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Research Article

Serum Levels of Some Essential Trace Elements in Patients with Osteoarthritis

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ABSTRACT

Osteoarthritis (OA) is a degenerative joint disease that affects both the articular cartilage and the underlying subchondral bone over time. Joint pain and stiffness are the most prevalent symptoms. The aim of this study was to estimate the serum levels of some essential trace elements in subjects with osteoarthritis (OA). A total of 300 subjects comprising of 150 OA (test group) and 150 non-osteoarthritis (healthy control) subjects, between the ages of 51 to 90 years old were recruited for this study. The control subjects were healthy individuals recruited from different locations in Ondo state. Questionnaires were administered first to the control subjects before being recruited for this study. Atomic absorption spectrometer was used to measure the serum concentrations of calcium, copper, zinc and selenium, after proper digestion with acid, while Vitamin D and K were measured using High Performance Liquid Chromatography (HPLC) and spectrophotometer respectively. There was high prevalence of female (60.7%) OA subjects when compared with their male (39.3%) counterpart. The concentrations of calcium, selenium and Vit. D of OA subjects were significantly higher (p<0.001) than the non-osteoarthritis. However, the concentrations of zinc, copper and Vit. K of OA was significantly lower than the non-osteoarthritis subjects between the distributions. Subjects with osteoarthritis had higher levels of calcium, Selenium and Vit. D and lower levels of zinc, copper and Vit. K. In addition, Zinc and selenium supplements which reduce the severity of OA should be further encouraged.

Keywords: Osteoarthritis, calcium, copper, zinc, selenium

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INTRODUCTION

Osteoarthritis (OA) is a form of joint disease caused by the degradation of joint cartilage and bone underneath the surface (Arden *et al.*, 2015). Joint pain and stiffness are the most prevalent symptoms . (Wang *et al.*, 2012). Symptoms may appear just after exercise at first, but they may become constant over time (Wang *et al.*, 2012). Other signs and symptoms include joint swelling, restricted range of motion, arm and leg weakness or numbness (Wang *et al.*, 2012). In Western countries, the total economic burden of arthritis is estimated to be between 1% and 2.5% of GDP. Osteoarthritis is the most common cause of impairment, affecting 60% to 70% of persons over the age of 60 years. Defective articular cartilage structure, biosynthesis, joint trauma, joint instability, inflammatory conditions, congenital and developmental abnormalities are all thought to play a role in the development of OA. The prevalence of osteoarthritis in Nigeria is estimated to be 0.4% of the population among adults aged 65 years (Silman *et al.*, 1993). OA is the most prevalent arthritis in urban settings, with 55.1%, and in rural settings, with 29.5%, 29.7%, and up to 82.7% among adults aged 65 years in South Africa (Bija *et al.*, 2015). Other urban hospital-based studies reporting OA of the knee include Burkina Faso, which reported a prevalence of 0.5% among adults; Tunisia, which reported a prevalence of 4.7% among elderly subjects; and Cameroon, which reported a prevalence of 9.9% among those with musculoskeletal conditions (Ouedraogo *et al.*, 2008). Around 27 million Americans are impacted by the osteoarthritis (Glyn-Jones *et al.*, 2015). As people get older, it becomes increasingly common in both sexes (Wang *et al.*, 2012).

Although any joint in the body can be affected by osteoarthritis, it most usually affects the hands, feet, spine, and large weight-bearing joints like the hips and knees, osteoarthritis can generate a cracking noise (called "crepitus"). Movement patterns (such as gait) are often impaired when osteoarthritis advances (Vincent *et al.,* 2012). The most prevalent cause of a knee joint effusion is osteoarthritis (Tas *et al.,* 2007). Hard bone enlargements termed Heberden's nodes (on the distal interphalangeal joints) or Bouchard's nodes (on the proximal interphalangeal joints) can occur in smaller joints, such as the fingers, and while they are not always painful, they do limit finger movement significantly (Wang *et al.,* 2012). Overweight people, people with one leg that isn't the same length as the other, and people who work in places that provide a lot of joint stress are at a higher risk (Vingard *et al.,* 2016). Mechanical stress on the joint and low-grade inflammatory processes are thought to be the causes of osteoarthritis (Bradt *et al.,* 2009). Medical imaging and other tests are often used to support or rule out other conditions, although most diagnoses are based on signs and symptoms (Wang *et al.,* 2012). Unlike rheumatoid arthritis, which is largely an inflammatory disease, osteoarthritis does not cause the joints to become heated or red (Wang *et al.,* 2012).

