SIN-CHN SCIENTIFIC PRESS PTE.LTD.

Molecular & Cellular Biomechanics 2024, 21(3), 441.
https://doi.org/10.62617/mcb441

Article

Innovative exploration of extracurricular physical exercise mode for college students integrating biomechanics and information technology

Weibin Wu

Chongqing Vocational College of Industry and Commerce, Chongqing Open University, Chongqing 401520, China; wuweibin1987111@163.com

CITATION

Wu W. Innovative exploration of extracurricular physical exercise mode for college students integrating biomechanics and information technology. Molecular & Cellular Biomechanics. 2024; 21(3): 441. https://doi.org/10.62617/mcb441

ARTICLE INFO

Received: 29 September 2024
Accepted: 14 October 2024
Available online: 6 December 2024

Abstract: Traditional college physical education courses require innovative methods of instruction in the wave of informatization education to stay with current trends. This study examines novel forms of physical exercise that college students can engage in outside the classroom by fusing cutting-edge information technology and advanced biomechanics. This study assesses the impact of these integrations on student engagement and physical health by utilizing methods including wearable sensors for real-time motion tracking, deep learning algorithms for pattern identification, and augmented reality (AR) for immersive training experiences. To improve the accuracy of reading movement intentions, data from 130 participants, including cardiorespiratory signals, heart rates, and motion imagery, were processed using a Binary Spotted Hyena Optimized Efficient Visual Geometry Group Network (BSHO-EVGGN). The findings show that these technology advancements greatly enhance students' motivation and exercise performance in addition to providing real-time physiological metrics monitoring. The evaluation's findings demonstrate how this strategy, which has received significant student support, considerably raises students' learning performance and engagement. Enhancing the effectiveness and efficiency of teaching physical exercise is made possible by the creative use of physical teaching models in college physical education.

Keywords: physical exercise; information technology; biomechanics; binary spotted hyena optimized efficient visual geometry group network (BSHO-EVGGN); college students

1. Introduction

In recent years the physical activity in the college student's life, the biomechanics and IT have been used in the improvement of physical exercise modes and have been accepted as significant assumptions. To propose enhancements to the exercise experiences leading to better solutions [1]. Consequently, biomechanics helps in explaining the motion of the body and enhancing the training sessions. Knowledge of biomechanical concepts regarding different human motions will enable the learner to carry out athletic movements more effectively and with the least injury likelihood. It derived from here is that when studying the pattern of movement, it becomes easier to intervene with the set aims of improving movements and paring instances of injuries in cases of an eventuality [2]. When biomechanics is used in conjunction with information technology, then it can assist in the designing of exercise regimens that will meet each student's needs. Thus, the data on the movement patterns and the physiological reaction of a student can be gathered, and more personalized training plans can be designed. That can also enhance the students' compliance level with the exercise regime which is of paramount importance in enhancing health [3]. The application of AR and virtual reality (VR) is an object that is designed to train the physical activity of the students to increase their performance. From this, it is clear that workout missions can transform ordinary exercise modes into a possible adventure, and so workouts are interesting. Not only does this innovation help capture the student's attention but also compels them to consider multiple physical education activities [4]. Sports players, fitness qualifications, and information technology (IT) specialists work together to deliver effective solutions for exercise. With them, they can create more complex programs in which they may apply biomechanics and other technologies to enhance the students' performances. The above-synchronized activities will help college students to integrate physical activity into their normal lives [5]. Furthermore, the application of the different exercise modes may lead to the identification of different exercise forms that fit other concerns. Because the types covered are diverse, students might be able to find something they like regarding physical activities. Ideally, this diversity helps achieve the ultimate goal of embracing long-term physical exercise [6].

