SIN-CHN
SCIENTIFIC PRESS PTE.LTD.

Molecular & Cellular Biomechanics 2025, 22(4), 926.
https://doi.org/10.62617/mcb926

Article

Research on the application of biomechanical analysis in optimizing movement techniques in physical education teaching

Changqing Liu, Yunfu Wang*

School of Physical Education, Hainan Tropical Ocean University, Sanya 572000, China
*** Corresponding author:** Yunfu Wang, wyf5717703@163.com

CITATION

Liu C, Wang Y. Research on the application of biomechanical analysis in optimizing movement techniques in physical education teaching. Molecular & Cellular Biomechanics. 2025; 22(4): 926. https://doi.org/10.62617/mcb926

ARTICLE INFO

Received: 27 November 2024
Accepted: 7 February 2025
Available online: 11 March 2025

Abstract: Biomechanical analysis has gained prominence in optimizing movement physical education (PE) teaching. Understanding the mechanics of human movement techniques within can lead to enhanced performance, skill acquisition, and injury prevention among students. The potential benefits of biomechanical analysis and its integration into PE programs remain limited, and educators often lack the tools and knowledge to apply these insights effectively in their teaching practices. The study aims to investigate the application of biomechanical analysis to optimize movement techniques in PE, focusing on its impact on student performance and engagement. A mixed methods approach was employed, with qualitative surveys and interviews. Participants were divided into two groups. Group A (the experimental group, EG) engaged in strength and conditioning activities enhanced by biomechanical analysis interventions, including motion capture and force plate assessment, over a six-week period. Group B (the control group, CG) receives standard PE instruction without biomechanical feedback. The findings revealed significant improvement in movement techniques within Group A, with increased efficiency and reduced injury risk compared to Group B. Group A demonstrated enhanced performance in strength and conditioning activities. This study highlights the significance of integrating advanced biomechanical strategy into PE programs to promote effective teaching and learning practices.

Keywords: biomechanical; teaching; movement; physical education (PE); student

1. Introduction

Biomechanical analysis as a technique in motion efficiency has recently conducted an important resource in physical education (PE). It helps educators to understand how distinct postures could either increase or cause other pathological effects. This is an interventional approach that applies principles of physics and biomechanics to efficient movement to reduce risks of injuries and improve overall efficiency of PE activities. It has important implications for the teaching aspect of physical activities as well as performance of the learners [1].

The PE is a unit of the school curriculum, which focuses on physical fitness, body control and general health of students. It is important to mention the success and efficiency of those educational programs directly combined with the correct performance of movements. Biomechanical analysis offers the scientific approach for studying and implementing these movements, guaranteeing that students perform exercises that are most beneficial in terms of the outcome and safe for musculoskeletal injuries [2].

Biomechanics has implications for sport and sport-related rehabilitation. In PE, it provides an understanding of how running, jumping, and throwing impact the body.

This is helpful for the PE teachers to get more effective ways of teaching the students to perform the required movements in a more accurate and less inaccurate way [3].

In the past few years, there has been much focus given towards Technology Integration (TI) within education. Motion capture systems, force plates and video analysis software enable assessment of movements to the students. These technologies allow educators not only to consider the biomechanical aspects of learners' performance but also specify their difference to adapt programmes of physical and sports training for students with different learning requirements and possibilities, as shown in **Figure 1** [4].

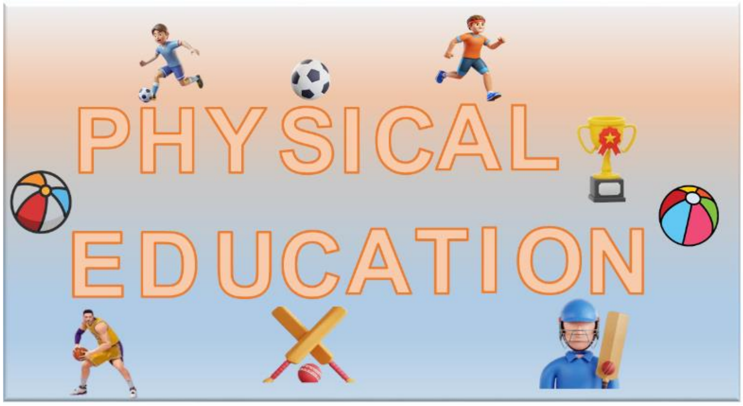

Figure 1. Various sports in physical education.

