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ORIGINAL RESEARCH

Postural stability, body composition and functional ability of the lower extremity in patients with lumbar degenerative spondylolisthesis

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Abstract. Although patients accessing rehabilitation services had been reported to have better functional ability of the lower limbs, postural stability, and low cardiovascular disease risk factors, updated data from developing countries is however vital for clinical practices. Hence, the aim of this study was to present the association between lower extremity functional ability (LEFA), stability, and body composition profiles in rehabilitative lumbar degenerative spondylolisthesis (LDS) patients considering age and gender. One hundred and twenty-four participants (45 females, 79 males), with a mean age of 56.45±11.13 years, volunteered for the study. Weight, height body fat percent (BFP), visceral fat, body mass index (BMI), resting systolic and diastolic blood pressure, and resting heart rate were measured while functional ability and stability tests were conducted on the participants. 53.4% were at least overweight; LEFA was below average, stability of both dominant and nondominant legs was very poor, blood pressure and heart rate were high. Women had high total body fat and visceral fat. Significant differences were observed in BMI (p=0.044) and BFP (p=0.035) based on age classification as well as BMI (p=0.000), BFP (p=0.000) and visceral fat (p=0.000) by gender. Overweight, high blood pressure, poor LEFA, and postural stability are crucial comorbidities of Ghanaian LDS patients in this study. Educationally and pragmatically comprehensive healthy lifestyle interventions of regular exercise regimes, adequate and quality nutrition, and occupational stress reduction would play major complementary roles in chiropractic treatment.

Keywords. Blood pressure, body fat, lower extremity functional ability, lumbar spondylolisthesis.

Introduction

Spondylolisthesis occurs at the vertebral column with most impact between the fifth lumbar /first sacrum vertebrae (L5/S1), with the L5 slipping anteriorly on the S1 (Abubakar et al., 2017; Wong 2004). Supervenient to the slip is osteophyte and synovial cyst formation; narrowing of the foramina as well as thickening of the ligamentum flavum (Vlok, 2008) triggering weak, painful, or numbness in the extremities, among other indicators (Abubakar et al., 2017).

Lumbar degenerative spondylolisthesis (LDS) (spondylolisthesis to the lumbar vertebrae) is the major cause of spinal stenosis, which leads to most impairments associated with quality of life as well as functional ability limitations in both middle-aged and

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Received: April 24, 2022 - ***Accepted:*** *June 18*, 2022 - ***Published:*** June 26, 2022
To Cite: Nanevi, Y. W., Moses, M .O., Ansu Gyeabour, E., & Boateng, R. J. (2022). Postural stability, body composition and functional ability of the lower extremity in patients with lumbar degenerative spondylolisthesis. *Turk J Kinesiol*, 8(2), 44-49.
DOI: 10.31459/turkjkin.1108377

the elderly (Moo et al., 2015). The estimated prevalence of spondylolisthesis in 2015 was between 3% and 11.5% of the general population, with a female to male ratio of 3:1 (Ogden et al., 2015; Kalichman et al., 2009). In the US, over 300,000 lumbar spine fusion surgeries (or arthrodesis) are performed annually, and one-third of these are for degenerative spondylolisthesis, spinal stenosis, or a combination of both. The study reported that ten to eleven percent occurrence of lumbar spine fusion surgeries has steadily risen in the past 20 years (Beschloss et al. 2021; Deyo et al., 2005).

Authors assume that the prevalence of LDS estimated could be greater in Africa. This assumption is linked to aging, heredity, the impact of the activity, and occupation which are key factors in the assessment procedures of functional abilities (Sharma et al., 2015; Duruöz et al., 2013). Studies have shown significant relationships between age, gender, occupation, and the development of degenerative spondylolisthesis (Kamal & Rouhi, 2019, Wang et al., 2019 & Hsu et al., 2019).

