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RESEARCH ARTICLE

COMPARISON OF GAIT PARAMETERS OF INDIVIDUALS WITH LOW BACK PAIN AND THEIR AGE-SEX MATCHED APPARENTLY HEALTHY CONTROLS

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ABSTRACT

Low back pain is reported widely but only a few studies have been conducted on the effects of low back pain on gait characteristics. This study was therefore aimed at determining gait parameters of individuals with low back pain and comparing them with that of their age and sex matched apparently healthy controls. This is a case control study in which 70 purposively selected participants, comprising thirty-five individuals with low back pain, and 35 apparently healthy controls were involved. They were recruited until all participants completed the study. Ethical approval was obtained from Health Research and Ethics committee, Institute of Public Health, Obafemi Awolowo University, Ile-Ife. Each informed participant was then educated on the procedure for data collection, and data was subsequently collected. Cadence and walking speed were then assessed using 6-metre walk test. Cadence calculated as number of steps per minute, and walking speed as distance covered in one minute. Data obtained were analyzed using descriptive statistics of mean and standard deviation and inferential statistics of Pearson`s Product Moment Correlation Coefficient (r), and independent t-test. Significance was set at 0.05 α- level. Participants comprised 19 females and 16 males per group. Participant's average age, height and weight were 49.714±13.868years, 1.629±0.741meters and 73.100±13.260kilograms respectively. There was no significant difference in anthropometric variables of participants with low back pain and their age and sex matched apparently healthy controls ($p>0.05$). There was no significant difference in gait parameters of male and female participants ($p>0.05$). There was significant difference in walking speed of participants in low back pain and apparently healthy control groups ($p>0.05$); with higher average value (0.830±0.145m/s) observed in the apparently healthy control group. There was no significant relationship between anthropometric variables and gait parameters ($p>0.05$) except height which was inversely related to walking speed among apparently healthy controls ($p<0.05$). It was concluded that the walking speed of participants with low back pain was lower than that of their apparently healthy controls. It was therefore recommended that focus of physiotherapy management of low back pain should include more emphasis on gait.

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INTRODUCTION

Low back pain (LBP) remains a prevalent and persistent problem that frequently compromisesphysical function, including walking (Maureen, *et al*., 2011). Best evidence management for LBP now emphasizes remaining active or resuming or increasing usual activity as soon as possible (Chou, *et al*., 2007), and walking is commonly recommended as a therapeutic exercise (Chou, *et al*., 2007). Unfortunately, although some people with LBP will remain active, others have difficulty doing so for a variety of physical, psychological and social reasons (Simmonds, 2006), and this can contribute to the individual's distress and disability and the economic cost of chronic LBP (Simmonds, 1996). Chronic low back pain (CLBP) is usually associated with functional and psychosocial impairment, and walking is often compromised (Walsh, 2004). Walking is an activity with both clinical and functional relevance for its impact on independence and quality of life. However, the impact of back pain on the walking's parameters still needs further understanding given the complexity of this syndrome and the wide range of factors that can contribute to loss of motion (O'Sullivan, 2005). Patients with low back pain often report difficulties with walking and usually walk slower than their healthy peers (Lamoth, *et al*., 2002). Furthermore, gait coordination is changed in these patients (Yun, *et al*., 2011). In normal slow walking, horizontal rotations of pelvis and thorax are more or less occurring at the same time, but at higher speeds, they occur separately. This change of coordination at higher speeds occurs less in patients with chronic LBP (Lamoth, *et al*., 2002). Human walking patterns are different. Each person's gait kinematic and kinetic quantities are assumed to be periodic (Cappozzo, 1975) (Perry, 1992) or pseudo periodic (Pecoraro, *et al*., 2006) and determined by the body characteristics and the personal ability to control the gait. In the case of neuromuscular and musculoskeletal pathologies or injuries, these movements may not be periodic, and they may result in increased gait instability (Pecoraro, *et al*., 2006). Given the fundamental nature of walking and the fact that it is an often-prescribed activity for patients with low back pain, it is clearly important to have a better understanding of the effect of pain on walking in individuals with low back pain. Additionally, the determination of abnormal gait requires one to first have an understanding of the basic components and biomechanics of normal gait (Lehmann, *et al*., 1992).

