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THE RELATIONSHIP BETWEEN BODY MASS INDEX (BMI) AND IMAGING OUTCOME OF PREVALENT LUMBOSACRAL SPINE DISORDERS IN ONITSHA ANAMBRA STATE, NIGERIA.

OKPALEKE, MICHAEL SUNDAY[1], NGOKA MIRACLE CHINELO[1]

[1]Department of Radiography, Nnamdi Azikiwe University, College of Health Sciences and Technology, Nnewi Campus, Anambra State

Corresponding author,
Dr Michael Sunday Okpaleke
Department of Radiography, Faculty of Health Sciences and Technology,
College of Medicine, Nnamdi Azikiwe University, Nnewi Campus, Anambra State

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ABSTRACT

Introduction: Radiographic examination of the lumbosacral spine is one of the frequently carried out examinations in the radiology department in Onitsha town due to the prevalence of lumbosacral disorders in the locality but unfortunately little is known of the role of body mass index (BMI) on lumbosacral disorders.

Purpose: This study was aimed at determining the relationship between BMI and imaging outcome of prevalent lumbosacral spine disorders.

Method: The study adopted a prospective cross sectional survey research design. Ninety (90) patients referred to the selected medical diagnostic Centers in Onitsha, Anambra state, Nigeria were recruited for this study between January to July 2021. Using a simple random technique, a convenient sample size of 74 patients were selected who met the inclusion criteria. The sample size was determined arithmetically according to Uzoagulu, et al., (2011). Request form of each patient was collected and the history recorded. Patient's weight and height were measured using with standard instruments and BMI was calculated and classified. The patient was positioned and lumbosacral x – ray examination performed using standard procedures. The patient's lumbosacral imaging outcome was evaluated, reported by a radiologist and documented. Data was analyzed using statistical package for social sciences version 21. The Pearson's moment correlation co-efficient was used to determine the relationship between body mass index and imaging outcome of the prevalent lumbosacral spine disorders. Descriptive statistics was used to determine the most prevalent lumbosacral spine disorders within the study population while the Analysis of variance was used to determine the relationship between the age, gender, BMI and lumbosacral spine disorders.

Result: Out of the 74 patients examined,41(58.1%) were males and 31(41.9%) females, mean age 56years. The mean BMI range from 29.599±7.40 to 41.88±11.10. Spondylosis was the most prevalent spinal disorder 7(29.2%) followed by osteophytes, spondylolisthesis, kyphosis and herniated disc. Osteophytes were found to be more common in male subjects within the age of 37-51 years. Obese patient showed higher occurrence of lumbosacral spine

disorders compared with patients of normal weight. There is positive correlation between BMI, age, gender and lumbosacral spinal disorders but on BMI showed statistically significant relationship ($p<0.05$).

Conclusion: Spondylosis followed by osteophytes were the prevalent imaging outcomes in lumbosacral spine disorders in the studied population and there is a positive relationship between BMI, age and imaging outcome of the prevalent lumbosacral spine disorders. Spondylolisthesis was significantly affected by increase in BMI.

Introduction

Lumbosacral spinal disorders involve mostly the muscles, nerves and bones of the back. It can be also lead to pain in the lower back area that can radiate to the lumbar spine, the discs between the vertebrae, the ligaments around the spine, muscles of the low back, Internal organs of the pelvis and abdomen, or the skin covering the lumbar area. Pain can vary from a dull constant ache to a sudden sharp feeling. Some low back pains are caused by damaged intervertebral discs and the straight leg raise test is a useful units of identification. Lumbosacral disorders are usually described by type and category of pain namely acute, subacute, chronic back pain, mechanical as well as radicular pains respectively [1]