The fundamental cause of osteoarthritis is thought to be mechanical stress combined with insufficient self-repair by joints (Bradt *et al.,* 2009). Misalignments of bones due to congenital or pathogenic causes; mechanical damage; excess body weight; loss of strength in the muscles supporting a joint and impairment of peripheral nerves, resulting in abrupt or uncoordinated motions, are all possible sources of stress (Bradt *et al.,* 2009). Running, on the other hand, has not been found to raise the incidence of knee osteoarthritis in the absence of injury (Bosomworth, 2009).

Obesity and a history of past joint injury are linked to the development of osteoarthritis (Deweber at al., 2011), particularly in the knees (Coggon *et al.,* 2001). It has been suggested that there may be a metabolic link to body fat rather than just mechanical loading because the correlation with obesity has been observed not only for knees but also for non-weight bearing joints, and the loss of body fat is more closely related to symptom relief than the loss of body weight (Pottie *et al.,* 2006).

Because osteoarthritis is more common in postmenopausal women than in males of the same age, changes in sex hormone levels may have a role in its development (Linn *et al.,* 2014).

Those who work with manual handling (e.g. lifting), have physically demanding employment, walk at work, and have climbing chores at work have an increased chance of getting knee and hip osteoarthritis (e.g. climb stairs or ladders). Those who work in bent or twisted positions, have a higher risk of developing hip osteoarthritis over time. Those who work in a kneeling or squatting position undergo heavy lifting in combination with a kneeling or squatting posture, and work standing up has an elevated risk of knee osteoarthritis. Women and men are both at risk for developing osteoarthritis as a result of their jobs.

Although osteoarthritis affects people of all ages, it is most common in people over the age of 60 years. Increasing age, obesity, past joint injury, overuse of the joint, weak thigh muscles and genes are all common risk factors. Zinc (Zn) and copper (Cu) concentrations are frequently measured in highly mineralized tissues among the elements required for life. Zinc has been discovered to speed up bone formation and is required for proper ossification and mineralization of the skeleton, particularly the femoral epiphysis. Zinc and copper are essential for bone tissue formation and metabolism. Calcium (Ca), copper (Cu), selenium (Se), and zinc (Zn), all naturally occurring minerals, have been demonstrated to have anti-inflammatory properties in both animal and human research. In an animal model of OA, a lack of dietary Mg has been found to hasten cartilage degradation (Shakibaei *et al.,* 1996). Copper is a necessary cofactor in enzymes like superoxide dismutase (SOD), which also requires Zn and Mn. Many studies have suggested that oxidative stress plays a role in the pathophysiology of OA, with ROS production and a low antioxidant state in the joint leading to cartilage joint remodeling deterioration (Henrotin *et al.,* 2005). Selenium is also an important co-factor for glutathione peroxidase that helps in mopping oxygen free radicals, which may help to reduce the risk of osteoarthritis (Kurz *et al.,* 2002). It's unclear whether trace element deficit causes disease or if disease occurs as a result of trace element deficiency. Although it is widely believed that strict metabolic management prevents the onset of late OA problems, this is not always the case. The goal of this study was to look at the levels of critical trace elements in patients who had been diagnosed with osteoarthritis.

MATERIALS AND METHODS

Study Area: This study was carried out at Federal Medical Centre, Owo, Ondo State, Nigeria. The Hospital serves an estimated population of 2,737,186 also serves as a reference center for orthopedic and dissabilities. Part of the analysis of this study was also carried out at Federal University of Technology Akure (FUTA), Ondo State.

Cross Sectional Study: In this study, a cross-sectional sampling method was employed in selecting our test subjects (osteoarthritis patients) and control subjects (non-osteoarthritis patients).

Participants' selection: All OA subjects recruited for this study were between the ages of 50 to 90 years with knee injury (which is associated with accelerated knee osteoarthritis), non-smokers and non-alchoholic patients who consented to participate in this study. All patients exempted had inflammatory arthritis, uncontrolled DM, HTN, CKD and uncorrected hypo/hyperthyroidism and subjects that refused participation.

Ethical Approval: An Ethical clearance was obtained from the Research and Ethical Committee of Federal Medical Centre, Owo, Ondo State, with the approval number FMC/OW/380/VOL.LIII/31. Also, written informed consent was sought from the participants as well as given assurance that the health history of the patients obtained will not in any way be linked with the true identity of the patient when recording the outcome of the findings.

