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Narrative Review

Comparative Analysis of Seasonal Variations in Musculoskeletal Pain Intensity in Temperate versus Tropical Regions

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Abstract

Introduction: Musculoskeletal disorders (MSDs) are among the leading causes of global disability. Patients often attribute symptom fluctuations to seasonal or weather changes, but scientific evidence remains inconsistent. Most robust studies are from temperate climates, with limited data from tropical regions.

Methods: We conducted a systematic review guided by PRISMA principles. PubMed, Web of Science, and Scopus were searched through May 2025 using combinations of "seasonal variation," "weather," "musculoskeletal pain," "osteoarthritis," "rheumatoid arthritis," "chronic pain," "temperate," and "tropical." Systematic reviews, meta-analyses, longitudinal cohort studies, and observational studies reporting pain intensity variations across seasons or weather factors were eligible. Data were extracted on study design, location, MSD type, meteorological variables, and outcomes, and narratively synthesised by climate zone.

Results: Of 742 records, 23 studies met criteria: 10 systematic reviews/meta-analyses, 9 longitudinal cohorts/time-series, and 4 cross-sectional studies. In temperate regions, modest associations were reported between barometric pressure, humidity, and osteoarthritis pain. Rheumatoid arthritis activity showed seasonal peaks in some registries. Chronic pain studies demonstrated high inter-individual variability, with ~20% of patients showing reproducible weather sensitivity. In tropical regions, evidence was sparse, mostly cross-sectional, with heterogeneous findings and limited meteorological linkage.

Conclusion: Seasonal influences on musculoskeletal pain appear modest but clinically relevant in subsets of patients, especially in temperate climates. Evidence from tropical settings remains insufficient, limiting global applicability. Future studies should employ longitudinal, multi-region designs using symptom diaries, personal exposure sensors, and mechanistic biomarkers. Physiotherapists can integrate season-adapted exercise strategies and patient education into care pathways.

Keywords: Musculoskeletal Pain, Weather Variation, Tropical, Musculoskeletal Disorder

Introduction

Musculoskeletal disorders (MSDs) such as osteoarthritis (OA, rheumatoid arthritis (RA), and chronic non-specific pain are leading causes of disability worldwide. Patients frequently report that pain worsens during specific weather conditions, particularly cold, damp, or humid environments.[1] Physiotherapists and clinicians encounter these reports in practice, yet empirical evidence is mixed: some studies support significant associations between meteorological factors and pain, while others find little or no relationship after adjusting for confounders.[2]

Geographical differences may partly explain this inconsistency. Temperate climates are characterised by wide seasonal fluctuations in temperature and barometric pressure, whereas tropical regions experience relatively stable temperatures with pronounced wet–dry cycles. Exploring whether musculoskeletal pain intensity varies differently across these climate zones is clinically relevant for personalised rehabilitation, service planning, and physiotherapy interventions.

This review synthesises available evidence on seasonal variation in musculoskeletal pain intensity, contrasting findings from temperate versus tropical regions, and discusses implications for physiotherapy practice.

Materials and Methods

Study Design

This review was conducted as a narrative synthesis guided by PRISMA 2020 recommendations for

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scoping reviews.

Eligibility Criteria

- Population: Adults with musculoskeletal disorders (OA, RA, fibromyalgia, chronic pain).
- Exposure: Seasonal variation or meteorological factors (temperature, barometric pressure, humidity, precipitation).
- Outcome: Pain intensity, symptom flares, or functional limitation.
- Study design: Systematic reviews, meta-analyses, longitudinal cohorts, time-series analyses, cross-sectional surveys.
- Language: English, hindi.

Information Sources

PubMed, Web of Science, and Scopus were searched from inception to May 2025.

Search Strategy

Search terms combined controlled vocabulary (MeSH) and free-text words:

- "seasonal variation" OR "weather" OR "climate" OR "temperature" OR "humidity" OR "barometric pressure"
- "musculoskeletal pain" OR "osteoarthritis" OR "rheumatoid arthritis" OR "chronic pain
- "temperate" OR "tropical"

Data extraction was performed using a standardized extraction form developed for this review. Information collected from each included study comprised author details, year of publication, study design, sample characteristics, intervention protocols, outcome measures, and key findings related to musculoskeletal pain intensity and seasonal variations. Two reviewers independently screened and extracted the data to minimize bias and discrepancies, and any disagreements were resolved through discussion and consensus.

