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# RELATIONSHIP BETWEEN LEG LENGTH DISCREPANCY AND MULTIPLE JOINT PAIN, CONSTITUTING A SUBSTANTIAL ECONOMIC BURDEN TO THE COMMUNITY

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**Abstract**

***Background:*** *Leg Length Discrepancy (LLD) is a common musculoskeletal condition that can disturb the normal biomechanics, resulting in compensatory gait and postural changes. These biomechanical changes may lead to multiple joint pain affecting the hip, knee, and spine, ultimately reducing functional ability and disturbing quality of life. In addition to physical consequences, LLD-related joint pain can present as a significant economic burden due to increased healthcare utilization and loss of productivity in an individual's life. However, this economic impact remains underexplored in existing literature.*

***Objective:*** *To assess the association between leg length discrepancy and multiple joint pain, and to further evaluate the economic burden associated with LLD-related joint pain among adult patients.*

***Method:*** *A cross-sectional quantitative study was conducted in which total of 329 adult participants were diagnosed or suspected LLD and recruited through convenience sampling. Data was collected using a self-administered structured questionnaire and standardized clinical assessments performed, including Body Mass Index (BMI), Observational Gait Scale (OGS), Modified Oswestry Low Back Pain Disability Index (ODI), Questionnaire to Identify Knee Symptoms (QuIKS), Kellgren–Lawrence grading for knee osteoarthritis, Tape Measurement Method (TMM) for leg length discrepancy, and the Lower Extremity Functional Scale (LEFS). The data was analyzed using descriptive statistics and linear regression analysis with a significance level of $p < 0.05$.*

***Result:*** *A significant positive relationship was found between leg length discrepancy and the incidence of multiple joint pain. Participants with greater*

*LLD reported increased pain severity and involvement of multiple joint pain. Furthermore, LLD-related joint pain was associated with higher healthcare expenditures and notable productivity loss, indicating a substantial economic burden on individuals and the community.*

***Conclusion:*** *The findings concludes that leg length discrepancy is significantly associated with multiple joint pain and contributes to a considerable economic burden. Early identification and appropriate management of LLD may help decrease musculoskeletal complications and minimize economic impact. This study emphasizes the need for preventive strategies and well informed healthcare planning in musculoskeletal care.*

## INTRODUCTION

Musculoskeletal systems is a complex structure, with its various interlocking components, has attracted a great deal of scientific attention. The most overlooked and common aspect of this complex system is leg length discrepancy (LLD). This condition is noticed when there is a significant difference in the length of one leg compared to the other. Leg length discrepancy is caused by congenital anomalies, developmental disorders, surgical procedures, or trauma that can leads to LLD. The discrepancy can provoke biomechanical adjustments in gait and posture(1). The biomechanical adaptation can potentially lead to multiple joint pains, affecting not only the hip and knee of the longer leg but also impacting the shorter leg and the spine due to compensatory mechanisms(2). Moreover, the impact on mobility and quality of life can cause a considerable economic burden on individuals. This burden comes in the form of increased healthcare needs, absenteeism from work, and disability related costs(2). The interplay of the musculoskeletal system suggests that an abnormality in one region, such as LLD, can create a chain effect, leading to multiple joint pains. However some studies have begun to untwist this relationship (3)and also seen a noticeable absence of comprehensive exploration of the significant economic burden associated with LLD in current literature.

The goal of this study, therefore, is to put light on the relationship between LLD and multiple joint pains and to quantify its associated economic burden. The insights of this study will serve as a stepping stone for the development of preventive and therapeutic strategies. The objective of this research is to assess the association between LLD and the incidence of multiple joint pains, and to measure the economic burden it imposes, based on data collected from a sample from the Tahir medical and Astro physiocare Opd. The importance of this study lies in the potential to uncover the relationship between LLD and multiple joint pain that results in economic burden. Understanding this relationship can inform strategies for early detection, treatment, and prevention of these conditions, thus reducing their economic impact on the community(4). Therefore this study would be significant in understanding the correlation between LLD and multiple joint pain, if any, and can also help healthcare professionals design better treatment and prevention strategies

Leg length discrepancy (LLD) is common, yet often overlooked, occurring in approximately 40-70% of the general population (5) This condition presents as a significant difference in the length of one leg compared to the other, with variations greater than 1 cm generally considered clinically relevant (6). The causes of LLD are congenital abnormalities, post-traumatic deformities, and growth disturbances, which results in significantly altering the biomechanics of the body, leading to compensatory mechanisms that results in joint pain and subsequently economic burden. Some studies has also suggested that leg length discrepancy has major impact on the lower back pain osteoarthritis of the hip joint, also impacting the standing balance and causing stress fracture.