Sample Size Determination: Sample size was determined according to the method of Daniel *et al*. [20].

$$n = \frac{Z^2 P(1- P)}{d^2}$$

Where,

n = sample size
P = prevalence rate in percentage (8.9%)
Z = confidence interval of 95% which is equivalent to confidence coefficientn of 1.96
d = desired level of precision or significance which is equal to 0.05.

The prevalence rate of knee osteoarthritis in Nigeria is 8.9% (Aderonke *et al*., 2007).

In this study a total of 150 osteoarthritis samples were used.

Sample Collection and Preservation: About 3ml of blood sample was collected into 5ml capacity plain plastic bottles from each of the subjects with the help of health personnel in the hospital. Samples from the test group (osteoarthritis patients) were collected from known osteoarthritis patients during their clinic days while subjects for the control group were recruited from healthy male and females outside the hospital premises. The control subjects were given questionnaires to fill prior to the collection of their blood samples for those that were eligible.

The blood sample collected from subjects in Federal Medical Centre, Owo, were immediately stored in the thermo-flask containing ice pack for transportation to Central Research Laboratory, Federal University of Technology, Akure, where the analysis was conducted.

The whole blood sample collected was centrifuged using refrigerated centrifuge manufactured by Harrier, Model 18/80 at speed 10,000 rpm for 15mins. The distinct layer obtained i.e. Plasma, where plasma was kept at low temperature for vitamin D analysis. The blood serum used for the analyses were stored under a low temperature of about -45ºC.

Sample preparation and Analysis of zinc: About 500µL of serum collected were mixed with 2N HCl into a 5ml Volumetric flask with the aid of graduated dispensing bottle and left for 24hrs.The mixture was centrifuged at 4000rpm for 15 minutes with the use of bench top centrifuge Harrier 18/80 model.

The supernatant obtained was analyzed for different elements using Atomic Absorption Spectrometer VGP210 model manufactured by Buck Scientific, USA.

The machine readings obtained was used to calculate the amount of zinc present in the serum in mg/l using the equation below:

$$\text{Conc of Zn in (ug/ml)} = \frac{\text{Total Volume of Samples} \times \text{Machine readings obtained}}{\text{Volume of Serum Used}}$$

Digestion Analysis of sample for Ca: The blood samples were digested using the conventional wet acid method, which involved adding 2ml of blood serum into a Pyrex flask and then adding 3ml of newly prepared concentrated nitric acid and hydrogen peroxide [HNO3:H2O2] and letting it sit for 10 minutes. The flasks were covered with watched glass and digested for 1 - 2 hours at 600 - 700C. The digests were then treated with 2ml nitric acid and a few drops of H2O2 while being heated continuously in a hot plate at 800C until a clear digested solution was formed. The excess acid combination was evaporated to a semi-dry mass, allowed to cool, and diluted with 0.1ml nitric acid, before being transferred to a 100ml volumetric flask and diluted to the mark with twice distilled-deionized water. A blank extraction (without the sample) was also carried out using twice distilled-deionized water throughout the entire procedure. The digest was examined using a Buck Scientific Model VGP 210 Atomic Absorption Spectrophotometer at the Federal University of Technology, Akure, Ondo State. Method adopted from Yahaya *et al.*, (2013).

Measurement of Metals: At the Federal University of Technology Akure, Ondo State, the trace elements were measured using atomic absorption spectroscopy (Buck Scientific Model VGP-210, Germany). Using an atomic absorption spectroscopy (Buck Scientific Model VGP-210, Germany), the metal content of the digested samples was measured by aspiration (air/acetylene flame) and appropriate wavelengths were selected for different trace elements, according to manufacturer's instruction. The absorbance read was used to obtain their concentrations in duplicate.

Determination of vitamin K: The procedure for colour development as adopted from Menotti's procedure is as follows. The solution in which the concentration of vitamin K is being determined was placed in a flask and the sodium pentacyanoamineferroate reagent was added. The solution was then stirred and then allowed to stand for fifteen minutes to allow maximum colour development. When the blue color had developed, the absorption of the solution was measured by means of a spectrophotometer at 650nm. The standard vitamin K solution was prepared by dissolving 5 milligrams of crystalline vitamin K in water and diluting to 100 milliliters. This solution was stable for 4 to 6 hours. The absorption of the solution was read on a spectrophotometer at 650nm, against a reagent blank.