The prevalence of lumbosacral spine disorders globally and in Nigeria has been on the increase[2]. It has been observed that lower back pain is about the commonest indication for lumbosacral examinations in the radiology department and the incidence is about 12% in Nigeria as at 2018[2] and this is expected to increase as population increase over the years. In the United States for instance, it has been reported that more than 80% of individuals older than 40 years have lumber spondylosis, increasing from 3% of individuals aged 20-29years[3]. Also, recent studies show that the prevalence of degenerative spinal pathologies lies between 4% to as high as 35% in older population[4]

Lumber spondylosis can begin in persons as young as 20 years. It increases with, and is an inevitable concomitant of old age. Adiposity has been seen as a risk factor of lumbosacral spondylosis in the British population. The relationship between lumbosacral spine disorders and demographic factors has been evaluated. Age and gender were weakly related to some of the disorders that affected the lumbar spine [5]. Spinal disorders include a wide and heterogeneous spectrum of diseases that affect the vertebrae, intervertebral discs, facet joint, tendons, ligaments, muscles, spinal cord and nerve roots of the spine. For examples, low back pain is a common spinal disorder and is the most common cause of disability in the population of Nigerians younger than 45years old, the second most common reason for visits to a physician, the fifth most common cause of hospital admission and the third most frequent cause of surgery (Markus 2019). Genetics may also put some people at increased risk. Some of the most common symptoms are; persistent lower back pain, stiffness in the back and legs, lower back tenderness, thigh pain and tight hamstring and buttock muscles [6]. Also, overweight and obesity tend to run in families, suggesting that genes may play a role. The chances of being overweight are greater if one or both of his/her parents were overweight or obese. Our genes may affect the amount of fat stored in our body and where on our body we can carry the extra fat[7].

Some racial and ethnic minority groups are more likely to have obesity. Obesity rates in American adults are highest in African Americans, followed by Hispanics/Latinos, then Caucasians. This is true for men and women[8]. While Asian American men and women have the lowest rates of obesity, for they can still be at risk of diseases associated with obesity if they carry a lot of unhealthy fat in their abdomen even when their body mass index (BMI) is lower [8].

There are two potential effects of BMI on the lumbar spine: modification of curvatures and changes in vertebral bodies, canal or disc morphology. In men, greater lean mass index was associated with a larger lordosis whereas greater fat mass index was associated with straighter spines. Greater current BMI was associated with a more uneven curvature in men and with larger anterior-posterior (a-p) vertebral diameters in both male and female subjects[9]. The researchers concluded that high BMI is associated with higher lumbo - sacral angle. A person's lifestyle such as eating and physical activity habits may also raise chances of becoming overweight and obsessed. Eating and drinking lots of foods and beverages that are high in calories, sugar, spending lots of time sitting / lying down and having less physical activity predisposes one to obesity or overweigh [10]. Social, ethnic, religious groupings or culture may also affect

weight and health because of shared eating and lifestyle habits. Some cultures may consume foods and beverages that are high in fat, salt, and added sugars. Some common food preparation methods, such as frying, may lead to high-calorie intake. Regularly consuming foods high in calories, fat, and sugar may lead to weight gain overtime [11].

Overweight and obese individuals are at an increased risk for the following diseases: Coronary artery disease, Dyslipidemia Type 2 diabetes, Gallbladder disease, Hypertension, Osteoarthritis, Sleep apnea and stroke. Cancers, including endometrial, breast, and colon cancer and Epidural lipomatosis. The possible effect of obesity on the spinal cord could be exerted through several postural changes that affect loading on joints, and thus result in long-term adverse effects on bones and joints. Increased BMI increases lumbosacral angles, which results in biochemical changes in the lumbosacral spine resulting in greater flexion of the sacroiliac joints, and increasing sheer forces that may overload the joints [12].