It also helps to overcome the difficulties resulting from the existence of sedentary forms of life and work by adopting the new modified physical exercise modes. It is well known that the academic schedule of most colleges does not allow students to dedicate the necessary time to physical training. Therefore, the exploration of the integration of technology and biomechanics is to establish efficient exercise modes to assimilate with their way of life [7]. As this innovation process progresses, it becomes important to ask students for their feedback to ensure the programs. Through understanding this it will be possible to have future exercise mode developments that are sensitive to their nature and keeping them interested and engaged. It will thus help in the process of attaining better physical fitness of college students in the future as may be deemed in this process in the future [8]. While this new endeavor is being undertaken feedback on the programs should be sought from the students to make all the necessary changes constantly. Their preferences and experience will also be studied in upcoming developments to ensure that the exercise modes are not boring to the people. It would just be a cycle and continuous improvement of general fitness among college students, thus enhancing the intended aim and objective [9]. The biomechanics and information technologies will therefore shape the development of college physical exercise. Thus, by utilizing such a progressive approach, it will be possible to guide current and future learners to integrated healthy lifestyle solutions. In conclusion, the fields represent the potential of restoring novelty to college fitness for the enhancement of active living [10].

1.1. Motivation of the study

The desire to raise student performance and participation in college sporting activities within a quickly changing technological environment made this study effective. Through the combination of novel technological advances and advanced biomechanics the study endeavors to generate customized and engaging exercise regimens that meet the needs of present learners. This study aims to promote healthy habits and increased physical activity, realizing that traditional methods might not be sufficient and to create a dynamic and productive educational setting in higher education.

1.2. Contributions of this study

- Biomechanics and IT combine to provide accurate physical performance monitoring and analysis, allowing for individualized training schedules as well as individualized responses to students.
- Research employing biomechanical principles can lessen the harness of sports among students at colleges evaluate physical-activity-related damage risk factors and encourage secure physical activity habits.
- Through activities and real-time data appearance technological advances that include wearables and systems that can make exercise engaging and readily available to students increase their involvement in it.
- The study advances the creation based on evidence of a physical education curriculum that directs future regulations for physical exercise and extracurricular activities. These regulations employ the assessment of data to understand patterns in student participation and their implications on health.

1.3. System overview

The association of the article is arranged as follows: Part 1 will deliberate the introduction of the study; Part 2 illustrates the related works; Part 3 provides Methods; Part 4 includes the results and a discussion. Part 5 presents the conclusion

2. Related works

The suggested method for expert game education in digital mediums was based on the Knowledge Coach System (KBCS), which was based on a universal basis and integrated AI and human-computer interactions (HCI) approaches [11]. It was employed in table tennis instruction to evaluate athletes' performance based on movement identification, striking platform categorization, and play characteristics. Studies revealed that KBCS improves serve-return trajectory performance in back-spin and slight-spin modes, and the accuracy increases with decreased service velocity.

In assessed how students' curiosity, inspiration, applicability, and instructional experience were affected by mobile applications used as educational tools in applied biomechanics [12]. There were seventy-six undergraduates studying applied biomechanics in a quasi-experimental approach. The experimental group performed better overall, regarding levels of interest, application, and general appraisal of the practical sessions, according to the results. There were noticeable variations in conceptual learning based on the Kinematic Lab Get© program. According to the study, apps have a favorable impact on university students' learning attitudes.

The low-tech instructional strategies tasks were viewed in students and how well they understood biomechanical principles [13]. The findings demonstrated that students' comprehension of biomechanical ideas had increased, especially in the case of individual tasks. However, think well of group-based activities. According to the study, biomechanics teachers should explain their pedagogical stance and progressively introduce both individual and group projects that include active learning.

To identify biomechanics changes in runners at leisure throughout low- and high-intensity training sessions, that research investigated the application of multilayer functional models [14]. It examined differences between different model levels through evaluating previous research and putting out a novel hypotheses test. Although there were little variations between the two workout types according to the data, prudence was urged because human gait patterns vary widely.

Key performance indicators and comprehensive data, including kinematic, motion, and electro-myographic data, were provided by these sensors [15]. The best sensors for sport biomechanics purposes include electromyography, force sensors, and inertial sensors. Electromyography and force sensors were still useful, even if inertial measurement devices were the most common. That work aided in the understanding of contemporary sports performance evaluation technology by researchers, players, and coaches.

The purpose of the research was to create a trunk-supporting stability training program that would be beneficial for students attending colleges [16]. The program focused on developing the shoulder blades, trunk, and buttocks muscles of sprint athletes in addition to limb control. It also aimed to strengthen, balance, and stabilize these muscles. Eight weeks of training and recruitment were spent with twenty undergraduate students from Xi'an Sports and Recreation University. The program had a considerable influence on college students who received physical education, as seen by the results.