Sample preparation of Vitamin D Analysis using HPLC: The extracted sample was analyzed for Vitamin D1 and D2 metabolites using C_{18} column and mobile phase Water: Methanol and 0.1% Formic acid in the two solvents. The reference standard was purchased through Sigma Aldrich with purity of 99.99%. Vitamin D metabolites were extracted with a liquid-liquid extraction method. Plasma (150µL) were mixed with 0.2M $ZnSO_4$ (150µL) in a 2ml glass HPLC vial and 300µL of methanol containing 25ng/ml of d-6-25(OH) D_3 (internal standard) and vortex were mixed (10secs). 750µL of hexane were added and mixed for 30secs, which were then centrifuged for 10mins at 4000 revolution per minute. The hexane layer (650µL) was removed and placed into the micro-vial and evaporated to dryness under nitrogen at 55°C. The dried extract was reconstituted with 75µL of 15:85 water, methanol solution and injected (5 µL) for analysis.

Statistical Analysis: All data obtained were subjected to SPSS Version 25.0 statistical analysis using the chi-square and students' t-test. Data was significant at $p < 0.05$.

RESULTS

About 300 subjects were recruited for this study, among which 150 were OA (test) while 150 were healthy (control) subjects. Among the OA subjects, 59(39.3%) were males while 91(60.7%) were females. About 64(42.7%) were males while 86(57.3%) were females among the healthy control subjects (Table 1). The ages of subjects recruited for this study ranges from 51 to 90 years with the highest number of subjects within the age bracket of 61-70 years had 84(56.0%) OA and 88(58.7%) healthy control, while the least number of subjects recruited for this study were within the age bracket 71 - 80 years old with 8(5.3%) OA and 14(9.3%) healthy control. There were no statistical age and sex differences observed between the test and control group.

Table 2 shows the result of age and gender compared between osteoarthritis and non-osteoarthritis subjects. Subjects whose ages are <65 years old are 46(30.7%) while subjects whose ages are ≥ 65 years old are 104 (69.3%). Age group did not strongly associate with the prevalence of OA and non-osteoarthritis subjects in this study.

The mean age of the subject was also tested with t test and there were no significant differences connecting age and Osteoarthritis. The t test shows that Osteoarthritis is independent of age within the age bracket of study. The preponderance of Osteoarthritis were highly recorded in female than male subject which had 91 (60.7%) and 59 (39.3%) respectively.

Table 3 shows the measured parameters of Osteoarthritis subjects compared with Non Osteoarthritis. Results gotten from the analysis showed decreased significant differences between Copper, Zinc and Vitamin K of Osteoarthritis subjects when compared with Non Osteoarthritis subjects while increased significant differences were observed between Calcium, Selenium, and Vitamin D of Osteoarthritis subjects when compared with Non Osteoarthritis subjects. In addition, Vitamin D result generated from t-test showed absence of significant difference

Table 1:
Socio-demographic characteristics study population of Osteoarthritis and Non Osteoarthritis subjects

		Test n (%) N = 150	Control n (%) N = 150	Chi square	*p*-value
Age (years)	51 – 60	30 (20.0)	28 (18.7)	3.132	0.372
	61 – 70	84 (56.0)	88 (58.7)		
	71 – 80	8 (5.3)	14 (9.3)		
	81 – 90	28 (18.7)	20 (13.3)		
Gender	Male	59 (39.3)	64 (42.7)	0.344	0.557
	Female	91 (60.7)	86 (57.3)		

p > 0.05.

Table 2:
Age and gender compared between Osteoarthritis and Non-osteoarthritis subjects

	Variable	Test (%) N = 150	Control (%) N = 150	Chi square	*p*-value
Age Group (in years)	< 65	46 (30.7)	54 (36.0)	0.960	0.327
	≥ 65	104 (69.3)	96 (64.0)		
	Mean age ± SD	68.3 ± 9.2	68.2 ± 7.6	0.137^t	0.891
Gender	Male	59 (39.3)	60 (60.0)	0.906	1.000
	Female	91 (60.7)	90 (60.0)		

t – Independent test; p > 0.05

Table 3:
Measured parameters compared between Osteoarthritis (Test) and Non Osteoarthritis (Control) Subjects

Variable	Test Mean ± SD; N = 150	Control Mean ± SD N = 150	t test	*p*-value
Calcium	1.86 ± 0.23	1.76 ± 0.30	3.462	0.001
Copper	8.69 ± 3.77	9.84 ± 4.34	-2.452	0.015
Zinc	12.71 ± 1.95	13.61 ± 2.34	-3.644	<0.001
Selenium	141.13 ± 53.86	106.07 ± 36.93	6.576	<0.001
Vit K	1.60 ± 0.25	1.67 ± 0.32	-2.291	0.023
Vit D	54.59 ± 15.69	53.74 ± 16.12	0.461	0.645

Significant at P< 0.05.