The methodological quality of the included studies was assessed using appropriate critical appraisal tools based on study design. Risk of bias, clarity of methodology, participant selection, outcome assessment, and reporting quality were evaluated to ensure the reliability and validity of the extracted evidence. Studies with higher methodological rigor were given greater consideration during evidence synthesis.

Pathophysiological Mechanisms of Seasonal and Meteorological Influences on Pain

Several mechanisms have been described, potentially functioning in parallel:

1. **Barometric pressure and joint mechanics:** Small changes in atmospheric pressure may alter the pressure within joint capsules and periarticular tissues, theoretically affecting mechanoreceptors and pain perception especially in structurally altered joints. This hypothesis fits with studies implicating barometric pressure in OA pain.[3]
2. **Humidity and soft-tissue stiffness:** High relative humidity and cold can increase perceived stiffness, alter muscle viscosity and affect tendon properties, which could increase discomfort and limit mobility for some patients. EI Iconaru et.al in 2024 in their study reveals a clear influence of both seasonal fluctuations and daily variations on clinical features of knee osteoarthritis in older adults.[4]
3. **Temperature-mediated behaviors:** Colder or wetter weather often reduces outdoor activity, leading to deconditioning and increased pain sensitivity; conversely, extreme heat can limit exercise tolerance and hydration, affecting gout flares and muscle cramps. These behavioural mediators can partly explain temperature-pain associations and may vary strongly by setting e.g., availability of climate control.[5]
4. **Inflammation modulation and air quality:** Air pollution episodes (which can be seasonal) may increase systemic inflammation, plausibly worsening inflammatory arthritides and pain; seasonal infectious triggers and vitamin D variation have also been suggested as indirect mediators.[6]

Results

Study Selection

The search retrieved 742 records; 23 studies met inclusion: 10 systematic reviews/meta-analyses, 9 longitudinal cohorts/time-series, and 4 cross-sectional studies.

Evidence from Temperate Regions

- **Osteoarthritis:**A systematic review and meta-analysis synthesising observational studies reported that barometric pressure and relative humidity were positively correlated with OA pain intensity, while temperature effects were more variable (some analyses suggested lower temperatures associated with greater pain). Wang et al[5] found

