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Article

The synergistic effect of biomechanics and psychological feedback in physical education teaching: Enhancing motor skills and psychological resilience

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Abstract: The combination of biomechanics and psychological feedback presents a unique approach to improving physical education outcomes. Biomechanics offers a detailed understanding of movement, allowing for the optimization of motor skills based on scientific principles. Meanwhile, psychological feedback helps students adapt mentally, fostering resilience and improving performance under pressure. This research explores how the dual application of biomechanical analysis and psychological feedback can enhance both physical and mental capacities in students during physical education. Through motion capture technology and real-time data analysis, motor skill performance is broken down into key components such as force, speed, and coordination. Students receive targeted feedback, allowing them to refine their techniques efficiently. Concurrently, psychological feedback mechanisms, such as self-reflection and stress management strategies, are introduced to help students build mental resilience and maintain focus. Results are a significant improvement in both motor skills and psychological well-being. Students displayed greater accuracy and efficiency in performing complex physical tasks and reported reduced anxiety and stress during physical education activities. The synergy between biomechanics and psychological feedback not only improved motor performance but also enhanced students' overall experience, making physical education more engaging and effective.

Keywords: biomechanics; psychological feedback; motor skills; resilience; physical education; performance optimization; stress management

1. Introduction

The last two decades have seen a tremendous advancement in research in motor learning based on scientific skills. To gain the attention of students and their lack of interest in learning motor activity, PE educators have recently employed innovative technologies, including biomechanics and psychological feedback, in as much as they present a unique approach to improving physical education outcomes [1]. However, research on the dual application of biomechanical analysis and physiological feedback in enhancing both physical and mental capacities in students during physical education remains a narrowly developed area. Biomechanics in physical education incorporates the detailed analysis of the sporting movements geared towards improving the levels of performance while reducing risks of injury. Sports and workout biomechanics cover the scientific area dealing with the analysis of the mechanics and motor actions of the body. It includes the explanation, detailed analysis, and valuation of the body movement during physical exercise. Mechanics is the physical branch of science describing movement and motion and how the forces creating that movement or motion are ascribed to the physical activity. Conventionally, biomechanics was considered as a broad perspective of the interplay between kinetics and kinematics. Whilst kinematics responds to geometrical questions of motion of objects, including velocity, acceleration, and displacement, without accounting for forces of influence, kinematics responds to questions dealing with relationships between the systems of force acting on the body, including the changes produced in the course of movement [2]. Thus, the performance of body movement can be enhanced in different ways since effective movement considers the skills in muscular activation, physiological abilities and psychological or mental capabilities, which are an area of interest in research. According to Cheng [3], biomechanics has become an essential scientific component in explaining movement techniques. It is utilized in sports where technique is the dominant factor as opposed to the physical structure or physiological capacities. Yet, this physiological feedback helps students adapt mentally, fostering resilience while improving performance under pressure. Newton's laws of motion are fundamental principles of biomechanics that have been applied to explain how forces create motor activity. According to the law of Inertia, objects resist the alterations in the motion states. This implies that an object not in motion retains the resting stage, while that under motion will stay under the same condition unless an external force acts upon it. In reference to sporting activities, a skater sailing on ice will exhibit the same motion in the same direction unless an external force changes its state. On its part, the law of acceleration shows that the tendency of an object to alter its direction and speed will be subject to the magnitude of the force and not directly proportional to its mass ($F = ma$). By application, whenever a ball is projected, struck, or kicked with a tool, it will travel linearly with the direction of the line of action of the applied force [4]. Whenever the force applied is great, the movement speed will be equal to that force. A player improving the strength of the leg through training while retaining mass should exhibit an increased acceleration ability of the body, and this results in improved agility and speed.