Table 4:
Measured parameters comparing between the males and females of both groups (test and control)

Variable	Male Mean ± SD; N = 119	Female Mean ± SD N = 181	t test	*p*-value
Calcium	1.76 ± 0.31	1.84 ± 0.23	-2.516	0.012
Copper	8.65 ± 4.36	9.66 ± 3.88	-2.101	0.037
Zinc	12.65 ± 1.96	13.50 ± 2.29	-3.301	0.001
Selenium	118.15 ± 48.31	127.18 ± 49.80	-1.555	0.121
Vit K	1.65 ± 0.33	1.62 ± 0.26	0.723	0.470
Vit D	47.58 ± 15.87	58.50 ± 14.37	-6.178	<0.001

Significant at p< 0.05.

Table 5:
Measured parameters comparing between subjects whose ages are <65 years old and those that are ≥65 years old of both groups (test and control)

Variable	<65 years Mean ± SD N = 100	≥ 65 years Mean ± SD N = 200	t test	*p*-value
Calcium	1.69 ± 0.30	1.87 ± 0.23	-6.070	<0.001
Copper	6.20 ± 2.54	10.79 ± 3.87	-10.746	<0.001
Zinc	12.61 ± 2.26	13.44 ± 2.12	-3.145	0.002
Selenium	102.50 ± 2.26	134.15 ± 37.70	-5.487	<0.001
Vit K	1.65 ± 0.22	1.63 ± 0.32	0.733	0.464
Vit D	54.45 ± 17.51	54.03 ± 15.05	0.216	0.829

Significant at p< 0.05.

Table 6:
Measured concentrations of vitamin D and K compared between Osteoarthritis and Non Osteoarthritis subjects.

Variable		Test n (%) N = 150	Control n (%) N = 150	Chi-square	*p*-value
Vitamin K (mm/L)	Low	29 (19.3)	14 (9.3)	6.108	0.013
	Normal	121 (80.7)	136 (90.7)		
Vitamin D (ng/L)	Low	46 (30.7)	8 (5.3)	32.611	<0.001
	Normal	104 (69.3)	142 (94.7)		

Significant at $p< 0.05$.

Table 7:
Mean comparisons of data obtained from Osteoarthritis and Non Osteoarthritis subjects

Variable	Test Mean ± SD N = 150	Control Mean ± SD N = 150	t-test	*p*-value
Age (years)	68.3 ± 9.2	66.7 ± 8.5	1.574	0.116
Calcium (mmol/L)	2.1 ± 0.2	2.3 ± 0.3	6.398	<0.001
Copper (mmol/L)	8.7 ± 3.8	12.0 ± 4.3	7.138	<0.001
Zinc (µm/L)	12.7 ± 1.9	13.6 ± 2.3	3.780	<0.001
Selenium (ng/mL)	109.4 ± 38.2	136.1 ± 36.9	6.144	<0.001
Vitamin K (mm/L)	0.61 ± 0.26	0.72 ±0.32	3.246	<0.001
Vitamin D (ng/L)	30.2 ± 14.9	53.7 ± 16.1	13.148	<0.001

Significant at p< 0.05.

Results generated from the analysis showed a significant difference between Calcium, Copper, Zinc, and Vitamin D, except Selenium and Vitamin K which are not significant (Table 4).

Table 5 reveals Measured parameters comparing between subjects whose ages are <65 years old and those that are ≥65 years old of both groups (control and test). Results generated from the study revealed decreased significant difference between Calcium, Copper, Zinc, Selenium, except Vitamin K and Vitamin D which were not significant.

