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# Technologies for Sustainable Development Goals 2025 (TECH4SDG-2025)

**School of Computer Science & Engineering**

**IILM University Greater Noida**

***Presents***

**1st National Conference**

***on***

**Technologies for Sustainable Development Goals 2025 (TECH4SDG-2025)**

**3rd March 2025**

Technically Co-Sponsored by IEEE UP SECTION (INDIA)

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# INTERNATIONAL JOURNAL OF RESEARCH IN MODERN ENGINEERING & EMERGING TECHNOLOGY (IJRMEET)

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On behalf of the *International Journal of Research in Modern Engineering & Emerging Technology (IJRMEET)*, I extend my heartfelt gratitude to all the authors and research scholars for choosing our platform to publish their valuable research contributions.

IJRMEET, a Refereed, Peer Reviewed, Indexed, and Monthly Journal in Electronic format, has been consistently dedicated since April 2013 to advancing scholarly work in the domains of Modern Engineering and Emerging Technologies. Your innovative and quality research is at the core of our mission to promote academic excellence and practical solutions in the ever-evolving field of engineering and technology.

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Our journal aims not only to disseminate high-quality research globally but also to highlight critical engineering problems and their practical resolutions. I encourage researchers, academicians, faculty members, and industry professionals to continue contributing to IJRMEET and to inspire their peers and students to join us in this academic pursuit.

We sincerely thank our respected Editors, Reviewers, Technical Advisors, Authors, Web Developers, Subscribers, Supporters, and the extended academic community whose efforts and encouragement make each issue of IJRMEET a successful endeavor.

**With warm regards,**

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**MESSAGE**

I am happy to know about Tech4SDG-2025, a distinguished national conference that aims to explore and highlight the transformative power of technology in achieving the United Nations Sustainable Development Goals (SDGs). This event serves as a critical platform for fostering collaboration among experts, innovators, and leaders who are dedicated to creating solutions that drive sustainable change.

As we face global challenges ranging from environmental sustainability to social equity, it is clear that technological advancements will play a pivotal role in shaping our collective future. Tech4SDG-2025 presents a unique opportunity to examine how cutting-edge technologies can contribute to solving the most pressing issues of our time, from climate change to poverty alleviation.

I look forward to the engaging discussions and innovative ideas that will emerge from this conference. I believe that by working together, we can harness the potential of technology to drive meaningful progress towards a sustainable and equitable world.

I extend my best wishes to all the participants and organizers of Tech4SDG-2025.

27.02.25

(Dr. Mohammad Rihan)

**Dated: 27th February, 2025**
**Place: Gurugram**

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# INDEX


| S. No. | Particulars | Page No. |
|---|---|---|
| 1 | A Comparative Study On Load Balancing Algorithms And Its Types<br>**Methily Johri & Aditri Ashish** | 1–10 |
| 2 | Optimizing Supply Chain Management with Ethereum 2.0: Innovations in Blockchain Technology<br>**Ayush Gupta & Dr. Ambuj Kumar Agarwal** | 11–17 |
| 3 | Smart Surveillance: "A Real-Time Crowd Analysis System for Density and Anomaly Detection"<br>**Komal Sharma, Dr. Pankaj Kumar Varshney, Aditi Aggarwal & Gaurav Kumar** | 17–22 |
| 4 | AI-Driven Network Optimization: Matching Policyholders to Cost-Effective Providers Using Business Intelligence<br>**Ruchi Mangharamani & Prof. (Dr) Sangeet Vashishtha** | 23–29 |
| 5 | The Future of UX: Designing for Emerging Technologies (AI, AR, VR, Voice UI)<br>**Ojas Gupta & Prof.(Dr.) Arpit Jain** | 30–37 |
| 6 | Enhancing Liquidity Stress Testing: Best Practices for Modern Banking Risks<br>**Padmini Bulani & Dr Abhishek Jain** | 38–45 |
| 7 | AI-Powered Investment Strategies: Optimizing Risk and Returns in Modern Banking<br>**Aditya Mehra & Dr. Shakeb Khan** | 46–53 |
| 8 | Scaling Customer Journey Optimization in a Multi-Tenant Distributed System | 54–61 |

| S. No. | Particulars | Page No. |
|---|---|---|
| | **Sumit Kumar Agrawal & Prof. (Dr) MSR Prasad** | |
| **9** | Object Detection Using Convolutional Neural Networks: Advances, Techniques, and Applications<br>**Bharath Thandalam Rajasekaran, Saravanan Thirumazhisai Prabhagaran & Prof. (Dr) Punit Goel** | 62–69 |
| **10** | AI-Augmented Intrusion Detection Systems for High-Speed Optical Networks<br>**Sattvik Sharma & Prof.(Dr) Avneesh Kumar** | 70–77 |
| **11** | Generative AI in Data Security: Opportunities and Challenges<br>**Vybhavreddy Kammireddy Changalreddy, Piyush Bipinkumar Desai & Prof (Dr) Ajay Shriram Kushwaha** | 78–86 |
| **12** | Integrating Salesforce with Cloud-Based Data Warehousing for Unified Analytics<br>**Nidhi Shashikumar & Dr S P Singh** | 87–94 |
| **13** | AI-Powered Cybersecurity: A Unified Approach to Protecting Enterprise, Cloud, and SaaS Applications<br>**Varun Grover, Khushmeet Singh & Er. Siddharth** | 95–103 |
| **14** | Sales and Order Analysis Using Excel-Based Dashboard: A Case Study on Vrinda Store<br>**Mohd Ammar Khan & Harun Faridi** | 104–106 |
| **15** | ChatMania: A Realtime Chat Application<br>**Dr. Kirti Shukla & Anshika** | 107–110 |