In a typical African setting like Ghana, manual lifting of heavy loads, poor techniques of lifting objects, long hours of sitting, and incorrect sleeping posture are common practices. Having excess body fat, heavy workload, and long hour of sitting are reported risk factors for degenerative spondylolisthesis (DeVine et al., 2012). Excess visceral fat potentiates an increase in lordosis that brings about anterior mechanical stress and weakens abdominal muscles which could lead to slippage on the L5/S1 vertebrae (Davies et al., 2019; Liu & Hai, 2019). According to Kamal & Rouhi (2019), weakness of abdominal muscles is a significant factor in spine instability which plays a vital negative functional role in forces of the trunk muscles. Spine instability would lead to poor recovery from daily activities, hinder mobility and decrease balance (Lee et al., 2019). Physical inactivity aggravates the onset of back pains and its associated neurogenic symptoms obesity and instability (Denard et al., 2010).

Degenerative spondylolisthesis is noticeably prevalent among physically inactive Ghanaians with chiropractic adjustment often used as prophylactic. Chiropractic adjustment seeks to facilitate a contemporary swing towards the healthy quality of life but has limitations in enhancing the well-being of victims in Ghana. The study indicated that in order to adapt therapeutic strategies for gaining functional abilities, it is necessary to measure physical performance and capacity limitations using sufficient assessment tools (Pfingsten et al., 2014).

The ability to qualitatively quantify functional ability, body composition, and stability using clinically important parameters will allow for an individualized, patient-specific approach to the treatment of LDS (Simmonds et al., 2015; Biely et al., 2006). A study has shown that LDS causes a decrease in the functional ability of the lower limbs, poor postural stability, and is a risk factor for obesity (Jiang et al., 2019) but there is limited information on the Ghanaian population. Although patients accessing rehabilitation services had been reported to have the better functional ability of the lower limbs, postural stability, and low cardiovascular diseases risk factors, updated data from a developing country is however vital for clinical practices. Hence, the aim of this study was to present the association between lower extremity functional ability (LEFA), stability, and body composition profiles in rehabilitative lumbar degenerative spondylolisthesis (LDS) patients considering age and gender.

Methods

Study Design and Setting

The study employed a cross-sectional descriptive research design. Spondylolisthesis patients, receiving chiropractic adjustment at a government-approved private spinal clinic in Ghana, served as a sample population. The study obtained approval from Kwame Nkrumah University of Science and Technology Ethical Committee (Committee on Human Research and Publication, Ref: CHRPE/AP/313/19) which entailed endorsement from the setting and consent of the patients.

Sample

To establish the initial data on the spinal condition, 232 participants older than or equal to 20 years were purposefully sampled using computer-generated random numbers. Out of this number, 148 who had completed their care plan but on maintenance visits once a month were available and recruited for the study. At the second and the subsequent five visits, 24 (16.2%) voluntarily withdrew their consents due to personal interest. Thus, data from a total sample of

one hundred and twenty-four (124) spondylolisthesis patients older than or equal to 20 years were finally analysed over the three months of data collection for the study. Spondylolisthesis patients with prior spinal surgery, pain attributed to current pregnancy, spinal fracture, infection, and tumors were excluded.

Measurements

Demographic information (age, sex, occupation) was obtained through participants' self-report. The Health O Meter, (floor type model RGZ-120, China), was used to measure participants' height. BMI, weight, BFP, and visceral fat were recorded from Omron (HBF-375) body composition monitor. The BMI value obtained was used to categorize obesity status. The age classification is clearly reported (Smith, Devine, Taddeo, & McAlister, 2017). Postural stability was measured with a balance standing stork test. The balance standing stork test is a well-established instrument for assessing stability (Chaouachi et al., 2017). Lower extremity functional ability was measured using the lower extremity functional scale (LEFS) as published (Binkley et al., 1999). The LEFS contains twenty items that describe activity limitations in day-to-day activities. Patients daily functioning were obtained by performing LEFS activities and were rated as extreme difficulty or unable to perform an activity, /quite a bit of difficulty, / moderate difficulty, / a little bit of difficulty, / no difficulty (Table 3). The participant's performance ratings were summed to get a total score. The score obtainable was 80. The reported test-retest reliability value of LEFS was 0.94**.**

Statistical Analysis

Statistical Package for Social Science (IBM SPSS Statistics version 21.0, IBM Corp. Armonk, New York, USA) and Microsoft Excel 2013 compatible with Microsoft window 7 was used to analyze the data. Descriptive statistics of frequency, percent count, mean, and standard deviation as well as inferential statistics of Pearson product-moment correlation coefficient and linear regression analysis were presented. Significance was set at 0.05 as appropriate.

