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ORIGINAL STUDY

Ambulatory Monitoring of Physical Activity and Its Association with Pain and Disability in Participants with Low Back Pain - A Pilot Study

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ABSTRACT

Low back pain (LBP) is a primary cause of global disability, yet the link between ambulatory physical activity and LBP-related pain and disability remains uncertain. While it's suggested that lower physical activity levels correlate with higher disability in chronic LBP patients, conclusive evidence is lacking regarding whether LBP patients are less active than their healthy counterparts. This pilot study aimed to compare ambulatory physical activity levels between LBP patients and age- and gender-matched healthy controls and to explore the relationship between ambulatory physical activity, pain, and disability in LBP patients. This was pilot study with a cross-sectional observational design conducted between October 2018 to January 2020. A total of Fifty-three participants were recruited from the general community of the South Gujarat region, India. They were recruited from diverse physiotherapy Outpatient Departments (OPDs) and outreach centers. The study participants were divided in two groups: LBP group (n=28) and 16 control group (n=25). Ambulatory physical activity monitoring using an actigraphy was done for three consecutive days. Pain intensity in patients with LBP was assessed using Numerical Pain Rating Scale (NPRS) and disability was assessed by Oswestry Disability Index – Gujarati version (ODI – G). Ambulatory Physical activities between patients with LBP and controls were compared using Wilcoxon Mann Whitney test. Correlation of physical activity with pain and disability was evaluated using Spearmen correlation. The mean age of study groups was LBP: 42.75 ± 7.2 years and control: 39.67 ± 8.425 years. A comparison of ambulatory physical activity showed the LBP group had less peak physical activity (8423 ± 436 Vs 13123 ± 954; $p < 0.01$) and spent less time in high-intensity level activities (1.5 24 ± 0.4 Vs 5.3 ± 0.5; $p < 0.01$) than controls. However, there was no difference in average daily physical activity (1489 ± 78 Vs1642 ± 89; $p = 0.42$) between both groups. In LBP patients, ambulatory physical activity was moderately positively correlated with disability ($r = 0.52$; $p < 0.01$) and weakly negatively correlated with pain in mid-morning ($r=-0.17$; $p=0.023$) and pain in the afternoon ($r=-0.16$; $p=0.036$). Patients with LBP demonstrated decreased peak physical activity as compared to the control group. This reduced peak activity level was correlated with self-reported disability and mildly correlated with pain intensity in LBP patients.

Keywords: *Actigraphy, Ambulatory physical activity, Disability, Low back pain.*

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INTRODUCTION

Low back pain (LBP) is characterized as localized pain and discomfort, either with or without leg pain, that is situated above the inferior gluteal folds and below the costal border. (1). It is the second most common reason for sick leave, a significant cause of disability, and a frequent reason for medical appointments. Because of its high direct and indirect expenses, it has a significant negative influence on the health, social standing, and financial stability of those who are affected as well as their families. (2-5). LBP shows that the majority of individuals experience mild to moderate LBP with little to no disability (6, 7). LBP affects approximately 60-80% of people throughout their entire lifespan (8, 9). The prevalence rate of LBP has been greatly impacted by geographical variations (10). Low back pain (BLP) is typically

divided into three distinct types based on how long the pain has persisted: acute, subacute, and chronic. Acute low back pain is characterized by episodes lasting less than six weeks, subacute pain lasting six to twelve weeks, and chronic pain lasting twelve weeks or beyond (11, 12). There have been reports of several environmental and personal factors that raise the risk of LBP. Advancing age is associated with structural changes in the spine, contributing to LBP (13). Gender differences may also play a role, with women potentially exhibiting a higher susceptibility (14). Physical stress on the spine, often stemming from repetitive lifting and overall body strain, is a recognized risk factor (15 – 17). Lifestyle choices, such as smoking and obesity, are linked to poor general health, further increasing vulnerability to LBP (18). Additionally, psychological stress, including monotonous work and depression, is acknowledged as a component affecting the beginning and persistence of lower back pain (19). Recognizing these diverse elements is crucial for developing holistic approaches to prevent and manage LBP, addressing both physical and mental well-being. A more comprehensive understanding of the possible causes of an LBP episode may offer critical views for its management and prevention (20, 21). Of note, numerous reviews evaluated physical stress aspects as possible risk factors for LBP (22-24). It has been stated that disability and physical activity have an inverse relationship with each other, suggesting that patients with long-term low back pain who engage in less physical activity experience a higher degree of disability (25, 26). No conclusive evidence exists that supports the notion that patients with LBP are less active than individuals with good health (27). Systematic review's conclusion, drawn from various studies, indicated differences in the distribution of daily activities between individuals with Lower Back Pain (LBP) and the control group (28). The study's aim was to compare ambulatory physical activity between LBP patients and age, gender matched healthy controls and the other objective was to assess the association between ambulatory physical activity with pain and disability in patients with LBP.

