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EFFECT OF 8-WEEKS WHOLE BODY VIBRATION AND STRETCHING EXERCISE THERAPIES ON LOW BACK PAIN AMONG TRAFFIC COMPLIANCE ENFORCEMENT CORPS IN ABEOKUTA, OGUN STATE, NIGERIA

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Abstract
Exercise is a natural stimulus for the healing process of low back pain (LBP). Controlled and progressive exercise often provides long-term solution to LBP rather than inactivity and bed rest. This study therefore investigated the effects of 8-weeks whole body vibration exercise (WBVE) and stretching exercise (SE) therapies on LBP among traffic compliance enforcement (TRACE) corps in Abeokuta, Ogun state, Nigeria. Randomised pre-test post-test control group experimental research design was adopted with sixty participants selected using multistage sampling procedures. The participants were assigned into experimental group one (WBVE) experimental group two (SE) and control group (physical fitness lecture). Data collected was analysed using frequency, percentage, mean and standard deviation for anthropometric parameters analysis, while Multivariate Analysis of Variance (MANOVA) was used to test the hypotheses formulated. There was significant main effect of WBVE ($F(2,12) = 9.764$, $p = 0.043 < .05$); SE ($F(2,17) = 58.864$, $p = 0.000 < .05$); and three-way interaction effects of treatments, age and gender ($F(2,43) = 2.395$, $p < .05$, $\eta^2 = .100$ [effect size, 10%]) on LBP. It was concluded that WBVE and SE could effectively reduce low back pain thereby improving health and job performance. The study recommended among others that combination of WBVE and SE be integrated into the routine programs for the TRACE personnel in order to curtail the issue of LBP.
Keywords: Whole-body vibration, Stretching, Exercise, Therapies, Low back pain.

Introduction

Low back pain (LBP) is a prevalent condition affecting the lower spine, encompassing various structures such as the lumbar vertebrae, discs, ligaments, muscles, nerves, and blood vessels. Its symptoms range from mild discomfort to severe debilitation and can manifest in diverse ways, including dull or achy pain, stinging or burning sensations, muscle spasms, and tightness (Knezevic, et. al, 2021). Studies have shown LBP ranks amongst the most frequently occurring musculoskeletal disorders among different occupational groups, including office workers, hospital staff, nurses, bricklayers, farmers, and law enforcement personnel (The Global Burden of Disease, 2021). Epidemiological research indicates a strong association between occupations involving prolonged standing and the incidence of LBP, with the perceived level of LBP increasing as the length of standing time increases (Shokouhyan, et al., 2022).

In the United States, LBP ranks second amongst the frequent health complaint, trailing only headaches, according to Goodman et al. (2013). Murray (2022) has indicated that each year,

between 2% and 5% of the population in industrialized countries suffer from LBP. Additionally, the National Safety Council has identified lower back pain as the most recurrent work-related ailment, accounting for 22% of the 1.7 million reported cases. Statistics from the United States reveal an annual incidence rate of 15% to 20% for LBP. Suzuki et al. (2020) also note that approximately 85% of LBP cases lack a discernible pathoanatomical origin, with imaging tests failing to reveal a definitive cause. Sheeran et al. (2012) support this, indicating that the majority of LBP instances cannot be traced to a specific anatomical issue.

Exercise is a personalized and structurally planned physical activities designed to restore musculoskeletal function, reduce pain, and promote recovery from injury or disease through neuro re-education, gait training, and therapeutic interventions (Jalilian et al, 2019). It is highly repetitive and intensive in nature, requiring time and dedication on the part of the client to encourage neuroplasticity. Exercise therapy is an important cornerstone in both the prevention and treatment of LBP through the improvement of fitness, good living and working habits as well as fostering good posture (Oladipo & Ogbuechi, 2006). Exercise programme that is structured and controlled often provides long-term solution for preventing or loosening occurrence of body pain including the reduction of LBP (Chadefaux et al, 2021).