Results

There is a statistical difference in BMI, BFP and duration of symptom (DOSS) based on age classification (Table 4; $p<0.05$). Post hoc Bonferroni showed that specific significant differences were between age group 20-39 and 60-99 in BMI [Mean diff = 4.45, 95% CI = 0.235 – 8.664, p = 0.036], BFP [Mean diff = 11.16, 95% CI = 0.811 – 21.500, p =0.030] and VF [Mean diff = 3.28, 95% CI=0.092 – 6.460, p =0.042].

Table 1
Distributions of demographic, physiological and anthropometric variables (n=124).

Characteristics	Gender	N - %	Mean ± SD	Rating
Age (year)			56.45 ± 11.13	NA
Height (m)			1.66 ± 0.07	NA
Weight (kg)			71.90 ± 10.05	NA
Duration of treatment (years)			0.37± 0.19	NA
Duration of spondylolisthesis symptom (years)			6.39±6.75	NA
Gender	Male	79 - 63.7%		NA
	Female	45 - 36.3%		NA
Total Body Fat (%)	Male		20.88 ± 2.25	Normal
	Female		37.83 ± 4.15	High
Visceral Fat	Male		7.68 ± 1.85	Normal
	Female		11.50 ± 2.37	High
BMI Classification	Male (52 - 65.8%), Female (5 - 11.1%)			Normal
	Male (11 - 13.9%), Female (11 - 24.5%)			Overweight
	Male (16 - 20.3%), Female (29 - 64.4%)			Obese

Table 2
Distributions of demographic, physiological and anthropometric variables (n=124).

Characteristics	Mean ± SD	Rating
Lower Extremity Functional Ability	39.55 ± 12.17	Below Average
Stability (Dominant leg) (seconds)	9.18 ± 4.74	Very low
Stability (Nondominant leg) (seconds)	8.75 ± 5.57	Very low
Body Mass Index (kg/m^2)	26.16 ± 3.65	Overweight
Systolic blood pressure (mmHg)	136.77 ± 12.67	Pre-hypertension
Diastolic blood pressure (mmHg)	81.42 ± 7.96	Pre-hypertension
Heat rate (bpm)	83.20 ± 11.77	Sedentary

Table 3
Distribution of difficulty with lower extremity functional ability.

	Any difficulty with LEFS	Extreme Difficulty n (%)	Quite a Bit of Difficulty n (%)	Moderate Difficulty n (%)	A Little Bit of Difficulty n (%)	No Difficulty n (%)
1	Any of your usual work, housework, or school activities.	0 (0.00)	1 (1.70)	20 (33.30)	25 (41.70)	14 (23.30)
2	Your usual hobbies, recreational or sporting activities.	12 (20.00)	19 (31.70)	11 (18.30)	18 (30.00)	0 (0.00)
3	Getting into or out of the bath.	2 (3.30)	0 (0.00)	15 (25.00)	31 (51.70)	12 (20.00)
4	Walking between rooms.	1 (1.70)	1 (1.70)	12 (20.00)	35 (58.30)	11 (18.30)
5	Putting on your shoes or socks.	1 (1.70)	9 (15.00)	25 (41.70)	19 (31.70)	6 (10.00)
6	Squatting.	15 (25.00)	21 (35.00)	20 (33.30)	4 (6.70)	0 (0.00)
7	Lifting an object, like a bag of groceries from the floor.	8 (13.30)	18 (30.00)	26 (43.30)	5 (8.30)	3 (5.00)
8	Performing light activities around your home.	1 (1.70)	11 (18.30)	31 (51.70)	14 (23.30)	3 (5.00)
9	Performing heavy activities around your home.	11 (18.30)	24 (40.00)	18 (30.00)	7 (11.70)	0 (0.00)
10	Getting into or out of a car.	3 (5.00)	4 (6.70)	16 (26.70)	29 (48.30)	8 (13.30)
11	Walking 2 blocks.	7 (11.70)	4 (6.70)	7 (11.70)	34 (56.70)	8 (13.30)
12	Walking a mile.	8 (13.30)	8 (13.30)	14 (23.30)	24 (40.0)	6 (10.0)
13	Going up or down 10 stairs (about 1 flight of stairs).	7 (11.70)	8 (13.30)	30 (50.00)	13 (21.70)	2 (3.30)
14	Standing for 1 hour.	6 (10.00)	14 (23.30)	23 (38.30)	13 (21.70)	4 (6.7)
15	Sitting for 1 hour.	2 (3.30)	12 (20.0)	12 (20.00)	19 (31.70)	15 (25.00)
16	Running on even ground.	15 (25.00)	21 (35.00)	15 (25.00)	7 (11.70)	2 (3.30)
17	Running on uneven ground.	19 (31.70)	22 (36.70)	11 (18.3)	6 (10.00)	2 (3.30)
18	Making sharp turns while running fast.	31 (51.00)	19 (31.70)	6 (10.00)	4 (6.70)	0 (0.00)
19	Hopping.	23 (38.30)	25 (41.70)	8 (13.30)	3 (5.00)	1 (1.70)
20	Rolling over in bed.	4 (6.70)	2 (3.30)	8 (13.30)	21 (35.00)	25 (41.70)