MATERIAL AND METHODS

Study design and population

This was a pilot study with cross-sectional observation study design conducted between October 2018 to January 2020. Total Fifty-three participants were recruited from the general community of the South Gujarat region, India. They were recruited from diverse physiotherapy Outpatient Departments (OPDs) and outreach centers. Study participants were divided in two groups: LBP (n=28) and healthy controls (n=25). If the participant satisfied the following inclusion specifications, they were eligible to participate in the study. For the LBP Group, the inclusion criteria were adults between the ages of 18 and 65 with a clinical diagnosis of Low Back Pain (LBP). For the Control Group, the inclusion criteria were age-gender matched healthy individuals between 18 and 65 years with no history of chronic pain or musculoskeletal disorders. Those participants who had medical diseases known to cause low back pain (LBP) and severe physical impairments that prevent ambulatory physical exercise (e.g., bilateral amputation, total blindness) or malignancy were excluded. To minimise bias caused by high levels of regular exercise, controls were recruited by omitting participants in regular exercise programmes. The Institutional Ethics Committee (IEC) granted approval for the study (ARIP/IEC/18/05), and participants provided signed informed consent.

Study procedure, data collection and outcomes

Sociodemographic information, including age, gender, height, weight, and duration of pain, was collected (29, 30) and participants who were having LBP asked to fill out Numeric Pain Rating Scale (NPRS) (31) and, the Oswestry Disability Index - Gujarati version (ODI - G) (32) form for the assessment of pain and disability respectively. Patients usually rate their pain using the Numeric Pain Rating Scale (NPRS) on a scale of 0 to 10, where 0 represents no pain and 10 represents the worst possible pain. The Oswestry Disability Index (ODI) assesses functional disability on a range of 0% to 100%, where higher scores correspond to more low back pain-related disability in daily activities. Both the participants and controls were asked to wear activity tracker Actigraph for three consecutive days for activity monitoring. Manufactured by ActiGraph, LLC, the wGT3X-BT ActiGraph Wearable Device is designed for objective physical activity monitoring, functioning as a sophisticated activity tracker that employs triaxial accelerometry to precisely capture and quantify physical movement. Over the course of the three-day observation period, the peak and average activity levels were evaluated, with missing data arising from the Actigraph being temporarily removed during water-based activities excluded. Ambulatory physical activity levels were assessed by using an actigraphy accelerometer for three days in both LBP and control groups and summed over five-minute epochs. In LBP patients' disability assessments were recorded by filling complete symptoms report of ODI Gujarati version only once at beginning of study. Pain intensity was evaluated by NPRS at five daily time points throughout the course of three days in LBP patients only. Self-reports of pain were scored using a ten-point system, where higher values indicate greater

symptoms. Pain was measured at five time points: in the morning before getting out of bed, an hour later, before lunch, in the late afternoon between 3:00 and 4:00 PM, and thirty minutes before bed. The actigraphs prompted patients with three alerts, pre-set depending on habitual wake-up time (one hour, five hours and nine hours post-awakening), to maximise compliance of symptom monitoring during daily activities. During the three days of the observation period, peak activity levels were defined as the maximum level of activity within each of the specific episodes during the day, measured in five-minute intervals (33). Morning (the first hour after waking up), mid-morning (one hour after waking until lunch), afternoon (ranging from lunch and 3:00–4:00 PM), and evening (between 3:00–4:00 PM until 30 minutes before going to bed) were the designated times for specific episodes. Every episode was divided into several five-minute sections, each of which included a cumulative number of units. For every patient, the current study examines epoch with the highest value to ascertain peak activity level. The average daily activity values for each 5-minute epoch within an episode were calculated and then averaged during the three days. For instance, the morning episode involved examining 12 five-minute epochs, with the peak activity level representing the greatest value among them on any given day. Additionally, the duration incurred in different activity levels (high, moderate, low, very-low) was recorded as a percentage of time, offering a nuanced assessment of activity patterns and mitigating potential biases from chance observations. Furthermore, the study measured a percentage of time spent in each of the following activity levels: high-level activities (>8,000 units/five minutes; e.g., running, gardening), moderate-level activities (>3,000–8,000 units/five minutes; e.g., effortful walking), low-level activities (1,000–3,000 units/five minutes; e.g., office work, minimal physical activity), and very-low activity levels (<1,000 units/five minutes; e.g., sitting still, lying down). To mitigate potential biases resulting from chance observations from a single, highly concentrated 5-minute period, an additional measure was employed: the percentage of time spent in high-level activities (33). All the participants had worn the Actigraph activity trackers for 3 days and no drop out was reported. The outcome measures for comparing physical activity in both the LBP and control groups include peak activity level, average daily activity level, and time spent in specific activity levels. Additionally, for the objective of correlating ambulatory activities with pain and disability in LBP patients, the outcome measures are average activity level, ODI (Oswestry Disability Index) Score, and NPRS (Numeric Pain Rating Scale) score.