To determine the effect of the Pilates machine experience on central motivation and imposing co-contraction, research contrasted 32 Pilate practitioners with non-practitioners [17]. According to the research, more seasoned Pilates instructors were able to better promote the core muscles located in the body and lower back, which improved pelvic and trunk stability. Additionally, a moderate association between the contraction of muscles and core stability was discovered by the study, with greater and more precise mobility segmental motions being a consequence of better trunk stability. All things considered, pilates was a useful kind of exercise for treating musculoskeletal conditions.

The anatomical and biomechanical alterations that occur in adults when they run. Comparing the results to younger respondents, the older individuals displayed decreased joint power, greatest strength, stride duration, and density of bone minerals [18]. However, there were no apparent relationships between age and the effect factors. The physical strength features and joint working for older athletes were shown to be weaker, indicating that enhancing dynamic joint function and exercising lower limb muscles could assist in preventing running-related injuries.

Developing biomechanical comprehension of loading and training specificity was the primary development of the study [19]. It analyzed data from eight workouts and six male runners executing block starts using joint kinematic and intra-limb coordination studies. The findings demonstrated that every workout can enhance proximate to in-phase extension coordination between joint mechanisms and overload pertinent joints' kinematic properties. According to the research, choosing an exercise program should take into account both task-specific synchronization characteristics and competitive motor task replication.

A study looked at how walking kinematics and the contraction of muscles were impacted by twelve weeks of bare running training in adult males with pronated feet [20]. Peak contact vertical and horizontal ground reaction forces significantly changed in the treatment group when they ran a few meters on the sand. Additionally, training improved the activity of the massive lateral, suggesting that the physical activity program improved the movements of the muscles in the lower limbs and effectively absorbed ground reaction pressures.

Dynamical sequences impact mechanical motions in the individual's body, yet dynamics are frequently ignored in research [21]. Responses to stress as well as private choices impact the constantly shifting base of motion laws. Biomechanical acquisitions can assist in analyzing and managing human mobility difficulties, but they require additional information and actions for optimal implementation. Additional interventions were required for the incorporation of mechanical acquisitions.

Using self-efficacy, behavioral intelligence, rating of exercise, and individual well-being questionnaires, examined the variables affecting the individual college student's well-being [22]. The findings indicated the correlation between confidence, psychological intelligence, individual happiness, and physical activity. Exercise involvement and subjective well-being were controlled by self-worth and psychological ability. According to the study's findings, exercise engagement raises the individual state directly as well as indirectly through enhancing self-efficacy, emotional regulation, and application skills, which in turn raise happiness as well as life satisfaction.

Although biomechanical data may be collected by wearable technology silently and for extended periods, nothing was being done to support these assertions with the biomechanical study examined [23]. Clinical and diagnostic medical decision-making may benefit from machine learning (ML) technologies. For sports biomechanics in injury prevention, quantum sensors are essential for damage prediction. The lack of predictors has limited current efforts, and athletes need to be taken into account while creating work-related injury prevention measures.

Sports biomechanics applications in the management and prevention of sports injuries were investigated in the study [24]. It draws attention to how important discipline is for maximizing athletic performance, avoiding injuries, and easing recovery. Important concepts like kinematics and kinetics are covered, in addition to biomechanical evaluation methods like electromyography and motion capture devices. Prospects for the future include multidisciplinary cooperation, artificial intelligence (AI), and machine learning (ML).

Football biomechanics is a branch of study that uses mechanics to enhance output and reduce the risk of injuries. Using viewer software (VOS) viewer software, a bibliometric study of 951 documents was carried out. Research has significantly increased, according to the survey, especially those published in journals with an immense impact [25]. The clustering study exposed seven different surfaces of football biomechanics, emphasizing how complex it was. The results demonstrated the field's increasing significance.

Research gap

Traditional college physical education courses frequently fail to effectively involve students, particularly in a time of advanced technology period. The inspiration and skill growth requirements of students in physical education are not sufficiently satisfied by current instructional approaches. Additionally, students are unable to participate in and get involved in extracurricular activities due to an absence of unique and immersive ideas. To address these issues through real-time monitoring of movement, deep learning (DL), and immersive consumption roles, attempts to find and apply the proposed method BSHO-EVGGN that makes use of biomechanics and information technology. The ultimate goal is to increase engagement among students, inspiration, and physical wellness effects in college settings.