MATERIALS AND METHODS

PARTICIPANTS: Thirty-five subjects were selected among patients diagnosed with low back pain and are undergoing physiotherapy treatment at the Physiotherapy Department of Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC). Thirty-five age and sex matched apparently healthy subjects who have no pain of any kind in the back were recruited to serve as controls from Ile-Ife community.

INCLUSION CRITERIA

- Patients with low back pain who were ambulatory were involved in the study.
- Apparently healthy age and sex matched individuals who were without any pain of any kind in their back were recruited as controls.
- Patients with nonspecific chronic low back pain undergoing physiotherapy treatment at the physiotherapy department of Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC).

EXCLUSION CRITERIA

- Patients with acute low back pain undergoing physiotherapy treatment at the Physiotherapy Department of Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) were excluded from the study.
- Patients with specific low back pain undergoing physiotherapy treatment at the Physiotherapy Department of Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) were excluded from the study.

SAMPLE SIZE DETERMINATION

The sample size was determined using this formula according to (Eng, 2003):

$$N = 4\sigma^2 (Z_{crit}\sigma + Z_{pwr})^2 / D^2$$

Where N is the total sample size (the sum of the sizes of both comparison groups), σ is the assumed standard deviation (SD) of each group (assumed to be equal for both groups), the Z_{crit} value is the standard normal deviate corresponding to significance criterion 0.05= 1.960, and Z_{pwr} is the standard normal deviate corresponding to statistical power 0.80= 0.842, where D is the assumed minimum expected difference between two means.

Where $\sigma = 15$, $Z_{crit} = 1.960$, $Z_{pwr} = 1.429$ and D= 10,

Then $N = \underline{4(15)^2 \text{ X } (1.960 \text{ X } 1.429)^2}\, 10^2$

$= 70.602$

Therefore, a total of 70 individuals were enrolled in the study.

RESEARCH DESIGN: Cross sectional survey research design was used for this study.

INSTRUMENTS

Height Meter: (Seca Mod.220, Germany) was used to measure the subjects' heights in centimeters to the nearest 0.1cm. It is calibrated from 0-200cm. Bathroom weighing scale (Hana bathroom scale): was used to measure the subjects' weights in kilograms to the nearest 1.0kg. It is calibrated from 0-120kg. Stopwatch: This was used to record the time taken to walk. Chalk to make indelible marks on the walkway.

PROCEDURE: Ethical approval was obtained from the Health Research and Ethics Committee, Institute of Public Health, Obafemi Awolowo University, Ile-Ife. Informed consent of each participant was also obtained. Each participant was educated on the procedure and subsequently anthropometric measurement of each subject were taken. After this, each participant was made to walk through a 6-metre pre-measured walkway with markings on the ground in order to ensure evenness and accurate measurement of gait parameters at his or her own self-selected normal walking speed. The stride length, step length, time taken to walk, number of steps were recorded and walking speed and cadence were calculated. The following variables were measured or calculated for each subject:

- Weight in kilogram (kg): Participants wore minimal clothing and were instructed to stand erect on the weighing scale with his or her barefoot. The scale was then read and record to the nearest 1.0 kg.
- Height in meters (m): Participants were instructed to stand erect on the base of the height meter, while looking straight ahead. The bar attached to the height meter was adjusted to touch the vertex of the head. The reading was taken and recorded in meters (m) to the nearest 0.01m.
- Body mass index in kilogram per meter squared (kg/m2): This was calculated by dividing the weight by the square of the height and recorded in kilogram/metre2.
- Body Mass Index= weight/height2
- Cadence (Steps per minute): The number of steps taken on the walkway by the participants was counted and from there, the cadence was calculated.
- Walking Speed (self-selected): The distance covered (6m) was divided by the time taken to walk through the walkway and recorded in meter/second.

DATA ANALYSIS: Data were analyzed using descriptive statistics of mean and standard deviation and inferential statistics or Pearson`s Product Moment Correlation Coefficient to determine the relationships between age, BMI and selected gait parameters. Independent t-test was also used to compare selected gait parameters of participants with low back pain and their age and sex matched apparently healthy controls. Significance was set at 0.05 α- level.

