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ORIGINAL PAPER

Effects of core-stabilization and trunk balance exercises on clinical parameters in patients with non-specific chronic low back pain – a randomized pilot study

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ABSTRACT

Introduction and aim. This study compared the efficacy of core stabilization (CSE) and trunk balance exercises (TBE) with flexibility training on pain-related disability (PRD), psychological status (PS) and fear avoidance belief (FAB) in patients with non-specific chronic low back pain (NSCLBP).

Material and methods. Twenty-eight (28) participants diagnosed of NSCLBP were randomly assigned into CSE, TBE, and control groups (CG). Participants in CSE (n=10); TBE (n=8) and CG groups (n=10) received core stabilization exercise, trunk balance exercise and back care advice respectively. All participants received flexibility training in addition to treatment in their respective groups. Assessment of outcomes were done at baseline, end of 4th and 8th week.

Results. There was significant improvement in all outcomes in the CSE, TBE and CG at 8 weeks; PRD (p=0.005, p=0.008, p=0.005), PS: depression (p=0.005, p=0.008, p=0.007); anxiety (p=0.005, p=0.007) and FAB about work (p=0.005, p=0.007, p=0.005); about physical activity (p=0.005, p=0.018, p=0.006). Comparison of outcomes between CSE and TBE groups showed no significant difference (p>0.05)

Conclusion. Both CSE and TBE with flexibility training are effective in improving PRD, PS and FAB of patients with NSCLBP.

Keywords. exercise therapy, fear, low back pain

Introduction

Low back pain (LBP) is a frequent cause of disability in the community and the leading cause of disability worldwide with a lifetime prevalence of 84% in industrialized countries.[1-3] Non-specific chronic low back pain (NSCLBP) is the most common type of back pain that exists and account for 85% of all cases of back pain.[4-5] The patient with low back pain not only experience pain, but also suffers from impairment which obstructs their day to day activities such as inability to ambulate and dress up.[6]

Core stabilization exercises have been reported as an effective treatment program in reducing physical and psychological symptoms in patients with non-specific chronic low back pain.[7] Balance exercises are designed to improve balance or postural stability. Balance is a dynamic process by which the body's position is in equilibrium, static or dynamic. It is greatest when body's center of mass or center of gravity is maintained within the base of support.[8-9] Trunk balance deficits and muscle impairments could also originate from poor position sense, which has been reported to be present in individuals with chronic low back pain.[9] Poor balance is also a frequent concern reported by patients with chronic low back pain and has been demonstrated through increased

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displacement of the center of pressure while standing upright.[9]

Flexibility is the ability to move a single joint or a series of joints smoothly and easily through an unrestricted pain free range of motion. Flexibility is the extensibility of musculotendinous units that cross a joint, based on their ability to relax or deform and yield to a stretch force.[8-9]

Exercises have been shown to relieve symptoms in patients with NSCLBP.[10] However, it appears there is dearth of empirical data establishing which is more effective between core stabilization exercise (CSE) and trunk balance exercise (TBE) interventions on individuals with NSCLBP. Moreover, there is limited evidence on the impact of the trunk balance exercise on depression, anxiety, and fear avoidance belief in patients with NSCLBP.

Aim

This study therefore compared the therapeutic efficacy of core stabilization and trunk balance exercises with flexibility training on pain-related disability, psychological status (anxiety and depression) and fear avoidance belief in patients with NSCLBP. This study was set to proffer answer to the following question: Would Core Stabilization and trunk balance exercises with flexibility training improve pain related disability, psychological status, (anxiety and depression) and fear avoidance belief in patients with NSCLBP.

Material and methods

Participants

A single blinded randomized controlled pilot study registered with the Pan-African clinical trial registry (PACTR202110750995790) was employed for this study. Approval to conduct the study (CMUL/HREC/02/21/812) was obtained from the health research and ethics committee of the College of Medicine University of Lagos. Informed written consent was obtained from the participant prior to enrolling them in the study. Thirty-three participants were involved in this study; they were patients with NSCLBP seeking treatment from a physiotherapy clinic of a tertiary health institution in Ogun state, Nigeria. Sample size calculation was based on minimum effect size of 0.25 and power of 80% using the G. power software calculator.[11,12] This research was conducted between April 2021 and July 2021. The participants involved in the study were patients diagnosed with recurrent history of non-specific chronic low back pain greater than 3 months with or without pain radiating to one or both lower limbs and patients that scored more than 5 on visual analogue scale. Participants were excluded if they had spinal surgery, history of trauma to the back or specific low back pain. Information on the physical characteristics (age, sex, height, weight, body mass index) were obtained from the participants, while the height and weight were measured following the protocol of the International Society for the Advancement of Kinanthropometry.[13]