| S. No. | Particulars | Page No. |
|---|---|---|
| **16** | Digital Surveillance and Domestic Abuse: A Legal Vacuum in Indian Marital Relationships<br>**Vishal Nehra & Dr. Rakesh Kumar** | 110–116 |
| **17** | The Role of Emotional Appeal in Online Advertisements Targeting Working Women in Delhi-NCR<br>**Mona Mishra & Dr. Praveen Mittal** | 116–120 |
| **18** | AI-Driven Data Governance Strategies for Enhanced Cloud Security in Enterprises<br>**Chandana Pandey & Dr Gauri Shanker Kushwaha** | 121–123 |
| **19** | Evolution of Social Media Advertising and Consumer Behavior<br>**Mr. Pramod Rana & Prof (Dr) Punit Goel** | 124–129 |
| **20** | Sustainability Accounting Practices in Indian Manufacturing Firms<br>**Mrs. Sonal Jain & Dr. Ajit Singh** | 129–134 |
| **21** | Fundamental Rights vs. Reasonable Restrictions: A Study of Evolving Judicial Balances<br>**Mrs. Anshika Agarwal & Dr. Vijay Kumar Singh** | 134–139 |
| **22** | सतत शिक्षा के लिए हिंदी साहित्य की भूमिका: सतत विकास लक्ष्य-4 (गुणवत्तापूर्ण शिक्षा) का सांस्कृतिक विश्लेषण<br>**श्रीमती रेणु गुप्ता, डॉ. बृजलता शर्मा** | 140–144 |
| **23** | Mind–Gut Synergy in Chronic Lifestyle Conditions: Evaluating Psychotherapy-Driven Behavioral Change and Microbiota-Mediated Metabolic Repair<br>**Krithika. V, Dr. Sarbesh Kumar Singh** | 145–151 |

| S. No. | Particulars | Page No. |
|---|---|---|
| 24 | प्राचीन शिक्षा प्रणाली से आधुनिक AI आधारित शिक्षा की ओर संक्रमण<br>**गौरव जोशी, डॉ सारिका गोयल** | 152–159 |
| 25 | पर्वतीय क्षेत्रों में शिक्षा के डिजिटलीकरण की चुनौतियाँ एवं संभावनाएँ<br>**राकेश उनियाल, डॉ. मीनाक्षी हर्राव वर्मा** | 160–168 |
| 26 | Women Leadership and Democratic Participation in India: Challenges and Opportunities in Parliamentary Politics<br>**Renu Yadav, Dr. P.P.S. Rana** | 169–176 |
| 27 | Evaluating GST Effects on Competitiveness and Industrial Development<br>**Aman Goel, Dr. Pooja Yadav** | 177–183 |
| 28 | एस०आर० हरनोट के कथा साहित्य में लोक संस्कृति, पर्यावरण चेतना और सामाजिक परिवर्तन का अध्ययन<br>**सीमा देवी, डॉ० अरविन्द्र कौर चुंबर** | 184–189 |
| 29 | Balancing National Security and Human Rights in Modern India<br>**Shalu Jain, Dr. Vijay Kumar** | 190–197 |
| 30 | Economic Performance Drivers and Fiscal Resilience in Indian Airports<br>**Lalit Kumar Sharma, Dr. Pooja Yadav** | 198–203 |
| 31 | Educational Governance and AI Learning Outcomes in Government Elementary Schools<br>**Dr. Shubhra Chaturvedi** | 203–210 |
| 32 | Artificial Intelligence and the Future of Teacher Roles in India Classroom<br>**Neeru Verma** | 211–220 |
| 33 | Research Culture Among Undergraduate Students in Indian Universities<br>**Dr. Dhanashri Rajshri Ravindra Jadhav** | 221–229 |

| S. No. | Particulars | Page No. |
|---|---|---|
| 34 | Awareness of Human Papillomavirus Vaccination Among Adolescent Girls and Their Parents<br>**Dr. Chintamani Venu Madhav Naresh Kumar** | 230–234 |
| 35 | Graduate Employability and Skill Gaps in State Universities<br>**Narender Panghal** | 235–242 |
| 36 | Political Funding Transparency in Indian Election<br>**Dr. Anand Kumar Dwivedi** | 243–252 |
| 37 | AI-Powered Platforms for Data Analytics and Audience Development<br>**Sachin Sangal** | 253–258 |
| 38 | Engineering Leadership Models in AI Startups: Balancing Innovation and Operational Efficiency<br>**Dr. Kalpesh Rasiklal Rakholia** | 259–269 |
| 39 | Challenges in Integrating CWSN in Regular Classrooms<br>**Anil Kumar** | 270–280 |
| 40 | An Artificial Intelligence-Based Legal Compliance Framework for Real-Time Environmental Governance to Advance SDGs 9, 12, 13, and 16<br>**Dr. Jyoti Janardhan Reddy** | 281–288 |
| 41 | Impact of Source Segregation and Waste Characterization on the Efficiency of Material Recovery Facilities<br>**Varinder Vikram Singh, Dr. Pankaj Kumar Bharti** | 289–296 |
| 42 | Significance of Emotional Intelligence of schedule caste students in relation to Self-concept at secondary level<br>**Mrs. Varsha Asher Wasker, Dr. Kuldeep Singh Tomar** | 297–305 |
| 43 | औपनिवेशिक भारत में स्थानीय बाजारों के सामाजिक परिवर्तन का ऐतिहासिक अध्ययन<br>**Pankaj Tamta** | 306–310 |

