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Article

Biomechanics intervention promotes college students' English vocabulary acquisition and mental health

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Abstract: The ability to access and use vocabulary effectively is critical to academic performance. Strong English vocabulary is important for college students because they will not only understand course material but also engage in discussion and writing activities, and interact with colleagues and teachers. However, the word order learning can be difficult, often leading to dissatisfaction and decreased desire students. The effectiveness of biomechanical intervention college students improves their mental health and develop vocabulary in English. A total of 145 college students participated in this study. Participants were randomly assigned to group A, which received a biomechanics-based exercise program, and group B, which received a traditional physical activity (PA) program. Participants completed validated questionnaires to measure mental health indicators, including anxiety, stress, and overall well-being. The questionnaires used included the Perceived Stress Scale (PSS), a well-established tool in psychological research. This research conducted tests that assessed various aspects of vocabulary knowledge, including word recognition, meaning, and usage in context. The data was analyzed using statistical methods, including descriptive statistics, t-tests, and regression analysis. ANOVA was to analyze connections between two groups. The data was analyzed using SPSS version 29 software. The results showed that it significantly improved English vocabulary acquisition and cognition health in Group A. These students also reported well, if low, mental health levels of stress and anxiety increased well-being in general. This study emphasizes biomechanics, which can be incorporated into language learning, showing increased PA. Vocabulary acquisition and positively influence mental health. The results showed that significantly improved English vocabulary acquisition and cognition health in Group A. These students also reported good, if low, mental health levels of stress and anxiety and increased well-being in general.

Keywords: biomechanics intervention; English vocabulary acquisition; mental health; college student's

1. Introduction

In education, thinking and teaching can be integrated to improve student learning outcomes. The acquisition of English vocabulary stands out as one of the most important factors in many aspects of language learning, with a significant impact on students [1,2]. English Proficiency Language (EPL) Vocabulary skills are essential for effective communication and other important language abilities such as speaking, listening, developing reading and writing. Learners have difficulties, sometimes leading to disinterest and poor comprehension of the material [3]. The observed inconsistencies between student experiences and effective teaching strategies highlight the urgent need for innovative strategies that improve vocabulary instruction [4,5]. **Figure 1** show the importance of vocabulary learning.

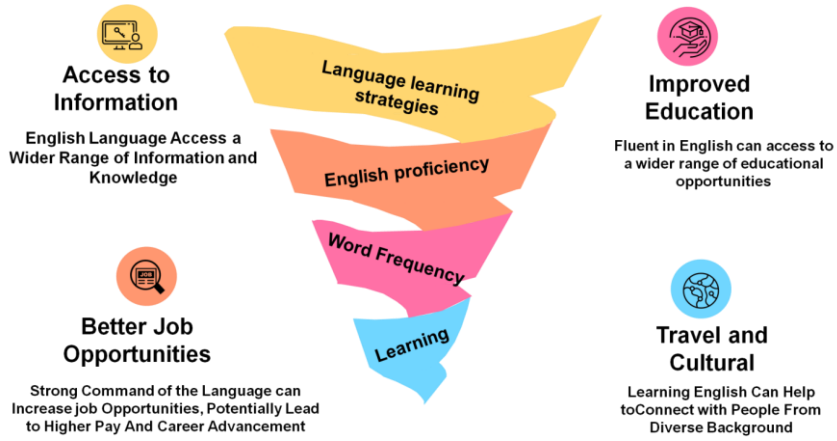

Figure 1. Importance of vocabulary learning.

The role of mental health education in enhancing vocabulary learning, including mental health education (MHE) in vocabulary training, is an appropriate way to move beyond the barriers faced by a learner [6,7]. MHE respects mental health as highly valued and works to promote psychological well-being. MHE can provide a learning environment that meets the emotional and psychological needs of students in addition to fostering psychological development by integrating psychological theory into instructional activities [9–11]. The purpose of the study is to investigate the effects of college students' biomechanical interventions on mental health and English vocabulary learning.