Assessment of height and weight of the participants

The participants were instructed to stand erect on the stadiometer with their eyes looking straight forward ahead and their hands held by the side. The height and weight were read and recorded to the nearest 0.1meters and 0.1 kilograms respectively.[13]

Assessment of outcome measures

The assessment of pain related disability, depression, anxiety, fear avoidance belief, were achieved with the pain disability index, hospital anxiety depression scale, and fear avoidance belief questionnaire respectively.

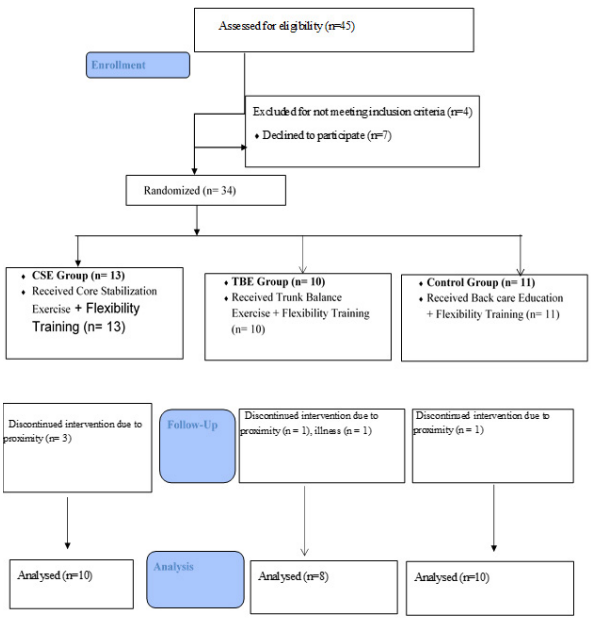

Fig. 1. Flow chart of the study

Randomization

Forty-five (45) patients with complaint of non-specific chronic low back pain were recruited for this study, eleven (11) were not eligible considering the inclusion criteria. Thirty-four (34) participants were allocated into 3 different groups (CSE+flexibility, TBE+flexibility and control) through a random generated number sequence, produced before the recruitment of the participants by the research assistant. Thirteen (13) participants were allotted into CSE+flexibility group, Ten (10) participants into TBE+flexibility group while eleven (11) participants were allotted into the control group that received flexibility and back care advice (Fig. 1). To ensure adequate blinding, allocation of study participants was done by a research assistant who was not involved in the clinical assessment and treatment of patients. Participants and the statistician were blinded to interventions to reduce bias. However, six (6) participants were not

able to complete the study due to proximity and illness (Fig. 1). All the groups received 30 minutes duration of the interventions twice weekly for a period of 8 weeks.

Evaluation methods

The CSE, TBE, back care and flexibility regimens were performed two times a week for 8 weeks. The assessment of pain related disability, psychological status (depression and anxiety) and fear avoidance belief were taken at baseline, and at the end of the 4th and 8th week. The research assistant who was the assessor did not administer any intervention on the participants. The investigators who are physiotherapists (FO and AA) supervised the intervention protocols. The participants and data analyst were also blinded to intervention to eliminate bias.

Outcome measures

Pain disability index (PDI)

This is a 7-item questionnaire used for investigating the magnitude of self-reported pain-related disability, independent from region of pain or pain related diagnosis. The items of the questionnaire are assessed on a 0-10 numeric rating scale in which 0 means no disability and 10 is maximum disability. The sum of the seven items equals the total score of the PDI, which ranges from 0-70, with higher scores reflecting higher interference of pain with daily activities. The PDI measures family/home responsibilities, recreation, social activity, occupation, sexual behaviour, self-care, and life support activity.[14] The PDI has test-retest reliability value of 0.78.[15]

Hospital anxiety and depression scale (HADS)