Another aspect found on the leg length discrepancy is that, when single leg lengthening

continues and develop as a real challenge to both, the patient and the orthopedic surgeon. However, it is not too complexes to the operative problem. Despite the fact that it's anything but a troublesome unavoidable issue sometimes, there can be a long and depleting postoperative responsibility that can risk early great outcomes. This means to audit the set of experiences, advancement, science, entanglements and current ideas of appendage stretching. Ilizarov's inventive system utilizing interruption histogenesis is the backbone of all recently creating techniques for treatment. The technique for obsession is advancing quickly from one-sided outer fixator to ring fixator, PC helped lastly stretching intramedullary nails. The recently fabricated nails stay away from a considerable lot of the downsides of outer obsession however they have their own difficulties. By and large, the signs for appendage extending are disputable. The signs have been reached out from lower appendage length disparity to furthest point protracting, including humeral, lower arm and phalangeal extending. A wide reach in recurrence of complexities is kept in the English writing, which might reach up to 100 percent of cases treated. With creating experience, corrective extending has become conceivable utilizing outer or interior stretching gadgets with an OK pace of issues.

Leg length discrepancy (LLD) is a condition where there is a noticeable difference in the length of one leg compared to the other. A difference of over 1 cm is generally considered clinically significant (Gurney, 2002). LLD may result from a variety of factors including congenital abnormalities, injuries, or growth disturbances(7). LLD can significantly impact the biomechanics of the body, leading to compensatory mechanisms that can cause joint pain (8) Compensatory mechanisms include changes in the way a person walks or stands to accommodate the difference in leg length, which can lead to an imbalanced load distribution on the joints(2). Moreover, leg length discrepancy has also subdivided in to two groups which are Structural Leg length Discrepancy (SLLD) and Functional leg length Discrepancy (FLLD). So structural Discrepancy is about or associated with the bony structure and the other one which is functional leg length discrepancy is about or it is related to the Lower pain or issue due to altered mechanics. Leg length discrepancy can also be found by two types in human nature. First one is that it can be found by birth and it could found late in life, furthermore a person who found leg length Discrepancy later in life are more incapacitated that those who have found since birth.

**Table 1: Studies on the impact of LLD on biomechanics**

| Author(s) | Year | Findings |
|---|---|---|
| Gurney, B (1) | 2002 | LLD of over 1 cm has clinical implications |
| Raczkowski, J.W., Daniszewska, B., Zolynski, K. (9) | 2010 | LLD leads to compensatory mechanisms |
| Defrin, R., Benyamin, S.B., Aldubi, R.D., Pick, C.G. (10) | 2005 | Imbalanced load distribution on joints due to LLD |

Multiple joint pain, involving the hip, knee, and spine, is a common complaint among individuals with LLD (11) This joint pain can result from various conditions, including osteoarthritis, rheumatoid arthritis, bursitis, gout, strains, sprains, and other injuries. The association between LLD and multiple joint pain is primarily due to the compensatory mechanisms that occur in response to the discrepancy (12)The changes in gait and posture can lead to abnormal stresses and strains on the joints, potentially accelerating joint wear and tear, contributing to conditions such as osteoarthritis(7). Some studies have also suggested that musculoskeletal is a major cause disability has been very common in the modern world and is also considered at the alarming stage if found somewhat because it could rise in the coming period as they are particular increasing day by day and also has spreading in human nature due to different disease and issues. The main reason of Joint pain or loss of a joint mobility is due to episodic pain which can be found in human nature due to psychological disorder. The effectiveness of current treatments for joint pain relief is limited, and several medications have unwelcome side effects that make them unsuitable for long-term usage. In other words, there is no effective treatment for the devastating symptoms of joint pain, which affect millions of individuals. Lacking in efficient pain management for multiple joint pain is due to our limited understanding of what actually causes pain. In order to create potential new targets that could more effectively reduce arthritis pain, we now only are beginning to understand some of the mediators and pathways that contribute to joint pain. This overview describes the processes of neurobiology which started in the joint that result in brain processes.

