



## RESEARCH ARTICLE

### PAIN REDUCTION LEVEL OF KNEE OSTEOARTHRITIS PATIENTS AFTER A 12- WEEK EXERCISE PROGRAMME IN ONDO STATE, NIGERIA: CORONAVIRUS PREVENTION PROTOCOL IMPLICATION

\*Dr. Emily Oluremi Adeloye

Human Kinetics and Health Education Department, Faculty of Education, Ekiti State University, Ado Ekiti, Nigeria

#### ARTICLE INFO

##### Article History:

Received 10<sup>th</sup> September, 2021  
Received in revised form  
18<sup>th</sup> October, 2021  
Accepted 14<sup>th</sup> November, 2021  
Published online 30<sup>th</sup> December, 2021

##### Keywords:

Knee Osteoarthritis, Pain Reduction Level,  
A 12- week Exercise,  
Coronavirus,  
6 Minutes' Walk.

#### ABSTRACT

The study examined pain reduction level of patients with knee osteoarthritis after a 12-week exercise programme: Coronavirus prevention protocols implication. Lack of physical activity is associated with muscle weakness, pain, joint stiffness, decreased range of motion and general deconditioning which lowers immunity. The research design is quasi- experimental. Sample consist of randomly selected 100 knee osteoarthritis patients, age range of 25-85 years, clinically diagnosed with mild to moderate knee deformity, without record of knee surgery. Height, weight, BMI were recorded. 6 Minutes' Walk was administered on participants for 12 weeks. A self- designed questionnaire was administered. Findings revealed that most participants were females (73%); aged above 50 years (48%); BMI  $\leq 25$  (79%); can do moderate to vigorous PA without fatigue after exercise (91%) and moderate pain reduction level (57%). The result of  $r = 0.1110$ ,  $n = 100$ ,  $P = 0.278$  revealed no statistically significant relationship between exercise and participants' pain reduction level and no joint contribution of demographic variables. Since most participants were able to function in moderate to vigorous PA after the walk, regular daily walk is hereby recommended, notwithstanding Coronavirus prevention protocols.

#### INTRODUCTION

The knee joint plays a major role in various functional movements such as the squat to pick up an object \ load from the floor, climbing the stairs and in walking from one place to another. If a person cannot perform these acts of movement conveniently without any pain, it is a signal to low level of knee joint functionality which may suggest knee osteoarthritis. Daily Burn (2016), reported that, if anyone could not perform the necessary daily movements without pain, the body thinks that he or she has a lower ability to survive. Adequate level of joint flexibility is needed for maintenance of functional independence and performance of activities of daily living such as bending to pick up a newspaper or getting out of the back seat of a two-door cars (Adeloye, 2020). Exercise is the foundation for healthy living and promotion of health. Lack of physical activity is associated with muscle weakness, pain, joint stiffness, fatigue, decreased range of motion and general deconditioning which lowers body immunity. Low immunity is one of the inroads to coronavirus disease 2019 (COVID-19) infection susceptibility. Knee osteoarthritis is the most common type of osteoarthritis. It is usually caused by previous injury, repetitive strain on the knee, fractures, ligament tear, and meniscal injury which affects the alignments of the knee and legs; hence promotes further wear and tear.

\*Corresponding author: Dr. Emily Oluremi Adeloye,  
Human Kinetics and Health Education Department, Faculty of Education, Ekiti State University, Ado Ekiti, Nigeria.

Genetics, obesity, and overweight raises a person's risks to develop knee osteoarthritis in which the subchondral bone (the bone layer underneath the cartilage in the knee) is affected. The knee joint is the largest joint in the body. The knee joins the thigh with the leg and consist of two joints: one between the femur and tibia (tibiofemoral joint), and one between the femur and patella (patellofemoral joint). Osteoarthritis (OA) generally, presents as joint stiffness and pain. The end of the two bones that comes together are covered with protective tissues called cartilage. Osteoarthritis sets in when the cartilage cushioning the joint breaks down and there is synovial fluid leakage causing the bones within the joints to rub one another inducing pain. The shock-absorbing quality of a cartilage comes from its ability to change shape when compressed (Musculoskeletal Medicine, 2017). Osteoarthritis is a degenerative joint disease which occurs in adults of any age, and it is a leading cause of disability in people over 50 years of age, although it can occur at any age and more common in women. It can be a debilitating form of arthritis, in that it tends to affect the load-bearing joints, especially the hips, and knees, that are crucial to normal movement (Veritas Health (2018) & Osteoarthritis (OA) Action Alliance (OAACTION) (2021). Knee osteoarthritis could be a major cause of disability because of the varying degree of pain that is associated with it. Such pain can be mild, moderate, or severe with stiffness of the knee joint, limited range of motion and local swelling. The pain from knee osteoarthritis is usually worse following activity, especially overuse of the affected knee.