The HADS is a fourteen-item scale with seven of the items assessing anxiety and seven assessing depression. Each item on the questionnaire is scored from 0-3 that a person can score between 0 and 21 for either anxiety or depression. A score of 0-7 is normal, 8-10 is borderline abnormal and 11-21 is abnormal.[16] It has a high sensitivity value and internal consistency of 0.86.[16]

Fear avoidance belief questionnaire (FABQ)

It has been proven to be a useful clinical tool that demonstrates specific fear avoidance beliefs which are strongly related to work loss due to low back pain.[17] It consists of 2 sub scales, which is reflected in the division of the outcome form into two separate sections. The first subscale (item 1-5) is the physical activity subscale, and the second subscale item (6-16) is the work subscale. Each subscale is graded separately by summing the response respective scale items (0-6) for each item, for scoring purposes, only 4 of the physical activity scale items are scored (24 possible points). The items 2, 3, 4, and 5 are summed for the score of the physical Activity Subscale, while the items 6, 7, 9, 10, 11, 12 and 15 are summed for the work subscale. The FABQ has been demonstrated to be valid and reliable in a chronic low back pain population.[17]

Post intervention assessment was done at the end of 4th and 8th week. All participants were told to abstain from any other treatment intervention for their back pain throughout the duration of the study and to inform the researcher of any complaints they have at any stage throughout the duration of the research.

Protocol for core stabilization exercises

This comprises of abdominal bracing (8 seconds, 30 repetitions), heel slides while bracing the abdomen (4 seconds, 20 repetitions), bridging with abdominal bracing (8 seconds, 30 repetitions), leg lift with abdominal bracing (4 seconds, 20 repetitions), bridging and leg lift with abdominal bracing (8 seconds, 30 repetitions), abdominal bracing in standing position (8 seconds, 30 repetitions), arm lift with bracing in quadruped position (8 seconds, 30 repetitions), leg lift with bracing in quadruped position (8 seconds, 30 repetitions), alternate arm and leg lift with bracing in quadruped position (8 seconds, 30 repetitions).[18]

Protocol for trunk balance exercise

This comprises of kneeling on a pillow and arms abducted to 90°, the trunk was rotated, head and upper limbs to one direction (2 times per direction, maintaining each position for 30 seconds), kneeling on a pillow, the upper limbs were moved in flexion and extension, with a simultaneous movement of the head (3 minutes, performing 6 repetitions of upper limbs movement). Supine with feet resting on the table, the pelvis was lifted up, after reaching maximum hip extension, one lower limb was raised from the table and the knee extended (twice for 30 seconds for each lower extremity), quadruped position, opposite upper and lower limbs were extended, Sitting on the side of the table with unilateral support (1 minute each side), Single-limb kneeling on the edge of the table with a pillow under the knee (30 seconds two repetitions for each limb).[8] The exercise was made more challenging by adding eye closure.

Protocol for flexibility

The participants performed flexibility exercises to the lower extremities such as quadriceps stretching, sitting hamstring stretching, calf muscles stretching, hip adductors, hip abductors, hip flexors/extensors stretch, gluteal muscle stretching. All stretches were held for 15-20 seconds to achieve the maximum benefit This was repeated with both legs 2-3 times.[10]

Protocol for back care education

It was an educational package comprising of instructions and drawings showing how to perform correct lifting and carrying techniques, how to maintain prop-

er posture while in upright position, avoiding prolonged sitting, bending, stooping and squatting and how to perform correct sweeping technique.[19]

Statistical analysis

Statistical Package for Social Sciences (SPSS Inc., Armonk, New York, USA) 25.0 version for Windows package program was used to perform data analysis. Demographic and quantitative data were expressed as mean and standard deviation (SD). Normality test was done with Shapiro Wilk test. One-way ANOVA and descriptive statistics were used to analyse demographic variables. Wilcoxon signed rank test was used to detect any statistically significant differences in the changes within each group pre and post treatment intervention. Kruskal Wallis was used to detect any significant difference across the three groups and Post Hoc analysis was used to detect where the significance lies in the three groups. Mann-Whitney U test was used to compare outcomes across the weeks between groups 1 and 2. All statistical test were performed at 0.05 level of significance (i.e., $p<0.05$).