Statistical analysis

SPSS version 22 was used for data analysis. The standard deviation ± mean is used to report continuous variables. Categorial variables are presented as frequency counts. The Shapiro-Wilk test was used to determine whether each variable's distribution was normal. Ambulatory Physical activities between patients with LBP and controls were compared using Wilcoxon Mann Whitney test. Correlation of physical activity with pain and disability was evaluated using Spearmen correlation. The estimated means were reported with a 95% confidence interval (CI), and for statistical significance, $p < 0.05$ was used..

RESULT

Baseline Characteristics

53 patients were analysed in the pilot study. The mean ages of study population in the LBP group and the control group were 42.75 ± 7.2 years and 39.67 ± 8.4 years, respectively. Female (62.26%) were predominately affected with LBP than male (37.73%). There were 6 patients (21.42%) with acute LBP, 5 patients (17.85%) with subacute LBP, and 17 patients (60.71%) with chronic LBP. **Table 1** provides a relevant summary of all baseline characteristics.

Comparison of physical activity

As demonstrated in **Table 2**, between the LBP and control groups, there was no significant difference found for average daily activity ($p=0.42$). LBP group and control group was significantly differed in terms of peak activity level ($p<0.01$) and time spent in high level activity ($p<0.01$).

Factors influencing ambulatory activities with pain and disability in LBP patients

Table 3 demonstrates correlation of ambulatory activities with pain and disability in LBP patients. Average activity level and ODI (Disability) was significantly moderately positively correlated with pain and disability in LBP patients. On the other hand, activity level and pain in the mid-morning ($r = -0.17$; $p = 0.023$) and afternoon ($r = -0.16$; $p = 0.036$) were weekly negatively correlated of pain and disability in LBP patients.

DISCUSSION

The current study compared physical activity in LBP and control group. Additional aim was to evaluate association between ambulatory monitoring of physical activity with pain and disability in patients with

LBP. Key findings emerged from the study were: (a) Average activity level was significantly moderately positively correlated with self-reported disability in LBP patients, and (b)Activity level and pain in the mid-morning and afternoon were weekly negatively correlated of pain and disability in LBP patients. Numerous research was conducted to explore the relationship between physical activity and LBP. According to those studies, physical activity can reduce overall mortality and variety of chronic diseases, such as obesity, diabetes, musculoskeletal conditions, cardiovascular and respiratory illnesses (34, 35, 36). A recent study found that LBP group is significantly varied depending on decreased peak activity level and decreased time spend in specific activity level (e.g., high and moderate) as compared to control group. However, low, and very low activity demonstrated increased time spend in specific activity level in control group than LBP group. However, there are conflicting reports about the relationships between physical activity and low back pain (19). From our findings we concluded that, with increased in average activity level may reduce disability in LBP patients. The American College of Sports Medicine (ACSM) recommends indulging in physical activity for minimum of thirty minutes 3 to 5 times a week to maintain good health (37, 38). Despite the great awareness (i.e., in up to 70% of cases of LBP) about the impact of regular exercise in reducing LBP and promoting overall health in afflicted patients, they do not actively perform so. Pooled analysis of cohort studies revealed that patients with LBP who participate in medium-intensity physical activity are 10% less likely than those who participate in low-intensity physical activity to develop chronic LBP (35). Additionally, compared to the control group (which received the booklet "Make your move – Sit less, be active for life!"), Amorim et al. (39) observed a significant increase in the amount of self-reported walking in the intervention group (which received an information booklet on physical activity and sedentary behaviour). In the current study, activity level in the middle of the morning and the afternoon, as well as pain, were factors influencing ambulatory activities with pain and impairment in LBP patients. This is in agreement with previous prognostic study as stated by Pinto et al. that patients with chronic LBP who were moderately active or more at baseline experienced less pain and impairment than those who were sedentary at the 12-month follow-up (8).

