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Bioelectrical impedance analysis and change disability post physiotherapy for patients with lower back pain attending rehabilitation care unit in Erbil

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Abstract

Background and objective: Determining the relationship between body compartments and Lower Back Pain (LBP) will increase our understanding about how body compartments can affect LBP disability. This study aimed to assess the association between body compartments and LBP disability pre and post-physiotherapy.

Methods: A prospective study conducted in the main two governmental physiotherapy departments in Erbil. One Hundred patients were diagnosed with LBP and referred to physiotherapy units. All patients were assessed before starting physiotherapy and body compartments were measured by bioelectrical impedance analysis (BEIA). LBP disability was measured for each patient by a modified Oswestry disability index (ODI). After completing six sessions of physiotherapy all patients were reassessed regarding body composition, obesity measures, and LBP disability.

Results: Regarding the body fat percentage (BFP), 61% of females and 56.7% of males were obese. Results showed a positive significant correlation (P = 0.013) between BFP and LBP disability after physiotherapy, while a negative significant correlation (P = 0.026) between total body water (TBW) and LBP disability. There was a significant improvement in disability after physiotherapy (P <0.001). Eleven percent of patients succeeded to reach minimal clinically important difference (MCID ≥ 30%). Body composition and other obesity measurements were not significantly different before and after physiotherapy.

Conclusions: LBP disability is positively associated with BFP and negatively associated with TBW. The physiotherapy protocol performed in the physiotherapy units was able to significantly improve disability although a low number of patients reached MCID ≥ 30%. Body compartments were not significantly different before and after physiotherapy.

Keywords: Low back pain; Disability; Bioelectrical Impedance Analysis; Total body water; Obesity measure.

Introduction

Low back pain (LBP) is considered as the most important cause of disability and work absence worldwide.[1] It is defined as pain, muscular tension, or stiffness in the area between the lower margin of the twelfth rib and the inferior gluteal folds with or without radiation to the lower limb.[2] In modern society, it is considered one of the most common musculoskeletal conditions with a prevalence of 9.4 % worldwide and it exerts a major burden on primary and secondary healthcare systems.[3] Over the last years, there is community acceptance that physical therapy has a significant role in the management of low back pain, as the disability resulting from LBP was dramatically increased.[4]

The main important role of rehabilitation for people with low back pain are to control pain, restore physical function, ensure no functional deficits occur in the future,

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reserve employment, and in the instance of acute LBP avoid chronification.[5]

Physiotherapy is one of the most often utilized kinds of treatment for relieving low back pain. It is utilized as a single therapy as well as in conjunction with other therapies. Physiotherapy consists of two types: active physiotherapy like exercise, and passive physiotherapy like (infrared, short wave diathermy, traction, or ultrasound). The back is a highly complex system that requires a strong rehabilitation program based on physiotherapy.[6]

The assessment of body composition has attained a prominent position because of its importance in evaluation of nutrition, physical activity, and health research.[7] Most studies used body mass index (BMI) and weight to examine obesity. These measurements, however, do not account for body composition measurements such as fat and muscle mass. BMI alone is not considered a good indicator of obesity as it does not differentiate between fat and lean body mass.[8] There is an increasing suggestion that fat and muscle have differing effects on the risk of musculoskeletal illness including low back pain.[9] Obesity has been related to changes in the vertebral plates, degenerative alterations in the intervertebral disc, and decreased spinal mobility.[10]

Investigating the relationship between body composition and LBP will increase the understanding of how adiposity may influence LBP. The existing methods of body compartments measurements range from simple to complex, but all methods have some limitations and measurement errors.[11]

This study aimed to assess the association between body compartment parameters measured by bioelectrical impedance analysis with the change in disability after physiotherapy in patients suffering from lower back pain attending rehabilitation care units in Erbil city, and to assess if there is a significant difference between body compartments before and after physiotherapy sessions with exercise and dietary advice.

Methods

A longitudinal prospective study conducted in rehabilitation and physiotherapy units in Erbil teaching hospital and Rizgary teaching hospital in Erbil city. The data were collected 1st October 2021 to 1st April 2022.