Whole Body Vibration Exercise (WBVE) is a therapeutic technique that transmits low-frequency vibrations to the body through a large contact area, originally developed to increase bone density in individuals with osteoporosis (Chadefaux et al, 2021). WBVE is carried out while standing and holding on vibrating platforms at a predetermined frequency, amplitude and magnitude of oscillations in order to enhance neural aspects such as muscle activation, coordination, and proprioceptive feedback (Manojlovi´c, 2021). The vibrations emitted by the equipment propagate through the body, prompting muscle activation through the vibratory tonic reflex, which is triggered by rapid muscle length changes sensed by various proprioceptive detectors, thereby increasing the frequency of motor-evoked potentials (Fethke et al, 2018). This process boosts muscle spindle function, leading to the engagement of the trunk muscle stretch reflex, which in turn activates and fortifies the lower back muscles (Dong, et al., 2020).

In the past few decades, WBVE has gained attention as a potential alternative therapy designed to bolster muscle strength and activity by tapping into neurogenic potentiation (Fethke et al, 2018). Its impact extends beyond its direct neuromuscular advantages, as it has been increasingly acknowledged for its comprehensive effects on individuals with LBP (Zafar, et al., 2024). Studies have shown that WBVE can significantly lower pain intensity, possibly by altering pain perception pathways and decreasing inflammation markers, providing a drug-free approach to pain relief for LBP patients (Zafar, et al., 2024; Manojlovi´c, 2021). Moreover, WBVE has been associated with reduced disability scores, indicating an enhancement in the day-to-day functional abilities of those affected by LBP (Dong, et al., 2020). Improvements in balance and proprioception are attributed to the stimulation of sensory receptors and the central nervous system's adjustment to vibratory inputs, which are crucial for sustaining postural equilibrium and minimizing fall risks (Meier, et al., 2019).

Additionally, WBVE has demonstrated improvements in functional performance, such as increased range of motion and muscle strength, aiding in the performance of daily tasks and potentially promoting a more active and self-reliant lifestyle (Zafar, et al., 2024). The overall enhancement in quality of life (QoL) is the cumulative result of advancements in pain relief, functional ability, balance, and performance, contributing to general well-being and life satisfaction (Dong, et al., 2020). These comprehensive benefits highlight the potential of WBVE

as an inclusive therapeutic approach for those with LBP, supporting its integration into treatment strategies aimed at meeting the intricate requirements of this patient group (Zafar et al., 2024).
Stretching exercises (SE) are recognised as an effective non-pharmacological intervention for pain relief. The efficacy of stretching lies in its ability to enhance physical fitness by boosting blood circulation within muscles, thereby diminishing muscle spasms and ischemia. This improvement in circulation ensures a more efficient metabolism and elimination of unnecessary bodily substances (Sheeran et al., 2012). Comprehensive body stretching, has been shown to effectively address musculoskeletal conditions like chronic back pain with these exercises designed to elongate muscle chains while concurrently enhancing the isometric strength of opposing muscles, thereby facilitating the active extension of the primary muscles involved (Ferreira et al., 2016; Lawand et al., 2015).
According to Gaurinindi, et al (2021), engaging in slow stretching movements can be instrumental in pain management. Furthermore, stretching promotes increased flexibility in muscles, ligaments, tendons, and joints, optimizing movement during daily activities, reducing muscle stress, and consequently easing workloads. It also contributes to lower levels of anxiety and depression, decreases the risk of injuries, and overall, fosters a healthier body (Gaurinindi, et al., 2021). Stretching can also help alleviate LBP by promoting flexibility, reducing muscle tension, and improving overall mobility (Lawand et al., 2015) Tight muscles can contribute to back discomfort, and stretching helps loosen them, relieving strain and pressure on the lower back (Ferreira et al., 2016). Incorporating stretching exercises into a routine can also enhance muscle strength and endurance, which are essential for supporting the spine and preventing further pain or injury (Sheeran et al., 2012).
Low back pain (LBP) is a prevalent issue, particularly among occupations involving prolonged standing, like that of the traffic compliance officers. However, despite the widely reported effect of WBVE and SE routines on LBP, this research endeavour has received little attention from Nigerian authors. Extensive search of previous studies by the researchers revealed that no prior existing studies on the subject matter was conducted by any authors in Nigeria. In order to address this gap in study and provide a non-pharmacological solution to LBP among traffic enforcement workers, this paper explored the effect of WBVE and SE therapies on LBP among Traffic Compliance and Enforcement Agency (TRACE) Officers in Abeokuta township, Nigeria.