Results

Forty-five participants with non-specific chronic low back pain were recruited for this study. However, 28 participants completed the study: with 10 (35.7%) of the participants in CSE+flexibility group, 8 (28.6%) participants in TBE+flexibility group and 10 (35.7%) participants in the control group (Figure 1). For the sex distribution, 15 (53.6%) of the participants were females and 13 (46.4%) were males. The mean age of the participants in all the groups was 48.62±1.88 years. The mean weight, height and body mass index (BMI) of the participants in all the groups were 67.26±1.28 kg, 1.62±0.01 m, and 25.49±0.37 kg/m^2 respectively. The groups did not differ significantly in age and height (Table 1).

Table 1. Demographic characteristics of the participants (n=28)*

Variables	All Groups Mean±SD n=28	CSE Mean±SD n= 10	TBE Mean±SD n= 8	Control Mean±SD n=10	F-value	p
Age (years)	48.62±1.88	50.31±3.191	50.40±1.74	45.00±4.16	0.877	0.426
Height (m)	1.62±0.01	1.63±0.02	1.60±0.02	1.62±0.01	0.747	0.482
Weight (kg)	67.26±1.28	71.62±1.32	65.00±2.02	64.18±2.72	4.3	0.022
BMI (kg/m^2)	25.49±0.37	26.87±0.28	25.27±0.67	24.06±0.71	6.899	0.003

* significance level p<0.05; Mean±SD – mean±standard deviation; BMI – body mass index; CSE – core stabilization exercise+flexibility group; TBE – Trunk balance exercise+flexibility group; F-value – One-way ANOVA

Table 2 shows the Wilcoxon Signed Ranks Test which revealed a significant improvement in the outcome parameters in all the 3 groups except for anxiety in the control group (p=0.075). Table 3 shows that there was a significant difference in Fear Avoidance Belief about physical activity score among the 3 treatment groups (p=0.041). Least significant difference Post hoc analysis showed that there was significant difference between the CSE and TBE groups (p=0.03), and the TBE and Control groups (p=0.01), for fear avoidance belief about physical activity.

Table 2. Outcome measure parameters at pre-treatment (baseline) and post-treatment (end of the 8th week) within each group

	Outcome measure	Baseline Mean±SD	End of 8th week Mean±SD	z-value	p
CSE	PDI	42.92±3.91	10.40±1.88	-2.803	0.005*
	Depression	13.85±1.15	2.20±0.93	-2.81	0.005*
	Anxiety	12.23±1.31	1.30±0.5	-2.81	0.005*
	FAB (work)	29.23±1.57	14.6±1.75	-2.81	0.005*
	FAB (physical activity)	22.62±0.61	10.6±1.56	-2.81	0.005*
TBE	PDI	46.4±5.47	17.50±3.96	-2.666	0.008*
	Depression	12.8±1.71	3.25±1.05	-2.673	0.008*
	Anxiety	10.8±1.83	2±1.24	-2.677	0.007*
	FAB (work)	28.4±2.43	13.63±1.73	-2.677	0.007*
	FAB (physical activity)	19.4±1.71	9.25±1.6	-3.371	0.018*
Control	PDI	36.73±4.58	10.00±1.61	-2.805	0.005*
	Depression	7.27±1.12	1.60±0.82	-2.692	0.007*
	Anxiety	6.27±1.44	2.80±1.75	-1.787	0.074
	FAB (work)	27.91±1.97	14.00±1.29	-2.805	0.005*
	FAB (physical activity)	21.45±1.17	12.20±0.81	-2.726	0.006*

* significance level p<0.05; CSE – core stabilization exercise+flexibility group; TBE – trunk balance exercise+flexibility group; PDI – pain disability index; FAB – fear avoidance belief; Z-value – Wilcoxon sign rank test

Table 3. Outcome measure parameters at baseline, end of 4th and 8th week between the 3 groups*