| S. No. | Particulars | Page No. |
|---|---|---|
| 44 | Teachers' Readiness to Integrate Generative AI into Lesson Planning and Classroom Instruction<br><br>**Prema Bharti** | 311–316 |
| 45 | Battery Usage Optimization Techniques for AI-Heavy Mobile Apps<br><br>**Dr. Akankasha Kathuria** | 317–321 |
| 46 | Gender, Technology, and Changing Family Structures in Urban India: A Socio-cultural Analysis<br><br>**Prof. Sawant Jeetendra Madhukar Usha** | 322–326 |
| 47 | Law and Alternative Dispute Resolution in Contemporary Civil Justice: A Legal Study<br><br>**Dr. Pooja Khurana** | 327–331 |
| 48 | English Literature and the Representation of Women in Contemporary Fiction: A Corpus-Based Study of Narrative Agency, 2000–2024<br><br>**Dr. Abu Farah Hoque** | 332–336 |
| 49 | Agricultural Impact of Biochar and Reduced Fertilizer on Mustard Soil Health and Yield<br><br>**Dr. Bibhu Santosh Behera** | 337–346 |
| 50 | Ethical and Privacy Frameworks for AI-Driven Customer Data Analytics in Medical Profession<br><br>**Dr. Gaurav Singh Tomar** | 347–351 |
| 51 | Influence of Abhyas and Meditation on Attention, Emotional Regulation, and Lifestyle Behaviour among Students<br><br>**Dr. Rakhee Rajendra Gugale** | 352–357 |
| 52 | Platform Culture and Fragmented Selfhood in Contemporary English Literature<br><br>**Dr. Akanksha Singh** | 358–362 |
| 53 | Digital Health Literacy and Health Information Inequality in Rural India: A Multidimensional Assessment | 363–368 |

| S. No. | Particulars | Page No. |
|---|---|---|
| | **Ranjana Jadaun** | |
| 54 | स्मार्ट विनिर्माण और उद्योग 5.0 में कृत्रिम बुद्धिमत्ता, मानव-केंद्रित तकनीक और सतत विकास का अंतःविषयक अध्ययन<br>**Dr. Ghamendra Kumar Sahu** | 369–375 |
| 55 | Contribution of Yoga-Based Breathing Techniques to Daily Stress Management<br>**Dr. Sweta Kumari** | 376–387 |
| 56 | Algorithmic Silence and Unspoken Meaning in Contemporary English Fiction<br>**Dr. Jyoti Devi** | 388–396 |
| 57 | Cost-Benefit Analysis of Custom Image Analysis Tools in Oncology Research<br>**Sumit Malhotra** | 397–405 |
| 58 | उच्च शिक्षा में सूक्ष्म अधिगम तकनीकों का शैक्षिक प्रभाव<br>**Ram Singh** | 406–412 |
| 59 | Optimising Laboratory Workflows with Low-Code/No-Code Software Solutions<br>**Dr. Amit Nampalliwar** | 413–421 |
| 60 | भारतीय बहुभाषिक समाज में भाषा, संस्कृति और राष्ट्रीय एकता का अध्ययन<br>**Dr. Geeta Rawat** | 422–428 |
| 61 | Influence of FinTech Innovation on Financial Resilience and Operational Efficiency of Retailers and Street Vendors<br>**Prof. Manmeet Kumar Siras & Shyam Pandey** | 429–435 |
| 62 | भारत में आपातकालीन शक्तियाँ और लोकतांत्रिक उत्तरदायित्व: संसदीय शासन के अंतर्गत राष्ट्रपति की संवैधानिक भूमिका का विश्लेषण<br>**सीता राम पंडित, डॉ. पी. पी. राणा** | 436–441 |
| 63 | Mechanical Design Improvements for Faster Thermal Dissipation in High-Capacity Batteries | 442–450 |

| S. No. | Particulars | Page No. |
|---|---|---|
| | **Dharmendra Tiwari** | |
| 64 | English Literature and the Changing Patterns of Communication among Young Adults<br>**Ravindra Hanmantrao Sagar** | 451–459 |
| 65 | An Explainable AI Framework for Transparent and Reliable Medical Diagnosis<br>**Dr. Thejoram Naresh Reddy Boya** | 460–466 |
| 66 | डिजिटल समुदायों का युवा शिक्षा और सामूहिक पहचान पर प्रभाव<br>**डॉ. मनोज कुमार सकलानी** | 467–473 |
| 67 | Adaptive Technologies for Enhancing Online Shopping Experiences<br>**Dr. Abhishek Bhattacharjee** | 474–479 |
| 68 | Impact of Digital Payment Adoption through AI-ML on Micro-Business Performance<br>**Ralphy Joseph C J** | 480–484 |
| 69 | Role of Regional Parties in Shaping Federalism in India<br>**Dr. Shailendra Kumar** | 485–489 |
| 70 | Serverless Computing Optimization: Enhancing Performance with AI-Based Resource Allocation<br>**S. Venkatasubramanian** | 490–495 |
| 71 | Student Satisfaction in Autonomous vs. Affiliated Colleges<br>**Dr. Mohit Dixit** | 496–500 |
| 72 | Psychological and Social Isolation and Its Effect on Urban Elderly<br>**Mredula P., Dr Sarita Gupta** | 501–507 |
| 73 | The Role of Folk Literature in Promoting Community Health Awareness in Rural India: A Study from the Perspective of English Literature | 508–512 |