In comparison, males had the higher functional ability, and postural stability (both dominant and nondominant legs) than females (Table 5). Males had normal BMI (24.58 ± 5.3) while females were overweight to obese (29.90 ± 3.92). Blood pressure and heart rate were also higher in females than males. There were statistically significant associations found between the gender, BFP ($p<0.05$ for each association), and gender.

Discussion

The study examined the lower extremity functional ability, stability, and body composition of spondylolisthesis patients receiving chiropractic adjustment while adjusting for age and gender. Descriptive results in Table 1 revealed that females had higher body fat percent and visceral fat while the males had normal values based on the classification in

the literature (Verkouter et al., 2019; Boyanov et al., 2003). In the same vein, 34.2% of the male and 88.9% of the female were at least overweight as earlier reported (Vlok, 2008). The prevalence ratio of LDS between males and females in this study was 1:1.5 which is lower than that of earlier studies which reported 3:1 (Ogden et al., 2015; Wang et al., 2017). The small sample size of this study and scarcity of local data may significantly account for the low M/F prevalence obtained.

Table 4
Comparison of lower extremity functional ability (LEFA), stability, and body composition by age classification (Mean ± SD).

Variables	20-39 (Young Adult)	40-59 (Middle Age)	60 Plus (Older Adult)	*F*	*p*
Lower extremity functional ability	33.40 ± 15.65	39.53 ± 12.19	41.05 ± 11.47	0.791	0.458
Stability (dominant leg)	9.80 ± 5.01	9.00 ± 6.43	8.10 ± 4.16	0.261	0.779
Stability (non-dominant leg)	12.00 ± 1.41	9.44 ± 5.26	8.10 ± 4.12	1.511	0.229
Body Mass Index	29.94 ± 3.68	26.02 ± 3.37	25.49 ± 3.72	3.289	0.044*
Body fat percent	36.26 ± 8.27	26.98 ± 8.27	25.49 ± 3.72	3.545	0.035*
Visceral fat	11.80 ± 3.49	9.03 ± 2.63	8.52 ± 2.50	3.082	0.054
Systolic blood pressure	133.40 ± 9.15	136.47 ± 11.68	138.04 ± 15.06	0.286	0.752
Diastolic blood pressure	80.40 ± 10.19	82.85 ± 6.63	79.33 ± 9.23	1.328	0.273
Heart rate	89.80 ± 12.52	83.08 ± 10.33	81.81 ± 13.72	0.932	0.400
DOSS	0.52 ± 0.25	5.32 ± 4.84	9.52 ± 8.67	5.232	0.008*
DOT	0.42 ± 0.22	0.38 ± 0.18	0.35 ± 0.20	0.380	0.686
Height	1.60 ± 0.070	1.66 ± 0.05	1.67 ± 0.07	2.564	0.086
Weight	76.00 ± 3.67	70.57 ± 9.92	73.10 ± 11.15	0.856	0.430

*DOSS=Duration of spondylolisthesis symptom; DOT=Duration of treatment (current chiropractic treatment); * Significantly different at p < .05.*

Table 5
Functional ability of the lower extremity, stability, and body composition of the participants based on Gender (Mean ± SD).