Table 6 compares the levels of vitamins D and K between the Osteoarthritis and Non- osteoarthritis control groups. About 19.3% of the cases with osteoarthritis had a low level of Vitamin K compared to only 9.3% of the apparently healthy controls. This difference was found to be statistically significant (p = 0.013). Similarly, 30.7% cases with osteoarthritis subjects had low level of Vitamin D and 5.3% among non-osteoarthritis had low level of vitamin D (p < 0.001).

Table 7 shows the mean of all measured parameters obtained from osteoarthritis subjects compared with that of non-osteoarthritis subjects (control groups) and this were found to be statistically significant at $p< 0.05$ except age which shows a very high significant difference (p= 0.116) between Osteoarthritis and Non-osteoarthritis subjects.

DISCUSSION

Osteoarthritis is a degenerative joint disease that affects both the articular cartilage and the underlying subchondral bone over time (Vingard *et al.*, 2016). Although most studies have focused on articular cartilage in order to identify the earliest changes in OA, a few studies have focused on the functional status and periodic measurement of some trace elements that aid in the lubrication of vital joints, ensuring holistic care and maintenance of elderly subjects. In this study, evaluation of serum levels of some trace elements calcium, zinc, copper, selenium, Vitamin D and K in subjects diagnosed with osteoarthritis among elderly attendees at a primary care clinic were reported. Information generated from the socio-demographic distributions of the study population depicts no significant difference when measured values were compared across all age groups, the same was obtained in the measurement between male and female (p = 0.372 and p = 0.557 respectively). The preponderance of Osteoarthritis was highly recorded in female than male subject which had 91(60.7%) and 59(39.3%) respectively. More osteoarthritis subjects were found within the age group of 61 - 70 years representing 56.0%, followed by 51- 60 years with 20.0%. The least are those within the age group of 71 - 80 years with 5.3%. Result generated from the age of osteoarthritis and non-osteoarthritis subjects revealed that the age group <65 years were 46(30.7%) while the age group ≥65 years were 104 (69.3%) out of 150 subjects tested in this work. This revealed

there was no significant difference between the age group of OA subjects when compared with that of non-osteoarthritis subjects. The t test shows that osteoarthritis is independent of age within the age group of study. The mean age of the subject was also tested with t test and there was no significant difference connecting age and Osteoarthritis among our study population.

There are decreased significant differences between Calcium, Copper, Zinc, Selenium and Vit. K serum levels of osteoarthritis subjects when compared with non-osteoarthritis subjects, except Vit. D whose results generated from t-test revealed absence of significant difference. Also, both genders (male and female) of Osteoarthritis subjects when compared with genders of non-osteoarthritis subjects revealed a significant difference between Calcium, Copper, Zinc, and Vit. D except Selenium and Vit. K which were not significant. Zinc deficiency is most commonly caused by a lack of zinc in the diet, but it can also be linked to malabsorption, acrodermatitis enteropathica, chronic liver disease, chronic renal disease, sickle cell disease, diabetes, cancer, and other chronic disorders (Prasad, 2008). The elderly are among the people who are at risk for zinc insufficiency.

Selenium is also an important co-factor for glutathione peroxidase, which may help to reduce the risk of osteoarthritis (Kurz *et al.*, 2002). In patients with knee OA, lower Zn, Se, and greater Cu and Cu/Zn ratio concentrations were found compared to controls, as well as a robust relationship between illness duration, severity and serum Cu, Zn, and Se concentrations.

There were 61.3% of subjects with Low calcium concentration and 38.7% subjects with normal calcium concentration among the osteoarthritis subjects while the non-osteoarthritis subjects, 26.7% had normal and 73.3% had low calcium concentration . 75.3% of subjects had low copper concentration and 24.7% of osteoarthritis subjects with normal copper concentration, while the non-osteoarthritis subjects had 46.0% and 54.0% for both low and normal copper concentration. The other important minerals such as zinc and selenium had also shown to have 20.0% and 80.0% (low and normal zinc concentration) while the non-osteoarthritis subjects had 13.3% and 86.7% low and normal zinc concentration respectively. But the selenium concentration levels recorded in this work indicate that 16.7%, 72.7% and 10.7% represent low, normal and high selenium concentrations respectively for osteoarthritis. While the non-osteoarthritis subjects had 5.3%, 66.0% and 28.7% representing number of subjects with low, normal and high values of selenium concentrations respectively. In blood plasma, zinc is bound to albumin and about 60% (low-affinity) are transported as transferrin representing 10% in the whole blood. Transferrin also transports iron, and excessive iron inhibits zinc absorption. Copper has a similar antagonistic relationship. In vitro, the human dopamine transporter features a high affinity extracellular zinc binding site that inhibits dopamine reuptake while amplifying amphetamine-induced dopamine outflow. Serum Zn and Se values were as low as 20.0% and 16.7%, respectively, in this study.