In addition, a possible link between obesity and disc degeneration of the spine could also be found among obese patients with the chronic inflammatory conditions. Obesity has been found to be associated with a chronic low-grade inflammatory response characterized by abnormal cytokine production, increased acute phase reactants, as well as activation of inflammatory signaling pathways in adipose tissues[12]. Several attempts had been made to determine the relationship between Body mass index and the curvature of a person's spine. In in similar research on Association of BMI and body height with low back pain in adolescents, 829,791 adolescents, 470,125 males and 359,666 females were evaluated by the regional recruitment centers between 1998 and 2010 [13]. The associations of BMI and height with low back pain were assessed by logistic regression analysis. The mean BMI was 22.04 $\pm$3.8 for males and 21.8 $\pm$3.7 for females, and the mean height was 174.1 $\pm$6.8 cm for males and 162.1 $\pm$ 6.25 cm for females. Of the total population of 829,791 participants, 25,416 (5.4%) males and 10,442 (2.9%) females had low back pain. For the males, the prevalence of low back pain was 5.2% for group A and 0.2% for group B. For the females, the prevalence of low back pain was 2.7% for group A and 0.2% for group B. The prevalence of low back pain was lowest for the underweight adolescents in group A (4.8% of males and 2.6% of females) as well as for those in group B (0.1% of males and 0.2% of females). Higher BMI was associated with low back pain. The highest odds ratios were measured for obese females in group B (odds ratio = 1.492, 95% confidence interval: 1.109, 2.009; $P = 0.008$). When we looked into the association between BMI and low back pain with and without objective findings, our main finding was a direct link between BMI and low back pain among both males and females. Specifically, subjects with higher BMIs had higher odds ratios for low back pain [13]. Sheng *et al.* 2017 [14] in their study on the association between obesity and spinal diseases in 23,048 subjects also found out that lower back pain was the most common problem (7.4%), followed by intervertebral disc disorder (1.7%) and other cervical disorder (1.3%) and spondylosis (0.2%). It was concluded that obesity was responsible for spinal diseases in the lower back and not in the cervical regions. Another study on impact on increased BMI on outcomes of elective spinal surgery on 49,314 patients who underwent elective fusion, laminectomy or both between 2006 and 2012 also showed that BMI itself is an independent risk factor for adverse outcomes in obese patients[15]. Ezemagu *et al.* 2016[16] collaborated this findings but added that low back pain sufferers 48 (56.5%) were females and 37 (43.5%) were males giving a female to male ratio of 1.3:1. The mean value of BMI for patients with low back pain was 27.5± 0.6kgm, and 50 patients were with normal reports. Most of the patients under study who had low back pain were within the age bracket from 34 years to 53 years (54.2%). The researchers further stated that BMI was significantly related to patient's gender and age at $P<0.01$. It was concluded that BMI is not indecent of age and gender.

The imaging modality used for the radiographic examination of the lumbosacral spinal disorders include computed tomography (C.T) magnetic Resonance Imaging (MRI) and x- ray imaging. In this study is x -ray imaging was used because its sensitivity, availability and affordability[17].

The influence of BMI on spine morphology remains a matter of discussion. Some studies have found significant effect but others did not. Nevertheless, the clarification of possible mutual interaction between these two variables could be of clinical and anatomical interest. The lumbar spine helps to support the weight of the body permitting various body movement and can be affected by the BMI [18]. Research has shown that increased BMI in obesity/overweight in western countries affects the

spine due to overload reasons and changes in spine static or curvature linked to soft tissue transformation but predisposition to various spine disorders is still unknown [19]. Previous studies in Nigeria have shown that the individual's body mass index (BMI) also contributes to the lumbosacral spine curvature and risk of spinal disorders [20]. However, all the studies above were carried out outside Anambra state and since BMI is affected by genetic, environmental and geographic factors [7,8,10], little is known on whether or not the body mass index and certain demographic factors plays significant role in lumbosacral spine disorders in Onitsha, Anambra state. Therefore, the current study aimed to establish the prevalence of spinal disorders and determine the roles of age, sex and BMI on common spinal disorders in selected imaging departments in Onitsha town, Nigeria. This will raise awareness to the general public on lumbosacral disorders in the locality. It will also be of immense benefit to clinicians, radiographers and other stakeholders in management of patients with lumbosacral disorders.