| S. No. | Particulars | Page No. |
|---|---|---|
| | **Dr. Revant Gautam** | |
| 74 | Exam Stress Clinical Psychology Mechanisms Among Rural Students<br>**Dr. Avinash D. Karambhe** | 513–517 |
| 75 | उभरती हिंद-प्रशांत सुरक्षा संरचना में भू-राजनीतिक प्रतिस्पर्धा और रणनीतिक प्रतिरोध<br>**Dr. Girish Chandra Pachauli** | 518–522 |
| 76 | Sustainable Edible Coatings for Reducing Oxidative Deterioration in Fresh Fruits<br>**Amar Jensi Solanki** | 523–528 |
| 77 | Impact of GST Implementation on Legal Disputes in Small Businesses<br>**Dr. Nikhat Khan** | 529–534 |
| 78 | Innovations in Healthcare Product Management Through AI and Machine Learning<br>**Dr. Navdeep Singh** | 535–538 |
| 79 | Psychological Effects of Music and Memory Recall in Elderly Patients<br>**Lindamulage Mithun Dilantha Deva Adithiya** | 539–544 |
| 80 | Comparative Study of Formative Assessment in Government vs. Private Schools<br>**Dr. Roopali Chandra** | 545–549 |
| 81 | Educational Learning Needs of Orphaned Children in Institutional Homes<br>**Ajitha. P. M** | 550–554 |
| 82 | Behavioral Differences in Joint vs. Nuclear Family Children<br>**Rajeevan Edadan Puthiya Veetil** | 555–559 |
| 83 | Leveraging Data Architecture to Enhance Business Intelligence in Retail and Finance<br>**Dr. Priyanka Gosain** | 560–563 |

| S. No. | Particulars | Page No. |
|---|---|---|
| 84 | Effect of Pelvic Floor Exercises on Women's Health and Functional Recovery<br>**Dr. Kapila Jain** | 564–569 |
| 85 | Acceptance of AI-Assisted Drug Information Systems by Pharmacists<br>**Dr. Tarun Sahani** | 570–574 |
| 86 | Jane Austen's Portrayal of Marriage and Society in English Literature<br>**Serjana Thapa** | 575–581 |
| 87 | Employability Skill Gaps in Engineering Graduates (2013–2016)<br>**Dr. A. H. Khan** | 582–586 |
| 88 | Aggressive Behavior, Family Conflict and Social Adjustment Among Students in Rural Kerala: A Comparative Study<br>**Vinod Babu, Prof . Dr. S. Chandrachud** | 587-592 |
| 89 | Impact of Digital Documentation on Logistics Management Efficiency<br>**S. Lakshmi Narasimma** | 593–599 |
| 90 | Generative AI Models for Product Design Innovation: Applications in Automotive and Last-Mile Delivery<br>**Dr. Bimal Kumar Kalita** | 600–603 |
| 91 | Prevalence of Low Back Pain Among Women Attending General Outpatient Departments<br>**Dr. Trushna Tembhekar** | 604–609 |
| 92 | Women's Reservation and Performance in Local Bodies<br>**Rashmi Shukla** | 610–613 |

| S. No. | Particulars | Page No. |
|---|---|---|
| 93 | Ayurvedic Approaches to Menopausal Health and Rajonivritti<br>**Dr. Ashwini R. Metangale** | 614–619 |
| 94 | Effect of Core Strengthening Exercises on Physical Function in Women<br>**Prof. (Dr.) Vrushalee Dodke** | 620–625 |
| 95 | Relationship Between Physical Activity and Joint Health Among Young Adults<br>**Dr. Priti S. Arikar** | 626–632 |
| 96 | Assessment of Screen Time and Sleep Quality Among School-Age Children<br>**Dr. Sayali Jichkar** | 633–638 |
| 97 | Cellular Responses of Yeast to Different Sugar Concentrations in Biology<br>**Aarthi B Pradhan** | 639–644 |
| 98 | Political Funding Transparency in Indian Elections<br>**Dr. Kanta Verma** | 645–648 |
| 99 | Gender Identity and Expression in College Students<br>**Dr. Babhuti Kashyap** | 649–653 |
| 100 | A Study of the Corrosion Inhibition Properties of Glycine and Alanine on Metal Surfaces<br>**Pinky** | 654–659 |
| 101 | The Impact of British Rule on the Indian Education System<br>**Dr. Nageshwar Joolu** | 660–664 |

| S. No. | Particulars | Page No. |
|---|---|---|
| 102 | Merchandising Optimization Techniques for Users in Online Marketplaces<br>**Dr. Munish Kumar Sharma** | 665–668 |
| 103 | Incorporating Voice Navigation and Control in Web Accessibility<br>**Venkata Sumanth Appari** | 669–673 |
| 104 | Relationship Between Posture and Common Musculoskeletal Problems Among Adults<br>**Dr. Rupali Vaibhav Selukar** | 674–677 |
| 105 | Influence of Household Water Sources on Basic Microbial Diversity<br>**Dr. Kunjlata Lal** | 678–681 |