Variables	Male (n=79)	Female (n=45)	*t*	*p*
Lower extremity functional ability	39.61 ± 2.80	39.45 ± 11.19	0.174	0.184
Stability (dominant leg)	9.45 ± 6.32	7.55 ± 3.79	-0.115	0.381
Stability (non-dominant leg)	9.00 ± 5.31	9.50 ± 3.64	-0.391	0.697
Body Mass Index	24.58 ± 5.31	29.90 ± 3.92	-5.335	0.000*
Body fat percent	20.88 ± 2.25	37.83 ± 4.46	-6.948	0.000*
Visceral fat	7.68 ± 1.84	11.50 ± 2.37	-0.694	0.000*
Systolic blood pressure	134.73 ± 12.07	140.27 ± 13.19	-1.655	0.103
Diastolic blood pressure	80.89 ± 7.40	82.82 ± 8.95	-0.664	0.505
Heart rate	81.82 ± 2.77	85.59 ± 9.61	-0.233	0.074
DOSS	6.95 ± 7.13	5.42 ± 5.70	0.338	0.008*
DOT	0.36 ± 0.19	0.39 ± 0.19	-0.104	0.427
Height	1.69 ± 0.05	1.61 ± 0.06	5.380	0.000*
Weight	71.32 ± 8.96	72.93 ± 11.86	-5.286	0.553

*DOSS=Duration of spondylolisthesis symptom DOT=Duration of treatment (current chiropractic treatment); *Significantly different at p < .05.*

This suggests that rehabilitative spondylolisthesis patients are at risk of cardiovascular diseases (Nazarov et al., 2019). This is in line with previous studies (Piché et al., 2018; Gailey et al., 2008; Grob et al., 2005) that degenerative spondylolisthesis in fifty years old and above patients are overweight, have a lower functional ability of the lower extremity as well as very poor postural stability, and both dominant and non-dominant legs. Participants in this study were sedentarily pre-hypertensive with a high heart rate. Although chiropractic treatment is prophylactic to spondylolisthesis, health outcomes associated with activities of daily living are compromised. These findings are not unexpectedly owning to the fact that obesity is a major risk factor for cardiovascular abnormalities (Piché et al., 2018; Jakobsen et al., 2018).

Outcomes of this study revealed that middle-aged and older patients with LDS had improved self-evaluated and activity-based physical function, body mass index and percent body fat when compared to young adults. It had been documented that both self-reported information and activity-based results complement validity of responses (Thornes et al., 2018). A vivid analysis of the result in Table 4 showed that functional ability increases with ageing whiles BMI and stability decrease with age category which is contrary to previous study where trunk muscle intramuscular fat (visceral fat) is related to both objective measures of physical function, as well as patient perceptions of physical function in older adults with lumbar degenerative spondylolisthesis (Sions et al., 2017; Rihn et al., 2015; Hicks et al., 2005). BMI rather decreased with increasing age category whiles functional abilities increased with increasing age category.

Although males had a higher duration of symptoms and less duration of treatment than females, males presented better health outcomes than females. This supports previous study that debunks the values of longer days of chiropractic treatment as a measure of improved functional ability of the lower extremity (Wasiak et al., 2007).

Conclusion

Chiropractic treatment is an important interventional modality for lumbar degenerative spondylolisthesis but has limitations in enhancing wellbeing. Overweight, high blood pressure, poor LEFA, and postural stability persist as comorbidities of Ghanaian LDS patients. Educationally and pragmatically comprehensive healthy lifestyle interventions of regular exercise regimes, adequate and quality nutrition, and occupational stress reduction would play major complementary roles in chiropractic treatment. Nationwide epidemiological and longitudinal studies are recommended for chiropractic treatment policy directives.

Authors' Contribution

Study Design: YWN, MO, EAG; Data Collection: YWN, MO, RJB; Statistical Analysis: YWN, EAG, RJB; Manuscript Preparation: YWN, MO, EAG; Funds Collection: RJB.

Ethical approval

The study obtained approval from Kwame Nkrumah University of Science and Technology Ethical Committee (Committee on Human Research and Publication, (Ref: CHRPE/AP/313/19) which entailed endorsement from the setting and consent of the patients.

Funding

The authors declare that the study received no funding.

Conflict of Interest

Authors declared no conflict of interest

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