The rest of the paper is articulated as follows: Phrase 2 highlights the literature review, Phrase 3 brings out the methods that were used in this study, and Phrase 4 presents the performance analysis while Phrase 5 provides the conclusion of this study.

2. Literature review

At 218 English foreign language (EFL) students' vocabulary acquisition techniques in an Iranian university were explored in [12]. Findings indicate that there are notable distinctions between postgraduate and undergraduate students. Knowing these techniques could assist the educators in creating the activities and resources that help students to acquire the language more effectively, therefore improving the learning environment. Students at Borneo University of Tarakan could increase their vocabulary with the usage of Duolingo applications. The pre-experimental research utilizing pre- and post-test techniques was used in [13], which involved ten students who practice every day for 30 days. The findings give educators and learners alike a new perspective on Duolingo complements language learning activities. Students felt about a mobile app that helps them to acquire vocabulary and phrases in English. 28 college students used the app for a semester before questions. They liked the app's corrected feedback and found it useful for exams. It was also available from anywhere, and did note however, that the app did not provide much assistance with the communication performance, teachers' messages were not motivated and pronunciation guidance was not used. The results added to students seeing mobile apps for educational purposes were discovered [14].

The mobile-rendered affects the vocabulary learning in EFL students. 49 Taiwanese seventh-graders were enlisted to compare their vocabulary acquisition with video viewers. While the virtual reality (VR) software offered real time interaction and multimodal support, the viewers of the videos had conflicting emotions. It emphasizes the need for more research on mobile-rendered as well as the promise of VR in second language acquisition, as presented in [15]. The link between the English competence of 38 EFL students and their language learning practices. The most popular strategies were the cognitive ones, which were followed by cognitive, emotional, memory, compensatory, and social strategies. Additionally, a strong link between these tactics and students' English competency was discovered by [16]. To create a situational vocabulary learning system based on games and included a competitive approach based on cognitive difficulty. Comparing the approach to traditional situational gaming, learning performance was dramatically increased, especially for low-achieving students. By raising or lowering learners' game levels, the system modified cognitive difficulty to make sure activities were at the right level for each student. Traditional game-based learning was more likely to experience repeated failures. The report recommends more research to investigate this strategy in more detail, as examined in [17].

The vocabulary was learned through digital games from five angles and it was discovered that ten varieties of digital games rule the market. Such games support vocabulary acquisition both short- and long-term, ease understanding, boost motivation, engagement, and encourage communication among students. These results highlight the significance of efficient word-learning strategies for second language acquisition and have implications for vocabulary learning and game design [18]. The students' motivation, problem-solving skills, and vocabulary acquisition in learning EFL were affected when VR was included in problem-based learning (PBL) environments. The result emphasizes how crucial it is to place EFL students in immersion settings to support contextualized learning was determined [19].

The eight conditions were randomly allocated to 240 Chinese primary school children to examine the effects of captioned movies on the vocabulary acquisition of young learners. The best results were obtained with the glossed complete captions, and learning form, meaning, and usage were improved with the usage of the advance organizer technique. It offers educational implications for applying these techniques, as examined by [20]. Chinese EFL learners acquire vocabulary and how task circumstances, multimedia input, and combination affected it. The definition plus information and videos group fared better than the information and definition only groups, according to [21]. The efficacy of vocabulary acquisition was enhanced by the sentence writing activity. The best method was discovered to combine the multimedia information with a sentence-writing assignment.

3. Methodology

In today's learning environment, the ability is to develop a strong vocabulary is important for college students, especially in language learning. A strong English vocabulary not only helps in understanding the course content but also facilitates effective communication with peers and instructors. However, many students

experience difficulties in finding vocabulary, leaving them feeling frustrated and decreased in motivation. Recognizing the interplay between physical health and cognitive performance, this study examines the role of biomechanical interventions as alternative strategies for enhancing vocabulary learning and cognitive well-being. By incorporating the physical activity into language learning, the study aims to identify strategies that can improve both academic achievement and students' overall health. **Figure 2** represents the flow of methodology.