Research Hypotheses

1. There would be no significant main effect of whole-body vibration exercise on LBP among TRACE Officers in Abeokuta township.
2. There would be no significant main effect of stretching exercise on LBP among TRACE Officers in Abeokuta township.
3. There would be no significant three-way interaction effect of treatments (whole body vibration and stretching exercise), age and gender and on LBP among TRACE Officers in Abeokuta Township

Methods

Research Design

The research design adopted for the study was static group pretest-posttest experimental research design of 3x2x2 factorial matrix. This design allowed for effective comparison between the pretest and posttest values of the participants' health performance both in experimental and control group. The design's outline is presented as follows:
follows:

Experimental Group 1 (8-weeks whole-body vibration exercise): O_1 X_1 O_2
Experimental Group 2 (8-weeks Stretching Exercise) O_3 X_2 O_4
Control Group: O_5 X_3 O_6

Where:
O_1, O_3 **and** O_5 = Pretest of the experimental and control groups respectively
X_1= Treatment (8-weeks whole-body vibration exercise)
X_2= Treatment (8-weeks stretching exercise)
X_3= Placebo (8-weeks lectures on physical fitness)
O_2, O_4 **and** O_6 =Posttest of the experimental and control groups respectively

Breakdown of the Factorial Matrix (3x2x2)

Independent Variables	**Moderating Variables**
1. Treatment 1 (8-weeks whole-body vibration exercise)	**Age**
2. Treatment 2 (8-weeks stretching exercise)	**Gender**
3. Control (8-weeks lectures on physical fitness)	

Population
The population for this study included all TRACE officers in Abeokuta Township, Ogun State.
Sample and Sampling Procedure
A total of thirty (30) TRACE officers in Abeokuta township was selected as sample for this study using multi stage sampling procedure:
Stage one
Purposive sampling technique was used to select the Obantoko and the Odeda divisions out of the divisions of TRACE in Abeokuta, Ogun State. This was due to the high number of vehicular movements that occur within these two divisions thereby making the personnel here highly susceptible to LBP than those in the other division.
Stage two
Simple random sampling technique of fish bowl without replacement was used to select five (5) out of seven units in each of the Obantoko and Odeda divisions thereby making a total of 10 selected divisions.
Stage three
Convenient sampling technique was used to select sixty (60) TRACE officers at six (6) officers from each of the ten (10) selected divisions in stage 2.
Stage four
Simple random sampling technique of fish bowl without replacement was used to randomly assign the officers into experimental group one, experimental group two and the control group respectively at twenty (20) participants per group.

Research Instruments

1. Whole body vibration machine; the GalileoTM 2000 was used. The machine function in a one directional oscillating pattern which stimulates muscles to contract and relax by natural reflex about 25-30 times per second.
2. Back and leg dynamometer was used for measuring back and leg strength.
3. Stop watch was used in taking accurate measurement of time when necessary.
4. Weighing scale was used to measure the weight of the body.
5. Measuring tape was up to take the stature of the body.

Inclusion Criteria

The following was included in the study;

- All TRACE officers who are under either the Obantoko or Odeda divisions.
- Participants who have are not engaging in any organised whole-body vibration and stretching exercise programme a week before and during the recruitment for this study.

Exclusion Criteria

The following was excluded from the study;

- Any TRACE officer who does not belong to either the Obantoko or Odeda divisions.
- Any participant who is suffering from very severe pains as a result of injury or illness will also be excluded.