Materials and Methods

The study adopted a prospective cross sectional survey research design. Ninety (90) patients referred to the selected medical diagnostic Centres in Onitsha, Anambra state were recruited for this study within the period of the data collection. Using a simple random technique, a convenient sample size of 74 patients were selected who met the inclusion criteria. The sample size was determined arithmetically according to Uzoagulu, et al., (2011) [21]. Request form of each patient was collected and the history recorded, thereby enabling lumbosacral x ray report of them to be recorded.

Patient's weight was measured using weight scale which model is ZT -120 dial body scale (ranges from 0-160kg) with height meter. Patients removed their shoes and mount the scale, with their hand swinging freely beside them, their weight was recorded. Their height was also measured using meter tape from the soul of their feet to the crown of their head.

The patients BMI was computed from their height and weight using the formula : BMI= weight(kg)/height $(m)^2$. An individual's BMI number was classified as follows, Underweight, if BMI was under 18.5kg/m^2; normal weight, if BMI lies between 18. 5kg/$m^2$to 24.95kg/m^2, overweight if BMI was between 25.0 kg/$m^2$to 29.95kg/m^2, and obese if BMI was greater than or equal to 30.0kg/m^2 [22]. The patient was then positioned and lumbosacral x -ray imaging performed, evaluated, reported by a consultant radiologist and documented. Data was analyzed using statistical package for social sciences version 21. The Pearson's moment correlation co-efficient was used to determine the relationship between body mass index and imaging outcome of the prevalent lumbosacral spine disorders. Descriptive statistics was used to determine the most prevalent lumbosacral spine disorders within the study population while the Analysis of variance was used to determine the relationship between the age, gender, BMI and lumbosacral spine disorders.

Result

Total of 74 patients aged between 18-36years which consist of 41 (58.1%) males and 31 (41.9%) females (table 1) were recruited for the study. Patients aged between 18-36 were predominant 24 (32.43%%), followed by 67-81, 18 (24.32%) and 37-51 15 (20.27%%). Least frequencies were observed in the older patients aged 82+ years 3(4.05%) and 52-66years 14(18.92%) as shown in table 1.

Table 1: Age and gender distribution of patients

Age (Years)	Gender		TOTAL
	Male	Female	
18 - 36	17(70.8%)	7(29.2%)	24(32.43%%)
37-51	8(53.3%)	7(46.7%)	15(20.27%)
52-66	8(57.1%)	6(42.9%)	14(18.92%)
67-81	9(50.0%)	9(50.0%)	18(24.32%)
82+	1(33.3%)	2(66.7%)	3(4.05%)
Total	43 (58.1%)	31 (41.9%)	74 (100%)

Patients aged 82 years and above had the highest BMI of (41.88±411.96), followed by 18-36 years (29.599±7.4042), 52 – 66 years (28.58±6.56), 67-81(25.97±3.94) and37-51 years (25.65±4.29) respectively.

Table 2: BMI distribution in the study subjects

AGE (YEARS)	Weight (mean ±SD)	Height (mean ±SD)	BMI (mean ±SD)
18-36	77.8±20.40	1.63±0.15	29.59±7.40
37 – 51	64.40±14.64	1.70±0.08	22.28 ±6.29
52 – 66	77.1±16.50	1.65±0.07	28.58±6.56
67 – 81	67.11±10.29	1.61±0.08	25.97±8.94
82+	85.00±0.00	1.5±0.24	41.88±11.96

Figure 1 shows that spondylosis was the most prevalent lumbosacral spinal disorder in the population studied followed by osteophytes