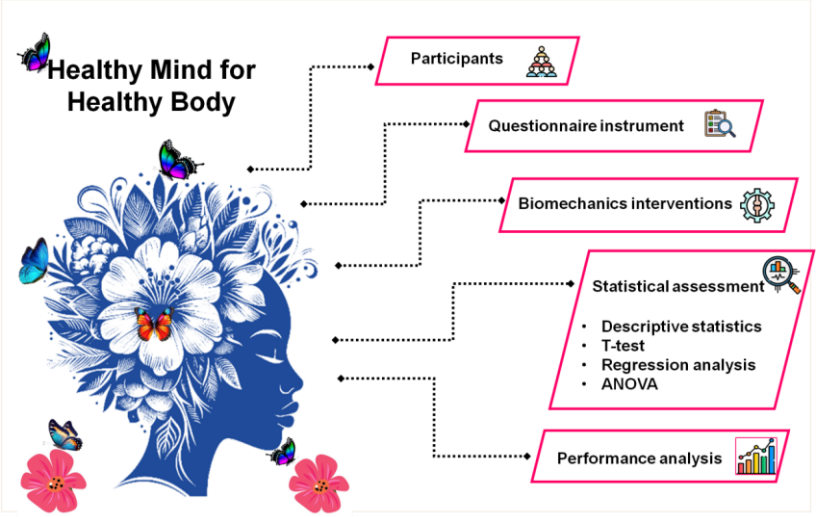

Figure 2. Schematic diagram of methodology.

3.1. Participants

The dataset consists of 145 college students, randomly assigned into two groups: Group A consists of 80 students, which received a biomechanics-based exercise intervention, and Group B consists of 65 students, which participated in a traditional exercise program. Each participant's demographic information, including age and gender, was recorded. This comprehensive dataset allows for a detailed analysis in effects of the intervention of vocabulary acquisition and mental health outcomes.

3.2. Questionnaire instrument using perceived stress scale (PSS)

The PSS measures the individual perceptions of stress, specifically feeling overwhelmed or out of control. For college students, increased perceived stress can negatively affect academic performance, including English vocabulary acquisition, by reducing concentration and motivation. The PSS assesses mental health indicators such as anxiety and overall well-being, and helps to understand the relationship between mental health and language acquisition. By assessing stress levels, this study can examine how interventions such as biomechanical-based exercise programs can reduce stress and improve mental health. Mental health indicators, such as stress levels (SL) and anxiety levels (AL), Overall Well-Being (OW), Word Recognition (WR), Meaning (ME) and usage in context (UC) were evaluated using the PSS instrument. Low levels of stress can increase the cognitive activity, leading to better vocabulary learning. **Table 1** illustrates the questionnaire based on college students of English vocabulary acquisition and mental health.

Table 1. Questionnaire based on college students' English vocabulary acquisition and mental health.

Factors	Question (Q) number	Questionnaire's
SL	Q1	What were the stress levels for participants in both groups as measured by the PSS?
	Q2	In what ways did the biomechanics-based exercise program specifically address the stress management for college students?
AL	Q3	How did the participants' levels of anxiety change after the biomechanics intervention compared to the traditional exercise program?
	Q4	What specific aspects of biomechanics intervention contributed to the reduction of anxiety among college students?
OW	Q5	How did the overall well-being of participants in Group A compare to those in Group B following the intervention?
	Q6	What factors contributed to the improvements in overall well-being for students who participated in the biomechanics intervention?
WR	Q7	What improvements in word recognition were observed in students after participating in the biomechanics intervention?
	Q8	How did the biomechanics intervention enhance the students' ability to recognize new vocabulary in academic contexts?
ME	Q9	How did the intervention influence students understand of vocabulary meanings in various academic subjects?
	Q10	What strategies used in the biomechanics program helped students grasp the meanings of new vocabulary effectively?
UC	Q11	What changes were noted in the ability of students to use vocabulary in context after the intervention?
	Q12	How did the biomechanics intervention facilitate opportunities for students to practice vocabulary usage in real-life situations?