In addition, biomechanical analysis exposes unchanged movement patterns that could cause chronic injuries. For instance, in some sports, improper posture or an obvious method of executing a physical activity can lead to joint stress or muscle over work. Physical damage to a child can be prevented by recognizing these issues in teaching. Teachers can prevent such activities and allow children to exercise safely and without pain in the long run with biomechanics [5].

A more important use of biomechanical analysis in PE is to improve motor skills. Precise measurement of force, time and body position make it possible to construct techniques to the finest detail, which continues to be a big advantage towards perfecting a human movement. When students are mastering the movements necessary for certain tasks, they not only complete physical tasks better, but they are empowered with body awareness that helps them to exercise more and these yields increased achievement motivation among students [6].

The introduction of biomechanical analysis in teaching PE is a revolutionary factor in improving movements and student performance. This aspect makes this method safe and efficient in making the students acquire the best movement that will facilitate the best PE. Given the consistent development of technology, biomechanical analysis as a tool for determining future directions of PE has numerous advantages for teachers and learners [7].

The aim of this study was to analyse biomechanical usage in the teaching of PE. It investigates the application of biomechanical analysis to optimize movement techniques in PE, focusing on its impact on student performance and engagement. A mixed methods approach was employed, with qualitative surveys and interviews. The analysis was performed in two categories, EG (Group A) and CG (Group B), for the efficacy of PE using biomechanical analysis.

The remaining works are as follows: Part 2 contains related works, Part 3 includes methodological framework, and Part 4 includes results and discussions. Part 5 contains the conclusion of the study.

2. Related works

261 footballers over the age of 18 participated in surveys in the Basra, Iraq Region, in southern Iraq as a component of Alsaeed et al.'s study [8] to find barriers to using biomechanical and statistical tools and soccer conditioning regimens. The findings indicated a deficiency in sports sciences, and suggestions included developing courses, studying kinetic analysis and biomechanics, and setting up facilities for various age groups.

According to Clapham et al.'s research [9], using movement to teach students about technical aspects of activity could improve their understanding of science, technology, engineering and mathematics (STEM) disciplines, and particular physical activities that emphasize biomechanical principles could be a useful teaching aid.

The effects of a 6-week teaching-training treatment were examined by Boujdi et al. [10]. It incorporated dynamic and weight training on the aerobic abilities, biomechanical outcomes, power-velocity pattern orientation, and sprinting efficiency of male athletes with deficiency force. The findings suggested that teens with deficiency force at moderate velocity would benefit from the training. The optimum theoretically vertical force, peak horizontal power, force-velocity slope, and strength-velocity sprinting mechanical results were all improved by the intervention.

Human biomechanics was affected by kinetic processes, but interconnections were typically ignored in Di Domenico's research [11]. The dynamic basis of mobility laws was influenced by personal decisions and reactions to stress. Biomechanical motions data acquisitions could be used to assess and address motion issues, but their effective application requires additional education and interventions. The incorporation of biomechanical acquisitions requires additional steps.

It aimed to enhance the theoretical knowledge and practical skills of graduates in sport and PE in handling statistics. Research, evaluation, literary organization, experiential generalizing, and educational experimentation were some of the methods it uses. Bukhovets et al.'s study [12] emphasized the importance of mathematical statistics in medical and sport-pedagogical contexts by demonstrating its adaptability and advantages in both education and sports. The report also proposed a practical developing abilities education for evaluating the empirical distribution's normality.

Developing and assessing the efficacy of individualised physical training for educators concentrating on biomechanical feedback was examined by ZhaoriGetu and Li [13]. It was always challenging to maintain proper posture, but it was essential for any activity to prevent injuries and get the best outcomes. A sophisticated analysis with biomechanics has been introduced for motion tracking and to provide students in this project with real-time biomechanical feedback.

The purpose of the Abdelkader et al.'s article [14] was to evaluate how biomechanical analysis technologies affected student evaluations during long jump competitions at school. 32 first-year students participated; they were split into two categories: one group that used kinetic data and the other that observed. Descriptive statistical analysis, ANOVA & *T* tests, *P* tests, and SPSS were used to analyse the data. The findings imply that appropriate evaluations at all stages were necessary to improve technological performance within sports and PE teaching.

The application of novel components and technologies, especially computer technology, has advanced sports biomechanics, was discussed by Ying and Huang [15]. It could accelerate the change process and has a special function for sports education. To increase educational and athletic effects to promote pupil awareness of motion standards, this investigation proposes strategies to make fitness teaching more productive.