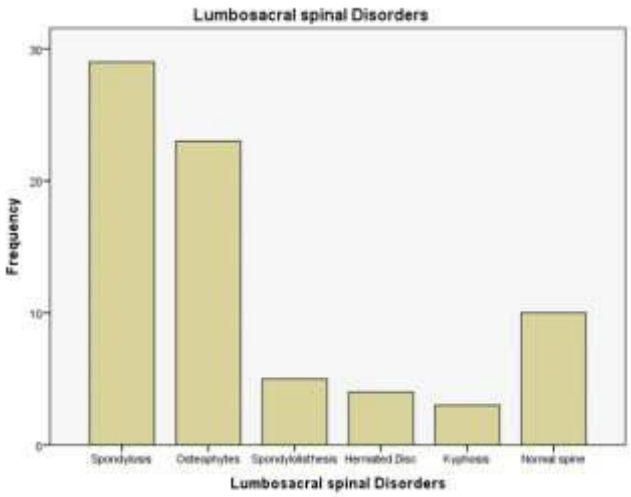

FIG 1: Imaging outcomes of lumbosacral spinal disorder

Osteophytes and kyphosis were higher in male patients than in female patients while the female patients were more affected by spondylosis and spondylolisthesis (figure 2).

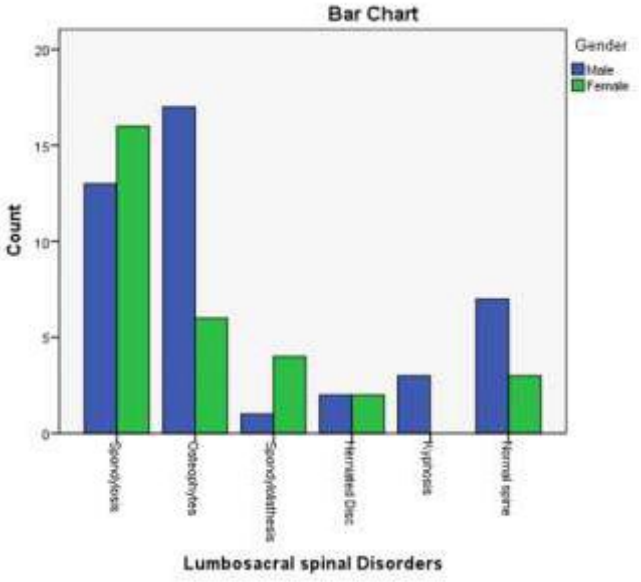

FIG. 2: Gender distribution of imaging outcomes of lumbosacral spine disorders

Osteophytes and spondylosis were common in all the age groups but not in those aged 82 years and above and were the highest lumbosacral disorders among the patients especially between the ages of 67-81 years and 52-66years respectively. Kyphosis was seen only in patients aged 18-36 years while spondylolisthesis and herniated disc were very common in patients aged 52 years and above (figure 3).

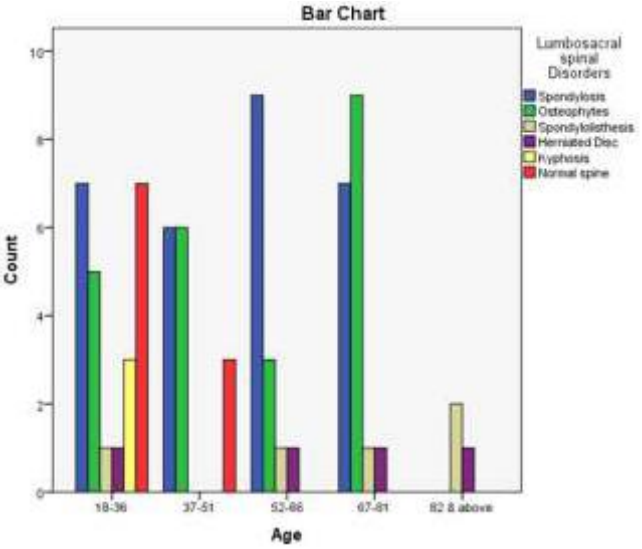

Figure 3: Age distribution of imaging outcomes of the lumbosacral spine conditions