3.3. Significant of biomechanics interventions on college students' English vocabulary acquisition and mental health

Biomechanical interventions are structured with exercise programs that use principles of biomechanics to improve movement efficiency and physical performance. Parallel to these interventions in college education, the specific challenges of students' learning and mental health can be addressed. **Figure 3** presents the significance of biomechanics intervention. By integrating such programs into the curriculum, educational institutions can offer a unique approach, to support the well-being and academic success of all students. The significant factors of the biomechanics intervention are listed as follows:

1) To enhance cognitive function through physical activity (PA): Regular PA has been scientifically proven to stimulate brain activity, improving memory, concentration, problem solving skills and other cognitive functions. For college students, these cognitive developments are crucial for effective learning, especially mastery of complex subjects such as English vocabulary. Students can enhance their brain plasticity, which facilitates better retention and recall of new words, ultimately leading to improved academic performance.
2) Addressing mental health challenges: College life causes a great deal of stress and anxiety, which can negatively affect students' overall academic performance and quality of life. Biomechanical interventions play an important role in reducing this mental illness through exercise, which has been shown to release the endorphin hormone and reduce stress hormone levels. As students participate

in these programs, they experience increased energy, improved concentration, and enhanced emotional regulation, which contribute to a healthier state of mind and a more positive approach.

3) A holistic approach to academic success: Biomechanical interventions offer a holistic approach that integrates PA and academic success for college students. By addressing PA and mental well-being, these programs provide the right environment for effective learning, especially in the acquisition of English vocabulary. As students navigate through their educational experiences, the benefits of such interventions can lead to enhance academic achievement and improve overall life skills, preparing them for the future challenges beyond the classroom.

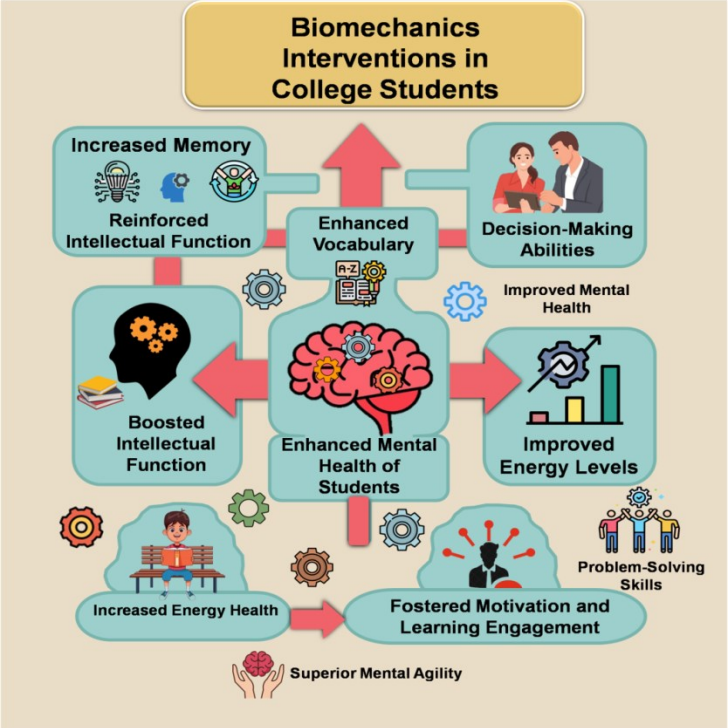

Figure 3. Significant of biomechanics intervention.