Motor abilities were reconstructed into key elements including effect, velocity, and balance using motion-capturing sensors and data collected in real time processing were evaluated by Jiang [16]. Students get focused feedback, which helps them to successfully modify their methods. Simultaneously, psychological assessments were implemented to assist students in maintaining attention and developing mental adaptability, including stress reduction techniques and self-reflection.

3. Methodological framework

This section includes the methodological framework that improves the impact of biomechanical analysis in PE for motion efficiency and to reduce the injury rates.

3.1. Data collection

This study involved 300 participants who were allocated into two groups: an experimental group (Group A) and a control group (Group B), with 150 individuals in every group. The participants were selected based on five standard demographic variables (age, gender, physical fitness level, educational background, and teaching experience). These variables ensured balanced representations across the groups. Group A received movement optimization interventions (6 weeks) based on biomechanical analysis in the PE classes, while Group B observed standard teaching methods. It assesses the effect of biomechanical analysis on movement efficiency and injury prevention, while the demographic variables presented insight. The detailed layout of the sample, shown in **Table 1** and **Figures 2** and **3** represents the demographic data.

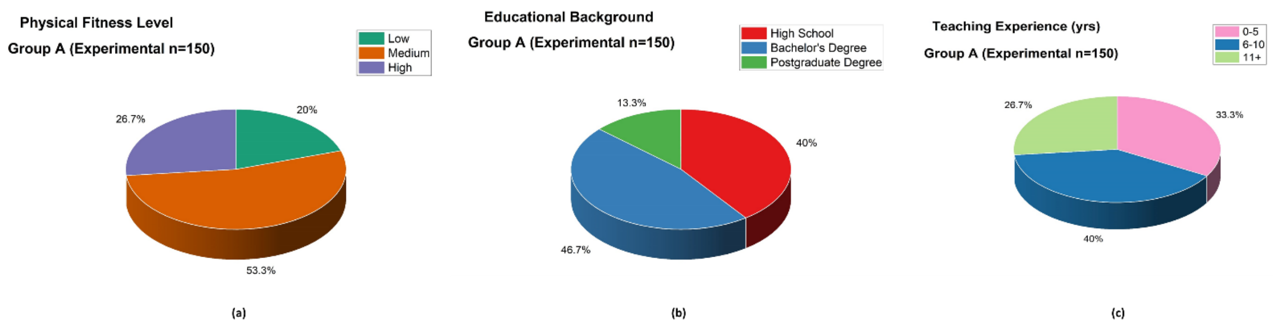

Figure 2. Demographic details of group A: **(a)** physical fitness level; **(b)** educational background; **(c)** teaching experience (yrs).

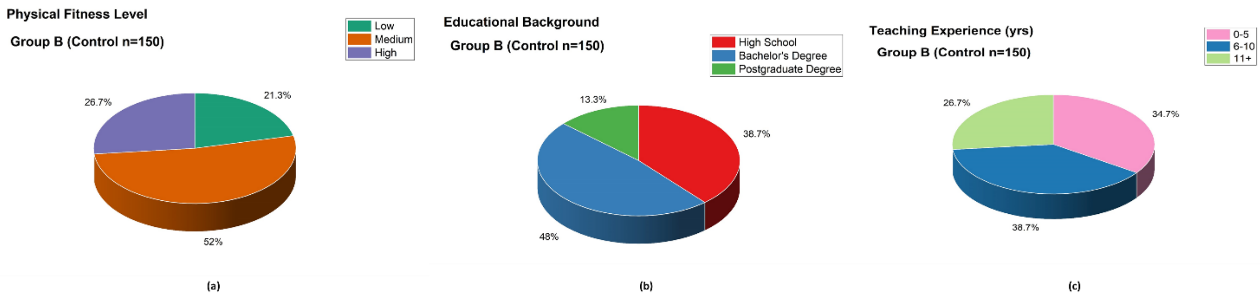

Figure 3. Demographic details of group B: **(a)** physical fitness level; **(b)** educational background; **(c)** teaching experience (yrs).

Table 1. Demographic data table.

Demographic Variable	**Group A (Experimental *n* = 150)**	**Group B (Control *n* = 150)**	**Total (*n* = 300)**
Age (years)			
18–25	40	42	82
26–35	50	48	98
36–45	40	42	82
46+	20	18	38
Gender			
Male	80	78	158
Female	70	72	142
Physical Fitness Level			
Low	30	32	62
Medium	80	78	158
High	40	40	80
Educational Background			
High School	60	58	118
Bachelor's Degree	70	72	142
Postgraduate Degree	20	20	40
Teaching Experience (yrs)			
0–5	50	52	102
6–10	60	58	118
11+	40	40	80

3.2. Survey instruments

The present study considers 300 participants randomly selected among 500 participants. Further, these questionnaires are categorized into five sections.