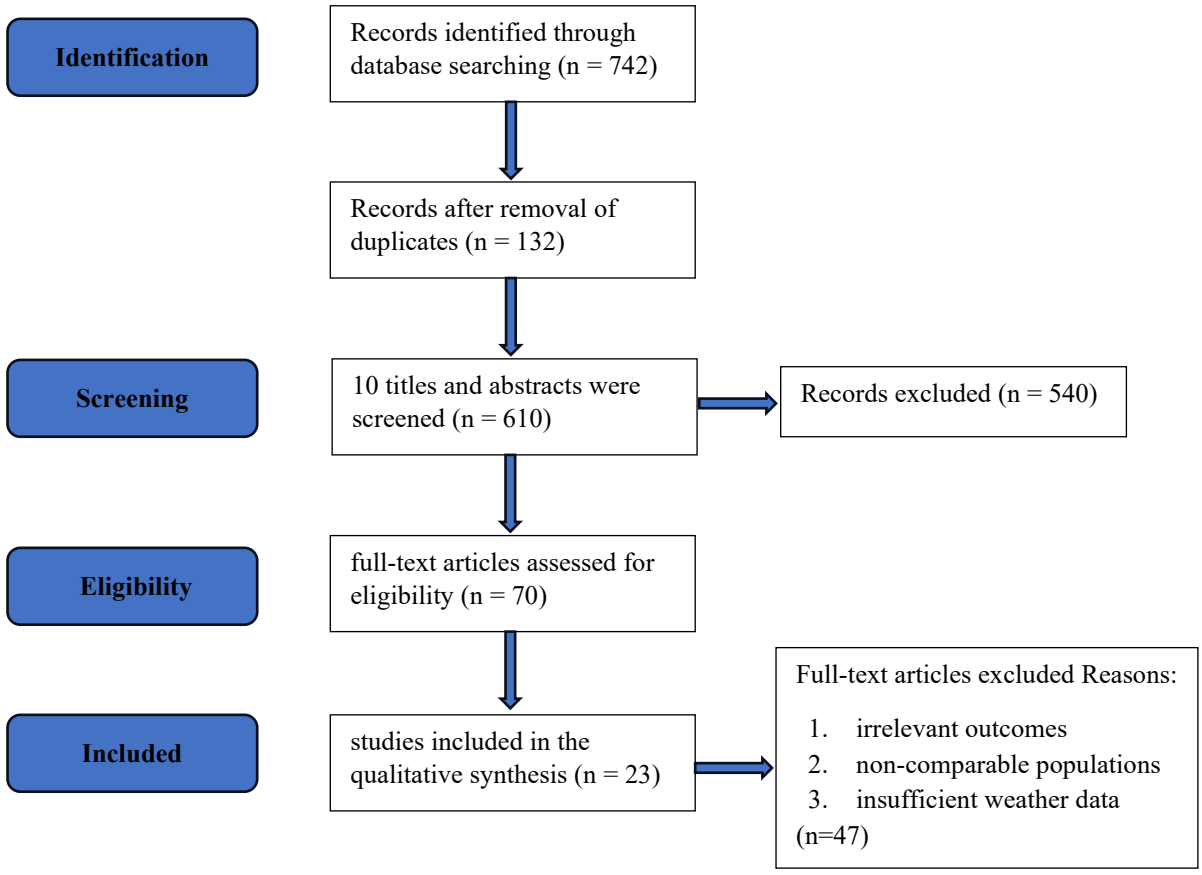


Figure 1. PRISMA 2020 Flow Diagram of Study Selection.

- positive associations between barometric pressure/ humidity and pain intensity, while temperature effects were inconsistent.
- **Rheumatoid arthritis**: Several time-series and registry-based studies in temperate countries report seasonal patterns in RA activity for example, peaks in flare or treatment initiation in particular seasons (often spring or winter, depending on the locale) suggesting weather- or season-related variation in inflammatory disease activity in some populations. However, effect sizes are generally modest and heterogeneous across studies. Mori et al.[7] and Azzouzi et al.[8] observed seasonal peaks in disease activity, although magnitudes were modest.
- **Chronic pain:**Multisite studies and longitudinal analyses in temperate climates find that a majority (but not all) of participants show some association between painfluctuations and one or more weather variables (temperature, humidity, pressure), but the direction and magnitude vary between individuals. Large, well-designed studies have emphasised that behavioural mediators (activity, sleep, mood) and recall bias can explain part of the association. Beukenhorst et al.[9] reported ~20% of patients demonstrated reproducible weather sensitivity, highlighting heterogeneity.

Evidence from Tropical Regions

- Sparse and mostly cross-sectional. Guedj et al.[10] and Talari et al.[11] described patient-reported worsening during rainy/humid seasons.
- Few studies integrated longitudinal diaries or precise meteorological data.

Seasonal Variation in Musculoskeletal Pain in Indian Populations

Indian studies demonstrated distinct and region-specific seasonal fluctuations in musculoskeletal (MSK) pain intensity, with patterns differing from those reported in temperate regions. Evidence from community -based, outpatient, and multi-site epidemiological datasets revealed two dominant seasonal peaks in India:

(1) monsoon-related increases in pain, particularly

among agrarian communities, and

(2) winter-associated worsening of osteoarthritis symptoms in older clinical populations.