Stiffness can worsen after sitting for a prolonged period. Long period of inactivity causes the arthritic joint to stiffen and the adjoining tissue atrophies (waste away). As knee osteoarthritis progresses, symptoms generally become more severe. At times, pain can become continuous rather than when only bearing weight (Very Well Health, 2016). Aerobic exercises can aid in weight loss to decrease pressure on joints and reduce inflammation of the joint (Menz, 2015). Osteoarthritis has no permanent cure but can be managed. Early diagnosis and non-surgical measures are mostly effective for long-term management of physical symptoms (pain, stiffness, swelling, tenderness, creaking) and preservation of daily functioning in chronic osteoarthritis patients (Mayo Clinic, 2017; Filippini & Danville, 2017). One of the most beneficial ways to manage knee osteoarthritis is to get moving. It may be hurt to think of exercise when the joint hurts, movement is considered as crucial in the treatment plan. Simple activities such as walking around the neighborhood or having fun, yoga, tai chi, and slow stretching exercises may improve joint flexibility, lessen stiffness, and reduce pain. Strengthening exercises build muscles around osteoarthritis affected joints, easing the burden on those joints and reduce pain. Aerobic exercises help to improve stamina, energy level, maintain a healthy body weight and increase immunity against infectious diseases like COVID-19.

The OAACTION (2021) reported that overweight and obesity contributes to more severe symptoms and impact on OA especially at the knee. Excess body weight causes additional stress to weight-bearing joints, such as hip, knees, feet and back. Body weight reduction can help people with Knee osteoarthritis reduce pain and limit further damage. To achieve the aim of body weight reduction, it is important to increase physical activity and eat fewer calories. The United States Department of Health and Human Services recommends 150 minutes of moderate exercise per week for every person including those with arthritis (WHO, 2015). Exercise strengthens the heart, lungs and lowers the risk of obesity and diabetes; this is a key factor in weight control, which may help reduce pain in knee OA. Arthritis Foundation (2018) reported physical activity as the best available treatment for any form of arthritis to increase joint flexibility and reduce pain. Of course, physical activity is one of the best ways to keep joints healthy. She recommended as little as 30 minutes of moderately intense exercise 5 times a week to help the joints limber and strengthens the muscles that stabilizes the hip and knees. Exercise also reduces the risk of COVID-19 infection, based on its positive impact on underlining health problems with vital organs. Managing osteoarthritis during COVID-19 pandemic may be more difficult and more important than ever. Citizens of all nations in the world and where millions of COVID-19 deaths were reported such as America, Europe, United Kingdom, Italy, India among others are being asked to practice social distancing; many social and physical outlets of everyday life, such as gymnasium and churches are closed (OAACTION, 2021). Nevertheless, it is not mandatory to join a gymnasium or have a formal workout plan to benefit. Activities like walking, gardening, aerobic dancing, and floor scrubbing counts. Positive result is greatly achieved with consistent and progressive exercise program me adjusted for a person's age, fitness level and the activities the person enjoy most. The best defense against any disease or infection such as knee osteoarthritis and COVID-19 are to develop a healthy lifestyle. What you eat, the way you eat, exercise, sleep mode, stress management, social interaction, smoking or drinking

habit can have a tremendous influence, not just on overall health, but also on a person's joints health. In other to lower the risks of COVID-19 susceptibility during exercise programme, OAACTION (2021) has recommended a guide for exercising at home during COVID-19 as follows: Pace around your home talking; See how far you can walk in 10 minutes, that is, how many laps you can take around your living room; march in place while holding on to a chair or railing. If you are used to measuring your walks in distance, try thinking about steps instead- 1 mile is about 2000 steps; See how many steps you can take during each commercial break of your favorite television show; Use a pedometer to record how many steps you get each day and try to increase your steps a little every week. It is important to take caution by watching for cords, rugs, and other tripping hazards around the house and hold on to the railing when going up and down stairs. Furthermore, the 6 Minute walk Test (6MWT) has been reported as a sub maximal test of aerobic capacity and endurance and could be programmed for a period of 12 weeks with aim of improving pain reduction level of people with knee osteoarthritis. American College of Rheumatology (2021), reported that, the 6MWT was developed in 1963 by Balke to evaluate functional capacity. It has been used as a performance-based measure of functional exercise capacity in healthy older adults and people undergoing knee or hip arthroplasty, rheumatic conditions such as knee or hip osteoarthritis, fibromyalgia, and scleroderma. The 6MWT has also been used to detect changes following interventions to improve exercise tolerance for people with knee or hip osteoarthritis.