3.4. Statistical assessment

This study used statistical methods to assess the effects of biomechanical interventions on college students' English vocabulary acquisition and mental health. Descriptive statistics were used to quantify and baseline participants. The independent t-tests comparing vocabulary skills and mental health outcomes from the biomechanical group (Group A) and the conventional exercise group (Group B), regression analysis examined how frequency and intensity of intervention affect student performance. ANOVA was used to determine significant differences between the two groups. All data analysis were performed using SPSS version 29 software, ensuring rigorous and reliable analysis of findings. The developer of SPSS version 29 is International Business Machines Corporation (IBM). The company's headquarters is in Armonk, New York, USA.

4. Performance analysis

This study examines the effects of a biomechanical intervention on college students' English vocabulary acquisition and mental health. This study aims to investigate how exercise can improve cognitive function and relieve stress, while identifying the challenges students face in mastering vocabulary. A total of 145 college students participated and divided into two groups: one received biomechanical-based exercises and the other performed traditional exercises. The findings could inform how an educational practice supports to the overall student well-being and academic success.

4.1. Demographic characteristics

Population data refer to the statistical characteristics of a population, which is used in this study to understand the makeup of groups. These characteristics can include age, gender, mental health history, PA level, and English proficiency. When examining interventions such as biomechanics and vocabulary acquisition, demographic factors like age and fitness discipline levels can help determine how students respond to efforts aimed at improving mental health and language skills. Understanding these variables ensures that findings apply to different subgroups in the population, allowing for more detailed analysis. Careful analysis of demographic data helps to interrupt the interventions for specific groups and improves overall effectiveness. **Table 2** illustrates the participant's characteristics of college students. **Figure 4a** represents the demographic data of gender and **Figure 4b** shows the mental health history. **Figure 5a** presents the demographic data of PA level and **Figure 5b** depicts the English proficiency. The demographic data of the 145 respondents gives crucial information about the characteristics of the participants. Majority of the participants were male, at 51.7%, and the remaining 48.3% were female. Most of the participants were in the age group of 18-21 years (58.6%), while the rest 41.4% were in the range of 19–22 years. Most of the participants reported mental health problems, including being stressful for 62.1% and getting anxious for 37.9%. In terms of PA, 69.0% reported being active, while the other 31.0% reported to be inactive. 62.1% of the participants' level of proficiency in English was intermediate and it reflects a balance of backgrounds among the participants.

Table 2. Demographic data of participants.

Features	**Characters**	**Range $n = 145$**	**Proportion** (%)
Gender	Male	75	51.7
	Female	70	48.3
Age group	18–21	85	58.6
	19–22	60	41.4
Mental health history	Stress	90	62.1
	Anxiety	55	37.9
PA level	Active	100	69.0
	sedentary	45	31.0
English proficiency	Beginner	20	13.8
	Intermediate	90	62.1
	Advanced	35	24.1

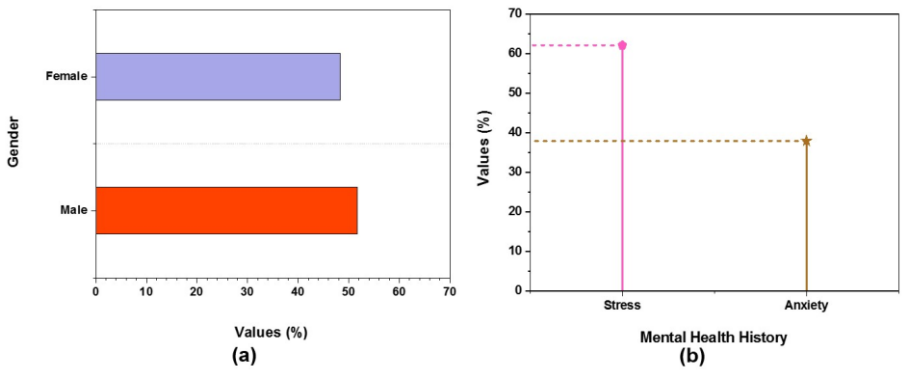

Figure 4. Graphical representation of **(a)** gender and **(b)** mental health history.