3. Research methodologies

The methodology involves data collection through wearable sensors, followed by a data pre-processing procedure using *z*-score normalization, principal component analysis (PCA) for the feature extraction, and the confusion matrix between exercise modes and performance metrics on college students is determined through accuracy, recall, precision and f1-score and AI.

Figure 1 depicts the proposed methodology of the workflow by including the suggested parameters to improve the innovative exploration of extracurricular physical activity among students.

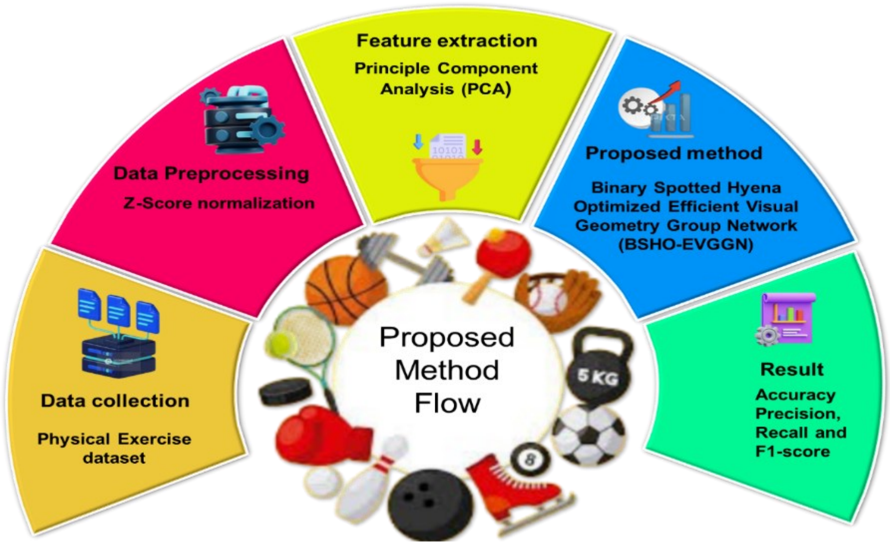

Figure 1. Block-diagram of proposed technique.

3.1. Data preparation

This research gathers the data from Kaggle [26].

A total of 130 people participated in training and competition in 11 different sports, and 168 cardio-respiratory datasets were collected by employing wearable sensors and portable equipment to create Sports Database 2.0. Every dataset consists of cardio-respiratory signals (electrocardiogram, RR-interval series, and breathing-rate series), training observation data (sport-dependent training protocol), and demographics. Athletes' health can be automatically monitored by this dataset. It can be used to validate the efficacy of wearable sensors and portable devices in sports, develop data analytics methods and intelligent applications to support sports sciences and investigate the cardiorespiratory physiological processes caused by sport.

3.2. Data preprocessing using *z*-score normalization

Normalization belongs to the most important preprocessing techniques in data which aims at scaling the values of numerical attributes to the range of one. This is important especially when analyzing biomechanical and cardiovascular data from technological sensors such as wearables, because allows for different parameters to be quantified on the same scale.

***Z*-score normalization**

Z-score normalization is intended to modify each valuew_j. From attribute $F$by normalizing it to a standard score through the mean and the standard deviation of a given data set. This technique is useful in preprocessing as it facilitates the ability to compare different exercise metrics across each other while eliminating scale from affecting the participant's physical performance. The Z-score normalization is expressed in Equation (1).

$$w' = \frac{w_j - \mu}{\sigma} \tag{1}$$

3.3. Extracting features by employing the principal component analysis (PCA)

In feature extraction, the various irrelevant traits are removed, and only relevant features are chosen for the classification of the program. In this study, PCA is a form of linear data reduction technique that provides direction components that point to maximal variance. They are implemented in the context of the biomechanical and cardiovascular data acquired from the wearable sensors to select the features for analysis. The PCA process involves.

Stage 1: Determine the N-dimensional signal samples' covariance matrix of order $M{\sim}M$ by Equation (2).

$$\Sigma = \frac{1}{M}\left\{\{w - \overline{w}\}(w - \overline{w})^S\right\} \tag{2}$$

where w is the mean vector of the given signal matrix, which is made up of N data points of dimension M each.