Consequently, the law of reaction posits that for every action, there is an equal and inverse force of reaction. This implies that forces can only occur under equal and opposite pairs between the bodies of interaction. The best example is when the legs of an athlete create a force through friction with the surface, resulting in a ground reaction force in which there is an equal force of the ground that allows for the change in the state of motion. The reasoning here is given by Hallett et al. [5], who show that the earth can have more mass than the player even though the player can change the state of motion against a stagnant surface that has more mass but is not in motion. The principles of biomechanics have thus been used to understand motor skills development, even though much research has concentrated on either biomechanics alone or psychological feedback alone without considering the combination of biomechanics and psychological feedback. Psychological feedback mechanisms such as self-reflection and stress-management strategies have been studied in terms of how they help students build mental resilience while maintaining focus. From the biomechanical perspective, the rightful execution of a movement is a consequence of the rightful synchronization between rhythm, timing, and stimulation of all components characterizing it in response to a specific stimulus [5]. The models of motor control emerging from different research sources are either closed or open-circuit motor control models. The closed-loop motor control relies on the cognitive information known as feedback anchored upon motion. Feedback tends to function in terms of modifying, correcting, and updating the posture of the body in real-time. The psychological information is comparable to the initial objective of the movement and is useful in detecting and correcting errors. On its part, the closed-loop circuit control model allows for the implementation of different strategies related to contributing to the flexibility of the system, even though it falls short of its contribution if the movements are not carried out in sufficiently lengthy times. The current research is informed by studies that show that the interplay between closed and open-circuit motor control informs the cognitive theory of motor instruction. In general terms, the motor program is the program defining the pattern of movement, in which the flexibility of the movement pattern allows the program to be adapted so as to produce variations in the motor design that are acclimatized to the modified demands of the environment. This means that learning is a relatively long-term yet unchanging modification of behavior that follows a series of repeated patterns over successive periods [6]. The application of biomechanics and psychological feedback in enhancing the physical and mental capacities of students in physical education follows the same pattern since the meaning of motor learning is comprised of the assimilation and internalization of movements or constituents of them, previously not preserved and which must be internalized.

2. Literature review

2.1. Effect of neuro-feedback training and scientific protocols in sporting events

Neurofeedback training (NTF) has emerged as one of the most important tools that guide professionalism in cognitive development. The mental and cognitive components of motor activity have been of significant interest in the field of psychology and sports science. Some sporting activities demand both physical skill and high levels of mindfulness, cognitive ability, and emotional control when participating in archery and shooting. According to Gu et al. [6], mental attributes have a direct influence on the ability of a physical student to perform under pressure while maintaining concentration over lengthy periods since aspects like stress and anxiety are attached to sporting events, especially those which competitive environments engender. Conventional models of training overlooked the substantial mental and psychological impacts presented during the training sessions. The neuroscientific advancements and sporting psychology tend to underscore the importance of neurofeedback training as an element that enhances psychology and cognition. According to Nyland et al. [7], neurofeedback is a form of biofeedback that has been tested as a promising approach that improves the cognitive skills needed for quality results in precision sports. The same sentiments are supported by research carried out by Gruzelier et al. [8] and Xiang et al. [9], which show that modulation of specific electroencephalogram (EEG) frequency bands implies that NTF is a tool that enhances mental processes, including stress management, attentional focus, and emotional regulation. Beyond the application of EEG, the NTF framework presents essential components such as heart rate variability (HRV) and conditioning of the respiratory system, which are key physiological aspects impacting the success of physical education. Dessy et al. [10] acknowledge that incorporating HRV and respiratory training has the potential to improve the levels of performance of an athlete, and this underscores the essentiality of the compressive approach to psychological feedback encompassing the physiological feedback mechanisms. This implies that according to Mirifar et al. [11] and McClean et al. [12], in as much as EEG-based feedback positively impacts cognitive enhancement, the broader perspective of NTF, taking into consideration HRV and breathing control, is indispensable in sports science.

