

Article

# The synergistic effect of biomechanical training and exercise on English learning outcomes

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**Abstract:** The combination of physical activity with language acquisition has gained popularity as an effective approach for improving educational outcomes. In exploring the combination of physical activity and language acquisition, it's crucial to consider cell molecular biomechanics. When students engage in biomechanical training and exercise, at the cellular level, mechanical forces are exerted on various tissues. These events involve the activation of mechanosensitive channels, which then influence intracellular signaling pathways. Such pathways can modulate gene expression related to neuroplasticity, as neurons are also affected by these mechanical forces indirectly. This, in turn, impacts cognitive processing linked to language acquisition. This study highlighted the interconnection of physical and cognitive functioning, showing that biomechanical training and exercise might improve cognitive performance, including language acquisition. The third and fourth academic terms saw the collection of data, which comprised pre and post-test results for listening, vocabulary, reading, writing, and grammar, among the students. There were 360 students, with a range of academic backgrounds and English proficiency levels (73% female, 27% male). The data were investigated using descriptive statistics, independent *t*-tests, one-way ANOVA, paired-sample *t*-tests, and assessments of student improvement with level changes. The results show that students' scores differ significantly in total and across skills. These findings have implications for curriculum and course design in terms of integrating biomechanical training and exercise, as well as formative assessment. These findings indicate that combining physical training with language learning programs can improve cognitive processing and result in higher educational performance. However, more studies are required to fully understand the long-term impacts and its suitability for other age groups and learning contexts, given the intricate cell molecular biomechanics at play.

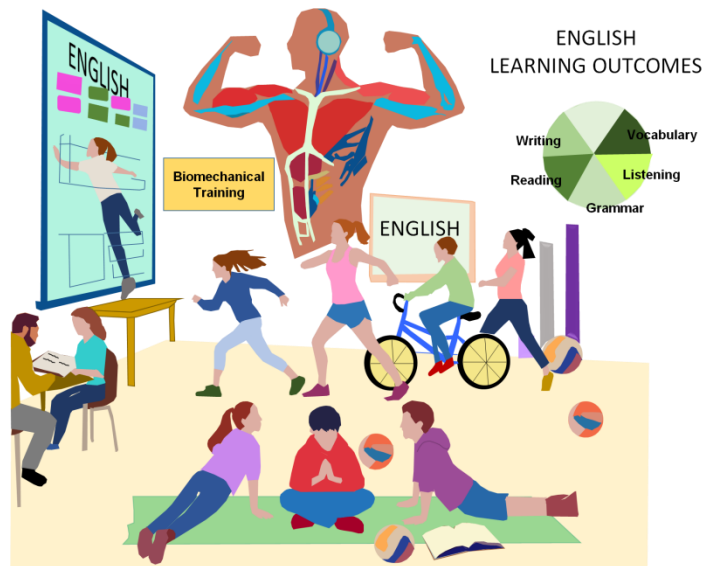
**Keywords:** synergistic effect; biomechanical training; cell molecular biomechanics; English learning outcomes; cognitive processing

## 1. Introduction

A growing variety of human beings are interested in mastering how physical pursuits, in particular exercising and biomechanical training, have an effect on cognitive approaches, along with language learning. Research has shown that accomplishing physical activities no longer most effectively complements standard fitness but additionally undoubtedly influences intellectual functions, such as interest, reminiscence, and learning capacity. Though the link between mental and physical well-being is well-installed, new investigations imply that mastering consequences, which include language talent, can additionally benefit from biomechanical physical activities [1]. These training applications are cognizant of improving muscular efficiency, coordination, and body motion, which can lead to superior neural connectivity and cognitive flexibility. By integrating biomechanical schooling into

instructional curricula, newcomers might also revel in advanced consciousness and retention of new language talents, as exercise stimulates various brain regions related to mastering and reminiscence. Moreover, the rhythmic and repetitive nature of biomechanical sporting events could also facilitate higher linguistic rhythm and pronunciation in language acquisition, thereby providing a complete technique for language learning that encompasses each physical and cognitive improvement [2]. Scholarly works referring to curriculum development and course design in the context of English Language Teaching (ELT) frequently acknowledge the recommendations and justifications of the ideas, frameworks, need analyses, goals, and so forth., but as an alternative lack unique instances or empirical analyses of ways diverse techniques to curriculum development and route layout impact students' performance and learning outcomes [3]. In English for Specific Purposes (ESP), there is an ongoing debate about the qualifications and expertise of teachers and the specific content of the courses offered. Proponents of this approach argue that ESP teachers must have a deep understanding of the relevant field, whether business, medicine, engineering, or another discipline, to meet their students' specific language needs and learning objectives effectively [4]. The promotion of unbiased studying, self-directed paintings, creativity, and the integration of Information and communication technologies (ICT) both inside and outside the lecture room is prioritized within the English curriculum. The coaching methodologies that are presently in use include integrated skills, cooperative gaining knowledge, content material-primarily based gaining knowledge, venture, and problem-primarily based studying, and holistic gaining knowledge. The communicative language teaching method remains popular, but it's utilized for talking and listening preparation [5]. Biomechanical schooling is a specialized method designed to enhance motion efficiency and decrease harm danger by focusing on the mechanical ideas of human motion. This form of schooling applies concepts from biomechanics, which includes pressure, movement, and leverage, to improve frame mechanics for the duration of physical sports. Whether in sports activities, rehabilitation, or regular motion, biomechanical education facilitates people to optimize their performance by way of correcting fallacious movement patterns and enhancing joint stability, flexibility, and electricity [6]. The effects of biomechanical training are extensive in diverse fields, specifically in sports activities, overall performance, and harm prevention. By refining how muscle groups, joints, and bones work together, this training aims to reduce the strain located on the frame during physical exertion. Athletes can gain stepped-forward coordination, velocity, and agility, at the same time as people in rehabilitation can experience quicker recovery and decreased recurrence of injuries [7]. Moreover, biomechanical education helps improve posture, balance, and overall physical fitness, making it a vital element of each performance enhancement and harm control program. The role of physical exercise in training, particularly in improving cognitive features, has been broadly studied. Engaging in physical activity not only promotes good health but also positively affects learning outcomes, including language acquisition [8]. When it comes to English language learning, exercise can play a crucial role in improving students' attention, memory, and motivation. This link between physical exercise and language learning outcomes opens up new pathways for educators to design holistic teaching strategies that integrate physical activities with language instruction. By