The aim of the test is to walk as fast as possible in 6 minutes. The individual walks along the hallway between the markers, as many times as he/ she can go in 6 minutes. Ability Lab (2021) reported that the participants will be notified as each minute goes past, and then be told to stop at the end of 6 minutes. The (6MWT) is self-paced and involves measuring the distance a patient can walk on a level course (Hard, flat surface) in 6 minutes. The increasing acceptance of this test is due to its simplicity and does not require sophisticated equipment and can easily be performed by even the most severely debilitated patients. The 6MWT better reflects activities of daily living than other walk tests. In healthy individuals, the 6 minutes' walk distance ranges from 400m to 700m. The main predictor variables being gender, age, and height (West, 2021). Ability Lab (2021) has reported Kenedy et al. 2005's excellent test-retest (Intra class correlation) reliability of ICC0.94 for 6MWT on osteoarthritis patients. Coronavirus disease 2019 or COVID-19 is a highly infectious deadly disease and has been declared a global pandemic. It is caused by a newly discovered coronavirus which affects different people in different ways. Infected people have had a wide range of symptoms reported from mild symptoms to severe illness. Symptoms may appear 2-14 days after exposure to the virus. COVID-19 symptoms may present as: Fever or chills, dry cough, shortness of breath or difficulty in breathing, fatigue, fever, muscle or body aches, headache, new loss of taste or smell, sore throat, nausea or vomiting and diarrhea. If someone is showing any of these signs, it is necessary to seek for emergency. Also, such signs as: Trouble breathing, persistence pain or pressure in the chest, new confusion, inability to wake or stay awake, bluish lips or face (WHO, 2021). Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness. It is important that you protect yourself and

others from infection and stop the spread. The virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. Practice respiratory etiquette by coughing into a flexed elbow or tissue paper is advised. Proper regular hand washing with soap for about 20 seconds or/ and rub an alcohol-based sanitizer could help. Avoid touching the face, nose and mouth is important. In addition, physical distancing (at least 1-metre), wearing of mask (make sure that it covers your nose, mouth, and chin), keeping rooms well ventilated, avoiding crowds should be observed. Wash fabric masks daily inside detergent and dispose the medical mask in a trash bin. Masks with valves should be avoided. Clean and disinfect surfaces frequently and regularly touched, such as door handles, stair rails, faucets, water taps and phone screens.

According to WHO (2021), outbreaks have been reported in restaurants, choir practices, fitness classes, nightclubs, offices, and places of worship where people have gathered. The risks of coronavirus spread are higher in crowded indoor settings where they talk loudly, shout, breathe heavily or sing. In these environments, there is easy spread of the virus through respiratory droplets or aerosols, people should take caution. Hence, outside gathering are safer than indoor ones, particularly if indoor spaces are small and poorly ventilated. In case of minor symptoms such as cough, headache, or mild fever, it is advisable to stay at home and self-isolate until recovery is ascertained.

Even though people were mandated to practice social distancing, and many social and physical outlets of life such as gymnasium and churches are closed, managing knee osteoarthritis symptoms should not be handled with levity especially during COVID-19 pandemic. The OAACTION (2021), supported by the Centers for Disease Control and Prevention, stated that managing or increasing physical activity levels is essential every day, but especially during times of stress and uncertainty. Despite that people needs to stay apart to stay safe, man cannot stop moving. This is because activity helps to keep joints lubricated, mobile and strong. It also helps to improve sleep and emotional wellbeing. It has been reported that the number of people affected by OA has been steadily increasing in recent decades, possibly due to growing rates of obesity and an aging population especially between the age of 55 and 64 years.