Ethical Consideration

Ethical approval was gotten by the researchers from the University of Ibadan Ethical Committee by making copies of the proposal available to them. A letter of introduction was taken to the Head of TRACE officers, Odeda Local Government in order to get their permission to include their personnel in the study. The trace personnel were also approached individually and as a group by the researchers in order to inform them about the aim of the research and make them see reasons to participate in it. The purpose of the study and the possible risks involved in the tests was explained to the participants.

Informed consent forms were given to the participants after explaining the purpose and the benefits of the study to them and only the participants who signed the inform consent form was allowed to participate in the study. Participation was however made voluntary as no participant was forced to participate against their personal wish. The participants were assured that information gathered from them would be treated with uttermost confidentiality while the facilities and equipment for training and measurement would be put in good shape throughout the study to protect the participants from injuries as a result of usage of any of the materials. Anonymity of the respondents was maintained by the use of code number for confidentiality.

Furthermore, in order to contain an accident situation during the training, adequate medical assistance was made available for the participants through provision of well-equipped first aid box at the venue of the training and testing. Also, the TRACE's medical team was carried along in order to help out during the training sessions and in case of emergency during the research work.

Validity and Reliability of Research Instruments

For this study, standardised scientific tests and instruments were used for this study while the researchers also cross-checked the workability of the instruments before use in order to ensure validity. Also, all the instruments used by the researchers for performance testing have been utilised by other researchers to test the various physical fitness components and have been found to be reliable (Wilke, et.al, 2019; Sheikh & Mondal, 2012).

Test Location

The test was carried out at the at TRACE office in Abeokuta South division.

Procedure for Data Collection

Treatment Group 1 (Whole Body Vibration): There were pre-test measurements of the selected dependent variables (low back pain) on the participants in this treatment group using visual analogue, and the pain level recording before being exposed to the 8weeks whole body vibration exercises. After the training programme there were post-test measurements of the dependent variables.

Treatment Group 2 (Stretching Exercise): There were pre-test measurements of the selected dependent variables (low back pain) on the participants in this treatment group using visual analogue, and the pain level recording before being exposed to the 8weeks stretching exercises. After the training programme there were post-test measurements of the dependent variables.

Control Group (Physical Fitness Lesson): There were pre-test measurements of the selected dependent variables (low back pain) on the participants in this treatment group using visual analogue, and the pain level recording before being exposed to the placebo (physical fitness lectures). After the training programme there were post-test measurements of the dependent variables.

Procedure for Data Analysis

Descriptive statistics of mean, percentages, chats and inferential statistics of Multivariate Analysis of Variance (MANOVA) was used to test all hypotheses at 0.05 alpha level of significance.

Results

Table 1: Showing Demographic/Anthropometric Data of the Participants

	Mean	**Std. Deviation**
Age	37.00	3.979
Height	1.66	0.095
Weight	64.53	13.11
Gender	**Frequency (N)**	**Percent (%)**
Male	35	58.3
Female	25	41.7
Age Group	**Frequency (N)**	**Percent (%)**
30 to 35years	26	43.3
36 to 40years	29	48.3
41 years and above	5	8.4

As shown in table 1, the mean and standard deviation of the respondents age was 37.00±3.979, the mean height was 1.66±0.095, while the weight of the participants was 64.53±13.11. This therefore showed that the average age of the study respondents was 37 years, average height was 1.7m while their average weight was 65kg. The table also shows that percentage of male participants was 35 (50.3%), while female was 25 (41.7%). This implies that male has higher percentage of the TRACE personnel in Ogun State. More so, the table revealed that respondents within age range of 30 to 35 years were 26 (43.3%), 29 (48.3%) were between ages 31 to 40 years, while 5 (8.4%) were 41 years and above. This shows that respondents with age range of 36 to 40 years have the highest percentage

Testing of Hypotheses

Hypothesis One: There was no significant main effect of whole-body vibration exercise on LBP among TRACE Officers in Abeokuta township**.**