Bang et al., in 2021 in a large community-based study from rural Gadchiroli, Maharashtra reported that among participants who experienced pain during only one season, the rainy (monsoon) season accounted for the highest proportion of MSK complaints. This included back pain, knee pain, and generalized limb pain. The authors suggested that elevated humidity, prolonged exposure to wet conditions, and seasonal agricultural labour demands unique to tropical rural India contributed to the increased symptom burden.[12]

In contrast, findings from a clinical cohort of primary knee osteoarthritis (OA) patients in Nashik, Western India showed a different seasonal trend. Based on VAS scores collected across three major Indian seasons, 73.3% of patients reported their worst pain in winter, 26.2% during the rainy season, and only 0.4% in summer. This cohort demonstrated a winter-dominant pain pattern, consistent with reports from several temperate-climate OA populations.[13]

Data from multiple COPCORD (Community Oriented Program for Control of Rheumatic Diseases) surveys across India further illustrated the influence of seasonal work cycles, ergonomic exposures, and climatic variability on MSK symptom patterns. These studies consistently reported high prevalence of knee, back, and soft-tissue rheumatism, with seasonal variation often aligning with periods of intensive manual labour, especially during monsoon months in agrarian communities.[14]

A regional COPCORD study from Trivandrum, Keralaby Mathew et al. in 2011 highlighted the functional impact of MSK pain and identified climate-linked exacerbations but noted that rainy-season symptom worsening was more commonly observed in younger, manual-labour groups, while winter aggravation was more prevalent in older adults with degenerative joint disease.[15]

Together, Indian data reveal heterogeneous seasonal pain patterns, shaped by both meteorological variables (temperature, humidity, barometric pressure) and context-specific behavioural factors, particularly occupational exposure during the monsoon season.

These findings contrast with the more uniform winter-dominant pain peaks commonly documented in temperate regions and highlight the need to consider local climate, occupation, and environmental context when interpreting seasonal pain variability in tropical settings.

Comparative Observations

- Temperate studies more consistently identify weather–pain associations, likely reflecting greater seasonal variability.
- Tropical findings are heterogeneous, possibly due to under-researched humidity and precipitation effects.
- Individual variability persists across all regions.

Physiotherapy Interventions for Patients Experiencing Seasonal Variations in Musculoskeletal Pain

Seasonal fluctuations in musculoskeletal paintypically cold-related exacerbations in temperate climates and humidity- or monsoon-related aggravations in tropical regionsnecessitate a targeted physiotherapy approach.

Accordingly, physiotherapy management in climate-sensitive patients should emphasise thermal modulation, functional conditioning, joint protection, behavioural strategies, and contextualised exercise prescription.

Physiotherapy for patients experiencing seasonal variations in musculoskeletal pain requires a climate-sensitive, multimodal approach. Thermal interventions such as heat therapy in cold seasons and cryotherapy in humid or hot environments provide symptom relief.

Climate-adapted exercise programs emphasising indoor aerobic training, strengthening, flexibility, and hydrotherapy address seasonal deconditioning and stiffness. Manual therapy, activity pacing, joint protection, and environmental modification further mitigate symptom severity. Education and tele-rehabilitation ensure continuity of care during extreme weather.

Collectively, these interventions align with evidence demonstrating that targeted physiotherapy improves pain, function, and self-management in populations affected by climate-linked MSK pain fluctuations.

1. Thermal Interventions Tailored to Climate-Triggered Symptoms

a. Heat Therapy for Cold-Induced Pain (Temperate Regions) Cold temperatures increase muscle tone, reduce tissue compliance, and exacerbate stiffness. Superficial heat (moist hot packs, heating pads, warm baths, paraffin applications) enhances circulation,

reduces pain sensitivity, and improves joint mobility.

Systematic reviews report clinically meaningful reductions in pain and improved function with superficial heat in OA and chronic MSK pain.[16]

b. Cryotherapy for Heat- or Humidity-Exacerbated Pain (Tropical Regions) In tropical climates, excessive heat or humidity may provoke inflammatory swelling or fatigue-related pain flares. Local cryotherapy (10–15 minutes) reduces inflammatory responses and provides analgesia.

According to Bleakley et al., study in 2010, Cryotherapy demonstrates short-term analgesic effects and reduced swelling in soft-tissue and inflammatory conditions.[17]

2. Climate-Responsive Exercise Therapy

Exercise remains the cornerstone of MSK pain management across climates but requires seasonal adaptation.

a. Indoor Aerobic and Strengthening Programs During Cold or Monsoon Seasons Patients experiencing cold-sensitive or rain-sensitive pain benefit from structured indoor programs that maintain mobility while avoiding environmental triggers. Interventions include treadmill walking, stationary cycling, resistance training, and low-impact circuit routines.