fostering an environment that encourages movement, teachers can enhance both the physical well-being and academic performance of their students, ultimately leading to better English language learning outcomes [9]. This method acknowledges the critical role that exercise plays in cognitive development since studies have shown that exercise can enhance brain function and promote learning. Engaging in physical activity not only helps students stay focused but also improves their general health, which is necessary for learning to occur effectively [10]. The purpose of the project is to find out how integrating language learning with physical activity, especially biomechanical training and exercise, affects academic performance, especially in the area of English proficiency. **Figure 1** demonstrates that combining biomechanical training with exercise improves English learning outcomes by enhancing brain function and physical coordination, which improves attention and retention of language skills.



**Figure 1.** Biomechanical training and exercise on English learning outcomes.

Contributions of this study

- This study demonstrated how physical and cognitive functioning are intertwined, suggesting that exercise and biomechanical training can enhance cognitive function, including language learning.
- There were 360 students, with a diversity of backgrounds in academia and English proficiency levels (73% female, 27% male).
- These results suggest that integrating physical exercise into language learning curricula might enhance cognitive function and lead to better academic outcomes.

The paper is organized into several sections: Part 2 covers the literature review, Parts 3 and 4 outline methodology and outcomes, and Parts 5 and 6 provide the discussion and the study's conclusion.

## 2. Related works

The relationship between scholar impressions of five low-tech energetic getting-to-know tasks, their learning philosophy, and their expertise in biomechanical

concepts. When implementing low-tech energetic schooling physical games, biomechanics teachers must bring their mastering philosophy, expectations for the course, and slow implementation of both collaborative and character-based lively learning experiences early inside the course [11]. Biomechanics, a vital area of kinesiology, provided important insights into human body mechanics. The need for comprehensive kinesiology education programs was rising, along with the need to comprehend the function and efficacy of biomechanics in these courses [12]. The impact of an aNMT (neuromuscular training) plan on the knee biomechanics of a collection of athletes with ACLR (anterior cruciate ligament reconstruction) wasn't well-identified. The study aimed to check whether knee biomechanics and mind-practical connections were probably modified using real-time biofeedback structures. Six weeks of augmented neuromuscular training (aNMT) [13] using real-time, interactive visual biofeedback were completed by seventeen young, healthy female athletes who were physically active, while thirteen acted as untrained controls [14], either on a hard court surface or in the sand, affected the biomechanical factors associated with jumps and the physical fitness of female indoor volleyball players. Regaining the knee to its pre-surgical levels of strength and function following anterior cruciate ligament reconstruction surgery was difficult, and failing to do so increases the risk of re-injury and long-term degenerative issues. Although it's becoming more and more common, BFR (blood flow restriction) [15] hasn't been a complete investigation of how it affects these workout' mechanics. The intention was to evaluate the efficacy of 8-week conditioning training (CT) [16] programs with and without feedback on the biomechanics of lower limbs and the occurrence of injuries in male runners who were free of injury during 1 year. The impact of eight weeks of dry-land strength training in addition to swimming training [17]. The effects of localized muscle injury on the knee on the biomechanics of the sagittal plane landing during a DVJ (drop vertical jump) [18] were examined. The learning results of students who have completed a general English course that incorporates ICT [19] integration, an integrated skills approach, formative assessment, and is based on the ideas of smart classroom and active learning. An almost experimental classroom investigation examined the effects of a General English (GE) pedagogical modification in a general English course at an industrial languages school. A longitudinal mixed methods approach was used for the study, and data from 24 school-aged learners were gathered using diaries five times and the English as an International Language Perception Scale four times [20]. The writing process for outcomes for general higher education programs was presented in this paper. Three categories of programs, such as program outcomes (POs) [21], program-specific outcomes (PSOs), and course outcomes (COs), were used to determine results for higher education programs. Utilizing adaptive and interactive e-learning materials made in the new Moodle question type Stateful, which extends the original e-learning platform STACK (System for Teaching and Assessment using a Computer Algebra Kernel) [22], a teaching experiment was conducted in a university-level thermodynamics course. An alternative perspective on learning English was presented in the article, which explains how motivation and other psychological variables affect a learner's ability to acquire English as an additional language [23]. In an ESP (English for Specific Purposes) [24] course called English for Agriculture and Forestry, college students' mastering stories were examined using