Stage 2: Determine the diagonal elements of matrix M and matrix U of eigenvectors as the eigenvalues of the covariance matrix$w$, given in Equation (3).

$$U^{-1}\Sigma U = C \tag{3}$$

Stage 3: The eigenvectors in C should be sorted according to their declining Eigenvalues.

Stage 4: The data can be displayed in terms of an ordered set of Eigenvectors by creating a dot product between the given data and the Eigenvectors.

Stage 5: Select the first principal components based on the percentage of variation each contains.

3.4. Improving movement intervention with binary spotted hyena optimized efficient visual geometry group network (BSHO-EVGGN)

Improving the methodology with Binary Spotted Hyena Optimized efficient Visual Geometry Group Network (BSHO-EVGGN) describes a novel approach to human movement analysis and interferential strategies enhancement. This paper combines the BSHO algorithm with the efficient Visual Geometry Group Network (EVGGN) to enhance the detection and classification of motion patterns. The BSHO algorithm uses various behaviors related to the movements of the spotted hyenas and applies them in adjusting network parameters about movement assessments. As such, it can be useful in real-time analysis of biomechanical abnormalities and thus appropriate in sports. Finally, the BSHO-EVGGN system is used to facilitate optimum movement planning by providing detailed information on movement patterns leading to performance optimization and injury risks.

3.4.1. Visual geometry group network (VGGN)

The VGG model combines biomechanical and informatics and is modified to improve the examination of the fitness paths of undergraduates. In contrast to conventional CNN models, VGG employs several successive 3 × 3 kernels of convolution rather than sizes. This design decision keeps the receiver field homogeneous while lowering the total number of training the variables, allowing an improved architecture. The gathering of tiny convolution kernels allows more sophisticated knowledge of biomechanics. Movement interventions can be more precise provided important spatial hierarchies are captured by convolution layers of receptive field computation models. This new strategy attempts to encourage physical exercise behaviors among students using data-driven insights and individualized are shown in Equation (4).

$$q_m = (q_{m+1} - 1)T_m + l_m \tag{4}$$

where q_m is the size of the receptive field of the layerT_m is the convolutional kernel layersize and T_m is the convolutional stridesize.

All hidden layers of the VGGN model are put through to the rectified linear unit (ReLU) activity to improve the analysis of undergraduate students' fitness pathways. The model successfully lessens the gradient missing issue, which is crucial for deep neural network (DNN) training, by utilizing ReLU in Equation (5).

$$e(w) = \max(0, w) \tag{5}$$

Nonlinear visualization can boost the health monitoring capacity and it is analogous to the ReLU function. Every data monitored i, j, is used in the feature graph is computable based on Equation (6).

$$b_i^j = e\left(\sum_{i \in N_i} \omega_j^i b_j^{j-1} + a_i^j\right) \tag{6}$$

where ω_j^irepresents the j^{th}value of the feature kernel at the level i, which links all layers with the i features graph N_i symbolizes every feature graph linked by the j^{th}layer i feature graph. The cost function corresponds to cross-entropy, which is shown in the following Equations (7) and (8).

$$Loss = -\left[\sum_{j=1}^{m}\sum_{l=1}^{3}\hat{z}_l^{(j)} log\left(z_l^{(j)}\right)\right] \tag{7}$$

where m the number of training instances is, Z_l^j is the j^{th} training and an instance of the l^{th} forecast results, and Z_l^j represents the l^{th} true result of j^{th} the training instance.

$$z_l^{(j)} = \frac{f^{\theta^{(l)} S_w^{(j)}}}{\sum_{i=1}^{3} f^{\theta^{(i)} S_w^{(j)}}} \tag{8}$$

3.4.2. Binary spotted hyena optimization (BSHO)

The Hyenas inhabit groups including over one hundred individuals. Typically, they hunt in packs. Hyenas come in four different varieties spotted, stripes, brown, and aardwolf. The largest and strongest predator among the hyena species is the spotted hyena. They make a noise similar to an individual's chuckle to exchange messages. It is created with a metaheuristic method called Spotted Hyena Optimization (SHO) which resembles the spotted hyena's hunt habits. It is easier to use than other heuristics because of its straightforward algorithmic structure, among other benefits. It prevents solutions from being trapped in their optimum. It is more capable of exploration and exploitation. The development speed of SHO is significantly faster owing to the constant shrinking of search space.