2.2. Exercise biomechanics in physical education

Biomechanics is a field of science dealing with the analysis of mechanical laws and ideologies governing human motor coordination and the functionality of biological systems. Within the context of physical education, workout and physical fitness, biomechanics has been shown to be a critical tool for understanding the most effective and efficient avenues for improving health and well-being. Zoefel et al. [13] studied the optimal patterns of movement. They provided an understanding of the proper patterns of movement and techniques with the objective of reducing injury risks while improving the efficiency of the efficiency of physical activities. According to Behnke et al. [14], physical biomechanics deals with levels of strength, postural alignment, and stability. Physical exercise tends to be an activity that improves the stability and strength of an individual, even though trainers are required to aid their trainees in understanding the right posture and misalignments while controlling stability and strength levels. Postural imbalances often lead to stress on joints and muscles, which in turn contributes to pain, discomfort, and functional decline. Ensuring the sound application of the NTF protocols by drawing from the current scientific principles calls for the continual incorporation of the NTF operators. For instance, Enriquez-Geppest et al. [15] acknowledge that NTF targeting specific frequency bands for EEG, including the upper alpha band, can significantly improve the levels of psychological performance. The research acknowledges the importance of leveraging evidence-based approaches by reducing the rates of training sessions while concentrating on the provision of psychological feedback. In follow-up research, Glazier et al. [16] studied the importance of double-masked placebo-controlled psychological feedback by documenting rigorous scientific evidence that validated psychological feedback interventions. Moreover, Alves et al. [17] documented the need for current evidence-based practice in psychological feedback, especially among students reported with ADHD symptoms.

2.3. Biofeedback system for optimization of motor skills

Biofeedback is the application of instrumentation for making altering physiological processes that are more covert to the overtones and incorporates the electronic options that shape helpful responses. Several studies have shown the potential of using biofeedback in physical training as a cue that reduces the possibility of anterior cruciate ligament (ACL) injury. For instance, Lang et al. [18] provided a technical report for the application of a real-time visual biofeedback system for the optimization of motor learning and correction of movement deficit. The results of the study are vital to the current study because they portray that participants developed an effective interaction with real-time biofeedback in which biomechanical improvements were realized in the squatting tasks. Supportive evidence has also shown that there is a technical feasibility when integrating real-time kinetic and kinematic data into a single, communicative display. Specifically, real-time biofeedback is supported by the evidence that it can be incorporated into the system of physical education independent of the involvement of an expert. Biofeedback is also interactive and personalized, which implies that it can enhance compliance and motivation [19]. The application of real-time biofeedback has also been successful in modifying the risk factors for injury during physical activities, making it a potential tool for effective performance among learners. However, it is relegated to a single risk factor or a single component of training, calling for more reliable approaches when responding to multi-component training programs [20]. Additive benefits for biofeedback can be realized when multiple variables are incorporated, with each contributing to complementary effects in the physical education program. The most important aspect that has been discovered is that the neurofeedback intervention, known as alpha-band training, can improve the emotional state of the trainee by enhancing the stress and anxiety functions, including memory. In 2021, Fournié et al. [21] showed that alpha-band exercise within the right hemisphere of the sensory mantle could variably improve the heart rate of athletes receiving NTF for more than three consecutive weeks as compared to the control groups. Whenever arousal and state anxiety become predominant in sports, they tend to contribute to negative performance, to which additional generation of incoordination resulting from increased muscle tension contributes to more distractors and negative thoughts.

3. Methods and materials

The methodology section uses motion capture technology and real-time data analysis in which motor skill performance is broken down into key components like force, speed, and coordination. Students are selected for targeted feedback, which allows them to refine their techniques efficiently. Concurrently, the researcher introduced feedback mechanisms like self-reflection and stress management strategies to help the students build their mental resilience and maintain focus. The training intervention for muscle coordination was designed using MATLAB to understand the compensatory force activations essential for the generation of normal motor kinetics with minimal gastrocnemius activation (See **Figure 1**).