the current experiment to evaluate the relationships between the instructional, social, and cognitive components of CoI (Community of Inquiry) and the effects of combined training. The impact of mechanical forces cellular signaling for cell fate decisions was investigated by [25]. It used the techniques of cell biology, mainly mechanical manipulation along with the examination of signaling pathways. It established that mechanical signals were crucial factors in stem cell differentiation and formation of tissues due to Mechanotransduction. The computational modeling that was combined with experimental data can be used to explore how mechanical forces interact with cell signaling in developmental processes by [26]. The results demonstrated that mechanical forces play a very important role in the cellular alignment and differentiation process, which is critical for the tissue structure and development [27]. Investigated cellular signaling pathways that were activated by mechanical and electromagnetic stimuli, focusing on the mammalian nervous system. A literature survey was carried out to examine the biomolecular response to mechanical stress, determining which mechanisms were critical and requiring more research for an improved understanding of these processes. Di et al. [28] intended to meticulously compile the traits and governing principles of common mechanical stimuli in both healthy and diseased environments. The review was comprehensive, and the summary of Mechanotransduction effectors and related signaling pathways may work as the nucleus for valuable potential therapeutic targets and most advanced clinical applications in diseases related to mechanical cues. Kilinc [29] aims to discuss mechanical regulation of synaptic strength in detail, with regard to cytoskeletal dynamics and cell adhesion molecules (CAMs), with particular attention to synapse plasticity and neurodegenerative diseases. It reviews existing literature regarding how the acting network and CAMs impact synaptic function and the role of disruption in trans synaptic force balance that might contribute to synaptic failure relevant to cognitive decline and dementia. Kotaleski and Blackwell [30] investigated synaptic plasticity as a mechanism of learning and memory, focusing attention on the interplay between ion channels, enzymes, and genes involved. For modeling synaptic plasticity, used computer modeling, mixing computational neuroscience and systems biology and emphasizing significant developments and promising approaches that use live cell imaging. The mechanisms of synaptic plasticity at a molecular level—that was, how altering neuron function promotes learning and memory. Martella [31] reviews experimental research that identifies main molecular players during synaptic modification processes. The finding points to involvement of protein synthesis, receptor trafficking, and dynamic ion channel states in plasticity.

### **3. Methodology**

The technique used in this research focused on a sample of 360 students from a variety of educational backgrounds, employing an organized and meticulous approach to data gathering during the third and fourth academic terms. A varied demographic that provides an excess of information for examination is indicated by the fact that 27% of those individuals were men and 73% were women. Students inside the study engaged in biomechanical coaching and custom-designed workout regimens in addition to their regular language learning materials to analyze the relationship

between physical activity and language acquisition. Pre and post-tests were carefully administered to examine college students' progress in five predominant language skill ability domains: vocabulary, listening, grammar, analyzing, and writing. This was finished to assess the effectiveness of this two-pronged strategy. This rigorous testing method ensured that a wide range of language proficiency had been evaluated and enabled a detailed understanding of student growth. Students were assessed through the use of quite several statistical analyses, inclusive of unbiased t-tests, one-way ANOVA, paired-sample t-tests, and critiques of development through stage modifications.

### 3.1. Data collection

The dataset for this observation contains pre- and post-test rankings gathered from 360 students (73% female and 27% male) throughout numerous instructional backgrounds and English proficiency stages at some point in the third and fourth educational terms. The facts encompass rankings on vocabulary, listening, grammar, studying, and writing competencies. This complete dataset highlights the interconnection between physical pastime and language acquisition, offering insights into the effect of biomechanical schooling on cognitive performance.

### 3.2. Questionnaire

To investigate the impact of biomechanical education and exercising on English learning consequences, a structured questionnaire will be developed. The questionnaire will include three sections: demographics, exercise, and education practices, and English learning studies. In the demographics segment, participants will offer records on their age, gender, and level of English talent. The second phase will be consciousness of contributors' engagement in biomechanical education and workouts, such as frequency, length, and types of sports completed. The final section will examine their English studying outcomes, incorporating Likert-scale inquiries to gauge upgrades in studying, writing, speaking, and listening competencies attributed to their schooling and workouts. This study includes qualitative insights into members' perceptions of how physical activity impacts their language acquisition and basic knowledge of enjoyment. This structured questionnaire targets to offer a radical assessment of ways biomechanical education and exercising affect English gaining knowledge of effects, facilitating a higher expertise of the ability advantages of physical hobby in instructional contexts. **Table 1** depicts the combination of quantitative and qualitative information that will allow a robust analysis that can inform destiny educational techniques and schooling programs.

**Table 1.** Assessments of questionnaire.

S. No	Biomechanical Training and Exercise on English Learning Outcomes
1	How familiar are with biomechanical training and its principles?
2	To what extent do believe that physical exercise influences cognitive functions related to language learning?
3	How significant do think biomechanical training is in improving language acquisition skills?
4	Have ever participated in any formal training or programs focused on biomechanical training or exercise?
5	What resources do find most useful in understanding the relationship between exercise and language learning?