Study Population

A non-probability convenience sample of 100 subjects including males and females diagnosed with lower back pain by specialists and referred to physiotherapy units for back-specific physiotherapy management. Patients' information was taken by direct face to face interview after verbal consent was taken from them using a questionnaire containing the patient's name, age, phone number, past medical history especially hypertension and diabetes, past surgical history especially cardiac surgery including pacemaker device, and keto diet.

Inclusion criteria: Patients aged above 18 years, patients who did not start the physiotherapy session at the time of interview. Exclusion criteria: Patients aged less than 18 years, patients who have already started physiotherapy sessions having one or more sessions at the time of the interview, pregnant patients because BEIA is not recommended to be used during pregnancy, diabetic patients because of the possibility of impaired sensation due to diabetic neuropathy, active spinal infection or malignancy, severe cases indicative for surgery, patients on Keto diet because this will affect the body compartment measurement by the BEIA device.

Body Compartment and Obesity Measurements

Body compartments were measured using a digital weight scale incorporating bioelectrical impedance analysis (Tanita BC 545n, Tokyo, Japan) Figure 1.[12]

It provides segmental body analysis in thirteen seconds and gives a reading nearest to 0.1 sensitivity, with a single

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frequency technology. The total of eight electrodes are built into the right-hand grip, left-hand grip, right footplate, and the left footplate as shown in Figure 1, which is considered the most accurate device than the other two and four electrode devices.[13]The two electrodes between the left and right hand were short-circuited, alongside those for the left and right feet. The device will provide the following parameters: weight, BMI, body fat percentage, muscle mass, total body water, bone mass, basal metabolic rate, and abdominal visceral fat. The reference charts for body composition used in this study were from the Tanita BC 545n manufacturer guide, and for body fat percentage we followed the American council on exercise for classification of fat percentage. [14, 15]

Height was measured using a stadiometer. Waist circumference was measured for each subject using standard tape measure at midway point between lower rib and iliac crest. Waist to hip ratio (WHR) was calculated for each subject and hip circumference was measured around the widest point of the buttocks.

Assessment of Low Back Pain Disability Modified Oswestry disability index (ODI) was used to assess the LBP disability.[16] It includes 10 domains that assess the disability of a patient; these sections are based on pain intensity, personal care, lifting things, standing, walking, sitting, sleeping, traveling, employment/ homemaking, and social life. Each domain has a score ranging from 0 to 5 point, and the resulting score out of 50 is converted to a percentage by multiplying the total score over the total possible score (50) and then multiplying by 100. Minimal clinical important difference (MCID) of ≥ 30% was used as a cut point for the improvement of the ODI score.[17, 18]

Procedure

Before the first physiotherapy session: body compartments were measured for all patients by BEIA device. The patient's age and height were entered into the device and the patient was asked to stand with bare feet and light clothes on the device plate with both feet touching the foot electrodes and the two hands extended and holding the hand electrodes for 30 seconds to complete all readings. The degree of disability was assessed for each patient by a modified ODI questionnaire. A combination of physical therapy modalities for them includes heat (infrared,

Figure 1 Picture of Tanita BC 545n bioelectrical impedance analysis device used in this study.[12]

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ultrasound, or diathermy), trans-electrical nerve stimulation (TENS), and exercise. Advice about the importance of a healthy diet was given to all patients and especially overweight and obese patients. After the patients completed six sessions of physiotherapy over two weeks, all of them were reassessed and the body compartments were re-measured for each patient by BEIA and the degree of disability was also reassessed for all of them.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 25). The Chi-square test of association was used to compare the proportions of two or more groups. Fisher's exact test was used when the expected frequency (value) was less than 5 of more than 20% of the cells of the table. Wilcoxon signed ranks test was used to compare the medians of the same sample but at two different time periods. Spearman's rank correlation coefficient was calculated to assess the strength of correlation. Normality of data was checked using the Shapiro-Wilk test, accordingly, non-parametric tests were used when indicated. A *P*-value of ≤0.05 was considered statistically significant.