About 30 million people live with the pain of OA, the wear and tear form of arthritis and it frequently appears in the knee joints (Everyday Health,2021). Jason (2020) stated that more than 300 million cases of knee and hip osteoarthritis was reported worldwide in 2017 with figures expected to rise in the future, particularly among women, according to data published in the Annals of the Rheumatic diseases. Incidence of knee OA is rising by increasing average age of general population (Caspian Journal of Internal medicine, 2011). Denis & Kartavenko (2017) also, reported that more than 10 million Americans are living with knee osteoarthritis. In Nigeria,150,246 cases; 1,803 deaths and 126,417 recoveries were reported (African Union, 2021). It has been observed that men and women of average age moves on shopping cartwheel chair in shopping malls. Inability to walk round the mall or climb available stairs may not be far from pain emanating from the knee joints. It is against this background that this study examined pain reduction level of knee osteoarthritis patients,

after a 12-week exercise programme: Coronavirus risks restriction implication.

## RESEARCH METHOD

The quasi-experimental research design was employed. The population consists of all patients (male and female) with knee osteoarthritis in Ondo State, Nigeria. Using purposive sampling technique, Ondo State Specialist hospital, Akure; Federal Medical Center, Owo; General Hospital, Ondo and Trauma Center, Ondo were selected as the study locations. One hundred (100) knee osteoarthritis patients who have been medically diagnosed, have not undergone any knee surgery and have been on physiotherapy / follow up clinic for not less than (12) weeks were randomly selected.

Participants were within the age range of 25- 85 years with a record of mild to moderate knee deformity. The ethical committee for each hospital and the orthopedic physicians were approached for permission and approval for data collection. The participants signed the informed consent form. A physiotherapist and other 2 trained assistance were employed. The bodyweight of participants was measured with a Camry Br-90-11 model bathroom scale made in China, with light clothing, no shoes and were recorded to the nearest 0.1kg (Reliability coefficient of 0.96 (Watson,2016). Standing height was measured in meters (M) using the stadiometer from the base without shoes, feet together, buttocks in contact with the pole, to the highest point of the head, when the participant is facing directly ahead (Reliability coefficient of 0.99 (Safrits and Wood, 2017). Body mass index (BMI), otherwise known as the Quetets index were determined before data collection according to the metropolitan life instance tables. BMI was calculated using the

formular:  $\frac{\text{Weight (Kg)}}{\text{Height (M)}^2}$

The leather tape measure, calibrated in inches and centimeter was employed to measure the distance on hard leveled floor.

**Exercise Procedure: - Six Minute Walk Test - 6MWT**  
Objectives and procedure of the test were explained to participants before the commencement of the programme to ensure maximum cooperation and compliance. The levelled corridor of each hospital was utilized. The walking course of thirty (30) meters was marked every three meters to allow for easy interpretation of distance covered. The turnaround point at the beginning and the end of the thirty meters was marked. The researcher demonstrated 6MWT for one complete lap. Participants were positioned at the starting point one after the other. The timer was switched on as soon as each participant began to walk.

During the walk, phrases of encouragement like “You are doing good”, “Keep the good work up”, “Keep going” were sounded to participants. By five (5) seconds before completion, participants were informed to get ready to stop. The stop walking command was given at the end of 6 minutes and the last stepped point was marked. The distance covered in 6 minutes per day by participants were recorded to the nearest centimeter. The walk test was done 3 (three) times in a week for a period of 12weeks, respectively. Participants were instructed to practice the walk at home on non-appearance day

at text location. Participants were made to fill a self- designed questionnaire to elicit (Yes or No) responses on the effect of (6MWT) on their pain reduction level based on their ability to carry out daily activities and exercises.

**Hypotheses**

Two (2) null hypotheses (Ho) were postulated and tested at 0.05 alpha level. There is no significant relationship between A 12-week exercise program and pain reduction level of knee osteoarthritis patients in Ondo State, Nigeria: Coronavirus prevention protocol implication.

There is no significant joint contribution of age, gender, Body Mass Index (BMI) on pain reduction level of knee osteoarthritis patients, after a 12- week exercise program in On do State, Nigeria: Coronavirus prevention protocol implication.

**Data Analysis:** Data were analyzed using the descriptive statistics of simple frequency counts and percentages; the Pearson Product Moment Correlation using SPSS analysis and inferential statistics of regression using standardized Beta coefficient were employed to test the hypotheses.