**Table 1.** (Continued).

S. No	Biomechanical Training and Exercise on English Learning Outcomes
6	How do evaluate the impact of physical exercise on English learning progress?
7	How aware are the scientific studies linking exercise to improved language learning outcomes?
8	To what extent do think that incorporating exercise into language learning can enhance engagement and retention?
9	How could educational programs that combine exercise and language learning improve student outcomes?
10	What measures would encourage more schools to incorporate biomechanical training and exercise in their English curriculum?

### 3.3. Research instrument

The investigative tool employed to evaluate the impact of biomechanical training and workout on English studying results consisted of a comprehensive survey using a five-point Likert scale, in which respondents indicated their degrees of settlement or confrontation with diverse statements, starting from “Strongly Agree” to “Strongly Disagree.” This scale was designed to capture the nuanced perceptions of individuals regarding the impact of biomechanical schooling and associated physical sporting events on their English language proficiency. Participants had been particularly requested to evaluate how specific elements of biomechanical education, including numerous physical activities, strategies, and methodologies, contributed to their development in key regions of English language competencies specifically, reading, writing, speaking, and listening. The survey’s shape allowed for a detailed evaluation of individuals’ ideals approximately the effect of their physical fitness on cognitive features, which includes memory retention and processing speed, which are important for powerful language learning.

### 3.4. Statistical analysis

In this study examining the effect of biomechanical training and exercising on English studying results, comprehensive statistical evaluation was performed with the use of both descriptive and inferential techniques, facilitated via SPSS model 17.0. The evaluation aimed to evaluate how precise route designs motivated diverse sides of students’ studying effects, particularly specializing in vocabulary acquisition, listening comprehension, grammatical proficiency, reading abilities, writing abilities, and general performance in post-test total scores. To inspect the have a look at the subject matter, an independent t-test and a one-way ANOVA have been executed. A one-way ANOVA was used to identify statistical variations among starting, intermediate, and superior students, while an impartial *t*-test was used to see whether there were any variations between male and female college students. To decide the reaction to the research query, a group of strategies called descriptive records is employed to enumerate and signify a dataset’s number one traits, which include its distribution, variability, and principal tendency. A Paired Samples *T*-Test was carried out. It is used to song how the direction design affects college students’ mastering from the pre- to post-take look at intervals. Using this method permits the individual to decide whether or not the direction design impacts pupil accomplishment. The outcomes indicated statistically extensive differences in ratings across all competencies, suggesting a fantastic effect of biomechanical training on cognitive performance and language acquisition.

## 4. Results

The outcomes of this study certainly exhibit that biomechanical training and exercise play a pivotal position in enhancing English studying effects throughout diverse language abilities. Students who engaged in structured physical schooling exhibited marked upgrades not only in vocabulary acquisition but also in listening comprehension, grammar talent, studying fluency, and writing competencies. Statistical analyses revealed full-size variations in both pre-and post-test scores, with p-values less than 0.05, indicating that the observed improvements are statistically sturdy and the likelihood that they did not result from threat. Independent t-tests and one-way ANOVA in addition confirmed that gains were steady throughout all scalability levels, suggesting that students at different tiers of language acquisition benefited in addition to the intervention.

### 4.1. Participants of the demographic

The demographic evaluation of the 360 members shows a predominantly lady population, comprising 73% (263) of the pattern, while men account for 27% (97), highlighting the need to discover the effect of biomechanical training and workout on English mastering results. **Table 2** depicts the age distribution, indicating that 44.4% (160) fall within the 21–25 years category, followed by 27.9% (100) aged 18–20 years. Regarding educational background, 45.8% (165) have higher education, while 41.7% (150) completed secondary education. In terms of socioeconomic status, the majority are from middle-income backgrounds (58.3%), and 25% (90) belong to the low-income group. **Figure 2** shows the participant's level of English competence (beginners, intermediate, advanced). By evaluating the effects of biomechanical exercise and physical activity on English learning across the range of ability levels, this distribution helps determine if the combined strategy is more beneficial for all students or more effective for particular competence levels.

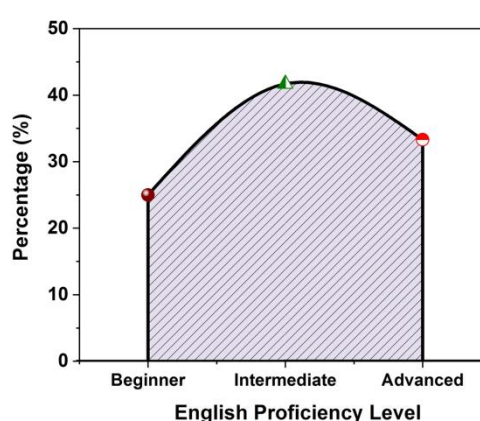
**Table 2.** Demographic table.