Table 2: Multivariate Analysis of Variance (MANOVA) of the effect of whole-body vibration exercise on LBP among TRACE Officers in Abeokuta township

Independent	Dependent Variable		Sum of Square	Df	Mean Square	F	P-value
Whole body vibration exercise	Low back pain	Between Group Within Group Total	114.086 70.114 154.200	2 12 14	57.043 5.842	9.764	0.043

From the multivariate test summary table 2, there was statistically significant effect of whole body vibration exercise on LBP ($F(2,12) = 9.764$, $p = 0.043 < .05$). It therefore implies that the hypothesis which stated that there was no significant effect of whole-body vibration exercise on LBP among TRACE in Abeokuta Township Hypothesis is rejected.

Hypothesis 2: There was no significant effect of stretching exercise on LBP among TRACE Officers in Abeokuta township.

Table 3: Multivariate Analysis of Variance (MANOVA) of the effect of stretching exercise on LBP among TRACE Officers in Abeokuta township

Independent	Dependent Variable		Sum of Square	Df	Mean Square	F	P-value
Stretching exercise	Low back pain	Between Group Within Group Total	113.60 17.60 131.20	2 17 19	56.800 1.035	54.864	0.000

From the multivariate test summary table 3, there was statistically significant effect of stretching exercise on LBP ($F(2,17) = 58.864$, $p = 0.000 < .05$). This therefore implies that the hypothesis which stated that there was no significant effect of stretching exercise on LBP among TRACE in Abeokuta Township Hypothesis is rejected.

Hypothesis 3: There would be no significant three-way interaction effect of treatment (whole body vibration and stretching exercise), age and gender and on LBP among TRACE Officers in Abeokuta Township

Table 4: Three-way interaction effect of treatments (whole body vibration and stretching exercise), age and gender and on LBP among TRACE Officers in Abeokuta Township

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta
Corrected model	11.047	1	11.047	63.741	.000	.597
Treatment*Gender*Age	.830	2	.415	2.395	.010	.100
Residual	7.453	43	.173			
Total	56.000	60				
Corrected Total	42.933	59				

From Table 4, it was shown that there was a three ways interaction effect treatments (whole body vibration and stretching exercise), age and gender and on LBP among TRACE Officers in Abeokuta Township ($F(2,43) = 2.395$, $p<.05$, $\eta^2=.100$ [effect size, 10%]). This therefore implies that the interaction of age and gender on whole body vibration as well as stretching exercise had positive influence on the LBP among TRACE corps. Hence. The null hypothesis was rejected.

Table 5: Estimated Marginal Means of the three-way interaction effect of treatments (whole body vibration and stretching exercise therapies), age and gender and on LBP among TRACE Officers in Abeokuta Township

Groups	Mean	Std. Error
Whole-Body Vibration Exercise	.296	.116
Stretching Exercises	.219	.130
Control Group	.713	.122

Table 5 showed the estimated marginal mean scores of three-way interaction treatments (whole body vibration and stretching exercise therapies), age and gender on post-test scores of LBP among TRACE Corps in Abeokuta, Ogun State, Nigeria. The participants in the stretching exercises group had the best post-intervention mean score of LBP of ($\bar{\chi}$ = .219), followed by participants in the whole-body vibration exercise group ($\bar{\chi}$ = .296) and lastly the control group obtained the low mean score of ($\bar{\chi}$ =.713).

Discussion of Findings

Finding from this study revealed a significant effect of whole-body vibration on LBP among TRACE officers in Abeokuta, Ogun State. This finding is consistent with the findings by Wang et al (2020) and Remer et al. (2023) who note that the use of WBVE can facilitate muscle relaxation and reduce pain linked to muscle tightness in the back. This finding also corroborated the finding of Elfering, et al. (2016) which showed that heightened muscle activity and circulation, followed by a spontaneous relaxation response post-contraction, can culminate in overall muscle relaxation and the effect of this relaxation might play a role in the observed decrease in pain levels post-WBV treatment.