RESULTS

Physical Characteristics: This study was done to determine gait parameters of individuals with low back pain, and compared with those of their age and sex matched apparently healthy controls. Seventy individuals, 35 with low back pain and 35 apparently healthy controls were involved in this study. They comprised 19 females and 16 males per group. Participant's average age, height and weight were 49.714±13.868 years, 1.629±0.741 meters and 73.100±13.260 kilogram respectively. Body mass indices were calculated in this study and categorized into underweight, normal and overweight. Results obtained showed that the majority of participants were overweight, 71.4% for low back pain (Figure 1) and 62.9% for age and sex matched apparently healthy controls (Figure 2). Anthropometric parameters of participants with low back pain and that of their apparently healthy controls were compared using independent t-test. Result showed that there was no significant difference in anthropometric parameters of height, weight and BMI of participants (P> 0.05).

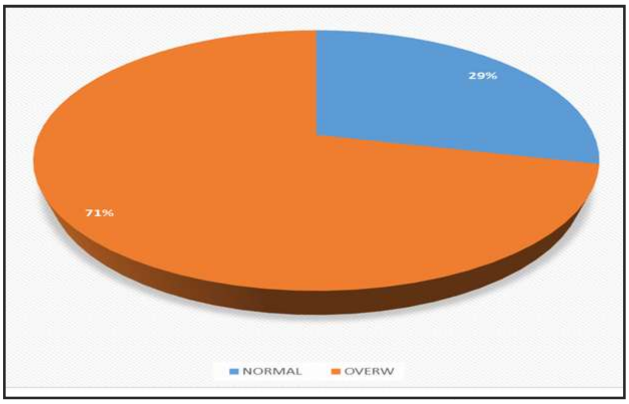

Figure 1. Body Mass Indices of Participants with Low Back Pain

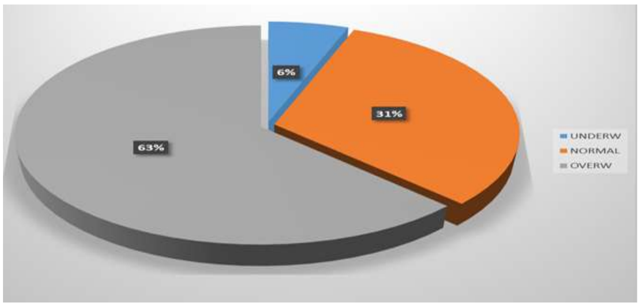

Figure 2. Body Mass indices of apparently healthy group

Comparison of gait parameters of participants: Gait parameters in terms of cadence and walking speed of all participants were assessed in this study. Results showed that walking speed and cadence of participants with low back pain was less than that of their apparently healthy controls group (Table 2). The independent t-test was used to compare parameters of walking speed and cadence among participants with low back pain and their apparently healthy controls. Results showed that there was no significant difference in cadence of individuals with low back pain and their age and

Table 1. Physical Characteristics of Participants N= 70

	Low back pain $\bar{X}$ ± S.D	Apparently healthy $\bar{X}$ ± S.D	t	p
Height (m)	1.632±0.073	1.626±0.076	0.336	0.738
Weight (kg)	74.086±11.698	72.114±14.764	0.619	0.538
BMI (kg/m²)	27.683±4.123	27.400±5.773	0.236	0.814

Key:
$\bar{X}$ =Mean
S$\bar{X}$D = Standard deviation
*Significant difference at α= 0.05
t= Independent t-test
p= probability

Table 2. Comparison of Gait Parameters of Individuals with Low Back Pain and Their Age and Sex matched Apparently Healthy Controls (n_1= 35, n_2=35).

	Low Back Pain $\bar{X}$ ± S.D	Apparently Healthy $\bar{X}$ ± S.D	t	p
Walking speed (Meter/seconds)	0.704±0.193	0.830±0.145	3.089	0.003*
Cadence (Steps/minute)	90.686±13.953	91.143±10.539	0.155	0.878

Key:
$\bar{X}$ =Mea$\bar{X}$n
SD = Standard deviation
*Significant difference at α= 0.05
t= independent t-test
p= probability

Table 3. Gender Comparison of Gait Parameters of Participants in Both Groups (N=70).