Demographic Factor	Subgroup	Count (n)	Percentage (%)
Total Participants		360	100%
Gender Distribution	Female	263	73%
	Male	97	27%
Age Group	18–20 years	100	27.9%
	21–25 years	160	44.4%
	26–30 years	70	19.4%
	31 years and above	30	8.3%
Educational Background	Primary	45	12.5%
	Secondary	150	41.7%
	Higher Education	165	45.8%
Socioeconomic Status	Low Income	90	25%
	Middle Income	210	58.3%
	High Income	60	16.7%



**Table 2.** (Continued).

Demographic Factor	Subgroup	Count (n)	Percentage (%)
English Proficiency Level	Beginner	90	25%
	Intermediate	150	41.7%
	Advanced	120	33.3%
Motivation Level	Low	80	22.2%
	Moderate	180	50%
	High	100	27.8%
Academic Term	Third Academic Term	180	50%
	Fourth Academic Term	180	50%

**Figure 2.** English proficiency level.

Finally, the participants examine a loose division of the third and fourth educational terms, with each organization accounting for half of the sample. This balanced distribution allows for a complete contrast of reviews and views from college students at terrific ranges in their instructional adventures. By including an identical range of participants from each term, the examiner's objectives are to capture a sizable range of insights concerning their academic demanding situations, coping strategies, and prevalent pleasure with their instructional experience. This technique not only effectively complements the validity of the findings but also guarantees that the conclusions drawn are reflective of the various viewpoints of university college students as they navigate their studies. Furthermore, this same representation allows a strong evaluation of any capability variations in responses that could get up from the wonderful contexts and pressures faced via manner of college students within the third and fourth phrases.

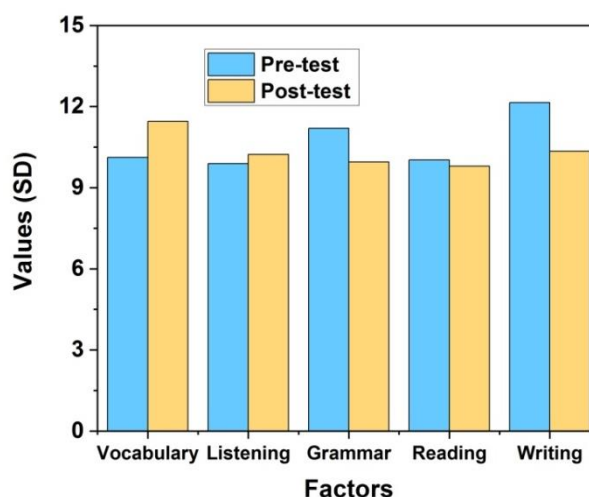
#### 4.2. Evaluation of descriptive statistics

A given statistics collection, which might include both the entire population and a pattern with it, is summarized by descriptive data, which are brief informative coefficients. Measurements of vital tendency and measurements of variability are used to break down descriptive facts in the context of the current observation. **Table 3** depicts the assessed 5 language abilities amongst 360 contributors, measuring pre-test and post-test mean rankings along standard deviations (SD) for each capacity. The findings discovered exceptional enhancements in the participants' language

competencies following the intervention, highlighting the impact of biomechanical training and exercising on English studying consequences. The pre-test suggestion turned to 58.45 (SD = 10.12), even as the post-test implies elevated substantially to 72.30 (SD = 11.45). Listening talents confirmed a pre-test mean of 62.15 (SD = 9.89), growing to a post-test mean of 74.50 (SD = 10.23). Grammar exhibited a pre-test mean of 55.60 (SD = 11.20), with the post-test mean improving to 70.25 (SD = 9.95). Reading rankings started with a pre-test mean of 60.85 (SD = 10.03) and improved to 75.15 (SD = 9.80) within the post-test. After biomechanical training and exercise, **Figure 3** illustrates how participants' language skills improved. It displays the mean result for vocabulary, listening, grammar, reading, and writing training before (Pre-test) and after (Post-test). All abilities improved significantly, demonstrating that the training helped improve English language learning.

**Table 3.** Outcomes of descriptive statistics.

Factors	Pre-test		Post-test Mean		N
	Mean	SD	Mean	SD	
Vocabulary	58.45	10.12	72.30	11.45	360
Listening	62.15	9.89	74.50	10.23	360
Grammar	55.60	11.20	70.25	9.95	360
Reading	60.85	10.03	75.15	9.80	360
Writing	57.50	12.15	73.40	10.35	360



**Figure 3.** Analysis of descriptive statistics.

The writing abilities of participants were assessed through a pre-test and post-test evaluation to measure the effect of biomechanical training and workout interventions on their English language proficiency. The pre-test results discovered a median rating of 57.50 with a general deviation of 12.15, indicating a mild stage of writing skill for the various contributors before the intervention. Following the implementation of the training and workout applications, the post-test looked at effects and showed a huge development, with an average score of 73.40 and a reduced trendy deviation of 10.35. This extremely good increase in ratings demonstrates an advantageous shift in individuals' writing abilities, suggesting that the aggregate of biomechanical

