/10.1093/pm/pnab175 PMid:34022052 PMCid:PMC8677434.
9. Rose AJ, Bayliss E, Huang W, Baseman L, Butcher E, García RE, Edelen MO. Evaluating the PROMIS-29 v2.0 for use among older adults with multiple chronic conditions. Qual Life Res. 2018; 27(11):2935-2944. https://doi.org/10.1007/s11136-018-1958-5. PMid:30088121 PMCid: PMC6196113.
10. Khutok K, Janwantanakul P, Jensen MP, Kanlayanaphotporn R. Responsiveness of the PROMIS-29 scales in individuals with chronic low back pain. Spine. 2021; 46(2):107-113. https://doi.org/10.1097/BRS.0000000000003724 PMid:33347091.
11. Moya CR, da Silva T, Costa LOP. Measurement properties of the Brazilian-Portuguese version of the PROMIS-29 questionnaire and the Impact Score in patients with chronic low back pain. BMC Musculoskelet Disord. 2024; 25:833. https://doi.org/10.1186/s12891-024-07946-5. PMid:39438832 PMCid: PMC11494812.
12. Janwantanakul P, Kanlayanaphotporn R, Jensen MP, Khutok K. Comparative responsiveness of the PROMIS-29 and SF-36 instruments in individuals with chronic musculoskeletal pain. J Orthop Sci. 2025; 30(4):704-710. https://doi.org/10.1016/j.jos.2024.09.004. PMid:39379212.
13. Gibson KA, Kaplan RM, Pincus T, Li T, Luta G. PROMIS-29 in rheumatoid arthritis patients who screen positive or negative for fibromyalgia on MDHAQ FAST4 or 2011 fibromyalgia criteria. Semin Arthritis Rheum. 2024; 66:152361. https://doi.org/10.1016/j.semarthrit.2024.152361. PMid:38360468.
14. Hwang MC, Bell C, Farran Y, Ogdie A, Green C, Reveille J. Reliability and validity of the PROMIS-29 health profile in ankylosing spondylitis patients: a cross-sectional study. Medicine (Baltimore). 2024; 103(9):37251. https://doi.org/10.1097/MD.0000000000037251. PMCid: PMC10906602.
15. Cella D, Riley W, Stone A, Rothrock N, Reeve B, Yount S, *et al.* The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005-2008. J Clin Epidemiol. 2010; 63(11):1179-94. https://doi.org/10.1016/j.jclinepi.2010.04.011. PMid:20685078 PMCid: PMC2965562.
16. Azam F, Shukla I, Hicks WH, Anand S, Furtado K, Smith PD, *et al.,* A 3-year study investigating the utility of patient-reported outcomes measurement information system-29 for long-term follow-up in adult spinal deformity. World Neurosurg. 2024; 186:506-513. https://doi.org/10.1016/j.wneu.2024.03. 165 PMid:38583560.
17. Hejazi A, Willis C, Ye X, Youssef J, Moebus C, Goss B, *et al.* The relationship of PROMIS physical function scores and healthcare resource utilization in patients treated for chronic low back pain. Interv Pain Med. 2024; 3(4):100522. https://doi.org/10.1016/j.inpm.2024.100522. PMid:39624774 PMCid: PMC11609540.
18. Karlsson C, Carlsson E, Åkerstedt J, Lilja P, von Essen C, Tabatabaei P, *et al.,* Outcomes after selective nerve root blockade for lumbar radicular pain from lumbar disc hernia or lumbar spinal stenosis assessed by the PROMIS-29: a prospective observational cohort study. Acta Neurochir. 2024; 166(1):306. https://doi.org/10.1007/s00701-024-06196-7. PMid:39052107 PMCid: PMC11272668.
19. Azam F, Anand S, Dragun A, Furtado K, Nguyen M, Shukla I, *et al.* Identifying correlation among patient-reported outcome measures: a study of PROMIS-29, ODI, and VAS in adult spinal deformity patients. World Neurosurg. 2024; 181:1059-1070. https://doi.org/10.1016/j.wneu.2023.11.039. PMid:37967743.
20. Deyo RA, Dworkin SF, Amtmann D, Andersson G, Borenstein D, Carragee E, *et al.,* Report of the NIH Task Force on Research Standards for Chronic Low Back Pain. Spine. 2014; 39(14):1128-1143. https://doi.org/10.1097/BRS.0000000000000434. PMid:24887571
21. United Nations General Assembly. Transforming our world: the 2030 Agenda for Sustainable Development. Resolution A/RES/70/1 [Internet]. New York: United Nations; 2015 [cited 2026 Jul 27]. Available from: https://docs.un.org/en/A/res/70/1

## Author Contribution

**Dr Anitha Mariappan:** Conceived the study, designed the research framework, supervised the project, and critically reviewed the manuscript. **Ifthisham:** Collected the data, performed the statistical analysis, interpreted the findings, and contributed to manuscript drafting. **Dr Sarath S. Kumar:** Assisted with data validation, literature review, methodology development, and manuscript review. **Dr Priya Sharma**: Contributed to data interpretation, preparation of the results section, manuscript editing,

and critical revision. **Dr Olivia Rose Mary:** Contributed to data interpretation, preparation of the results section, manuscript editing, and critical revision. **Dr Janani Arul:** Organised and managed the references, formatted the manuscript according to journal guidelines, reviewed the manuscript, prepared the tables and figures, and contributed to the final editing of the manuscript. All authors reviewed, revised, and approved the final version of the manuscript and agree to be accountable for all aspects of the work.


| Access this journal online | |
|---|---|
| **Website:** www.informaticsjournals.co.in/index.php/JEOH/index | **Quick Response Code** |