Motor kinetics were simulated with two dissimilar static optimization objective functions: a gastrocnemius avoidance objective penalizing gastrocnemius activation and a surrogate for metabolic energy. The simulations portray that lack of activation of the gastrocnemius while walking needs more generation of force from the soleus, hip flexors, and hamstrings (See **Figure 2**). **Figure 1** illustrates the compensatory force activations required for maintaining motor kinetics with minimal gastrocnemius activation. The gastrocnemius muscle is crucial for generating ankle plantarflexion force, but as **Figure 2** shows, increased activation of the soleus compensates for the reduced gastrocnemius force, ensuring stability during walking. Additionally, the hamstring muscle supplements knee flexion, highlighting the role of coordinated muscle activation in maintaining optimal movement patterns. These adaptations underscore the effectiveness of biomechanical feedback in enhancing motor performance while reducing injury risks [21].

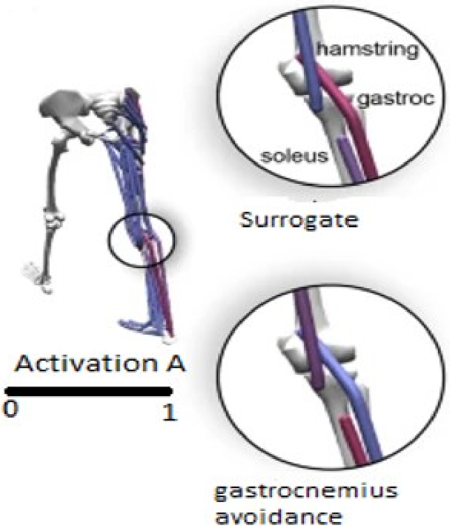

Figure 1. Gastric and surrogate objectives.

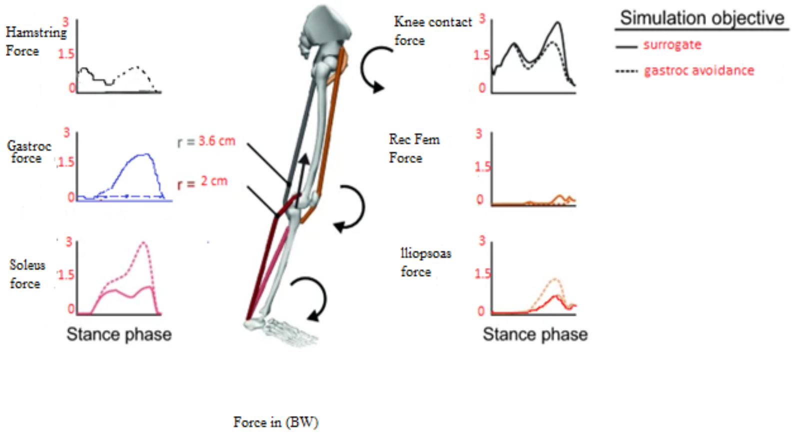

Figure 2. Force generation from soleus, hamstring, and gastrocnemius.

Increasing the soleus force compensates for the moment of ankle plantarflexion that the gastrocnemius generates. Equally, increasing the force on the hamstring tends to supplement the flexion of the knee moment that the gastrocnemius generates, even though the knee flexion moment at the hamstring is nearly 1.5 times greater than the gastrocnemius activation. This has the effect of the generation of an equal force of moment with reduced force [22]. The hamstring generates an opposite hip extension moment that comes with more iliopsoas force. There are large alterations in the force within the ankle plantar flexors, which is associated with normal kinematics in the walking face on the treadmill, which necessitated the focus in biofeedback intercession on the relative stimulation of the soleus and gastrocnemius soleus. Since the participants were supposed to train on how to reduce the gastro activation force without necessarily reducing the moment at the plantarflexion ankle, the researcher designed the biofeedback in such a way that it could instruct them to reduce the level of gastric activation while increasing the soleus activation.