# Relationship Between Physical Activity and Joint Health Among Young Adults

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**Abstract : Physical activity is an important determinant of musculoskeletal health, influencing muscle strength, joint stability, movement coordination, functional capacity, and the ability to participate in daily activities. Among young adults, regular physical activity may help maintain healthy joint function and reduce the burden of inactivity-related musculoskeletal complaints. However, the relationship is complex because exercise intensity, training frequency, previous joint injuries, body composition, recovery practices, and the type of physical activity can influence joint health differently. This study examines the relationship between physical activity levels and joint health among young adults, with particular attention to joint pain, stiffness, functional mobility, perceived joint stability, and exercise-related symptoms. A quantitative cross-sectional research framework is presented using standardized physical activity assessment, joint symptom questionnaires, and functional evaluation. The proposed analytical approach compares joint health indicators across low, moderate, and high physical activity groups while accounting for relevant demographic and lifestyle factors. Existing evidence suggests that appropriately prescribed exercise generally supports musculoskeletal function, while excessive repetitive loading and previous joint injuries may increase the risk of selected joint problems. The study emphasizes that physical activity should be evaluated according to both its volume and characteristics rather than treating all exercise as equally beneficial or harmful. Its findings framework may help inform exercise education, preventive healthcare, and future longitudinal research into joint health during early adulthood.**

**Keywords: Physical activity, joint health, young adults, musculoskeletal health, joint pain, exercise, mobility, joint stability, sedentary behaviour**

## Introduction

Physical activity is a fundamental component of a healthy lifestyle and contributes to the maintenance of muscular strength, cardiovascular fitness, bone health, coordination, and functional independence. During young adulthood, generally defined in this study as 18–35 years, individuals establish physical activity habits that may influence their health over subsequent decades. Walking, running, cycling, resistance training, recreational sports, and occupational movement represent different forms of activity, each involving distinct patterns of joint loading.

Joint health refers to the ability of joints and their associated structures to support movement with adequate stability, mobility, load tolerance, and minimal symptoms. Healthy joint function depends on interactions among articular cartilage, subchondral bone, synovial tissues, ligaments, tendons, and surrounding muscles. Physical activity influences these structures through mechanical loading, muscular adaptation, neuromuscular coordination, and changes in body composition.

Regular, appropriately dosed exercise can improve muscular support around joints and help maintain functional capacity. However, the assumption that greater physical activity always produces better joint health is not supported in every circumstance. Repetitive high-impact loading, inadequate recovery, sudden increases in training volume, and acute joint injuries may contribute to pain or other musculoskeletal problems. These considerations are particularly relevant to young adults participating in competitive sports, intensive resistance training, or physically demanding occupations.

Sedentary behaviour presents a different challenge. Prolonged sitting and low levels of movement may coincide with reduced muscular conditioning, lower physical fitness, and discomfort during daily activities. The relationship between sedentary behaviour and joint symptoms is nevertheless influenced by posture, occupational demands, body weight, psychosocial factors, and underlying health conditions.

The World Health Organization recommends that adults undertake 150–300 minutes of moderate-intensity aerobic activity or 75–150 minutes of vigorous-intensity activity per week, or an equivalent combination, alongside muscle-strengthening activities on at least two days per week.

These recommendations provide a general health framework but do not imply that every individual will experience identical joint outcomes.

Understanding the relationship between physical activity and joint health therefore requires consideration of activity level, exercise type, symptom patterns, previous injury, and functional performance. This research examines these

relationships among young adults and explores how activity habits may be associated with joint pain, stiffness, and mobility.

## Review of Literature

### Physical activity and musculoskeletal health

Warburton, Nicol, and Bredin (2006) reviewed the health benefits of physical activity and emphasized its importance in the prevention of chronic disease and the maintenance of physical functioning. Their work provides a foundation for understanding physical activity as a broad determinant of health rather than an isolated intervention for individual joints.




The World Health Organization (2020) consolidated evidence-based recommendations for physical activity and sedentary behaviour across population groups. The guidelines emphasize that regular activity is beneficial for adults and that the type, frequency, intensity, and duration of movement should be considered when developing health recommendations.

### Exercise and joint tissue health

The mechanical loading associated with movement contributes to the normal function of joint tissues. Appropriate loading supports muscular adaptation and functional capacity, while prolonged unloading and excessive repetitive loading may have different consequences.

Bricca et al. (2019) systematically reviewed randomized controlled trials examining exercise-related changes in articular cartilage among adults with or at risk of knee osteoarthritis. Their findings suggested that exercise was not generally harmful to cartilage in the studied populations, although evidence quality was limited and results varied by outcome.

Roos and Dahlberg (2005) investigated the effects of moderate exercise on cartilage glycosaminoglycan content in individuals with knee osteoarthritis. Their work contributed to the understanding that appropriately dosed mechanical loading may influence cartilage composition, although findings from clinical populations cannot automatically be generalized to all healthy young adults.

### Physical activity, pain, and joint function

Exercise may influence joint symptoms through improved muscular strength, movement control, and physical conditioning. However, pain does not always correspond directly to structural joint damage, and symptoms may also arise from tendons, ligaments, bursae, or other periarticular tissues.

The systematic umbrella review by Goh et al. (2019) found that physical activity reduced pain and improved physical function among people with hip or knee osteoarthritis, with evidence also supporting improvements in health-related quality of life. These findings concern people with established osteoarthritis and should not be interpreted as direct estimates of effects among healthy young adults.

Behan, Oswald, and O'Sullivan (2026) reviewed exercise interventions for younger adults with osteoarthritis. Their review identified limited directly applicable evidence, despite improvements in some pain, functional, and tissue-related outcomes across the included studies. The authors highlighted the need for further research focused on younger populations.

### High-intensity activity and joint injury

The relationship between intensive sport participation and joint health differs according to the sport, training exposure, previous injuries, and individual characteristics. Activities involving repetitive high-impact loading, abrupt directional changes, and substantial rotational forces may expose certain joints to greater injury risk.