This finding is also consistent with the findings of Pozo-Cruz et al. (2011) found that a 12-week program of whole-body vibration exercise is not only feasible but also potentially a novel form of physical therapy for individuals with LBP. This exercise regimen is deemed both suitable and safe for those with chronic LBP. Complementing these findings, Zheng et al. (2019) also reported that lumbar flexion and extension proprioception, as gauged by joint position, showed significant improvement, and there was a notable reduction in pain following a 12-week course of whole-body vibration exercise in NSLBP patients. Similarly, Weissenfells et al. (2018) have indicated that whole-body vibration exercises are an efficacious method for diminishing chronic non-specific LBP and for enhancing trunk strength among sufferers.

Moreover, according to Jung, et al. (2020) and Wang, et al. (2019), a key factor in WBVE's success in diminishing pain is its ability to enhance posture by stimulating the trunk muscles with such postural improvements lessening the mechanical strain and tension on the trunk's passive structures, thereby aiding in pain relief. Moreover, the harmless vibratory stimulus produced may lessen the firing of neurons in the spinothalamic tract and alter the timing of neural signals arriving at the cerebral hemisphere, which can result in a heightened pain threshold and diminished pain perception (Kim, et al., 2018).

Finding from this study also revealed significant effect of stretching exercises therapy on LBP among TRACE officers in Abeokuta. This finding is in line with the findings of Seif, et al. (2015) that the use of gastrocnemius manual stretching to a regimen of hamstring, iliopsoas, and back muscle stretches, coupled with abdominal muscle strengthening exercises, is very effective in alleviating pain and enhancing function in individuals with low back pain. This finding is also in consonance with the findings of Gaurinindi, et al. (2021) suggests that providing stretching exercises to workers suffering from LBP can lead to enhanced muscle relaxation while also helping to soothe and relax muscles that are in spasm. This further corroborated the findings of Bolarinde et al. (2017) on workers with LBP which demonstrated that stretching exercises significantly reduce pain levels in affected individuals.

Conclusion

In conclusion, this study presents compelling evidence that both whole-body vibration and stretching exercises significantly alleviate LBP among traffic compliance enforcement corps in Abeokuta, Ogun State, Nigeria. The statistical analysis revealed a notable main effect of whole-body vibration exercise and an even more pronounced effect of stretching exercises. Moreover, the interaction of treatments with age and gender also showed a significant impact on LBP, with a 10% effect size. These findings advocate for a paradigm shift in the management of LBP within the traffic enforcement corps. Hence, the adoption of whole-body vibration and stretching exercises could serve as effective therapeutic interventions, promoting not only pain relief but also enhancing overall physical health as well as improved job performance, reduced healthcare costs, and a higher quality of life for the affected personnel.

Recommendations

Based on the findings of the study and recent research, here are five research-based recommendations for the management of low back pain (LBP):

1. Given the significant main effect of whole-body vibration exercise on LBP, it is recommended to integrate this modality into the routine physical therapy programs for traffic enforcement corps.
2. Stretching exercises have shown a pronounced effect on alleviating LBP, hence, a regular and structured stretching regimen should be adopted by individuals suffering from LBP, tailored to their specific needs and physical capabilities.
3. This study indicates that age and gender interact with treatment effects on LBP. It is recommended to develop age and gender-specific exercise programs to optimize the therapeutic outcomes for LBP management.
4. Encouraging active lifestyles and educating the TRACE officers on the benefits of movement and exercise can help in the long-term management of LBP. This includes staying active and avoiding prolonged inactivity or bed rest during LBP episodes.
5. Use of Non-Pharmacological Interventions that are consistent with global clinical practice guidelines, such as therapeutic exercise, spinal manipulation, and acupuncture should be considered for managing different stages of LBP, especially chronic conditions.
6. A combination of Whole-Body vibration and stretching exercises could be integrated into the routine health maintenance programs for the corps in order to bring about holistic effect of the exercise therapies.

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