	Males $\bar{X}$ ± S.D	Females $\bar{X}$ ± S.D	t	p
Walking speed (Meter/seconds)	0.751±0.185	0.781±0.179	0.689	0.493
Cadence (Steps/minute)	88.406±11.413	93.026±12.725	1.586	0.117

Key:
$\bar{X}$ =Mean
S$\bar{X}$D = Standard deviation
*Significant difference at α= 0.05
t= independent t-test
p= probability

sex matched controls (p<0.05). However, there was significant difference in walking speed of individuals with low back pain and their age and sex apparently healthy controls (p<0.05). Gender comparisons of gait parameters were done for all participants in this study. Results showed that there were no

Table 4. Gender Comparison of Gait Parameters of Participants in Low Back Pain Group (n=35)

	Males	Females	t	p
	$\bar{X}$ ± S.D $\bar{X}$	$\bar{X}$ ± S.D $\bar{X}$		
Walking speed (meter/seconds)	0.679±0.191	0.725±0.198	-1.327	0.194
Cadence (Steps/minute)	87.3±12.945	93.53±14.474	-0.696	0.491

Key:
$\bar{X}$ =Mean
S$\bar{X}$ D = Standard deviation
*Significant difference at α= 0.05
t= independent t-test
p= probability

Table 5. Gender Comparison of Gait Parameters of Participants in Apparently Healthy Control Group (n=35)

	Males	Females	t	p
	$\bar{X}$ ± S.D $\bar{X}$	$\bar{X}$ ± S.D $\bar{X}$		
Walking speed (Meter/seconds)	0.822±0.152	0.836±0.142	-0.282	0.779
Cadence (Steps/minute)	89.50±9.953	92.53±11.082	-0.843	0.405

Key:
$\bar{X}$ =Mean$\bar{X}$
SD = Standard deviation
*Significant difference at α= 0.05
t= independent t-test
p= probability

significant differences (p<0.05) (Table 3). Similarly, gender comparison of participants with low back pain (Table 4) and that of their age and sex matched apparently healthy controls were not significant (p<0.05) (Table 5).

Table 6. Relationship of Anthropometric Variables and Gait Parameters of All Participants

	Cadence		walking speed	
	r	p	r	p
Height (m)	-0.192	0.111	-0.175	0.147
Weight (kg)	0.011	0.929	0.029	0.814
BMI (kg/m²)	0.113	0.353	0.076	0.530

Key:
*. Correlation is significant at the 0.05 level
BMI= Body Mass Index
r= Pearson correlation

Relationship of Anthropometric variables and gait parametersof participants with low back pain and their apparently healthy counterparts: The relationship of anthropometric variables and gait parameters of all participants in this study was done using Pearson's Product Moment Correlation Coefficient. It was observed that there was no significant relationship between anthropometric variables and gait parameters (p>0.05). Height was however inversely related to cadence (-0.192) and walking speed (-0.175) (Table 6). Relationship of anthropometric variables and gait parameters of participants with low back pain was also done using Pearson's Product Moment Correlation Coefficient, results showed that there was an inverse relationship between anthropometric variables except BMI and cadence. Also, there is an inverse relationship between height and walking speed (Table 7). The relationship of anthropometric variables and gait parameters of participants in the apparently healthy controls group was done using Pearson's Product Moment Correlation Coefficient, results showed that there was an inverse relationship between height and gait parameters (Table 8)

Table 7. Relationship of Anthropometric Variables and Gait Parameters of Participants with Low Back Pain

	Cadence		walking speed	
	r	p	r	p
Height (m)	-0.169	0.332	-0.047	0.787
Weight (kg)	-0.400	0.821	0.086	0.624
BMI (kg/m²)	0.105	0.548	0.140	0.422

Key:
*. Correlation is significant at the 0.05 level
BMI= Body Mass Index
r= Pearson correlation

Table 8. Relationship of Anthropometric Variables and Gait Parameters of Apparently Healthy Control Group

	Cadence		walking speed	
	r	p	r	p
Height (m)	-0.226	0.192	-0.337	0.047*
Weight (kg)	0.068	0.700	0.034	0.844
BMI (kg/m²)	0.132	0.451	0.056	0.751

Key:
*. Correlation is significant at the 0.05 level.
BMI= Body Mass Index
r= Pearson correlation