Results

A Hundred patients were included in the study. Their mean age and standard deviation (SD) were 45 (11.7) years, the median was 46 years. The age range was 19 – 69 years. The largest proportion of the sample (30%) was aged between 50-59 years, as presented in Table 1.

The majority (70%) of the sample were females, and 53% were employed. The majority (70%) were living in urban areas, and 17% had a past history of chronic diseases. More than half (54%) were single (Table 1).

Table 1 Sociodemographic characteristics of the patients

	No.	(%)
Age		
< 30	11	(11.0)
30-39	21	(21.0)
40-49	27	(27.0)
50-59	30	(30.0)
60-69	11	(11.0)
Gender		
Male	30	(30.0)
Female	70	(70.0)
Occupation		
Employed	53	(53.0)
Unemployed	47	(47.0)
Residency		
Urban	70	(70.0)
Rural	30	(30.0)
Past History of Chronic Illnesses		
Yes	17	(17.0)
No	83	(83.0)
Marital status		
Single	54	(54.0)
Married	46	(46.0)
Total	100	(100.0)

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Table 2 shows that before the physiotherapy sessions, the majority (71.4%) of the females were obese according to the body mass index, compared with 30% of males (*P* <0.001). Similarly, for the fat percentage, the majority of females (87.1%) were obese compared to 56.7% of males (*P* = 0.003). There was a difference between overweight and obese patients by BMI, and the majority of the patients were obese. By BFP, the majority of the patients were also obese and the percentage of obese patients by BFP (78%) were higher than obese patients by BMI (59%).

It is evident in Table 3 that there was significant decrease in the ODI score and ODI percentage after physiotherapy (*P* <0.001). The table shows that there were no significant differences in all body composition and obesity measures after physiotherapy compared with the readings before physiotherapy.

Table 2 Body mass index (BMI) and fat percentage categories before physiotherapy by gender

	Male No. (%)	Female No. (%)	Total No. (%)	*P* value
BMI				
< 25	9 (30.0)	3 (4.3)	12 (12.0)	
25-29	12 (40.0)	17 (24.3)	29 (29.9)	
≥ 30	9 (30.0)	50 (71.4)	59 (59.0)	< 0.001†
Body Fat percentage				
Athletes	4 (13.3)	1 (1.4)	5 (5.0)	
Fitness	2 (6.7)	1 (1.4)	3 (3.0)	
Average	7 (23.3)	7 (10.0)	14 (14.0)	
Obese	17 (56.7)	61 (87.1)	78 (78.0)	0.003*
Total	30 (100.0)	70 (100.0)	100 (100.0)	

†By Chi square test. *By Fisher's exact test.

Table 3 Body parameters before and after the physiotherapy

	Before physiotherapy			After physiotherapy			
	Mean	SD	Median	Mean	SD	Median	*P* value
Waist	93.0	11.1	94.0	93.1	10.5	94.0	0.702
Hip	107.6	12.2	105.5	107.6	11.9	105.5	0.872
WHR	0.9	0.1	0.9	0.9	0.1	0.9	0.485
Weight	82.0	13.9	81.0	82.0	14.1	80.8	0.531
BMI	31.4	5.9	30.9	31.4	6.0	30.9	0.530
Fat percentage	36.1	10.6	38.0	36.1	10.8	38.2	0.515
Water	47.2	8.0	45.7	47.2	7.7	45.8	0.992
Muscle mass	49.1	8.9	48.0	49.3	9.2	47.8	0.799
BMR	1576.6	276.4	1539.0	1602.1	453.8	1555.0	0.956
Abdominal fat	10.1	4.5	10.0	10.1	4.5	10.3	0.695
Bone mass	2.6	0.5	2.5	2.6	0.4	2.6	0.732
ODI score	16.3	5.2	16.5	14.8	5.3	15.0	<0.001
ODI %	32.6	10.4	33.0	29.5	10.5	30.0	<0.001

*By Wilcoxon Signed Rank test.

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No significant correlation was detected between the ODI with the studied variables, except for the correlation with fat % (rho = 0.249, *P* = 0.013), and total body water (rho = -0.222 and *P* = 0.026) as presented in Table 4.