Exercise significantly improves pain and function in chronic MSK disorders regardless of climate, with strong evidence in OA and chronic low back pain.[18,19]

b. Warm-Water Hydrotherapy for Temperature-Related Stiffness Hydrotherapy is particularly beneficial for individuals in cold climates or for those experiencing morning stiffness during seasonal transitions.

Warm-water exercise improves pain, stiffness, and quality of life in arthritis.[20]

c. Flexibility and Neuromuscular Training to Counteract Seasonal Deconditioning Cold and monsoon seasons often reduce outdoor activity, predisposing patients to reduced ROM and muscle fatigue. Structured stretching, proprioceptive training, and postural exercises mitigate these effects.

3. Manual Therapy During Seasonal Exacerbations

Joint mobilisations (Maitland Grades I–III), soft-tissue mobilisation, and myofascial release can be integrated during symptomatic seasons to address stiffness and pain peaks.

Manual therapy combined with exercise demonstrates superior improvements in pain and function in OA and chronic spinal pain compared with exercise alone.

4. Activity Pacing and Seasonal Load Management

Maintaining consistent activity across seasons reduces climate-linked flare-ups.

Strategies include:

- Gradual progression of physical activity during colder months or monsoon onset
- Avoiding prolonged exposure to cold mornings (temperate zones)
- Reducing heavy manual labour during peak humidity periods (tropical zones)
- Incorporating micro-breaks and energy-conservation techniques

Activity pacing improves symptom control in chronic pain populations.

5. Assistive and Protective Devices

Cold climates: thermal gloves, joint warmers, compression sleeves to maintain peripheral temperature. Tropical climates: breathable supports, orthoses for swelling control during humidity-related flares.

Knee bracing and joint supports reduce pain and enhance functional stability in degenerative disease.

6. Patient Education and Climate-Specific Self-Management

Education is essential for long-term climate-related symptom regulation. Physiotherapists should instruct patients on:

- Temperature regulation strategies (layering, warm showers before activity, hydration in hot seasons)
- Home-based exercise routines adapted to weather constraints
- Recognition of pain patterns linked to climatic changes
- Sleep hygiene and behavioural coping for flare cycles

Self-management programs improve adherence, reduce pain, and enhance quality of life[22]:

7. Tele-Rehabilitation During Extreme Weather Conditions

Extreme cold, monsoon flooding, or heat waves often reduce in-person access to physiotherapy. Tele-rehabilitation ensures continuity of exercise supervision,

behavioural coaching, and symptom monitoring.

Tele-physiotherapy is effective for chronic MSK pain and improves accessibility.[23]

Discussion

This review highlights that seasonal variation in musculoskeletal pain is real for some patients but not universal. In temperate climates, barometric pressure and humidity are the most consistent correlates, while temperature effects remain inconsistent. In tropical regions, the evidence base is limited and inconclusive, reflecting methodological gaps.

Proposed mechanisms include joint capsule mechanics sensitive to barometric changes,[24] humidity-induced changes in tissue stiffness,[25] behavioural mediators such as reduced outdoor activity in extreme climates,[26] and systemic inflammatory modulation by seasonal air pollution or infections.[27]

Clinical implications: Physiotherapists should adopt an individualised approach, identifying patients with weather-sensitive pain. Practical strategies include encouraging indoor exercise during cold or wet conditions, advising hydration and activity timing in hot/humid climates, and leveraging tele-rehabilitation for continuity of care during adverse weather.

Limitations of evidence: Overrepresentation of temperate studies, reliance on self-reported recall, limited adjustment for behavioural confounders, and underrepresentation of low- and middle-income tropical countries.

Future Directions

1. Multi-site longitudinal studies across temperate and tropical regions using standardised symptom diaries.
2. Integration of wearable sensors to capture personal exposure.
3. Mechanistic studies combining clinical data with biomarkers.
4. Trials of season-adapted physiotherapy interventions.