DISCUSSION

This study was done to determine gait parameters of participants with low back pain that were undergoing physiotherapy management in Obafemi Awolowo Teaching Hospitals Complex, comparisons were done with their age and sex matched apparently healthy controls. Age in this study was determined based on the availability of low back pain patients. It therefore means that the average age of participants is reflective of the average age of low back pain patients. The average age was just below 50years, which suggested that the average participant in this study was around middle age. This observation is in line with previous submission in literature that low back is commonly among individuals in their forties and fifties. According to Macfarlane *et al*, (2012), the peak prevalence of low back pain is between 41-50years of age, Peter *et al*, (2005) also reported peak prevalence of low back pain at 45-59years old. According to Hoy *et al*, (2012) the highest prevalence of low back pain fell within the age range of 40-80years globally. Results of this study showed that majority of the participants were overweight with no difference between those in low back pain and apparently healthy control groups. Anthropometric variables were compared in the groups studied. Results showed that over 2/3of participants with low back pain were overweight, and about 2/3rd overweight in the apparently healthy group. Participants in this study were around middle age, and weight has been reported to tend to much higher values with age (David, 2014). Overweight, being overweight has been implicated in several clinical conditions including low back pain (Timothy & Leon, 2005). Individuals around middle age have been reported to have almost an equal prevalence of overweight as those in their sixties (AF El-Hazni Mohsen & Arjumand, 2002) with females having higher obesity prevalence. It has been reported that obesity increases with age. For example, AF El-Hazni Mohsen and Arjumand, 2002 in their study among Saudi Arabians reported highest prevalence of obesity among 40-49years population. The population in the work of AF El-Hazni and Arjumand, 2002 is similar to that of present study in terms of average age of participants. Cadence and walking speed were observed to be lower than suggested average values in research. The normal walking speed is between 1.2metre/second to 1.3metre/second, while the average cadence is 110 steps per minute for men or 115 steps per minute for women (Johnson and Peter, 2000). The majority of participants in this study were overweight, and this may contribute to a reduction in their average walking speed. Devita *et al*, (2003) reported that obese individuals tend to walk with significantly slower gait speed since they take shorter steps and strides, with higher step widths. According to Asfour *et al*, (2013) obese individuals spend significantly less time in single support and more time in double support than in their non-obese counterparts, with consequent reduction in walking speed.Walking is a complex dynamic task that is fundamental to function and requires an individual to generate and withstand a variety of multifunctional forces around each joint and with the ground (Simmonds, *et al*., 2007). In this study, the walking speeds of participants in both low back pain and apparently healthy control groups were compared. Participants with low back pain had slower walking speed than their counterparts. This may be because individuals with pain appear to attain a variety of alternative strategies while walking and this effort to compensate for pain experience may affect walking speed (Simmonds *et al*, 2007). Previous studies have shown that individuals with low back pain tend to walk slower, with shorter steps than their apparently healthy controls (Simmonds, *et al*., 2007). Lamoth, *et al*, (2006) also reported that gait coordination is changed in patients with low back pain. Human beings tend to adopt a gait pattern much comfortable to them in face of pain (Robinson *et al*, 2003), which will affect the number of steps taken per minute that is cadence (Johnson, 2000). In this study, the average cadence for apparently healthy controls was higher than that of low back pain participants. Although not significantly higher, it may be of clinical importance to note this observation. This study showed that there was an inverse relationship between walking speed, cadence, and height in the low back pain and apparently healthy control groups. This observation suggested that walking speed decreases with increased height and vice versa. Samson *et al*, (2001) in their study reported that cadence was not correlated with height and body weight. Leg length contributes to height and determines individuals maximum possible walking speed, although walking speed is not dependent solely on leg length (Budhram, 2011). There was an inverse relationship between height and cadence and walking speed of participants. However, the significance was only among the height and walking speed of apparently healthy controls. According to a study by Lowth, (2014) everyone has a preferred cadence which relates to leg length and usually represents the most energy efficient rhythm for individual body structure. The number of steps taken per minute in individuals is also affected by their height. Tall people take longer steps and therefore lower cadence while short people take shorter steps and therefore higher cadence.

CONCLUSION

It was concluded that the walking speed of participants with low back pain was lower than that of their apparently healthy controls. There was no relationship between anthropometric variables and gait parameters ($p>0.05$) except height which was inversely related to walking speed among apparently healthy controls ($p<0.05$).

RECOMMENDATIONS

It was therefore recommended that focus of physiotherapy management of low back pain should include more emphasis on gait. Gait assessment and re-education should therefore be encouraged as routine in management of low back pain patients.

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