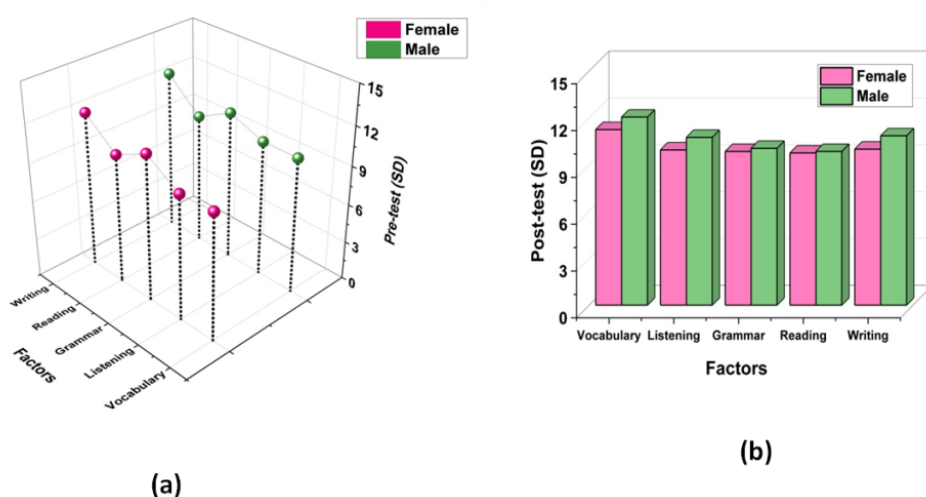
education and physical activities performed a crucial function in enhancing their language abilities. Furthermore, the discount in standard deviation suggests a greater consistency in performance amongst participants after the interventions, highlighting that training not only improved the scalability of standard writing but also contributed to an extra uniform improvement of talents across the organization. These consequences underscore the nice correlation between the interventions and the enhancement of English language abilities, suggesting that similar training programs could be useful in other instructional contexts geared toward enhancing language skill ability.

### 4.3. Evaluation of independent *t*-tests

The impartial samples *t*-test is a statistical approach used to examine pattern approaches from unrelated groups, indicating that distinct individuals provide rankings for each group. In **Table 4**, the effects of gender on pre-test and post-test performance in various language skills are examined, revealing notable differences in the findings. This resulted in a *t*-value of 1.88 (*df* = 358) and a *p*-value of 0.061, suggesting a trend toward significance. **Figure 4a,b** depict the pre and post-independent *t*-tests for listening skills. Females started with a mean of 62.50 (*SD* = 9.75) and progressed to 75.00 (*SD* = 9.95), compared to males who scored 61.35 (*SD* = 10.05) in the pre-test and 72.90 (*SD* = 10.75) in the post-test, yielding a *t*-value of 1.55 (*p* = 0.102), indicating no significant difference. In grammar, females improved from a mean of 56.10 (*SD* = 11.35) to 71.00 (*SD* = 9.85), while males transitioned from 54.20 (*SD* = 11.50) to 68.15 (*SD* = 10.05), revealing a significant *t*-value of 2.25 (*p* = 0.024). The reading scores for females increased from 61.10 (*SD* = 10.05) to 76.00 (*SD* = 9.75), whereas males went from 59.95 (*SD* = 10.10) to 73.90 (*SD* = 9.85), resulting in a *t*-value of 1.95 (*p* = 0.052), which approached significance.

**Table 4.** Outcomes of independent *t*-tests.

Factors	Gender	Pre-Test		Post-Test		<i>T</i>	Df	<i>P</i> -Value
		Mean	SD	Mean	SD			
Vocabulary	Female	59.00	9.85	73.45	11.25	1.88	358	0.061
	Male	57.25	10.50	70.10	12.05			
Listening	Female	62.50	9.75	75.00	9.95	1.55	358	0.102
	Male	61.35	10.05	72.90	10.75			
Grammar	Female	56.10	11.35	71.00	9.85	2.25	358	0.024
	Male	54.20	11.50	68.15	10.05			
Reading	Female	61.10	10.05	76.00	9.75	1.95	358	0.052
	Male	59.95	10.10	73.90	9.85			
Writing	Female	58.00	12.00	74.40	10.00	1.80	358	0.073
	Male	56.25	12.35	71.30	10.85			



**Figure 4.** Independent t-tests (a) pre-test; (b) post-test.

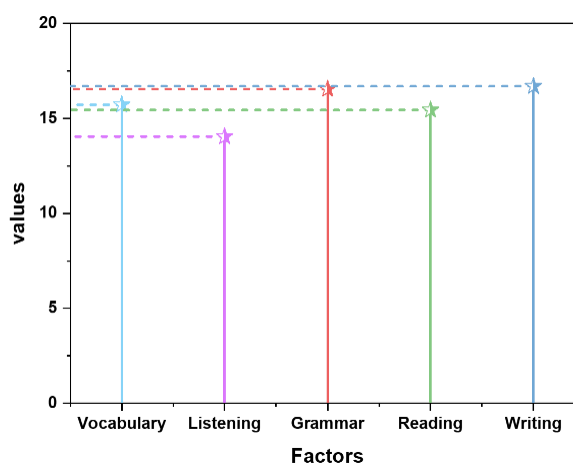
The results indicate a noteworthy trend in the writing scores of both females and males throughout the study. Females demonstrated a significant improvement, with their scores increasing from an average of 58.00 (SD = 12.00) to 74.40 (SD = 10.00). This change indicates a significant improvement in their writing abilities, suggesting that the interventions or academic strategies employed have effectively met their learning needs. Meanwhile, men additionally made progress, with their scores rising from an average of 56.25 (SD = 12.35) to 71.30 (SD = 10.85). The *t*-test of 1.80 ( $p = 0.073$ ) reflects a fashion toward importance inside the variations determined between the genders, even though it no longer reaches traditional stages of statistical importance.