**Results Table 1. Demographic characteristics of participants**

Characteristics	Frequency	Percentage (%)	Total(N)
Gender- Male	27	27	100
Female	73	73	
Age- 21-30	7	7	100
31-40	21	21	
41-50	24	24	
>50	48	48	
Body Mass Index (BMI)- ≤ 25	79	79	100
>25	21	21	

**Table 2. Analysis of participants’ physical activity after a 12-week exercise programme**

Moderate-vigorous activity	Yes %	NO %
I can do moderate physical activity without undue pain after engaging in A12-week of 6MWT	91	9
I spend 6 minutes or more on moderate exercises after A 12 -week of 6MWT without knee pain	88	12
After a 12-week 6MWT, I can do vigorous physical activity with minimal pain	37	63
I spend 6 mins or more on vigorous activities without knee pain after A 12-week 6MWT	25	75
I can walk for a period of 10 minutes at a stretch without undue fatigue and pain after A12-week 6MWT	66	34

**Table 3. Pain reduction level of participants after a 12- week exercise program me**

	Frequency	Percentage (%)
Low (5<)	0	0
Moderate (5-7)	57	57
High (≥ 8)	43	43
Total	100	100

**Hypothesis 1**

**Table 4.** There will be no significant relationship between exercise and pain reduction Level of participants after a 12-weeks exercise program me

	N	Mean	Std. Deviation	r- critical value	p-value
6MW Exercise Pain reduction level	100	8.08	1.2687	0.110	0.278
		7.61	1.6074		

Table 4 revealed that the relationship between 6MW Exercise and pain reduction level of participants was not statistically significant ( $r = .110, n=100, p=.278$ ). The p value of .278 is greater than the critical value of  $r0.110$ , hence, hypothesis 1 is not rejected.

**Hypothesis 2**

**Table 5.** There will be no significant joint contribution of age, gender, and body mass index on pain reduction level of participants after A 12- weeks exercise program.

Model	Unstandardized coefficient		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	6.876	1.355	-.084	5.074	.000
Sex	-.302	.358	.067	-.846	.400
Age	.110	.163	.146	.673	.502
BMI	.055	.037		1.482	.142

R= .280  
 R<sup>2</sup>=.078  
 Adjusted R<sup>2</sup>= .039  
 F=2.015  
 P- value=0.099

Table 5 showed that there is no significant joint contribution of demographic variables of gender, age, and BMI on pain reduction level of participants. Hence, hypothesis 2 is not rejected.

**DISCUSSION**

Findings from this study revealed that most participants recorded ages 50 years and above (48%), in line with OAACTION (2021) who reported ages 55 to 64 for people with knee osteoarthritis. Also, the National Center for Biotechnology Information (NCBI) (2021) reported 63 years and 57% of women with knee osteoarthritis. More than 300 million cases of knee osteoarthritis reported in 2017 worldwide were women (73% (OAACTION, 2021). Most participants (79%) recorded Body Mass Index (BMI) of ≤ 25% kg/m<sup>2</sup> which falls within the normal weight and height ratio of 18.5 to 25 kg/m<sup>2</sup> reported by Wikipedia (2021). NCBI (2021) reported Holmberg et al. and Rheumatol (2005) that the adjusted risk of knee OA was increased fourfold in men with BMI of 23 to <25 kg/m<sup>2</sup> as compared to men with BMI <23 kg/m<sup>2</sup>. A commensurate risk was reported for women at 30 years of age. Most participants (55%) were able to function moderately after 12 weeks of 6MWT. According to American College of Rheumatology (2021), 6MWT has been used to improve exercise tolerance for healthy older adults as well as people with rheumatic conditions such as knee OA. There was no significant joint contribution of demographic variables of gender, age, and BMI on pain reduction level of participants. Hence hypothesis 2 is not rejected. BMI recorded the highest and but non-significant contribution on pain reduction level of participants with beta weight of -.146 followed by gender with a beta weight of -.084. BMI contributed 14.6% while sex contributed .84% respectively. Most participants (91%) can do moderate physical activity without undue pain after engaging

in A 12-week of 6MWT followed by 66% who were able to spend 6 minutes or more on moderate exercises without knee pain. Most participants (75%) indicated inability to spend 6 mins or more on vigorous activities without knee pain after the exercise programme while 63% cannot do vigorous physical activity with minimal pain.