There is significant balance between male and female patients that were underweight, Males 10(58.8%) were more overweight than females 7(41.2%). Females were more obese 15(57.7%) than males 11(42.4%). So male patients 43(58.1%) have higher BMI than female patients 31(41.9%) as shown in table 3

TABLE3 : Gender distribution and BMI

			Gender		
			Male	Female	Total
Body Mass Index	Underweight	Count	4	4	8
		% within Body Mass Inde	50.0%	50.0%	100.0%
	Normal	Count	18	5	23
		% within Body Mass Inde	78.3%	21.7%	100.0%
	Overweight	Count	10	7	17
		% within Body Mass Inde	58.8%	41.2%	100.0%
	Obese	Count	11	15	26
		% within Body Mass Index	42.3%	57.7%	100.0%
Total		Count	43	31	74
		% within Body Mass Inde	58.1%	41.9%	100.0%

Lumbosacral spinal disorders are common in obese and overweight patients compared to underweight and patients with normal weight (figure 4). The common lumbosacral disorders in obese and overweight patients were spondylosis, osteophytes and spondylolisthesis.

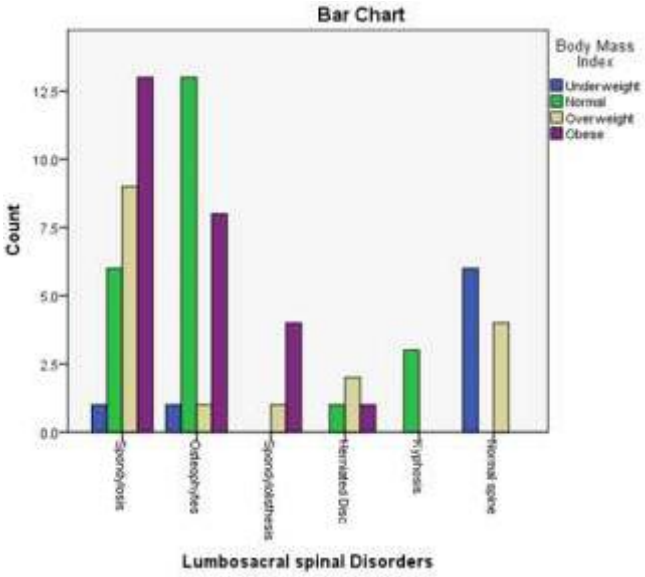

FIG. 4: Distribution of imaging outcomes with BMI

BMI does not have any significant effect on some lumbosacral spinal disorders such as spondylosis, osteophytes, herniated discs and kyphosis. Only spondylolisthesis was significantly affected by BMI in the population on analysis of variance (table 4).

TABLE 4: Multiple comparison tests of lumbosacral disorders, and BMI using ANNOVA

S/N	Lumbosacral disorders	frequency (%) within lumbosacral spine				Total Frequency (%)	P-value
		Normal weight	Under weight	Over weight	obese		
1	spondylosis	6(20.7)	1(3.4)	9(31.0)	13(44.8)	29(100)	0.088
2	Osteophytes	1(56.5)	6(4.3)	1(4.3)	8(34.8)	23(100)	0.43
3	spondylolisthesis	0(0%)	0(0)	1(20.0)	4(80.0)	5(100)	0.003
4	Herniatic disc	1(25)	0(0)	2(50)	1(25)	4(100)	0.410
5	kyphosis	3(100)	0(0)	0(0)	0(0)	3(100)	0.739
Total		11(17.2)	7(10.9)	17(26.6)	26(40.6)	64(100)	

Pearson's moment correlation coefficient showed a positive correlation between age, gender as well as BMI and lumbosacral disorders but only BMI showed significant positive association with lumbosacral disorders (table 5).