As they come to an end close to the articular blood vessels, sympathetic fibers control joint blood flow by altering the vasoconstrictor tone. Sensory nerves' main job is to pick up and send the central nervous system mechanical information from the joint. Signals of proprioception, which are interpreted as either dynamic (movement feelings) or static (position sense), are encoded and transmitted by large diameter militated nerve fibers. Usually less than 5 m in diameter, pain-sensing nerve fibers are either unmyelinated (type IV) or myelinated with an unmyelinated 'free' nerve terminal (type III). These slow conducting fibers are known as nociceptors because they generally have a high threshold and only react to painful stimulus that is mechanical in nature. If we notice, in rats and cat, almost 80% of all knee joint afferent nerve fibres are nociceptive, proving that joints are also designed to sense abnormal and potentially destructive movement. Then nociceptors have been found in the capsule, ligaments, menisci, periosteal, and subchondral bone, and they are distributed throughout the joint. It is thought that the most distal segment of type III and type IV afferents, which lacks a myelin sheath and epineurium, represents the sensory portion of the nociceptive nerve. According to transmission electron microscopy, type III and type IV nerve terminals have an hourglass-shaped repeating pattern along their length, and the numerous bulbous portions show the distinctive characteristics of receptive sites. The 'bead-like' formations on the terminals of 'free' nerve endings are where joint pain arises. It is still unclear how a painful mechanical stimulus is transformed into an electrical signal that can travel through sensory nerves and reach the central nervous system. The first understanding of the physiological mechanisms underlying mechano-transduction in joints came from the recent electrophysiological finding of mechanogated ion channels on type III and type IV knee joint afferents. According to the current theory, when a joint moves, it creates shear pressures on the axolemma of the "free" nerve endings, which cause mechanogated ion channels to activate. This causes the nerve terminal to depolarize and the generation of action potentials, which are subsequently transmitted to the central nervous system where they are decoded into mechano-sensation. If a noxious movement is applied to the joint, the firing rate of the afferent nerve increases dramatically and the central nervous system interprets this nociceptive activity as pain.

**Table 2: Studies on LLD and multiple joint pain**

| Author(s) | Year | Findings |
|---|---|---|
| Gurney, B (1) | 2002 | Multiple joint pain is common in LLD |
| Defrin, R., Benyamin, S.B., Aldubi, R.D., Pick, C.G.(10) | 2005 | Joint pain in LLD results from compensatory mechanisms |
| Shrader, M.W., Draganich, L.F., Pottenger, L.A., Piotrowski, (13) | 2004 | Changes in gait due to LLD can accelerate joint wear and |

The economic burden of a health condition extends beyond the direct costs of healthcare. It includes the indirect costs related to lost productivity due to disability, decreased work capacity, and the need for assistance with daily activities (2) The economic burden of LLD and associated multiple joint pain can be substantial. The cost of late detecting, treating, and managing these conditions, along with the cost of lost productivity has increased the dependence on other, ultimately imposing a significant economic burden on individuals and the community (4)

**Table 3: Study on the economic burden of LLD**

| Author(s) | Year | Findings |
|---|---|---|
| Rice, D.P.(14) | 2000 | Economic burden extends beyond healthcare costs |

Many studies have found an association between leg length discrepancy(LLD) and multiple joint pains(15). These studies suggest that individuals with LLD are more likely to experience hip, knee, and back pain compared to those without LLD. This pain can be correlated to the biomechanical alterations and compensatory mechanisms that occur due to LLD (16)

**Table 4: Studies linking LLD to joint pain**

| Author(s) | Year | Findings |
|---|---|---|
| Gurney, B (1) | 2002 | LLD is associated with multiple joint pain |
| Defrin, R., Benyamin, S.B., Aldubi, R.D., Pick, C.G. (10) | 2005 | Biomechanical alterations due to LLD cause joint pain |