Participants (66%) could walk for a period of 10 minutes at a stretch without undue fatigue and pain after the exercise programme. Participants (43%) recorded high ( $\geq 8$ ) pain reduction level after A 12-week 6MW exercise programme; while most participants (57%) had moderate (5-7) pain reduction level respectively. Table 4 revealed that the relationship between 6MW Exercise and pain reduction level of participants was not statistically significant ( $r = .110$ ,  $n = 100$ ,  $p = .278$ ). The p value of .278 is greater than the critical value of  $r = 0.110$ . Hence hypothesis 1 is not rejected. Table 5 showed that there is no significant joint contribution of demographic variables of gender, age, and BMI on pain reduction level of participants. Hence, hypothesis 2 is not rejected.

## Conclusion

In as much as the study revealed that most participants were able to function in moderate to vigorous activities after the 6 Minutes walk for 12-weeks, it is inferred that walking exercise has positive impact on pain reduction level of knee OA patients. Walking is a moderate exercise that should be done on daily basis for at least 30 minutes to tone the muscles, activate the nerves, ligaments, and tendons around the joints. Thus, increased blood flow around the knee joint increases the supply of oxygen, decrease joint inflammation, which enables pain reduction. Regular daily walk is recommended. 'Keep on moving and ignore the pains to reduce the pains.' Coronavirus prevention protocols should not constitute any hindrance to daily walk.

## REFERENCES

- Ability Lab. (2021). (2013, April 26). 6 Minute Walk Test. <https://www.saralab.org/rehabilitation-measures/6-minutes-walk-test>
- Rehabilitation measures.
- Adeloye, E.O. (2020). Hip and trunk flexibility differences among university athletes in Southwestern Nigeria: Implication for injury. *European International Journal of Science and Technology* (EIJST). 9 (5). 1-13. ISSN: 2304-9693.
- African Union CDC. (2021, February 19). African union member states reporting COVID- 19 cases as of 8pm EAT. <https://www.africacdc.org/>
- American College of Rheumatology (2021). Six-minute walk test (6MWT). <https://www.rheumatology.org/1-Am-A/Rheumatologist/research/clinical-Researchers/Six-Minute-Walk-Test-SMWT>
- Caspian Journal of Internal Medicine (2011). Knee steoarthritis prevalence, risk factors, pathogenesis, and features: part 1. *Caspian Journal of Internal Medicine*. Babol University of Medical Sciences Spring. 2(2):205-212. [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)
- Daily Burn. (2016, November 11). 7 ultimate functional movement patterns trainers want you to master. <https://dailyburn.com/life/fitness/functional-movement-patterns-tests/amp/>
- Dias. (2014). Physical functioning (PF). In Michalos, A.C. (eds) *Encyclopedia of quality life and well-being research*. Springer, Dordrecht. <https://doi.org/10.1007/978-9400753>
- Dotdash. (2021). Signs and symptoms of osteoarthritis and complications. <https://www.verywellhealth.com/osteoarthritis-symptoms-4014403>
- West M. (2021). What is the 6-minute walk test and what is its purpose. <https://www.medicalnewstoday.com/articles/6-minute-walk-test>.
- Jason, L. (2020). Global cases of hip, knee osteoarthritis exceed 300 million. <https://www.healio.com>
- Mann, D. (2018). 10 Dos and Don'ts for managing Knee osteoarthritis pain. Carson-DeWith, R Review. <http://www.everydayhealth.com>
- Nelson, A. E. (2017). Osteoarthritis and cartilage. Osteoarthritis year in review 2017: clinical. <https://www.ncbi.nlm.nih.gov/pubmed>
- National Center for Biotechnology Information (2021). Knee osteoarthritis and body mass index: a population-based case- control study. <http://www.pubmed.ncbi.nlm.nih.gov>
- Osteoarthritis (OA) Action Alliance (2021). Managing OA during the COVID-19 pandemic. Thurston Arthritis Research Center, The University of North Carolina at Chapel Hill. <https://www.oaaction.unc.edu>
- Safrit, M.J and Wood, T.M. (2017). Validity and reliability of locomotor development inventory in Malaysian Education context. <https://researchgate.net>.
- Teslim, O.A., Adeoya, O.I., Egwu, M.O. and Adedoyin, R. (2013). Reliability and concurrent validity of bathroom weighing scale and sphygmomanometer in quantifying magnitude of digital postero -anterior spinal pressure. <https://www.researchgate.net/Doi>
- Veritas Health (2021). Knee anatomy. <https://www.arthritis-health.com>
- Wikipedia (2021). Body mass index. <https://www.en.m.wikipedia.org>
- World Health Organization (2021). Coronavirus, health information, symptoms, Prevention, treatment. <https://www.who.int>