Muscle coordination under visual feedback

The next intervention involved training students to alter the comparative activation of their soleus and gastrocnemius muscles while walking on the treadmill under visual feedback. In the experiment, 10 participants performed eight 5-minute walking trials on the treadmill, as shown in **Figure 3**:

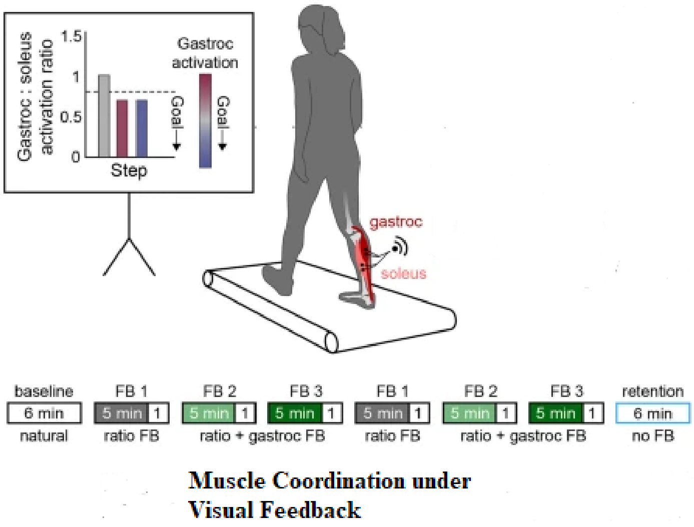

Figure 3. Muscle coordination under visual feedback.

The participants were instructed to reduce the ratio between the gastrocnemius and solutes muscle activation during the feedback trials (eq3). In this case, are the mean EMG direct packets over the stance face for the activation of gastrocnemius and the soleus, respectively? The participants equally received feedback to reduce the activation of the gastrocnemius muscle during the final dual feedback trials and to compensate for the reduction by increasing the soleus muscle activation [23]. The retention trial required that participants should retain their learned coordination pattern without any form of feedback to test their level of engagement with the training program. The participants reduced their ratio of activation by a mean of 20 ($P < 0.001$, t-test, n equals 10) after they had received visual biofeedback for muscle activation ratio within the first trial. However, this did not translate to the reduction in the activation of the gastrocnemius muscle ($P = 0.679$), t-test, n equals 10), as shown in **Figure 4**. The essence of additional gastrocnemius feedback during the subsequent feedback trials after the first trial was to help participants acquire skills in reducing their ratio of activation by reducing activation on the gastrocnemius muscle. After the third feedback trial, the gastrocnemius activation was reduced by an average of 17 ($p = 0.034$, t-test, $n = 10$) relative to baseline. In the final stages, the researcher determined whether the participants could replicate the new pattern of coordination without visual feedback. At the end of the retention test, the researcher reported a 25 ($p = 0.039$, t-test, $n = 10$) retained pattern of coordination following six minutes of walking without visual aid. In as much as there were changes in the activation ratio, the ankle kinematics and kinetics were reserved for the baseline, as shown in **Figure 5**. The mean ankle moment was altered by a mere 3% during the retention trial as compared to the baseline, which approached an equivalence of statistics within a single baseline standard deviation (*p* = 0.061, two-one-sided t-tests for equivalence, n equals 10).

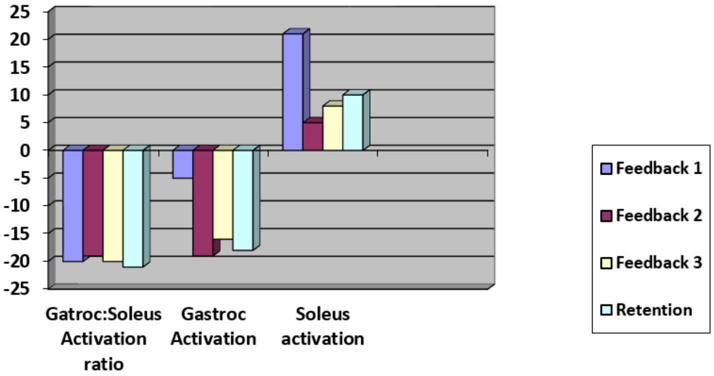

Figure 4. The changes in muscular activity and ankle system after coordination training.