- Theoretical maximal horizontal force (HZT-FO): In this section, evaluation of HZT-FO (Variable 1) contains 2 questions. The HZT-FO assesses peak horizontal force generation through an activity, and provides important understandings into biomechanical efficiency and movement optimization. Monitoring HZT-FO could set the basis for performance improvement and minimize the occurrence of injury risk as well as provide foundational reference points for effective strategies in PE settings.

- Theoretical maximal velocity of running (HZT-VO): This section has 2 questions that measure the HZT-VO (Variable 2). HZT-VO is used to assess the peak running speed achievable; it is a sprinting test with individual fitness levels and biomechanics as contributors. It facilitates training optimization and improved performance outcomes.
- Maximal mechanical power outcome horizontally oriented (HZT-Pmax): This section contains 2 questions to measure HZT-Pmax (Variable 3). HZT-Pmax involves the measuring of the maximum mechanical power output in horizontal movements in optimizing training methods and performance in sprinting.
- Maximal ratio of force (RFmax): This section includes 2 questions of the RFmax (Variable 4). To evaluate how much force the body can exert in relation to body mass, RFmax is best for other strength and power-involving facilities gained by means of proper resistance training.
- Ratio of decrease in RF (DRF): This section consists of 2 questions that assess the amount of DRF (Variable 5). DRF considers the drop in force production over time and is an indicator of muscle endurance and fatigue. This variable is responsive to training and modifiable depending on recovery strategies.

To measure the biomechanical optimization, players' pre- and post-intervention were evaluated through questionnaires. The research questionnaires, developed through performance factors, determined the success of biomechanical analysis with the integration in PE teaching. Quantitative measurement of the impact of the training on movement efficiency and prevention of injuries was done using a 5-point Likert Scale (I-strongly disagree, II-disagree, III-neutral, IV-agree, V-strongly agree).

3.3. Types of groups

- Group A (experimental group): Group A underwent a 6-week training program incorporating biomechanical techniques to improve movement in physical education. Each session utilized motion capture analysis to track joint angles, velocity, and posture during running activities. Motion capture analysis was utilized to track joint angles, velocity, and posture during running activities, while force plates simultaneously measured ground reaction forces to assess balance, stability, and force distribution. Participants received individualized recommendations focused on technique refinement, performance enhancement, and injury prevention. The structured sessions emphasized improving movement performance through detailed biomechanical analysis, ensuring better learning outcomes and enhanced physical capabilities. This comprehensive program provided a clear framework of training frequency, intensity, and duration to achieve optimal results. Group A was subjected to biomechanical techniques, including various techniques to improve movement in PE, as shown in **Figures 4** and **5**.

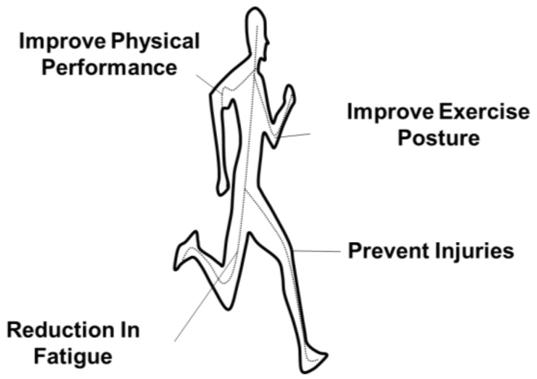

Figure 4. Motion capture image of sprinting.

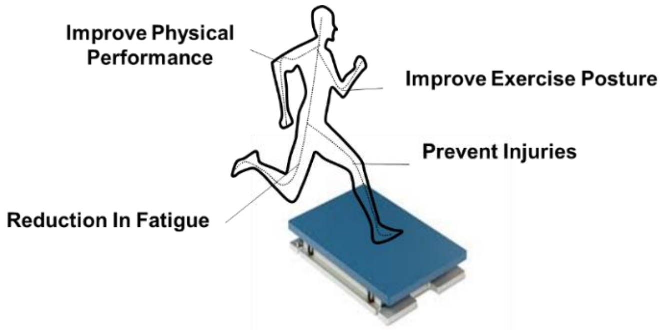

Figure 5. Sprinting using force plate.