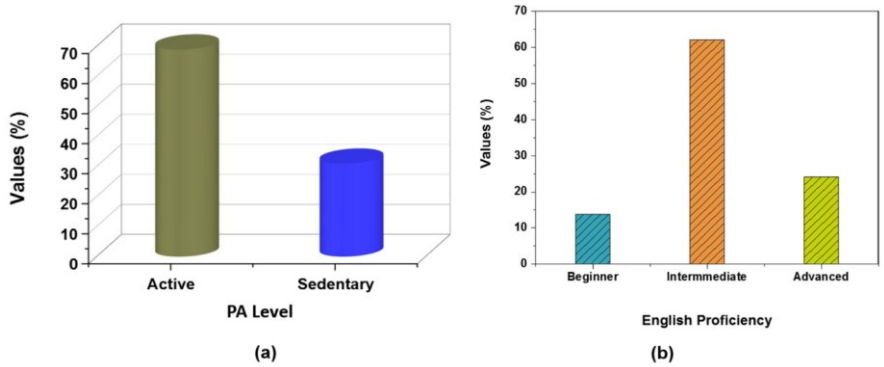

Figure 5. Graphical representation of **(a)** PA level and **(b)** English proficiency.

4.2. Descriptive statistics

Descriptive statistics play an important role in understanding biomechanical process. The descriptive statistics in this study facilitate the examination of mental health indicators such as SL, AL, OW, WR, ME and UC in the given factors. This quantitative study enables to identify the patterns and relationships that emphasize the effectiveness of group A and group B. By analyzing this statistical result, this study highlights how supplemental exercise can improve language skills but also mental health, ultimately contributing to college students' academic performance emphasizes the effectiveness. **Table 3** illustrates the quantitative outcomes of descriptive statistics. Group A has a lower SL ($M = 3.5$) and AL ($M = 3.2$) than Group B, suggesting better mental health. Group B has high SL ($M = 5.8$) and AL ($M = 5.0$). Conversely, Group A has higher OW ($M = 7.0$) and cognitive measures such as WR ($M = 8.0$), ME ($M = 7.5$), and UC ($M = 7.8$). Overall, the results raise significant mental differences between the two groups, which described how various influences would impact overall mental health.

Table 3. Quantitative outcomes of descriptive statistics.

Factor	Group A			Group B		
	Mean	Median	Mode	Mean	Median	Mode
SL	3.5	3.0	2.0	5.8	6.0	6.0
AL	3.2	3.0	3.0	5.0	5.0	5.0
OW	7.0	7.0	8.0	4.5	4.0	4.0

Table 3. (*Continued*).

Factor	Group A			Group B		
	Mean	**Median**	**Mode**	**Mean**	**Median**	**Mode**
WR	8.0	8.0	8.0	6.2	6.0	5.0
ME	7.5	7.0	7.0	5.9	6.0	4.0
UC	7.8	8.0	8.0	6.1	6.0	6.0

4.3. *T*-tests

T-tests are statistical methods for comparing strategies in two groups, making them particularly useful in evaluating the effectiveness of interventions, such as group A and group B, by looking for differences in mental health indicators such as SL, AL, OW, WR, ME and UC in the given factors to determine the importance of intervention effects. The result of the T-test provides insight that biomechanical exercises not only enhance vocabulary acquisition, but also contributes positively to students' mental health. If $p - values$ indicate significance, this indicates that the biomechanical intervention resulted in significant improvements in measured mental health outcomes, highlighting the dual benefits of exercise in language learning contexts. This statistical analysis helps to reinforce that biomechanics, plays an important role in improving the cognitive and psychological aspects of college students' experiences. **Table 4** represents the quantitative outcomes of *T*-tests. The mean of Group A for SL is smaller than that of Group B with $M = 35.5$ whereas the *T*-value is 7.25, and its *p*-value is smaller than 0.001. Similarly, AL in Group A is smaller compared to Group B at $M = 30.0$ with the values of $T = 6.15$ and $p < 0.001$. Group A shows higher levels for OW ($M = 40.0$), WR ($M = 80.0$), ME ($M = 70.0$), and UC ($M = 75.0$), all having a significant difference with a *p*-value of less than 0.001.