Figure 2 shows that 11% of the study sample were able to reach the improvement of ≥ 30% MCID, while the majority of the study sample (89%) failed to achieve the improvement of MCID ≥ 30%.

Table 4 Correlation of ODI (after physiotherapy) with post-physiotherapy parameters

Post-physiotherapy parameters	Spearman rho	*P* value
Waist	0.092	0.362
Hip	0.092	0.363
WHR	-0.056	0.580
BMI	0.119	0.240
Body Fat percentage	.249	0.013
Total body water	-.222	0.026
Muscle mass	-0.135	0.181
BMR	-0.108	0.285
Abdominal fat	-0.025	0.808
Bone mass	-0.165	0.101

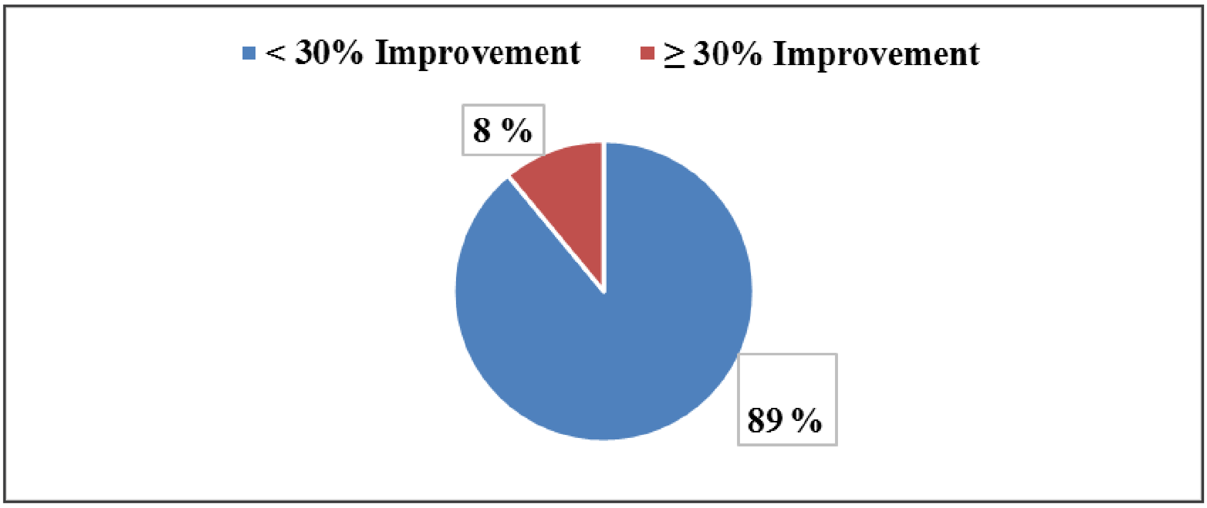

Figure 2 Minimal clinical important difference (MCID ≥ 30%)

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No significant association was detected between the rate of improvement (MCID ≥ 30%) with the following variables (after physiotherapy): age (*P* = 0.355), occupation (*P* = 0.241), residency (*P* = 1.000), marital status (*P* = 0.547), BMI (*P* = 0.722), total body water (*P* = 0.305), abdominal fat (*P* = 1.000), waist (*P* = 0.497), and WHR (*P* = 0.697). There was a significant association between the fat % categories and the rate of improvement according to MCID ≥ 30%, thus, the rate of improvement was 60% among athletes (lowest fat %) compared with 10.3% among obese (*P* = 0.018) as presented in Table 5.