- Group B (control group): Group B followed a traditional teaching approach in physical education, emphasizing verbal explanations, demonstrations, and repetitions. Instructors provided clear verbal instructions on movements, breaking them down step-by-step and using analogies to aid understanding. They also demonstrated the techniques, often performing the movements themselves or using students as examples. Students practiced the movements through repetition, focusing on refining technique and form. Feedback was given primarily based on visual observation, with instructors offering general comments to improve performance. The curriculum focused on skill development through routine exercises and group activities designed to enhance physical performance and movement perception. Group B did not utilize advanced biomechanical analysis or technology, relying instead on traditional methods for teaching PE, which is displayed in **Figure 6**.

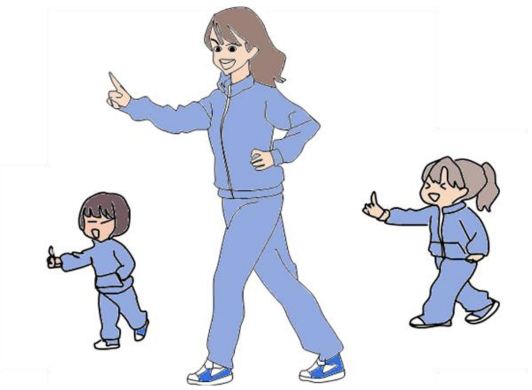

Figure 6. Physical education at control group.

3.4. Evaluation factors

Table 2 discusses the evaluation variables that gives the efficacy in biomechanical analysis in PE.

Table 2. Evaluation factors of the variables.

Variables	Definitions
HZT-FO	HZT-FO is the maximum force a source can generate in the horizontal direction for activities such as running, hence the name. It reduces the injury rates at the assessment period. Maximum force production in a horizontal direction (per unit body mass). Corresponds to the athlete's first push downward during sprint acceleration. The output of horizontal force unique to a sprint increases with increasing value.
HZT-VO	HZT-VO has the highest running speed achieved in density, performance being affected by leg strength and biomechanics and signifying explosive speed. The maximum velocity at which the athlete can run. Just a bit faster than the actual top speed. The maximum sprinting velocity an individual might possibly reach if mechanical resistances to motion were eliminated. It also represents the ability to produce horizontal forces at incredibly high sprinting velocities.
HZT-Pmax	HZT-Pmax reflects the power generated during horizontal physical movements like running or jumping and hence is an important parameter in evaluating the mechanical power in this aspect. Maximum horizontal power output (per unit body mass) that the athlete is capable of producing during sprint acceleration.
RFmax	RFmax assesses the level of force exerted during the completion of the resistance movements by expressing it per unit of body mass. Maximum force application efficacy in concept. Direct assessment of the percentage of total force output during sprint start that is focused on forward motion.
DRF	DRF compares the rate of reduction in force production over time and the ability to sustain force during the long-durations tasks and fatigue. An indicator of the athlete's capacity to sustain an overall horizontal force output in spite of increased running velocity, it describes the athlete's ability to minimise an inevitable decline in mechanical performance with increasing speed. The efficiency of force distribution during acceleration decreases more quickly with a higher negative slope, and vice versa.

3.5. Statistical analysis

The utilization of biomechanical analysis for the improvement of movement techniques that are applied in PE teaching is tested through two analysis tests: descriptive statistics and independent sampled *t*-test. SPSS is employed in each analysis to analyse the results, which are mentioned below. These analyses evaluate the feasibility of various biomechanical approaches in improving the abilities of students in PE. The statistical methods applied for determining the effectiveness of biomechanical optimization on teaching and movement patterns are mentioned below.

- Descriptive Statistics: The movement techniques in PE by biomechanical analysis descriptive statistics involve summarization and description of the key characteristics during the study process. These statistics explain mean, median, distribution of coefficient of variation, standard deviations, and range of horizontal force, velocity and power. It assists comparisons between Group A and Group B, mainly providing a view of biomechanical intervention effects. The mean Y is calculated by Equation (1).

$$Y = \frac{\sum_{j=1}^{m} Y_j}{m} \tag{1}$$

where Y_j represents the individual scores and m is the total number of observations.