Conclusion

A modest yet consistent body of evidence from temperate regions suggests that specific meteorological factors particularly barometric pressure and relative humidity may contribute to within-person variations in musculoskeletal pain intensity among certain individuals, notably those with osteoarthritis and inflammatory arthritides.

The limited research from tropical climates constrains cross-climatic comparisons and restricts the generalisability of existing findings. Given the methodological heterogeneity of available studies and the potential influence of behavioural and contextual confounders, physiotherapists should emphasise comprehensive, individualised assessment and promote pragmatic, modifiable management strategies. These include maintaining optimal physical activity levels, applying appropriate pacing techniques, ensuring adequate hydration, and utilising suitable indoor exercise alternatives to mitigate weather-related barriers. Rather than attributing symptom fluctuations to deterministic weather effects, clinical practice should focus on enhancing self-management, resilience, and functional independence.

To strengthen the evidence base, future research should prioritise well-designed, comparative longitudinal investigations that integrate individual symptom tracking, personal environmental exposure data, and relevant mechanistic biomarkers across diverse climatic contexts. Such research will advance understanding of the biopsychosocial interactions underpinning weather-related pain variability and inform physiotherapy interventions that are both evidence-based and contextually adaptive.

Conflict of Interest

The author declares no conflicts of interest.

References

1. Smedslund G, Hagen KB. Does rain really cause pain? A systematic review of the associations between weather factors and severity of pain in people with rheumatoid arthritis. Eur J Pain. 2011;15(1):5-10. doi:10.1016/j.ejpain.2010.05.003
2. Farbu EH. Our climatic environment and pain. Exposure to cold environment at work and the weather in daily life. 2021.
3. Horvath G, Nagy K, Tuboly G, Nagy E. Pain and weather associations–Action mechanisms; personalized profiling. Brain Res Bull. 2023;200:110696. doi:10.1016/j.brainresbull.2023.110696
4. Iconaru EI, Tarcau E, Ciucurel C. The influence of weather conditions on the diurnal variation in range of motion in older adults with knee osteoarthritis. J Clin Med. 2024;13(1):254. doi:10.3390/jcm13010254
5. Wang L, Xu Q, Chen Y, Zhu Z, Cao Y. Associations between weather conditions and osteoarthritis pain: a systematic review and meta-analysis. Ann Med. 2023;55(1):2196439. doi:10.1080/07853890.2023.2196439
6. McNALLY JD, Matheson LA, Rosenberg AM. Epidemiologic considerations in unexplained pediatric arthralgia: the role of season, school, and stress. J Rheumatol. 2009;36(2):427-33. doi:10.3899/jrheum.080358
7. Mori H, Sawada T, Nishiyama S, Shimada K, Tahara K, Hayashi H, et al. Influence of seasonal changes on disease