Leg length discrepancy (LLD) and the associated multiple joint pains can have notable economic involvement. The direct costs associated with medical care, such as diagnostic tests, surgical treatments, and physiotherapy, are often high. Indirect costs, such as those associated with loss of work related productivity and increased

dependence on others for daily living activities, can also be major (17)

## METHODOLOGY

This cross-sectional quantitative study was conducted at Taj Medical and Astro Physiocare outpatient departments (OPD) in compliance with ethical principles for human subject research. Data collection was carried out in the time period of one-month. The objective of this research is to investigate the relationship between leg length discrepancies (LLD), multiple joint pain, that are associated with economic burden among adult patients. The total sample size of 329 participants were included that was determined using RaoSoft sample size calculator with a 95% confidence level and a 5% margin of error. Participants were recruited through convenience sampling. Adults with diagnosed or suspected LLD in the OPD, individuals with congenital or acquired LLD were included, while those with recent trauma or surgery affecting leg length and those who declined consent were excluded from this research.

Data was collected using a self-administered printed questionnaire prepared in English, supported with clinical and radiographic assessments. The questionnaire included socio-demographic information, medical history, joint pain symptoms, functional limitations, and economic impact, including direct medical costs and productivity loss due to missed or reduced work. Body Mass Index (BMI) was calculated using self reported height and weight. Gait was evaluated using the Observational Gait Scale (OGS), a validated tool with reported inter-rater reliability ranging from 0.84 to 0.95(18). Low back pain related disability was measured using the Oswestry Disability Index (ODI), which demonstrated high internal consistency with Cronbach's alpha values between 0.83 and 0.90(19). Knee-related symptoms were assessed using the Questionnaire to Identify Knee Symptoms (QuIKS), a reliable screening instrument with acceptable internal consistency of approximately 0.80(20). Radiographic severity of knee osteoarthritis was evaluated using the Kellgren–Lawrence grading system based on knee joint X-rays, which shows high inter-observer reliability. Leg length discrepancy was measured from the anterior superior iliac spine to the medial malleolus, a commonly used technique known as Tape Measurement Method (TMM) with reported reliability ranging from 0.78 to 0.96(21). Functional status was further assessed using the Lower Extremity Functional Scale (LEFS).

Primary data was obtained through questionnaires and clinical examinations. Secondary data was collected from participants' medical records. Data was analyzed using SPSS software. Descriptive statistics was reported as mean, standard deviations for quantitative variables and frequencies and percentages for qualitative variables. The association between leg length discrepancy, multiple joint pain, and economic burden was examined with statistical significance set at $p < 0.05$. The study was conducted in relevancy with ethical guidelines, and informed consent was obtained from all participants prior to data collection. Formal ethical review committee approval was not required as per institutional policy for observational survey-based studies.

## RESULTS

A total of 329 participants with diagnosed or suspected leg length discrepancy were included in the final analysis. Leg length discrepancy was assessed using the Tape measurement method and categorized according to the extent of discrepancy. Descriptive findings indicated that LLD was commonly observed among adult patients of orthopedic and physiotherapy outpatient departments. A considerable proportion of participants reported pain involving more than one joint, with the lower back, knee, and hip being the most affected regions of the body. Leg length discrepancy was clinically assessed using the tape measurement method that showed the majority of participants had a discrepancy ranging between 1–2 cm(Figure 1).