- Independent Sampled *T*-test: The technique of comparing two independent groups in terms of mean is an independent samples t-test, which has a definition of testing for the difference between two independent samples. In PE and optimisation of movement techniques, it can be used to determine the difference in the performance improvement between two teaching methods is statistically significant. The independent samples *t*-test is given by Equation (2).

$$s = \frac{N_1 - N_2}{\sqrt{\frac{t_1^2}{m_1} + \frac{t_2^2}{m_2}}} \quad (2)$$

where N_1 and N_2 are the sample means and t_1^2 and t_2^2 are the sample variance, and m_1, m_2 are the sample sizes.

4. Result and discussions

The section discusses the outcomes using biomechanical analysis in the improvement of movement patterns in PE teaching. It exposes the benefits of biomechanical approaches in entries, such as improvement of student performance and coaching techniques.

4.1. Pre and post questionnaires based on survey

The 10 questions are distributed to 210 participants before and after the training sessions; the percentages of questions scored for both groups Group A and Group B are shown in **Figure 7**.

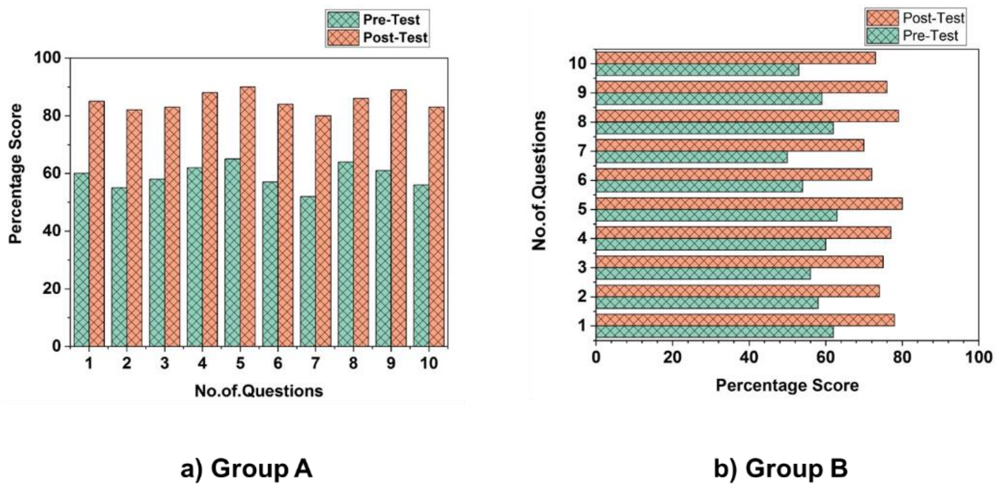

Figure 7. Pre and post questionnaires of: **(a)** group a; **(b)** group B.

4.2. Descriptive statistics for group A (pre and post tests)

Table 3 shows descriptive statistics of test results of Group A on five variables. It shows the minimum (Min), maximum (Max), median, standard deviation (SD), skewness, and kurtosis for both pre-test and post-test data. The distribution and variability of each variable used in the PE before and after the intervention are evaluated using these descriptive statistics, which are helpful in documenting changes in group performance or trends of differences on the different measures.

Table 3. Numerical values of descriptive statistics in group A.

Variables	Pre-test						Post-test					
	Min	**Max**	**Median**	**SD**	**Skewness**	**Kurtosis**	**Min**	**Max**	**Median**	**SD**	**Skewness**	**Kurtosis**
Variable 1	25	120	60	15	0.2	−0.1	30	130	70	14	0.1	−0.2
Variable 2	5	15	9	2.3	0.5	0.3	6	17	10	2.1	0.3	0.2
Variable 3	50	200	120	40	0.3	−0.4	60	220	130	38	0.2	−0.5
Variable 4	1.2	3.5	2.4	0.5	0.1	−0.2	1.5	3.8	2.6	0.4	0.2	−0.1
Variable 5	0.05	0.3	0.15	0.07	0.4	0.6	0.07	0.25	0.12	0.05	0.3	0.5

4.3. Descriptive statistics for group B (pre and post-tests)

Table 4 depicts the pre-test and post-test statistics for the five variables among the subjects in Group B. The descriptive statistics used have the assessment for both test populations. It gives the idea of distribution of the data with identified variables and changes in the group performance. From **Table 4**, the performance of the variables can be analysed during pre and post-test in Group B.

Table 4. Comparison of descriptive analysis in group B.