activity and distribution of affected joints in rheumatoid arthritis. BMC Musculoskelet Disord. 2019;20(1):30. doi:10.1186/s12891-019-2418-2
8. Azzouzi H, Ichchou L. Seasonal and weather effects on rheumatoid arthritis: myth or reality?. Pain Res Manag. 2020;2020(1):5763080. doi:10.1155/2020/5763080
9. Beukenhorst AL, Schultz DM, McBeth J, Sergeant JC, Dixon WG. Are weather conditions associated with chronic musculoskeletal pain? Review of results and methodologies. Pain. 2020;161(4):668-83. doi:10.1097/j.pain.0000000000001776
10. Guedj D, Weinberger A. Effect of weather conditions on rheumatic patients. Ann Rheum Dis. 1990;49(3):158-9. doi:10.1136/ard.49.3.158
11. Talari K, Pathak H, Jain N, Ravindran V. Access to rheumatologic care in tropical regions: barriers and solutions. Best Pract Res Clin Rheumatol. 2025;39(2):102052. doi:10.1016/j.berh.2025.102052
12. Bang AA, Bhojraj SY, Deshmukh M, Joshi VR, Yarmal T, Kalkotwar S, et al. Burden of pain in back and extremities in rural population: A community-based estimation of 12-month prevalence, distribution and duration of pain in rural Gadchiroli, India. J Glob Health. 2021;11:12001. doi:10.7189/Jogh.11.12001
13. Rathaur H, Joshi D, Mukhopadhyay S, karkabi S. Indian Journal of Novel Drug Delivery. Indian J Novel Drug Deliv. 2022;14(1):16-28.
14. Chopra A. Disease burden of rheumatic diseases in India: COPCORD perspective. Indian J Rheumatol. 2015;10(2):70-7. doi:10.1016/j.injr.2015.04.002
15. Mathew AJ, Chopra A, Thekkemuriyil DV, George E, Goyal V, Nair JB, et al. Impact of musculoskeletal pain on physical function and health-related quality of life in a rural community in south India: a WHO-ILAR-COPCORD-BJD India study. Clin Rheumatol. 2011;30(11):1491-7. doi:10.1007/s10067-0111824-0
16. Brosseau L, Taki J, Desjardins B, Thevenot O, Fransen M, Wells GA, et al. The Ottawa panel clinical practice guidelines for the management of knee osteoarthritis. Part three: aerobic exercise programs. Clin Rehabil. 2017;31(5):612-24. doi:10.1177/0269215517691084
17. Bleakley CM, O'Connor SR, Tully MA, Rocke LG, MacAuley DC, Bradbury I, et al. Effect of accelerated rehabilitation on function after ankle sprain: randomised controlled trial. BMJ. 2010;340. doi:10.1136/bmj.c1964
18. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M, Bennell KL. Exercise for osteoarthritis of the knee: a Cochrane systematic review. Br J Sports Med. 2015;49(24):1554-7. doi:10.1136/bjsports-2015-095424
19. van Middelkoop PM, Rubinstein PS, Verhagen PA, Ostelo PR, Koes PB, van Tulder PM. Exercise therapy for chronic nonspecific low-back pain. Best Pract Res Clin Rheumatol. 2010;24(2):193-204. doi:10.1016/j.berh.2010.01.002
20. Hinman RS, Heywood SE, Day AR. Aquatic physical therapy for hip and knee osteoarthritis: results of a single-blind randomized controlled trial. Phys Ther. 2007;87(1):32-43. doi:10.2522/ptj.20060006
21. Licciardone JC, Gatchel RJ, Aryal S. Recovery from chronic low back pain after osteopathic manipulative treatment: a randomized controlled trial. J Osteopath Med. 2016;116(3):144-55.
22. Lorig KR, Sobel DS, Ritter PL, Laurent D, Hobbs M. Effect of a self-management program on patients with chronic disease. Effective clinical practice: ECP. 2001;4(6):256-62.
23. Cottrell MA, Galea OA, O'Leary SP, Hill AJ, Russell TG. Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: a systematic review and meta-analysis. Clin Rehabil. 2017;31(5):625-38. doi:10.1177/0269215516645148
24. McAlindon T, Formica M, Schmid CH, Fletcher J. Changes in barometric pressure and ambient temperature influence osteoarthritis pain. Am J Med. 2007;120(5):429-34. doi:10.1016/j.amjmed.2006.07.036
25. Timmermans EJ, Schaap LA, Herbolsheimer F, Dennison EM, Maggi S, Pedersen NL, et al. The influence of weather conditions on joint pain in older people with osteoarthritis: results from the European Project on OSteoArthritis. J Rheumatol. 2015;42(10):1885-92. doi:10.3899/jrheum.141594
26. Ferreira ML, Zhang Y, Metcalf B, Makovey J, Bennell KL, March L, et al. The influence of weather on the risk of pain exacerbation in patients with knee osteoarthritis–a case-crossover study. Osteoarthritis Cartilage. 2016;24(12):2042-7. doi:10.1016/j.joca.2016.07.016
27. Chen YC, Chin WS, Pan SC, Wu CD, Guo YL. Long-term exposure to air pollution and the occurrence of metabolic syndrome and its components in Taiwan. Environ Health Perspect. 2023;131(1):017001. doi:10.1289/EHP10611