Table 4. Quantitative outcomes of *T*-tests.

Factor	Group A Mean	Group B Mean	*T*-Value	Degrees of Freedom (df)	*P*-Value	Significance (S)or not
SL	25.5	35.5	7.25	143	< 0.001	S
AL	20.0	30.0	6.15	143	< 0.001	S
OW	40.0	30.0	8.32	143	< 0.001	S
WR	80.0	70.0	6.75	143	< 0.001	S
ME	70.0	60.0	5.92	143	< 0.001	S
UC	75.0	65.0	6.40	143	< 0.001	S

4.4. Regression analysis

Regression analysis is an important tool in this study related to biomechanics interventions and their effects on English vocabulary acquisition and college students' mental health. Using regression techniques, it can quantify the effects of biomechanics-based exercise programs on various mental health indicators such as SL, AL, OW, WR, ME and UC improvements in vocabulary related skills. In context can be considered, which reveals the direct effects from the process but also provides insight into how these factors interact, ultimately contributing to the role of PA in improving academic performance and psychological well-being in students. Findings

from the regression analysis can inform the instructional strategies and supportive strategies, emphasizing the importance of incorporating PA interventions to create an appropriate learning environment. **Table 5** represents the quantitative outcomes of regression analysis. The SL of Group A ($M = 22.5$) have smaller mean value compared to SL of Group B ($M = 30.0$), and AL of Group A ($M = 18.0$) have smaller mean value than AL of Group B ($M = 25.0$), with negative regression coefficients ($\beta = -7.25\ and\ -6.15$) and p-values of less than 0.001. On the other hand, Group A has a higher OW ($M = 75.0$), WR ($M = 15.0$), ME ($M = 13.0$), and UC ($M = 12.0$) than Group B, which provided empirical evidence for superior mental health outcomes for Group A.

Table 5. Quantitative outcomes of regression analysis.

Factor	Group A	Group B	Regression Coefficient (β)	Standard Error (SE)	*T*-Value	*P*-Value
SL	22.5	30.0	-7.25	1.00	-7.25	< 0.001
AL	18.0	25.0	-6.15	0.90	-6.15	< 0.001
OW	75.0	65.0	8.32	1.05	8.32	< 0.001
WR	15.0	10.	6.75	0.85	6.75	< 0.001
ME	13.0	8.0	5.92	0.80	5.92	< 0.001
UC	12.0	7.0	6.40	0.75	6.40	< 0.001

4.5. ANOVA

ANOVA is an important statistical technique used to assess between-group differences and identify the importance of these differences. In context of effects, Group A on English vocabulary acquisition and mental health PA program Group B. By examining changes in mental health indicators Such as SL, AL, OW, WR, ME and UC. ANOVA is used to assess whether biomechanical interventions result in statistically significant improvements when compared to traditional methods. The results of this study can provide insight into the effectiveness of incorporating exercise into language learning, ultimately revealing the importance of biomechanics in enhancing mental health and academic achievement in college students. **Table 6** represents the quantitative outcomes of ANOVA. For SL, Group A has a value of $SS = 180.00$, indicating a significant difference from Group B that has a value of $S = 170.00$, with the values of $F = 20.15$ and $p < 0.001$. Similarly, Group A's AL has a value of $SS = 140.00$ and OW has a value of $SS = 220.00$, which reveal significant disparities with F-values of 15.45 and 25.75, respectively. WR, ME, and UC also show significant differences, highlighting the positive mental health outcomes for Group A across all measured factors.