Variable	Pre-test						Post-test					
	Min	**Max**	**Median**	**SD**	**Skewness**	**Kurtosis**	**Min**	**Max**	**Median**	**SD**	**Skewness**	**Kurtosis**
Variable 1	20	110	55	17	0.3	−0.2	25	120	60	16	0.2	−0.3
Variable 2	4	13	8	2.5	0.6	0.2	5	14	9	2.3	0.5	0.1
Variable 3	40	180	100	35	0.4	−0.3	50	190	110	36	0.3	−0.4
Variable 4	1.0	2.8	1.7	0.4	0.2	−0.4	1.1	2.9	1.8	0.38	0.3	−0.3
Variable 5	0.1	0.6	0.3	0.15	0.5	0.7	0.1	0.65	0.33	0.14	0.4	0.6

4.4. Independent sampled *t*-test for group A (pre and post-tests)

Table 5 depicts the pre and post-test comparison of 5 measured variables for Group A, showing their means, SD and *t* & *p* values. The analysis of variance shows the group's performance has shifted across the various parameters. The *t*-value and *p*-value for each variable show how the pre-test and post-test findings differ significantly. **Table 5** demonstrates improvements in 5 variables where the *p*-values were less than 0.05.

Table 5. Numerical values of independent sampled *t*-test of group A.

Variable	Standard Deviation		Mean		*t*-value	*p*-value
	Pre-test	**Post-test**	**Pre-test**	**Post-test**		
Variable 1	15	14	60	70	4.2	0.0001
Variable 2	2.3	2.1	9	10	2.4	0.02
Variable 3	40	38	120	130	3.1	0.003
Variable 4	0.5	0.4	2.4	2.6	2.2	0.03
Variable 5	0.07	0.05	0.15	0.12	1.8	0.04

4.5. Independent sampled *t*-test for group B (pre and post-tests)

In **Table 6**, the pre-test and post-test differences in 5 variables in Group B in terms of mean, standard deviation, '*t*' value and '*p*' value have been shown. The statistical analysis also exposes variables, which are 5 variables, with the *p*-value of changes at $p < 0.05$. The *t*-values verify the magnitudes of the performances in the physical movements.

Table 6. Comparison of Independent sampled *t*-test in group B.

Variable	**Standard Deviation**		**Mean**		***t*-value**	***p*-value**
	Pre-test	**Post-test**	**Pre-test**	**Post-test**		
Variable 1	17.0	16.0	55.0	60.0	1.40	0.004
Variable 2	2.5	2.3	8.0	9.0	2.08	0.039
Variable 3	35.0	36.0	100.0	110.0	1.12	0.001
Variable 4	0.4	0.38	1.7	1.8	1.10	0.032
Variable 5	0.15	0.14	0.3	0.33	1.20	0.046

4.6. Discussion

The 300 sample was selected from PE classes to establish the effects of biomechanical analysis on movement behaviours; 150 subjects were included in Group A, and 150 in Group B. Descriptive analysis has increased the scores of all the five variables in both groups post intervention, which were statistically significant ($p < 0.05$). Variables 1, 2, 3, and 4 were significantly improved for Group A than Group B at pre and post-tests in independent sampled *t*-tests. Hence, it shows the effectiveness of biomechanics for improving PE outcomes and offers some implications for students and instructors' performance. In Group A, the median values for Variable 1 increased from 60 (pre-test) to 70 (post-test), and Variable 3 from 120 to 130, reflecting improvement. In Group B, Variable 1's median increased from 55 to 60, and Variable 3's median went from 100 to 110. Both groups showed consistent standard deviations and slight positive skewness. Group A show significant improvements in all five variables ($p < 0.05$). Group A's variables showed substantial shifts, with *t*-values ranging from 1.8 to 4.2 and *p*-values from 0.0001 to 0.04. Group B's *t*-values ranged from 1.12 to 2.08, with *p*-values from 0.001 to 0.046. These results confirm that the intervention led to meaningful performance improvements.

5. Conclusion

The study discussed the biomechanical optimization enhancement in movement's efficiency and injury free teaching in PE. In all, 300 participants were eventually selected, 150 in Group A (experimental group) while the other 150 in Group B (control group). Both groups were asked with questionnaires consisting of five sections and each sections had two questions about several aspects of physical performance and injury rates. The improvements in biodynamic variables of Group A have improved biomechanical interventions such as HZT-FO, HZT-VO, HZT-Pmax, RFmax and DRF in comparison to Group B. Independent sample *t*-tests, a comparative analysis show the differences between Group A and Group B are statistically significant ($p <$

0.05). From such outcomes, it can be concluded that biomechanical methods that are incorporated in the PE programs can help students achieve great performances and minimize the incidences of injuries within learners. More studies should be done in the future to cover other areas of learning.