	Outcome measure	CSE Mean±SEM n=10	TBE Mean±SEM n=8	Control Mean±SEM n=10	H-value	p
Baseline	PDI	42.92±3.91	46.40±5.472	36.73±4.581	2.914	0.233
	Depression	13.85±1.154	12.80±1.705	7.27±1.121	11.368	0.003
	Anxiety	12.23±1.307	10.80±1.825	6.27±1.440	8.298	0.016
	FAB (work)	29.23±1.565	28.40±2.432	27.91±1.965	0.139	0.933
	FAB (physical activity)	22.62±0.605	19.40±1.714	21.45±1.171	3.311	0.191
End of 4th week	PDI	25.45±3.730	28.75±5.583	23.73±3.873	0.360	0.835
	Depression	6.55±1.275	6.75±1.800	3.55±1.178	3.538	0.171
	Anxiety	4.45±0.824	4.63±1.487	2.82±0.942	2.258	0.323
	FAB (work)	20.00±1.668	19.63±2.725	20.64±1.636	0.098	0.952
	FAB (physical activity)	17.73±1.356	12.88±1.865	18.73±1.214	6.369	0.041*
End of 8th week	PDI	10.40±1.881	17.50±3.960	10.00±1.606	3.007	0.222
	Depression	2.20±0.929	3.25±1.048	1.60±0.819	1.725	0.422
	Anxiety	1.30±0.496	2.00±1.239	2.80±1.75	0.171	0.918
	FAB (work)	14.60±1.746	13.63±1.731	14.00±1.291	0.372	0.83
	FAB (physical activity)	10.60±1.558	9.25±1.601	12.20±0.814	2.425	0.298

* significance level p<0.05; SEM – standard error of mean; CSE – core stabilization exercise+flexibility group; TBE – trunk balance exercise+flexibility group; PDI – pain disability index; FAB – fear avoidance belief; H-value – Kruskal Wallis Test

Table 4 shows the comparison between the mean score on pain disability index, psychological status (depression, anxiety), fear avoidance belief about work

and physical activity at baseline, mid-treatment, and post-treatment between the CSE and TBE groups. Mann-Whitney U test showed that there was no significant difference (p>0.05) between the outcome parameters of both intervention groups.

Table 4. Comparison between outcome measure parameters at baseline, mid-treatment, and post-treatment between CSE and TBE groups

	Outcome Measures	CSE Mean ±SEM N=10	TBE Mean± SEM N=8	u-test	p
Baseline	PDI	42.92±3.91	46.40±5.472	50.5	0.376
	Depression	13.85±1.15	12.80±1.705	59.5	0.738
	Anxiety	12.23±1.31	10.80±1.825	52.5	0.446
	FAB (work)	29.23±1.57	28.40±2.432	62	0.879
	FAB (physical activity)	22.62±0.61	19.40±1.714	38	0.101
End of 4th week	PDI	25.45±3.73	28.75±5.58	40.5	0.778
	Depression	6.55±1.28	6.75±1.80	43	0.968
	Anxiety	4.45±0.82	4.63±1.49	42.5	0.904
	FAB (work)	20.00±1.67	19.63±2.73	40	0.778
	FAB (physical activity)	17.73±1.36	12.88±1.87	20	0.051
End of 8th week	PDI	10.40±1.88	17.50±3.96	23	0.146
	Depression	2.20±0.93	3.25±1.048	32	0.515
	Anxiety	1.30±0.5	2.00±1.239	39.5	0.965
	FAB (work)	14.60±1.75	13.63±1.731	35	0.696
	FAB (physical activity)	10.60±1.56	9.25±1.601	32.5	0.514

* significance level p<0.05; CSE – core stabilization exercise+flexibility group; TBE – trunk balance exercise+flexibility group; PDI – pain disability index; FAB – fear avoidance belief; U-test – Mann-Whitney U test

Discussion

This study determined the therapeutic efficacy of core stabilization and trunk balance exercises with flexibility training on pain-related disability, psychological status (anxiety and depression) and fear avoidance belief in patients with NSCLBP.

In this study, core stabilization exercise with flexibility training was found to be effective in decreasing pain related disability of patients with non-specific chronic low back pain. This is consistent with a study by Kumar et al[20] which concluded that core muscle strengthening exercise along with lumbar flexibility is an effective rehabilitation technique for all chronic low back pain patients. A previous study has shown that stabilization exercises are more beneficial than conventional treatments to reduce pain and disability in chronic LBP patients.[21] This could be associated with the reestablishment of the normal control of the local muscles of the trunk which, when recruited, stabilizes the spine, and increases activity in the lumbar muscles, and reduce the activity of more superficial muscles such as rectus abdominis, external oblique, and internal oblique. The reduction in pain could be attributed to muscular contraction during spinal stabilization exercises which provides sensory input to trigger different pain inhibitory mechanisms in the central nervous system.[22] These led to a rise in the plasma serotonin level, as a likely means of the spinal stabilization exercises-induced analgesia.[22] This would subsequently cause a reduction in pain-related disability.[7]