Table 5 Rate of improvement according to MCID (≥ 30%) by the studied factors

	MCID (≥ 30%)			
	Improved No. (%)	**Unimproved No. (%)**	**Total No. (%)**	***P* value**
Age				
< 30	3 (27.3)	8 (72.7)	11 (100.0)	
30-39	2 (9.5)	19 (90.5)	21 (100.0)	
40-49	2 (7.4)	25 (92.6)	27 (100.0)	
50-59	4 (13.3)	26 (86.7)	30 (100.0)	
60-69	0 (0.0)	11 (100.0)	11 (100.0)	0.355*
Occupation				
Employed	4 (7.5)	49 (92.5)	53 (100.0)	
Unemployed	7 (14.9)	40 (85.1)	47 (100.0)	0.241
Residency				
Urban	8 (11.4)	62 (88.6)	70 (100.0)	
Rural	3 (10.0)	27 (90.0)	30 (100.0)	1.000*
Maritalstatus				
Single	5 (9.3)	49 (90.7)	54 (100.0)	
Married	6 (13.0)	40 (87.0)	46 (100.0)	0.547
BMI (post.)				
< 25	2 (16.7)	10 (83.3)	12 (100.0)	
25-29	3 (11.1)	24 (88.9)	27 (100.0)	
≥ 30	6 (9.8)	55 (90.2)	61 (100.0)	0.722*
**Fat % ** **				
Athletes	3 (60.0)	2 (40.0)	5 (100.0)	
Fitness	0 (0.0)	3 (100.0)	3 (100.0)	
Average	0 (0.0)	14 (100.0)	14 (100.0)	
Obese	8 (10.3)	70 (89.7)	78 (100.0)	0.018**
Water				
Low	4 (8.9)	41 (91.1)	45 (100.0)	
Normal	6 (11.5)	46 (88.5)	52 (100.0)	
High	1 (33.3)	2 (66.7)	3 (100.0)	0.305*
Abdominal fat				
Healthy	9 (11.7)	68 (88.3)	77 (100.0)	
Excess level	2 (8.7)	21 (91.3)	23 (100.0)	1.000*
Waist				
Low risk	4 (16.7)	20 (83.3)	24 (100.0)	
Moderate risk	2 (11.8)	15 (88.2)	17 (100.0)	
High risk	5 (8.5)	54 (91.5)	59 (100.0)	0.497*
WHR				
Normal	6 (12.2)	43 (87.8)	49 (100.0)	
High	5 (9.8)	46 (90.2)	51 (100.0)	0.697
Total	11 (11.0)	89 (89.0)	100 (100.0)	

*By Fisher's exact test. ** *P*-value <0.05 (significant)

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Discussion

This study examined the association between body compartments including BFP, muscle mass, bone mass, visceral abdominal fat, and TBW measured by the BEIA instrument in addition to the other obesity measurements and the change in disability after physiotherapy sessions performed for patients with low back pain. The age of the study sample was between 18-70 years old, with low back pain attending rehabilitation care units in Erbil city. The majority of the sample (males and females) were obese depending on BFP (Table 2) with a significant difference between males and females ($P = 0.003$) in a way that in the current study females were more obese, while the mean muscle mass in males was higher than in females.

Body composition varies between males and females, with females having proportionally more fat and male having proportionally more muscle mass. [19]

Recent findings according to the review done by Cooper et al,[20] the prevalence of obesity is more in females than males in most countries. Understanding the relationship between body compositions, especially BFP and LBP can help us develop new strategies for treating LBP and better understand the mechanism through which obesity impacts LBP. Excess adiposity has detrimental consequences on body structure and movement patterns, which lead to LBP disability.[21]

The assessment of disability is an important part of LBP management, in this study, we measured the disability with modified ODI. This index is valid and has developed as the most commonly suggested condition-specific measure of outcome for a spinal condition.[22] In our study there was a significant improvement in ODI score (p <0.001) after six sessions of physiotherapy done for the patients (Table 3). This significant improvement in disability after this physiotherapy regime in our study was consistent with Alarab et al.,[23] on 36 patients with nonspecific chronic LBP, in which, demonstrated a significant reduction in mean ODI score after receiving infrared, TENS, and exercise. A study conducted by Yurdakul etal.,[24] found significant improvement in ODI score in the patient's group who used combined heat and TENS physiotherapy, the results of these studies were in line with our results and the types of physical therapy devices used in them were similar to what we employed. Özcan et al.,[25] showed that disability (ODI score) was improved significantly in patients who received ten sessions of combined physical therapy (heat, TENS, US, and home exercise).