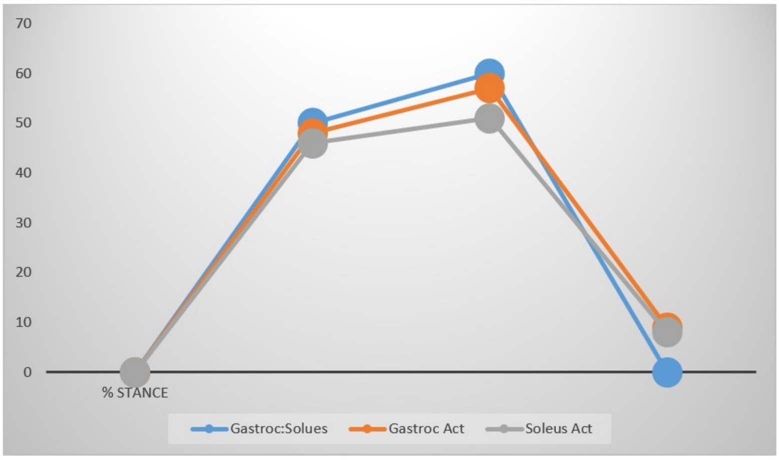

Figure 5. Plantar flexor muscle activity.

The graph depicts the percentage changes from the baseline of the muscle activities for the gastro: soleus activation ratio, gastric activation, and soleus activation following coordination retraining. The graph shows that there was a reduction in the gastrocnemius: soleus ratio of activation and mean gastric activation during training [24]. The participants retained the reduction after the retention test ($*p < 0.05$, paired t, test, *p*-values reported following the control of the rate of false detection). **Figure 5** provides the mean and standard deviations of the ankle plantar flexor muscle system and the mechanics of the same ankle at reference line and retention trials. **Figures 4** and **5** provide insights into muscle activation ratios and changes after coordination training. The reduction in the gastrocnemius-to-soleus activation ratio indicates an improved coordination pattern, which is critical for reducing muscle strain during physical tasks. The participants were able to retain this new coordination pattern even after the feedback was removed, as demonstrated in the retention trials. This demonstrates the lasting impact of biomechanical feedback, as the improvements in muscle coordination were sustained without external cues.

All the data were prepared and processed using the Dicam II 2.2.3. SPSS Version 20 was applied in all statistical analyses. The variations in the static parameters and anthropometric data between females and males taking part in the study were evaluated using the Mann-Whitney U test (significance level $\dot{\alpha} < 0.05$). The Kruskal-Wallis test was then performed to reveal the parameters that had been found in the activities of each walking speed for significance variations. At the same time, the level of significance was rectified based on the Bonferroni correction model $p < 0.007$ significant levels at different walking speeds. The researcher determined the correlational variations using medians and means for each range of frequency for each EEG and EMG area at different walking speeds on the treadmill. The spectrograms for EEG and EMG were then obtained concurrently for each speed and each source [25]. The variations in the significance of indices of the anaerobic and aerobic capacities were then determined during each test. They were then evaluated by means of each participant's t-test for dependent samples. Non-parametric tests were applied in the statistical data analysis, and descriptive statistics were used to confirm the hypotheses.

4. Results and discussion

4.1. Comparing static measurements

The lordotic Angle, lateral deviations, and trunk inclination in **Table 1** show that there is a sex difference in the participants, with females having higher values of rotation along the surface and lateral deviations. This may mean that female participants undergo different biomechanical stress distributions and, therefore, different physical education results. These differences show the need to provide feedback for each child to enhance their motor skills in a classroom setting. For example, increased lateral displacement in the female group may cause a higher imbalance risk, which biomechanics-based strategies could address. The same applies to the differences in trunk inclination, which point to divergent postural changes that may influence coordination and force production during movement [26].