It's unclear whether trace element deficit causes disease or if disease occurs as a result of trace element deficiency. However, oxygen free radicals induce oxidative damage to key cell components, which culminates in the pathobiology of degenerative joint disease. The development of late problems in OA is thought to be delayed by careful metabolic management. Many studies have discovered a link between OA and trace elements. Changes in the concentration of these components were seen in numerous cases.

The increased serum Cu concentration is also thought to be a sign of clinical activity of this disease by some other authors. Reduced levels of selenium and activity of selenium-dependent enzymes have also been explored in other disorders, such as epilepsy, with a strong association between their reduction and disease severity. Decreased serum Se levels in humans is unlikely to happen, but may be the etiological factor of some serious disorders such as Keshan disease (endemic cardiomyopathy) and Kashin-Beck disease (endemic osteoarthritis). Potential confounding biases could not be ruled out due to the absence of some covariates, such as BMI, smoking, food intakes, and anti-inflammatory drug use. Some studies, however, found no link between drug dosages, smoking status, and changes in various trace elements, such as Se, Fe, Cu, and Zn (Yazar *et al.*, 2005). Given that Se is a cofactor of some antioxidant enzymes, we can speculate that low Se levels in the blood make a person more vulnerable to oxidative stress-related harm.

The serum levels of vitamins D and K in the osteoarthritis and non-osteoarthritis groups are compared in Table 6.0 In comparison to 9.3% of non-osteoarthritis subjects, 19.3% of cases with osteoarthritis had a low level of Vitamin K. This distinction was discovered to be statistically significant (p = 0.013). In addition, 30.7% and 5.3% of people with osteoarthritis and non-osteoarthritis respectively had insufficient vitamin D levels. Calcium homeostasis and metabolism are both influenced by vitamin D. Its discovery was due to effort to find the dietary substance lacking in children with rickets (the childhood form of osteomalacia) (Wolf, 2004). Vitamin D supplements are used to treat or prevent osteomalacia and rickets in the general population, but the evidence for other health benefits is mixed (Pittas *et al.*, 2010). The effect of vitamin D supplementation on mortality is unclear, with one meta-analysis finding a small reduction in mortality in the elderly (Bjelakovic *et al.*, 2012) and another concluding that there is no clear justification for recommending supplementation for the prevention of many diseases, and that similar research is not needed in these areas (Bolland *et al.*, 2014). However, vitamin D deficiency has become a worldwide problem in the elderly and remains common in children and adults (Holick, 2007). Low blood calcifediol (25-hydroxy-vitamin D) can result from avoiding the sun (Schoenmakers *et al.*, 2008). Deficiency results in impaired bone mineralization and bone damage which leads to bone-softening diseases including rickets, osteomalacia and osteoathritis.

All the parameter compared in table 7.0 were all found to be statistically significantly at $p < 0.05$ level except age which shows a very high significant difference ($p > 0.05$) between osteoarthritis and non-osteoarthritis subjects. Expectedly, this study further revealed that functional disability was more prevalent amongst respondents living below poverty level and those who lack formal education. The same trend has been observed in the studies reviewed (WHO, 2022). Poverty,

ignorance, diseases and consequent disability is a vicious cycle, which mont asserted are inseparable (Mont, 2007). Poverty leads to malnutrition, poor health services and sanitation, as well as unsafe living and working conditions, which are all associated with disability. This may reflect a reporting bias: poor access to medical service as well as a high level of illiteracy, which would limit the number of elderly persons who might be aware of having a medical condition (Gureje *et al.*, 2006). Some of the morbidities were associated with a higher prevalence of functional disability, although this was not statistically significant. These include cataract, osteoarthritis, diabetes mellitus, glaucoma, UTI and RTI. Cataract and glaucoma are the major causes of visual impairment, which will obviously affect the ability to carry out BADL. Osteoarthritis reduces joint mobility and inflicts pain, which may explain why its occurrence in this study was associated with a higher prevalence of functional disability.

In conclusion, result revealed that subjects with osteoarthritis had higher levels of Calcium, selenium and vit. D and lower levels of zinc, copper and vit. K.

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