Tran et al. (2022) reviewed the association between athletic participation and the development of knee and hip osteoarthritis. The review suggested that some forms of intensive sports participation may be associated with increased risk, particularly in younger male athletes, although sport-specific exposures and other risk factors complicate interpretation.

Kujala et al. (1995) investigated the risk of hospitalization for knee osteoarthritis among former elite athletes and found that risk differed by sport. This work highlights the importance of distinguishing recreational exercise from long-term exposure to highly demanding athletic training.

### Sedentary behaviour and movement patterns

Young adults may experience prolonged sitting because of educational, occupational, or digital activities. Low daily movement can coexist with occasional intensive exercise, meaning that exercise sessions alone may not fully describe a person's overall activity pattern.

The World Health Organization (2020) recommends limiting sedentary time and replacing it with physical activity of any intensity where possible. However, research should distinguish sedentary time from physical inactivity because an individual may meet exercise recommendations while still spending substantial portions of the day sitting.

**Research gap**

Existing literature provides evidence that physical activity can support musculoskeletal function, but fewer studies focus specifically on otherwise generally healthy young adults while simultaneously considering activity level, joint symptoms, previous injuries, sedentary time, and functional mobility. Research is also needed to distinguish the benefits of regular moderate activity from the potential risks associated with excessive training loads or inadequate recovery.

The present study addresses this gap by evaluating multiple dimensions of physical activity and joint health within a unified quantitative framework.

**Aim of the Study**

To examine the relationship between physical activity levels and joint health among young adults aged 18–35 years.

**Objectives of the Study**

- To assess physical activity levels among young adults.
- To determine the prevalence and distribution of self-reported joint pain and stiffness.
- To examine differences in joint health indicators across physical activity categories.
- To investigate the association between physical activity and functional mobility.
- To assess whether previous joint injury, sedentary time, body mass index, and other relevant factors influence the relationship between physical activity and joint health.

**Research Hypotheses**

Null hypothesis ($H_0$): There is no statistically significant association between physical activity level and joint health among young adults.

Alternative hypothesis ($H_1$): Physical activity level is significantly associated with one or more joint health indicators among young adults.

**Materials and Methods**

**Research Design**

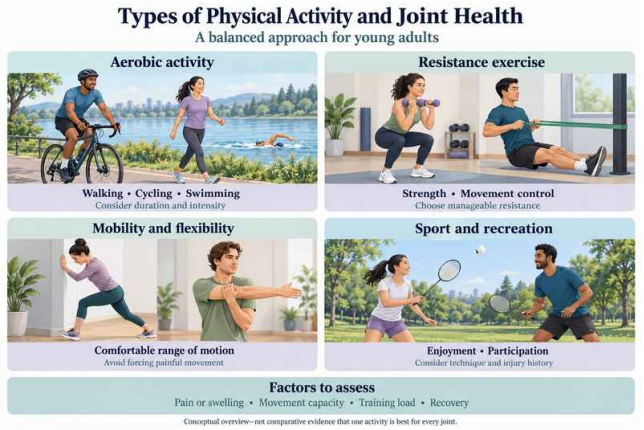
A quantitative cross-sectional analytical study design is proposed to examine the association between physical activity and joint health among young adults. This design allows researchers to compare activity levels and joint health indicators at a defined point in time. Because exposure and outcomes are measured concurrently, the study can identify associations but cannot establish whether physical activity causes changes in joint health.

**Study Setting and Population**

The study may be conducted among university students, early-career employees, recreational athletes, and other community-dwelling young adults in an urban or semi-urban setting.

The target population consists of adults aged 18–35 years. Participants would be recruited through educational institutions, workplaces, fitness facilities, and community networks, subject to ethical approval and access permissions.

**Inclusion and Exclusion Criteria**




The inclusion criteria are:

- Adults aged 18–35 years.
- Individuals able to complete the physical activity and joint health assessments.
- Participants willing to provide informed consent.
- Individuals with a range of activity levels, including low, moderate, and high activity.

Individuals with acute injuries preventing safe functional testing, recent major joint surgery, or medical conditions that make the proposed physical assessments inappropriate would be excluded from those assessments. Chronic joint conditions should be documented rather than automatically excluding all affected individuals, as their inclusion may be important to understanding the relationship being studied.

**Sample Size and Sampling Technique**

A target sample of 240 participants is proposed for the study framework. A formal sample-size calculation should be completed using the expected association between physical activity and the primary joint health outcome, a prespecified significance level of 0.05, statistical power of at least 80%, and an allowance for incomplete questionnaires.

Convenience or consecutive recruitment may be used when probability sampling is not feasible. The sampling approach and recruitment sources should be reported transparently because they influence how widely the findings can be generalized.

**Assessment of Physical Activity**

Physical activity would be assessed using the International Physical Activity Questionnaire–Short Form (IPAQ-SF), which records walking, moderate-intensity activity, vigorous-intensity activity, and sitting time over the previous seven days.

Activity data would be processed according to the questionnaire's scoring protocol and summarized as metabolic equivalent minutes per week (MET-min/week). Participants would be categorized into low, moderate, and high physical activity groups using the IPAQ scoring criteria rather than arbitrary thresholds.




Self-reported activity is susceptible to recall and social desirability bias. If resources permit, accelerometers or validated activity trackers could be used in a subsample to provide an objective comparison.