The table below shows presents the results for the comparison of static measurements:

Table 1. Comparison of static measures.

		Females		Males		Total	
	Km/h						
		Mean	SD	Mean	SD	Mean	SD
Lordotic Angle (degrees)	Static	37	9.1	28	7.5	32.5	9.4
	2	32	8.1	24	7.3	28	8.4
	4	30	7.2	23	7.2	25.5	8.3
	6	29	7.1	22.5	7.1	25.3	8.1
	8	28	7.0	22.3	6.9	25.3	8.0

Table 1. (*Continued*).

		Females		**Males**		**Total**	
	Km/h						
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Trunk inclination(degrees)	Static	2.24	2.25	1.89	1.89	2.13	2.14
	2	5.34	2.12	5.79	1.87	5.45	2.04
	4	6.24	2.15	6.89	1.89	6.45	2.02
	6	6.74	2.45	6.99	1.89	6.82	2.24
	8	7.24	2.65	7.89	1.93	7.65	2.35
		Females		Males		Total	
	Km/h						
		Mean	SD	Mean	SD	Mean	SD
Lateral Deviation (mm)	Static	5.59	2.41	5.07	2.12	5.25	2.24
	2	4.68	2.12	4.54	1.82	4.59	2.44
	4	4.72	2.15	4.61	1.84	4.66	2.02
	6	5.25	2.35	4.71	1.82	4.89	2.24
	8	5.54	2.55	5.34	1.92	5.48	2.25

The results in **Table 1** above portray intersexual variations ($p < 0.001$) for lordotic Angle, with greater values being portrayed among women in the sense that they had greater values of rotation along the surface and lateral deviations. The evaluations also featured the trunk length between different walking velocities when the speed is increased. There was a noted increase in the lateral deviations at increasing walking speeds, which was statistically reduced among the selected male and female participants [26]. To evaluate the variations in the parameters occurring between being localized in a neutral position and while moving on a treadmill, there was the need to compare the static against dynamic measurements. For the static conditions, there was an increase in the mean average length of the lateral Deviation with an increase in the walking speed. This confirms the first hypothesis that through motion capture technology and real-time data analysis, skill performance influences key components like force, speed, and coordination.

4.2. Results for anthropometric indices, composition of the body, and physical capacity

Table 2 below presents the results of the neurofeedback-EEG training effect on the range of cognitive work concert and personal physiological parameters among participants. In **Table 2**, the neurofeedback (nfb) training data reveals the enhancement of the correction ratio and the stability of emotion ($P < 0.05$). These improvements are associated with better cognitive control and better physiological adjustment during tasks, which include fewer errors and increased attentiveness during exercises. The neurofeedback training improved the ability to regulate emotions, which is expressed in the convexity and oscillation indices that are essential for maintaining performance during physical education. These studies demonstrate that biomechanics and psychological feedback work hand in hand to improve human performance in physical and psychological domains. The enhanced cognitive work concert and the increased persistence, which is statistically significant at $P < 0.05$, also support the notion that students' stress coping during complex tasks is enhanced through neurofeedback intervention [26].

Table 2. Results for the anthropometric indices.

Indices	Rank Sum Before nub	Rank Sum After nub	*U*	*Z*	*P*
Total Number	270	382	105	−1.74	0.075
First three minutes	269	389	99	−1.96	0.051
Period 1	262	362	113	−1.34	0.178
% increament	269	389	99	1.96	0.052*
II/I ratio	262	401	94	2.15	0.032*
Peak Location	357	271	100	1.7	0.088
Convexity 1	384	242	146	0.5	0.043*
Convexity II	371	233.5	123	1.24	0.056*
Oscillation I	349	255	143	0.56	0.058*
Mistake ratio	295	235	80	1.75	0.082
Correction Ratio	262.9	401.9	93	−2.2	0.029*
Initial Decline	350	314	144	0.53	0.058
Duration of Decline	397	269	96	2.1	0.042*

The comparison is drawn from the Wilcoxon signed-rank test.