#### 4.4. Evaluation of one-way ANOVA

One-way ANOVA is a statistical method for assessing the means of three or more impartial companies to see whether there are significant differences between them. By analyzing the variance within every organization and between the corporations, One-Way ANOVA assesses whether or not any located variations in organization means are greater than what would be expected because of random variation. **Table 5** depicts the outcomes of One-Way ANOVA. **Figure 5** despite the findings of the one-way ANOVA, which shows substantial differences in language abilities across various educational backgrounds.

**Table 5.** One-Way ANOVA results for educational background.

Factors	<i>F</i>	<i>df1</i>	<i>df2</i>	<i>p</i> -VALUE
Vocabulary	4.25	3	356	0.006
Listening	3.75	3	356	0.012
Grammar	5.80	3	356	0.002
Reading	3.10	3	356	0.021
Writing	4.90	3	356	0.004



**Figure 5.** Outcomes of one-way ANOVA.

In the context of the analysis of variance (ANOVA) effects for numerous language competencies revealed significant variations across the businesses, especially concerning the effect of biomechanical education and exercise on English learning results. The talent of vocabulary had an  $F$ -value of 4.25 with degrees of freedom  $df1 = 3$  and  $df2 = 356$ , yielding a  $p$ -value of 0.006, indicating a giant effect. Listening additionally showed significance with an  $F$ -value of 3.75 ( $df1 = 3$ ,  $df2 = 356$ ) and a  $p$ -value of 0.012. Grammar exhibited the highest  $F$ -value at 5.80 ( $df1 = 3$ ,  $df2 = 356$ ) and a  $p$ -value of 0.002, suggesting robust importance. For Reading, the  $F$ -value was 3.10 ( $df1 = 3$ ,  $df2 = 356$ ) with a  $p$ -value of 0.021, and Writing demonstrated a  $p$ -value of 0.004 and an  $F$ -value of 4.90 ( $df1 = 3$ ,  $df2 = 356$ ), both showing significant variations across the organizations analyzed. These findings underscore the significance of thinking about how physical training and exercise might influence cognitive competencies, including language acquisition, and skill ability, suggesting that interventions integrating biomechanical training could enhance English, gaining knowledge of effects amongst novices.

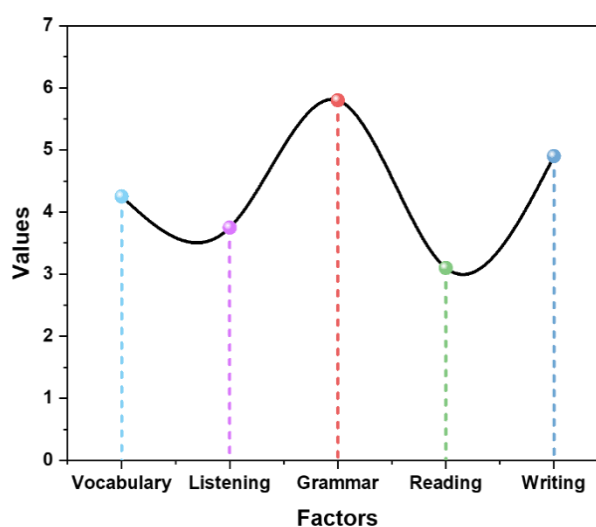
#### 4.5. Evaluation of paired-samples $t$ -test

A paired samples  $t$ -test, also referred to as an established samples  $t$ -test, is a statistical technique that compares the method of measurements taken from the equal man or woman, object, or associated units. **Table 6** depicts the analysis of numerous abilities and discovered widespread mean variations between the two organizations throughout all examined areas, highlighting the impact of biomechanical schooling and exercising on English learning outcomes. For vocabulary, the mean difference changed to 16.85, with a value of  $t$  and  $p$  15.72, (0.001) indicating a noticeably huge distinction. In phrases of listening competencies, the mean distinction was 12.35, showing a  $p$ -value of less than 0.001 and a significant  $t$ -value of 14.05. Similarly, grammar exhibited an average distinction of 14.65, accompanied by a  $t$ -value of 16.55 and a  $p$ -value under 0.001, emphasizing the wonderful impact of the interventions. Reading abilities additionally confirmed promising results, with an average difference of 14.30, a  $p$ -value significantly below 0.001 and a compatible  $t$ -value of 15.45, in addition underscoring the efficacy of the training. **Figure 6** despite the findings of the paired-sample  $t$ -test, reveals statistically significant mean variations in vocabulary,

listening, grammar, reading, and writing abilities following biomechanical training and exercise procedure.

**Table 6.** Paired-samples *t*-test results.

Factors	Mean Difference	<i>t</i>	<i>df</i>	<i>p</i> -VALUE
Vocabulary	13.85	15.72	359	< 0.001
Listening	12.35	14.05	359	< 0.001
Grammar	14.65	16.55	359	< 0.001
Reading	14.30	15.45	359	< 0.001
Writing	15.90	16.70	359	< 0.001