Table 6. Quantitative outcomes of ANOVA.

Factor	Group A	Group B	Sum of Squares (SS)	df	Mean Square	*F*-Value	*P*-Value
SL	180.00	170.00	350.00	1	350.00	20.15	< 0.001
AL	140.00	135.00	275.00	1	275.00	15.45	< 0.001
OW	220.00	200.00	420.00	1	420.00	25.75	< 0.001
WR	160.00	150.00	310.00	1	310.00	18.35	< 0.001
ME	120.00	120.00	240.00	1	240.00	12.90	< 0.001
UC	150.00	140.00	290.00	1	290.00	16.80	< 0.001

4.6. Analysis of PSS factors-based questionnaires

The factors of SL, AL and OW marked the questionnaire used to assess the college students to compare the assessment of group A and group B in vocabulary processing measures. To quantify effects is, to highlight the value of integrating biomechanics into educational settings. Overall, the findings highlight the importance of physical activity in enhancing language learning and improving students' mental health. **Table 7** illustrates the values of PSS factor-based questionnaires. For SL, Group A scored higher ($Q1 = 3.5$ and $Q2 = 3.0$) than Group B ($Q1 = 5.8$ and $Q2 = 5.5$), with *T*-values being 7.25 and 6.00, respectively, the differences between the two groups were statistically significant at $p < 0.001$. On the other hand, for AL, OW, WR, ME, and UC, Group A scored greater at all questions, which transforms to healthy mental outcomes, since the *T*-value and the *p*-value were statistically significant, which aided in highlighting the outstanding difference of both groups in all measured factors.

Table 7. Values of factors-based questionnaires.

Factors	Q Number	Group A	Group B	*T*-Value	df	$p-$Value	S or not
SL	Q1	3.5	5.8	7.25	143	< 0.001	S
	Q2	3.0	5.5	6.00	143	< 0.001	S
AL	Q3	3.2	5.0	6.15	143	< 0.001	S
	Q4	3.1	5.2	5.80	143	< 0.001	S
OW	Q5	7.0	4.5	8.32	143	< 0.001	S
	Q6	6.5	4.0	7.10	143	< 0.001	S
WR	Q7	8.0	6.2	6.75	143	< 0.001	S
	Q8	7.5	6.0	5.9	143	< 0.001	S
ME	Q9	7.5	5.9	5.92	143	< 0.001	S
	Q10	7.0	5.5	6.10	143	< 0.001	S
UC	Q11	7.8	6.1	6.40	143	< 0.001	S
	Q12	7.0	5.0	7.00	143	< 0.001	S

5. Conclusion

The findings of this research support the impressive value of introducing biomechanics intervention in the college education environment to reach students. By comparing the results of participants who fell under Group A with those under Group B, this study represents notable advancements over previous related researches, which indicated not only that bio mechanic interventions are beneficial in enhancing the vocabulary of English terms but also that they are beneficial for improving symptoms of mental health conditions such as anxiety, stress, and well-being. Through ANOVA and regression analysis, the study showed that the vocabulary skills which include word recognition and contextual usage have significantly improved in students of Group A while these experience higher levels of stress and anxiety. Hence, these findings highlight the crucial role of exercise activities, especially biomechanics, in creating a learning culture. This study further advocates for including biomechanical interventions in education, which will improve the language skills of college students

as well as their mental health. This holistic educational approach will bring enormous benefits to both learning and self-esteem. However, the study has some limitations. It assumes that the characteristics of the individual might influence the results and cause unmeasured differences. As a result, some kind of validity for findings would arise. In addition, the study excluded follow-up measures, so long-term durability of the observed effects cannot be concluded. Therefore, it is recommended that future studies should be conducted on many biomechanical interventions, exercise techniques, duration, and intensity and compare the effectiveness of various strategies in enhancing vocabulary acquisition and mental health.

Ethical approval: Not applicable.

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

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