Limitations:

While the study provides valuable insights into the relationship between physical activity and low back pain (LBP), several limitations need consideration. Firstly, the pilot study's small sample size may restrict the generalizability of the findings. The reliance on self-reported measures for pain intensity and disability scores introduces the potential for subjective biases and inaccuracies, highlighting the need for caution in interpreting these outcomes. Additionally, The study's cross-sectional design limits the establishment of causation, warranting further longitudinal investigations to elucidate the temporal dynamics between physical activity, pain, and disability in LBP.

Future Recommendations:

To address the limitations and advance the awareness of the relation between physical activity and LBP, future studies should prioritize larger-scale cohorts for enhanced statistical power and generalizability. Longitudinal designs would enable a more comprehensive exploration of the dynamic interplay between physical activity, pain, and disability over time. Interventional studies, incorporating targeted exercise programs, can further elucidate the potential therapeutic impact of increased physical activity on mitigating disability in individuals with LBP.

Table 1: Baseline characteristics of study participants

Characteristics	LBP (n=28)	Control (n=25)	P
Age, mean ± SD	42.75 ± 7.2	39.67 ± 8.4	0.11^
Gender, n (%)			0.19^^
Male	11 (39%)	9 (36%)	
Female	17 (61%)	16 (64%)	
BMI, Kg/m^2	25.71 ± 4.04	26.86 ± 4.54	0.23^
LBP category			
Acute	6 (21.42%)	N.A.	
Sub-acute	5 (17.85%)		
Chronic	17 (60.71%)		
ODI score, mean ± SD	37.4 ± 6.1	N.A.	
NPRS score, mean ± SD	2.56 ± 1.13	N.A.	

##

^ p-values were determined using the Wilcoxon Mann-Whitney test, and the significance level was maintained at 0.05.

^^ p-values were determined using the proportion test, and the significance level was maintained at 0.05.

LBP= low back pain; BMI= body mass index,

ODI = Oswestry disability index, NPRS=numeric pain rating scale

Table 2: Comparison of physical activity in LBP and control groups

Characteristics	LBP	Controls	p-value
Peak activity level, mean ± SD	8423 ± 436	13123 ± 954	<0.01*
Average daily activity level, mean ± SD	1489 ± 78	1642 ± 89	0.42
Time spent in specific activity level, n (%)			
High	1.5 ± 0.4	5.3 ± 0.5	<0.01*
Moderate	16.5 ± 1.8	19.3 ± 1.6	
Low	37.8 ± 1.4	32.7 ± 1.8	
Very Low	44.2 ± 2.3	42.7 ± 3.4	

p-values were calculated using Wilcoxon Mann Whitney test, and the significance level was maintained at 0.05.
LBP= low back pain.
*Indicates statistically significant.

Table 3: Correlation of ambulatory activities with pain and disability in LBP patients

	Correlation coefficient (r)	p-value
Average activity level and ODI (Disability)	0.52	<0.01*
Activity level (in morning) and pain	0.076	0.13
Activity level (in mid-morning) and pain	-0.17	0.023*
Activity level (in afternoon) and pain	-0.16	0.036*
Activity level (in evening) and pain	-0.10	0.56

p-values were calculated using Spearmen correlation, and the significance level was maintained at 0.05.
LBP = Low Back Pain, ODI = Oswestry disability index.
*Indicates statistically significant

Clinical Implications:
The study's findings bear significant clinical implications for managing LBP. The reported inverse relationship between disability and physical activity emphasizes the potential benefits of promoting increased activity levels as part of the therapeutic approach for LBP patients. Clinicians should consider incorporating personalized exercise regimens into treatment plans to enhance overall well-being and alleviate disability associated with LBP. Furthermore, the identification of time-of-day variations in activity levels underscores the importance of temporal considerations in tailoring rehabilitation programs. Integrating these insights into clinical practice could optimize interventions and contribute to more effective management of LBP.

CONCLUSION
In conclusion, this pilot study aimed to compare ambulatory physical activity between individuals with low back pain (LBP) and healthy controls matched by age and gender and to assess the relationship between ambulatory physical activity, pain, and disability in LBP patients. The study's findings reveal that LBP patients exhibited reduced peak physical activity levels and spent less time in high-intensity activities compared to healthy controls, although average daily physical activities were similar. Notably, average activity level demonstrated a significantly moderate positive correlation with self-reported disability in LBP patients. Conversely, activity levels and pain in the mid-morning and afternoon were weekly negatively correlated with pain and disability in LBP patients.

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