*Coefficient significance $P < 0.05$

The composition of the body assessed before starting the neurofeedback-EEG training sessions and following the conclusion of the experiment did not depict any statistical variations. The mean rate of maximal uptake of oxygen among athletes was above 56 mL/kg/min, while the variations between subsequent measurements did not portray any statistical significance (0.6 mL/kg/min. The parameters of power determined by the Wingate test used for the evaluation of the anaerobic capacity did not reveal any statistical variations between the subsequent measurements. The table above shows that there were significant changes in the mean indices describing the incomplete measures of the work curve at $P < 0.05$ after neurofeedback training, which confirms the second and third hypotheses (H2 and H3).

The results have shown that through motion capture technology and real-time data analysis, motor skills performance and physiological feedback can enhance physical and mental capacities in students during physical education [27]. The results in **Table 2** suggest that among the three psychological work measures, there were tendencies observed for improvement in performance rates. Moreover, there was a significant change ($p < 0.05$) in cases where more than a single parameter was determined based on the test results for persistence and energy. The alterations in the partial measures portray that the work curve increased, which was a product of fatigue because of high-performance rates within the first hours of the test. Both the measures of persistence and motor action without self-restraint (Convexity I&II) diminished significantly (*P* < 0.05). The oscillation index around the performance curve was equally reduced, which portrayed that there are variability levels in consistency and reduction in the emotional distress levels during the tests [28]. The correction ratio is seen to be increasingly determined as the percentage of the sum of the additional performance operations. This can be interpreted as an improvement in the levels of diligence and accuracy during performance. Moreover, there was a reduction in the mistake percentages with a consequent increase in the percentage of corrections following the observations, which can be explained in terms of adaptation and gaining of experience to the performance of the tasks in the physical exercise (*P* < 0.05).

5. Conclusion

The results are consistent with the literature analysis, which shows that biomechanics and physiological feedback help in the identification of optimal techniques for enhancing motor skill performance. They work together in the analysis of the body loading system to determine the safest method for performing a particular motor task while assessing muscle recruitment and loading. Study show that biomechanics alone can help in the analysis of the exercise equipment, such as surfaces, rackets, and shoes of athletes. When examining the role of biomechanics in motor activity, Ward [28] suggested that it is essential to understand the biomechanical terms and principles. For instance, a force is a simple push and pull. It becomes necessary to understand that force changes the motion of the body segment and is created or modified courtesy of the forces and actions. A torque is generated when a force results in the rotation of the body segment or a racket, which is essentially the moment of force. For instance, in the service action, the internal rotation torque at the joints within the shoulder leads to the internal rotation of the upper arm as a product of the muscle actions, including the latissimus dorsi, the pectoralis major, and the deltoid. More muscle force would result in the rotation of the segment of the arm with more power. The findings of this study show that biomechanics and psychological feedback should be incorporated when teaching physical education. Real-time data analysis, motion capture technology, and neurofeedback (nfb) training also showed that it is possible to enhance motor skills and psychological well-being. Based on the present study, it can be concluded that the given feedback not only improves motor performance by increasing muscle co-contraction but also has positive effects on students' psychological state by decreasing anxiety and stress levels. These results highlight the significance of an integrated approach to physical education, where biomechanics and psychological feedback are intertwined to promote the child's motor and mental development. The motor performance, emotional regulation, and cognitive work improvements that were seen in the study show the possibility of using this dual approach in enhancing physical education outcomes. Future research should be devoted to the extension of these interventions for the improvement of performance and well-being in various groups of people.

Ethical approval: Not applicable.

Conflict of interest: The author declares no conflict of interest.

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