**Assessment of Joint Health**

Joint health would be assessed through a standardized questionnaire and selected functional tests. The following measures are proposed:

- Joint pain: A 0–10 Numeric Pain Rating Scale (NPRS), with higher scores indicating greater pain intensity.
- Joint stiffness: A standardized self-report item measuring perceived stiffness, including its frequency and interference with daily activities.
- Joint-related function: A suitable validated regional questionnaire, such as the Knee injury and Osteoarthritis Outcome Score (KOOS) for knee-related symptoms, where applicable.
- Functional mobility: A standardized five-times sit-to-stand test or another test selected in advance for the population and research question.
- Previous injury: Self-reported history of clinically assessed joint injuries, including anatomical site, approximate date, and whether symptoms remain.
- Body mass index: Calculated from measured body weight and height where feasible.

A regional questionnaire should not be used as if it measures every joint in the body. The primary joint site should therefore be prespecified, or joint-specific outcomes should be analysed separately.

**Data Collection Procedure**

After informed consent, participants would complete demographic and lifestyle questionnaires, followed by the physical activity assessment and joint health evaluation. Data collection would be conducted using standardized instructions and consistent procedures.

The collected variables would include age, sex, educational or occupational status, activity level, average sitting time, body mass index, previous joint injury, and the presence of joint symptoms. Researchers should also record the main type of physical activity, such as walking, running, resistance training, cycling, or organized sport.

Questionnaires would be checked for completeness before data entry. Participants' identities would be separated from analytical data, and records would be stored securely.

**Statistical Analysis**

Data would be analysed using appropriate statistical software. Continuous variables would be summarized as means and standard deviations or medians and interquartile ranges, depending on their distributions. Categorical variables would be summarized as frequencies and percentages.

Associations between activity categories and the prevalence of joint pain would be assessed using chi-square tests or Fisher's exact tests, as appropriate. Differences in continuous outcomes would be examined using analysis of variance or suitable nonparametric alternatives.

Multivariable logistic regression would be used to assess the relationship between physical activity and the presence of joint pain, adjusting for relevant covariates such as age, sex, body mass index, previous joint injury, and sedentary time. Adjusted odds ratios, 95% confidence intervals, and p-values would be reported. The statistical significance threshold would be set at $\(p < 0.05\)$.

Potential nonlinear associations should be considered because both very low activity and certain patterns of excessive training may be associated with adverse outcomes. Missing data, model assumptions, and sensitivity analyses should be documented.

## Results

The following tables demonstrate a consistent way to present results for this study. The numerical values are hypothetical reporting values and must be replaced with actual observations before the work is submitted as an empirical research paper. They are not findings from a completed study.

### Demographic Characteristics of Participants

*Table 1. Baseline characteristics of participants (N = 240)*

| Characteristic | Value |
|---|---|
| Total participants | 240 |
| Mean age (years) | 26.1 ± 4.7 |
| Men | 124 (51.7%) |
| Women | 116 (48.3%) |
| Mean BMI (kg/m²) | 23.8 ± 3.6 |
| Previous joint injury | 48 (20.0%) |
| Regular participation in organized sport | 72 (30.0%) |
| Mean daily sitting time (hours) | 7.1 ± 2.2 |

The proposed profile illustrates a sample comprising young adults with varied activity habits and injury histories. The sex categories total 240 participants, and the reported injury prevalence corresponds to 48 participants.

### Distribution of Physical Activity Levels

*Table 2. Physical activity categories among participants*

| Physical activity level | Participants | Percentage |
|---|---|---|
| Low | 72 | 30.0% |
| Moderate | 96 | 40.0% |
| High | 72 | 30.0% |
| Total | 240 | 100.0% |

In the completed study, group classification would follow the IPAQ-SF scoring protocol. The distribution should be calculated from each participant's valid activity responses rather than assigned to produce balanced groups.

### Joint Health Indicators Across Activity Groups

*Table 3. Joint health outcomes by physical activity level*

| Outcome | Low activity (n = 72) | Moderate activity (n = 96) | High activity (n = 72) |
|---|---|---|---|
| Participants reporting joint pain | 32 (44.4%) | 29 (30.2%) | 27 (37.5%) |
| Mean pain score (0–10) | 3.1 ± 2.0 | 2.4 ± 1.8 | 2.7 ± 1.9 |
| Frequent stiffness, n (%) | 25 (34.7%) | 21 (21.9%) | 20 (27.8%) |
| Mean sit-to-stand completion time (seconds) | 10.8 ± 2.1 | 9.7 ± 1.9 | 9.5 ± 1.8 |

These hypothetical values show a non-linear pattern in which the moderate-activity group reports fewer joint symptoms than the low-activity group, while the high-activity group falls between the other groups for pain and stiffness prevalence. This pattern is useful for examining the possibility that activity type, training exposure, and injury history matter in addition to total activity volume.




The functional test values would require consistent administration and confirmation that the test is appropriate for the recruited population. The table alone does not establish statistically significant differences.

### Multivariable Analysis

*Table 4. Proposed adjusted regression reporting format*

| Predictor | Adjusted odds ratio | 95% confidence interval | p-value |
|---|---|---|---|
| Moderate vs low activity | 0.62 | 0.34–1.12 | 0.112 |
| High vs low activity | 0.79 | 0.42–1.48 | 0.463 |
| Previous joint injury | 2.41 | 1.28–4.53 | 0.006 |
| Each 1 kg/m² increase in BMI | 1.04 | 0.98–1.11 | 0.191 |
| Each additional sitting hour per day | 1.09 | 0.98–1.22 | 0.116 |

Outcome: Presence of self-reported joint pain. The estimates above are hypothetical and do not represent fitted results from participant-level data. The model is intended to demonstrate reporting format; actual odds ratios, confidence intervals, and p-values must be calculated from the final dataset.