Limitations and future scope

This study depends on self-reported measures, which could bring response bias and there is no control for the external environment, which might have an impact on the generalised statistic. However, the study was of a short period and hence it lacks the ability to represent long term effectiveness. In the future, objective performance data could be combined using the motion capture technology, and cross-sectional biomechanical trainings could be assessed in different types of sports, and further research might be done on how these interventions could be incorporated in educational curriculum to improve learning efficiency.

Author contributions: Conceptualization, CL and YW; methodology, CL; data curation, CL; writing—original draft preparation, CL; writing—review and editing, YW; visualization, YW. All authors have read and agreed to the published version of the manuscript.

Ethical approval: Not applicable.

Conflict of interest: The authors declare no conflict of interest.

References

1. Glazier PS. Beyond animated skeletons: How can biomechanical feedback be used to enhance sports performance? Journal of Biomechanics. 2021; 129: 110686. doi: 10.1016/j.jbiomech.2021.110686
2. Herbert C. Enhancing Mental Health, Well-Being and Active Lifestyles of University Students by Means of Physical Activity and Exercise Research Programs. Frontiers in Public Health. 2022; 10. doi: 10.3389/fpubh.2022.849093
3. Wei W, Yalong L. Study on treatment and rehabilitation training of ligament injury of javelin throwers based on sports biomechanics. Measurement. 2021; 171: 108757. doi: 10.1016/j.measurement.2020.108757
4. Ascenso G. Development of a non-invasive motion capture system for swimming biomechanics [PhD thesis]. Manchester Metropolitan University; 2021.
5. Barua R. Unleashing Human Potential. Global Innovations in Physical Education and Health; 2024. doi: 10.4018/979-8-3693-3952-7.ch015
6. Mischenko N, Romanova E, Vorozheikin A, et al. Developing a model to enhance professional competence in physical education for preschool instructors. Journal of Physical Education and Sport. 2024.
7. Muharram NA, Suharjana S, Irianto DP, et al. Development of Tenda IOT174 Volleyball Learning to Improve Cognitive Ability, Fighting Power and Sportivity in College Students. Physical Education Theory and Methodology. 2023; 23(1): 15-20. doi: 10.17309/tmfv.2023.1.02
8. Alsaeed R, Hassn Y, Alaboudi W, et al. Biomechanical analytical study of some obstacles affecting the development of football players. International Journal of Physical Education, Sports and Health. 2023; 10(3): 342-346. doi: 10.22271/kheljournal.2023.v10.i3e.2967
9. Clapham E, Orendorff K, and Fournier K. Utilizing Physical Education to Support Principals of Biomechanics. Journal of Health and Physical Literacy. 2023.
10. Boujdi R, Rouani A, Elouakfaoui A, et al. The effectiveness of a physical education teaching intervention based on biomechanical modeling on anaerobic power and sprint running performance of youth male students with deficit force profile. International Journal of Chemical and Biochemical Sciences. 2023.

11. Di Domenico F. From biomechanics to learning: Continuum for the theory of physical and sports education. Journal of Human Sport and Exercise-2020-Winter Conferences of Sports Science. 2020. doi: 10.14198/jhse.2020.15.proc2.18
12. Bukhovets BO, Kashuba VA, Stepanenko O, et al. The formation of human movement and sports skills in processing sports-pedagogical and biomedical data in masters of sports. International Journal of Human Movement and Sports Sciences. 2020.
13. ZhaoriGetu H, Li C. Innovation in physical education teaching based on biomechanics feedback: Design and evaluation of personalized training programs. Molecular & Cellular Biomechanics. 2024; 21(2): 403. doi: 10.62617/mcb403
14. Abdelkader G, Madani R, Bouabdellah S, et al. The Contribution of Biomechanical Analysis Technology to Improve the Assessment of Students During Certain School Sports Activities (Long Jump). Kinestetik: Jurnal Ilmiah Pendidikan Jasmani. 2021; 5(2): 429-436. doi: 10.33369/jk.v5i2.14529
15. Ying W, and Huang W. Research on Methods of Improving Teaching Efficiency of Physical Training Based on Sports Biomechanics. Curriculum and Teaching; 2021.
16. Jiang Z. The Synergistic Effect of Biomechanics and Psychological Feedback in Physical Education Teaching: Enhancing Motor Skills and Psychological Resilience. Molecular & Cellular Biomechanics. 2024; 21(2): 447. doi: 10.62617/mcb.v21i2.447