In this study, core stabilization exercise with flexibility training was found to be effective in improving depression, anxiety, and fear avoidance belief in patients with NSCLBP. This is in line with findings of Akodu and Akindutire, which reported that core stabilization exercises are very useful in the management of depression and anxiety in NSCLBP patients.[7] This result is also supported by a study done by Akodu et al. which concluded that stabilization exercise is effective in the management of pain-related disability, depression, and anxiety in NSCLBP patients.[10] This could be due to the decline in the pain sensation of the participants' post-treatment. This is also in line with the claim of Balasubramaniam et al[23], who reported that when there is a reduction in the level of perception of pain and disability, the level of depression reduces, as a result, leads to reduction of patients' fear of pain and improvement in avoidance of physical activity. A study by Akodu et al., reported that stabilization exercise is effective in managing fear avoidance belief of patients with non-specific chronic low back pain.[21]

In this study, trunk balance exercise with flexibility training was found to be effective in reducing pain-related disability, improve psychological status (anxiety and depression) and fear avoidance belief in patients with NSCLBP. This is supported by a study done by Gatti et al. which concluded that trunk balance exercises appeared to be effective in reducing disability due to chronic LBP.[8] Trunk balance exercise has a big effect on chronic low back pain patients as it strengthens deep abdominal muscles and improves flexibility and balance.[24] This could be because balance exercises promote recruitment of the trunk musculature. Proper recruitment of these muscles may be lost in patients with CLBP, which may explain the pain, poor postural control and the muscle activation delays and subsequent disabilities. Trunk balance exercises also improves activation of the trunk muscles during both unpredictable and predictable trunk perturbations by providing spinal stability which act through feed-forward and feedback control mechanisms that modulate the stiffness of the spinal muscles to control internal and external forces generated during body movements.[24]

This study also showed that back care plus flexibility exercises was effective in the management of pain disability, psychological status (depression and anxiety) and fear avoidance belief of patients with NSCLBP. This improvement could be due to the reduction in pain and disability level of the participants.[23] This is in line with studies done by Paolucci et al., and Akodu et al., which concluded that back care and stretches has pos-

itive effects on the psychological status of patients with NSCLBP.[10,25]

However, the result of the comparison of both core stabilization exercise with flexibility training and Trunk balance exercises with flexibility training showed that both interventions are both effective in improving pain-related disability, psychological status (depression and anxiety) and fear avoidance belief of patients with NSCLBP as there was no difference in the clinical outcome variables in the two intervention groups after 8 weeks post treatment. This study was limited due to small sample size, lack of gender division, drop out from the study, and short study duration (8 weeks). Caution should also be taken when interpreting the result of this study due to the small sample size, because the result cannot be generalized.

Practical and scientific implication

Core stabilization exercises and trunk balance exercises with flexibility training can be used by physiotherapists along with conventional physiotherapy interventions in the management of patients with NSCLBP.

Conclusion

It can be concluded from this study that both core stabilization exercise with flexibility training and trunk balance exercises with flexibility training were effective in improving pain-related disability, psychological status (depression and anxiety) and fear avoidance belief of patients with NSCLBP. However, when the two interventions were compared, no protocol was found to be superior to the other. It was therefore recommended that core stabilization exercises and trunk balance exercises with flexibility training can be used by physiotherapists in the management of patients with NSCLBP.

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Declarations

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No author has any financial interest or received any financial benefit from this research.

Author contributions

Conceptualization, O.A.F. and A.E.O.; Methodology, A.A.K. and A.E.O.; Software, A.E.O.; Validation, O.A.F., A.E.O. and A.A.K.; Formal Analysis, O.A.F. and A.E.O.; Investigation, A.E.O.; Resources, A.E.O.; Data Curation, A.E.O. and A.A.K.; Writing – Original Draft Preparation, O.A.F.; Writing – Review & Editing, A.A.K.; Visualization, A.E.O.; Supervision, O.A.F. and A.A.K.; Project Administration, A.E.O.; Funding Acquisition, A.E.O.

Conflicts of interest

The authors declare no competing interests.

Data availability

The datasets generated during the current study are available from the corresponding author on reasonable request.

Ethics approval

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the declaration of Helsinki and the protocol was approved by the health research and ethics committee of the College of Medicine, University of Lagos (CMUL/HREC/02/21/812).

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