If estimates similar to those displayed were observed, the interpretation would be that previous joint injury is associated with higher odds of reporting joint pain after adjustment for the included variables. The activity-category estimates would not meet the conventional significance threshold in this example, and their confidence intervals would indicate uncertainty. No conclusion of a statistically significant protective effect should be drawn from these values.

## Discussion

The relationship between physical activity and joint health is multifactorial. Physical activity can support muscle strength, coordination, and functional capacity, but the effect on joint symptoms depends on the type of exercise, intensity, frequency, recovery, and previous injury. The proposed

analytical framework therefore examines activity categories alongside pain, stiffness, mobility, and injury history.

**Physical Activity and Joint Pain**

The hypothetical results in Table 3 suggest that participants reporting moderate activity have a lower prevalence of joint pain than those reporting low or high activity. This pattern would be consistent with the possibility that regular, appropriately dosed activity supports joint function while some high-volume or high-impact activities may produce symptoms in susceptible individuals.

However, a cross-sectional association cannot establish an optimal activity level or demonstrate that moderate activity prevents joint pain. Individuals with existing pain may reduce their exercise, creating reverse causation. Differences in sports participation, injury history, and occupational activity may also explain the observed pattern.

Bricca et al. (2019) found no consistent evidence that exercise harmed articular cartilage in the populations included in their systematic review. Their findings support the distinction between appropriately prescribed exercise and excessive or poorly managed loading. The evidence should nevertheless be interpreted cautiously because most included participants had or were at risk of knee osteoarthritis, rather than being healthy young adults.

**Physical Activity and Functional Mobility**

The proposed sit-to-stand results show slightly shorter completion times in the moderate- and high-activity groups than in the low-activity group. If confirmed in actual data, this finding could indicate that more active participants have better lower-limb strength, coordination, or functional capacity.

Nevertheless, sit-to-stand performance is not a direct measure of cartilage health. It reflects several components of physical function, including strength, balance, body mass, and movement strategy. Functional tests should therefore complement, rather than replace, joint-specific symptom measures.

**Influence of Previous Joint Injury**

Previous injury is particularly relevant when evaluating young adults who participate in recreational or competitive sports. Ligament injuries, meniscal damage, and recurrent joint instability may influence pain and subsequent joint function.

Tran et al. (2022) reported an association between some forms of intensive athletic participation and knee or hip osteoarthritis risk. Such findings do not mean that ordinary exercise damages joints; rather, they emphasize the importance of injury prevention, progressive training, rehabilitation, and appropriate recovery.

If previous injury remains associated with joint pain after adjustment for other factors, prevention strategies should emphasize safe movement techniques, adequate conditioning, appropriate equipment, and complete rehabilitation before unrestricted return to demanding activities.

**Sedentary Behaviour and Joint Health**

Prolonged sitting may coexist with low overall activity and reduced physical conditioning. Regular movement breaks, walking, and strengthening activities can help individuals maintain physical function. However, sitting time should be analysed separately from total physical activity because some individuals meet weekly exercise recommendations while remaining sedentary for much of the day.

The World Health Organization's guidelines recommend reducing sedentary behaviour and incorporating physical activity throughout daily life. These recommendations provide a practical foundation for promoting healthier movement patterns among university students and working young adults.

**Clinical and Public Health Implications**

The findings framework supports several practical recommendations:

- Encourage regular physical activity appropriate to individual ability and health status.
- Include muscle-strengthening activities and progressive conditioning.
- Increase training volume and intensity gradually, especially after inactivity or injury.
- Promote appropriate recovery and early assessment of persistent or worsening joint symptoms.
- Reduce prolonged uninterrupted sitting by incorporating movement breaks.
- Provide injury-prevention education for recreational athletes and individuals involved in intensive training.

Healthcare professionals should avoid discouraging exercise solely because a person experiences occasional joint discomfort. Persistent swelling, instability, severe pain, or an acute injury warrants appropriate clinical assessment.

**Limitations**

The proposed cross-sectional design cannot establish causality or determine whether activity patterns preceded joint symptoms. Self-reported physical activity and pain may be affected by recall bias, while convenience sampling may limit generalizability.

The broad concept of joint health also presents a measurement challenge. Pain in the knee, hip, shoulder, and

wrist may arise from different causes, and a general pain score cannot fully capture these differences. Future studies should specify the primary joint site and include validated region-specific measures.

Further research should use longitudinal designs, objective activity monitoring, injury records, and repeated assessments. These approaches could clarify how changes in activity patterns relate to joint symptoms and functional recovery over time.

## Conclusion

Physical activity is an important component of musculoskeletal health among young adults, but its relationship with joint health depends on more than the total amount of movement. Regular, appropriately dosed exercise can support muscular strength, mobility, and functional capacity, while previous injury and excessive or poorly managed training loads may contribute to joint symptoms.

A comprehensive assessment should therefore examine activity volume, exercise type, sedentary behaviour, pain, functional performance, and injury history together. The proposed framework provides a basis for investigating these relationships and identifying opportunities for preventive healthcare.

The numerical tables demonstrate how a completed study could report participant characteristics, physical activity categories, joint symptoms, and adjusted associations. Final conclusions about statistical significance and the strength of relationships must be based on verified participant data and appropriate statistical analysis.

## Ethical Considerations

Ethical approval should be obtained from the relevant institutional ethics committee before recruitment. All participants should provide informed consent, and confidentiality should be maintained throughout data collection, analysis, and reporting. Participation should be voluntary, with the right to withdraw at any time. Any physical testing should be appropriate to participants' health status, with referral procedures available for significant symptoms or suspected injury.

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