**Figure 6.** Outcome of paired-samples *t*-test.

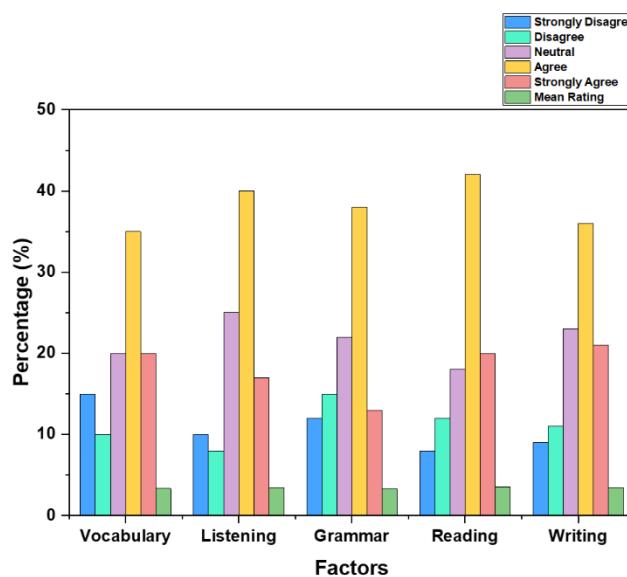
Lastly, writing skills displayed a mean difference of 15.90, with a *p*-value below 0.001 and a *t*-value of 16.70. Collectively, these results indicate statistically significant differences across the evaluated skills, demonstrating that biomechanical training and exercise can play a crucial role in enhancing English learning outcomes.

#### 4.6. Evaluation of likert scale

In the latest assessment of diverse language abilities, contributors furnish their rankings on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). **Table 7** shows the various perceptions of language abilities among respondents. For vocabulary, 15% of respondents strongly disagreed with their skill ability, even as 10% disagreed, 20% remained neutral, 35% agreed, and 20% strongly agreed, resulting in a mean score of 3.35. Listening abilities were rated with 10% strongly disagreeing, 8% disagreeing, 25% neutral, 40% agreeing, and 17% strongly agreeing, leading to a slightly better-implied score of 3.46. Grammar acquired a mean score of 3.25, with 12% strongly disagreeing, 15% disagreeing, 22% neutral, 38% agreeing, and 13% strongly agreeing. **Figure 7** illustrates that the participants had the strongest confidence in their reading skills, followed by writing and listening. Vocabulary and grammar had lower ratings, showing that while there is an overall assessment of growth in language ability, confidence in vocabulary and grammar is less prominent.

**Table 7.** Likert scale assessment of student perception of improvement.

Factors	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean Rating
Vocabulary	15%	10%	20%	35%	20%	3.35
Listening	10%	8%	25%	40%	17%	3.46
Grammar	12%	15%	22%	38%	13%	3.25
Reading	8%	12%	18%	42%	20%	3.54
Writing	9%	11%	23%	36%	21%	3.48



**Figure 7.** Analysis of the likert scale.

In contrast, reading skills had the highest mean score of 3.54, with only 8% strongly disagree, 12% disagree, 18% disagree, 42% agree, and 20% strongly agree. Writing skills also scored well, with a mean of 3.48, while 9% strongly disagree, 11% disagree, 23% neutral, 36% agree and 21% strongly agree. Overall, reading achieved the highest score, closely followed by writing and listening, with slightly lower vocabulary, and grammar. These data suggest that with biomechanical training and exercise, English language learning can greatly enhance this knowledge.

## 5. Discussion

The findings of this learning emphasize the important effects of incorporating physical activity into language acquisition programs, emphasizing the synergistic relationship between physical and cognitive functions. Findings show that students who attended biomechanical training showed remarkable improvement in various language skills. This suggests that the incorporation of physical workouts not only enhances physical well-being but also fosters cognitive improvement, leading to stepped-forward academic consequences. The substantial variations in ratings across distinct language skills indicate that focused interventions can efficaciously cope with precise regions of language learning. Moreover, those effects have important implications for curriculum design, advocating for a holistic technique that includes physical training in language learning applications. This method could improve

cognitive processing and probably lead to higher educational overall performance among college students. The huge variations in overall performance across distinct language talents suggest that centered interventions can efficiently with specific regions of language learning. Furthermore, these findings have critical implications for curriculum layout, advocating for a holistic technique that consists of physical training in language learning programs. This approach can enhance cognitive processing and can lead to better academic outcomes for students. It is especially important to assess the long-term effects of these interventions and explore their applicability to different age groups and learning environments. This will lead to a better understanding of the benefits of this integrated approach.

## **6. Conclusion**

The investigation shows that learning a language and receiving biomechanical education together significantly enhance cognitive abilities, which increases English proficiency across a range of important language domains. According to the statistical analysis of pre-and post-check evaluations, students who participated in physical activities during their language research showed significant improvements in their vocabulary, listening, grammar, reading, and writing skills. These findings support the incorporation of physical exercise as a strategy to both enhance cognitive processing and enhance educational outcomes in language learning, providing curriculum and direction makers with invaluable insights. This study demonstrates how an interdisciplinary approach that combines physical and mental sports can yield more extensive educational advantages. However, additional study is required to determine the long-term effects of this approach as well as its applicability to unique learning contexts, demographics, and subjects beyond language acquisition.

## **Limitations and future study**

The examination focused on short-term effects because the facts have been amassed over educational terms, leaving the lengthy-time period effect of combining physical activity with language studying unexplored. Investigating the outcomes of different kinds and intensities of physical activity on language learning results provides a deeper knowledge of the choicest integration strategies.

**Ethical approval:** Not applicable.

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

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