As for the association between body compositions and LBP disability (ODI), we found a significant positive correlation between body fat percentage and LBP disability post physiotherapy ($P = 0.013$). Some previous studies depend only on weight, BMI, and WHR to identify obesity, but these measures do not offer information on body composition.[26, 27] Study done by Hussain et al., [21] on Australian adults found that percent fat mass, measured by BEIA was significantly associated with LBP disability. It also found a significant association between WC and LBP disability which was inconsistent with our study. In another study done in 2016 about the association between body fat percentage and LBP disability, Hussain et al., [28] found consistent results with our study. They found a significant association between BMI, waist circumference, and waist-hip ratio which were inconsistent with the results of our study.

We found a significant negative correlation between TBW and LBP disability ($P = 0.026$), which reveals disability of LBP increased when TBW decreased. A study which was conducted by Ul-Haq et al.,[29] about the daily water intake of medical students and practicing doctors with low back pain concluded that reduced water intake might be a cause for increasing intensity of LBP. Two other studies conducted by Eslamian et al.,[30] and

Iizukaet al.,[31] had inconsistent results with the current study as they concluded no association between TBW and LBP disability. Dehydration has appeared as a risk factor for back pain and the degenerative disc may be the mechanism behind it.[32]

In our study, MCID ≥30% was taken as a dependable MCID cut point.[17, 18] Based on that, 11% of our study sample achieved this percentage of improvement after 6 sessions of physiotherapy while the majority (89%) failed to reach this MCID. In a study conducted by Brooks et al.,[33] they used an exercise rehabilitation program for 8 weeks, and 46.9% of the sample reached such a reduction in ODI score. In another study conducted by Schwind et al.,[34] found that about 70% of the study sample reached MCID of 30% improvement or more after exercise rehabilitation with manual therapy.

Factors affecting physiotherapy outcome are many including psychological factors (depression and anxiety),[35-37] BMI,[38,39] number of sessions done,[40] adherence of the patients to physiotherapy sessions and exercise done at home,[41] higher baseline disability score, and older age.[42] In addition to heavy work, lifting heavy things and heavy housework, and the duration of the session and exercise should be longer than 20 minutes.[43,44] Finally most of these factors including anxiety, fear of pain, number of sessions, and duration of sessions were present in our patients

In the current study, a significant association between body fat percentage categories and the rate of improvement according to (MCID≥ 30%) was found (P = 0.018). Furthermore, 89.7% of obese patients were not improved and only 10.3% of them were improved, thus, the majority of the patients who failed to reach MCID ≥ 30% were obese. A study conducted by Wertli et al.[39] concluded that the rate of patients reached MCID ≥ 30% was low among obese patients, indicating that these patients while we relied on both BMI and BFP which gives a better definition and understanding of obesity. There were no statistically significant differences in all body composition parameters before and after physiotherapy and low back exercise despite the advice about the importance of diet control, although the majority of our sample were obese but with little if any awareness and care about their diet and weight reduction to improve their disability despite the educational advice about the diet.

Brooks et al.,[33] performed a study among low back pain patients who have had 8 weeks of exercise at 3 -5 sessions per week and they found no significant change in BMI after exercise physiotherapy and no significant association between BMI and change in disability. Furthermore, they recommended a higher frequency of sessions or duration of treatment which may produce better results. In the current study, the follow-up after physiotherapy and exercise with dietary advice was just two weeks as this was the routine protocol of physiotherapy in the physiotherapy units. Subsequently, a longer duration of treatment, increase frequency of sessions, adherence to physiotherapy and exercise, and nutritional intervention may be of great value for producing weight loss. The mechanism of "vicious cycle" is noticed where the pain causes physical inactivity and lack of exercise which contributes to obesity and obesity then exacerbates the pain and disability.[45]

Conclusion

There was a significant improvement in LBP disability after physiotherapy sessions, however, a low percentage reached the MCID of ≥ 30%. LBP disability has a positive significant correlation with BFP and a significant negative correlation with TBW. No significant differences between all the body compartments before and after physiotherapy sessions with dietary advice. Further work is recommended to study the psychological aspects of the patients with chronic LBP; and work more on diet, exercise, and weight reduction.

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Competing interests

The authors declare that they have no competing interests.

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