TABLE 5: Correlation of BMI, age, gender and imaging outcomes

	Lumbosacral spine disorders	
	r	p-value
Age	0.309	0.007
Gender	0.155	0.19
Body Mass	0.395	0.001

Discussion

The age, gender and BMI distribution of apparently healthy male and female healthy subjects referred for lumbosacral x-ray were assessed. The ratio of male to female subjects in this study was 1:1 with mean age of 58years similar to the study which showed no difference in the ratio of male to female subjects with lower back pain with mean age and BMI of 52 years [23]. The mean BMI was 23.26 $\pm$6.83 and majority of the subjects were aged 18-36 years (table 1 and 2) with normal lumbosacral spine and spondylosis. There were very few cases of spondylolisthesis and kyphosis in this age group (figure 4). This could be attributed to the fact that spondylolisthesis leads to kyphosis and both being degenerative spinal disorders are usually accompanied by wear and tear over time and is therefore not a common spinal disorder in the younger age group[2].

This study also showed higher prevalence of most lumbosacral spinal disorders especially spondylosis as early as 18 years and above 50 years. This has been collaborated by a similar study which opined those patients within the age of 37-50 years predominantly have lumber spine disorders and further explained that people within this age limit were more physically active [23, 24]. Our study also show that there were more lumbosacral spinal disorders at older age especially between the ages of 52-81 years (figure 3) than at younger age and this has been collaborated by a recent study [25].

We also observe that spondylosis and osteophytes were the predominant lumbosacral spinal disorder in the population (figure 1) especially at older ages between 67-81 years (figure 3) while the incidence of other lumber spine abnormalities such as spondylolisthesis, herniated disc and kyphosis

were low (figure 1). This explains the positive correlation between age and lumbosacral disorders (table 5). It was also observed in this study that lumbosacral spine disorders correlated positively with gender such that male patients appear to have more lumbosacral spinal disorders than female patients (table 3 and 5, figure 2). Also we observed that Osteophytes and kyphosis were higher in male patients than in female patients while the female patients were more affected by spondylosis and spondylolisthesis (figure 2). It is therefore clear from our study that lumbosacral disorders affect male and female gender differently.

Men have been reported to more active and involved in more strenuous physical activity than females. These may predispose men to more lumbosacral disorders than females. This finding disagrees with the work carried out by [24] in Saudi Arabia who stated that females were prone to lumber disorders than men.

We also observed that there is a high incidence of osteophytes, spondylosis and spondylolisthesis in overweight patients when compared to normal and underweight patients (figure 4). This result agrees with [26,27] as they postulated that lumber spine disorders are associated with the increase in body mass index. The reason for this could be due to the fact that obesity and overweight conditions are associated with excess body weight. This excess body weight pushes the pelvis forward thereby putting strains at the lower back or induces an increase in the anterior pelvic tilt to compensate for the anterior shifting of the center of the pelvis resulting in increased flexion of the sacroiliac joint resulting in lumbosacral disorders [28,29]. In this study, lumbosacral spinal disorders appear to increase with increase in BMI especially in overweight and obese patients. This explains the positive linear correlation between BMI and lumbosacral spinal disorders (table 5). This implies that, although increased BMI could lead to increase in the occurrence of spondylolisthesis in the population similar to the findings of [13] which linked increase in BMI to the incidence of lumbo- sacral disorders.

However only spondylolisthesis was significantly ($p<0.05$) affected by increasing BMI scores in the population (table 4) on further analysis. Also age, gender correlated positively with lumbosacral disorders in this study (table 5). Therefore, Individuals should therefore ensure that they maintain a healthy n lifestyle especially the elderly population in order to mitigate the possible occurrence of spinal disorders. Based on the findings of this study, it is recommended that further studies should be carried out on the effect of BMI on the cervical and thoracic vertebrae.

Conclusion

Spondylosis followed by osteophytes were the prevalent imaging outcomes in lumbosacral spine disorders in the studied population and there is a positive relationship between BMI, age and imaging outcome of the prevalent lumbosacral spine disorders. Spondylolisthesis was significantly affected by increase in BMI.

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