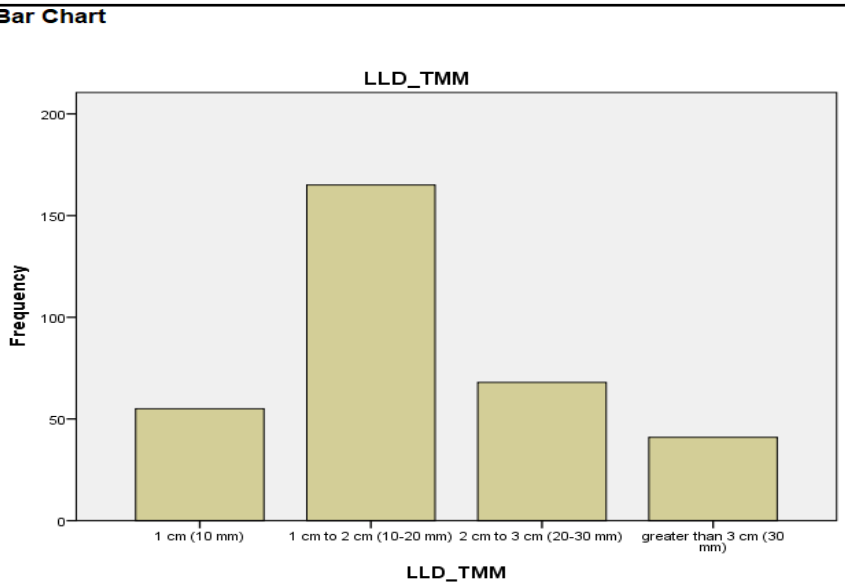


Figure 1: Distribution of leg length discrepancy measured by tape measurement method. The bar chart shows majority of participants with LLD between 1–2 cm.

Gait assessment was done using the Observational gait scale (OGS) revealed more pronounced gait deviations among participants with greater leg length discrepancy. Functional impairment related to low back pain was measured using the Oswestry Disability Index (ODI), that showed increased severity of LLD. Knee-related symptoms was evaluated through the Questionnaire to Identify Knee Symptoms (QuIKS) were more prevalent among participants with higher levels of discrepancy, while radiographic evaluation using the Kellgren–Lawrence grading system demonstrated higher severity of knee osteoarthritis in these individuals.

A statistically significant association was observed between leg length discrepancy and multiple joint pains ($p < 0.05$) As the extent of LLD increased, the number of affected joints and severity of symptoms also increases. Participants with greater discrepancy reported lower scores on the Lower Extremity Functional Scale, interpreting reduced mobility and functional limitations.

Analysis of economic indicators revealed that participants experiencing multiple joint pains related to LLD also faced higher direct medical costs, including consultation fees, physiotherapy sessions, medications, and diagnostic investigations. Indirect costs such as work related absenteeism, reduced productivity, and limitations in daily living activities were also reported, indicating a evident amount economic burden associated with leg length discrepancy.

## DISCUSSION

The findings of this study demonstrates a significant association between leg length discrepancy and the presence of multiple joint pains. The results are consistent with previous literature suggesting that biomechanical alterations caused by LLD lead to compensatory gait and postural adaptations. Gait deviations identified through the observational gait scale indicates abnormal loading patterns, which may put mechanical stress on the hip, knee, and lumbar spine.

The increased disability scores observed on the oswestry disability index among participants with greater LLD suggests that untreated discrepancy contributes to low back pain related functional impairment. Similarly, higher prevalence of knee symptoms assessed using Questionnaire to Identify Knee Symptoms (QuIKS) and greater

severity of knee osteoarthritis observed through Kellgren Lawrence grading that supports the role of LLD in accelerating degenerative joint changes in the lower extremities.

Reduced lower extremity functional scale scores among participants with greater discrepancy highlight the negative impact of LLD on mobility and daily living activities. These functional limitations may explain the increased utilization of healthcare services observed in this study.

Beyond clinical connections, the study highlights the economic consequences associated with LLD-related multiple joint pains. Increased healthcare expenditures and productivity loss contribute to a considerable economic burden on affected individuals and the consistent with evidence that musculoskeletal disorders impose significant direct and indirect costs.

The findings focuses on the importance of early identification and appropriate management of leg length discrepancy. Simple and reliable assessment tools such as the tape measurement method, combined with functional and gait assessments, may facilitate early detection. Interventions including orthotic correction, physiotherapy, and patient education may reduce joint stress, improve functional outcomes, and minimize long-term economic impact. The limitation of this study is its cross-sectional design, short duration of data collection, and use of convenience sampling, which may restrict causal interpretation and generalizability.

## CONCLUSION

This study concludes that leg length discrepancy is significantly associated with multiple joint pains and contributes to a evident economic burden. Individuals with greater LLD experience increased pain severity, functional limitations, increased healthcare and productivity related costs. Early identification and timely management of LLD may help prevent secondary musculoskeletal complications and decrease economic burden. The findings focuses on the need for preventive strategies, improved screening, and effective management protocols within orthopedic and physiotherapy clinical settings to enhance patient outcomes and optimize healthcare resources.

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