The SHO was created to address ongoing optimization issues. SHO is not an easy fix for discrete problems. The binary version of the SHOBSHO has been proposed as an approach to this problem.

Because all variable's solutions are limited to one and zero, the binary-encoded technique of BSHO replaces the float-encoding approach of SHO. It is suggested that spotted hyenas use a position-updating method that increases local search proficiencies to locate superior solutions in binary search spaces. To accomplish this, a tangent hyperbolic functional is employed to update the location of spotted hyenas. The method of clustering is the main difference between BSHO and two other versions of the metaheuristic methods Only "0" and "1" are used to alter places in BSHO. The search space's dimension falls. The following is an equation of the formation of clusters in Equation (9).

$$D_g = R_l + R_{l+1} + \cdots + R_{l+M} \tag{9}$$

where D_g represents the cluster of ideal answers that the suggested algorithm produces in Equations (10) and (11).

$$w_c^{t+1} = \begin{cases} 1, & S(D_g \geq rand) \\ 0, & Otherwise \end{cases} \tag{10}$$

$$S(D_g) = \tanh(D_g) = \frac{\left(exp^{-\tau(D_g)} - 1\right)}{\left(exp^{-\tau(D_g)} + 1\right)} \tag{11}$$

where the variable rand represents a random number taken from a uniform distribution

[0, 1]. BSHO is w_c^{t+1}, where $e$denotes a dimension and t, an iteration number, is 1.

Algorithm 1 illustrates that BSHO-VGGNim proves the existing performance in different applications by adding BSHO to the VGGN architecture. The algorithm is initialized by creating a population of hyenas that are equivalent to potential solutions. A comparison of performance metrics is done on the dataset to determine each hyena's fitness. After that, the positions of hyenas are adapted by the algorithm according to their fitness scores using both exploration and exploitation methods. It is believed that this kind of mixed strategy is the best solution for the tuning of VGGN parameters and is most optimal in desired task performance while keeping the search in balance with convergence.

Algorithm 1 Binary spotted hyena optimization with visual geometry group network (BSHO-EVGGN)

```
Initialize parameters for BSHO
Initialize VGGnet model architecture
 Define the fitness function for BSHO
function fitness function(data):
    Forward pass through the VGGnet model
    predictions = VGGnet.forward(data)
 Calculate loss (e.g., cross-entropy)
Loss = calculate_loss (predictions, true_labels)
Return loss
 Main optimization loop
For iteration in 1\ to max_iterations:
 Generate a population of spotted hyenas
    population = initialize_population(num_hyenas)
 Evaluate the fitness of each hyena
    For hyenas in the population:
        data = preprocess_data(hyena.position)
hyena.fitness = fitness_function(data)
 Update positions based on the BSHO algorithm
    For hyenas in the population:
update_position(hyena)
 Identify the best solution (lowest fitness)
best_hyena = find_best_hyena(population)
 Final evaluation using the best parameters found
final_model = VGGnet
final_model.train (data, true_labels, best_hyena.position)
 Save or return the final model
return final_model
```

4. Experimental results

The results suggest the incorporation of biomechanical and information technology considerably improves student participation and physical achievement in extracurricular activities. Students' views about physical activity and their involvement have shifted significantly as a result of real-time activity monitoring, DL information, and AR. These developments are also enhancing motivation and health outcomes.

4.1. System configuration

The results of this research are performed by utilizing certain hardware and software specifications and the system configurations are provided in **Table 1**. The proposed BSHO-EVGGN technique's performances for carried out by utilizing the Python 3.8 version language.

Table 1. System configuration.

Components	**Details**
Operating system	Windows 10
RAM	16 GB
Programming language	Python
Version	Python 3.8

4.2. Evaluation criteria

The proposed methodology BSHO-EVGGN uses the performance metrics with accuracy, recall, F1-score, and precision used for the comparison with 11 different kinds of sports for better outcomes.

- Accuracy measures the overall accuracy of the model by calculating the ratio between the correct predictions and the total predictions (Equation 12).

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{12}$$

- Precision refers to the quality of predictions, and Equation (13) measures the ratio between true predictions and all predicted positive forecasts.

$$Precision = \frac{TP}{TP + FP} \tag{13}$$

- Recall is also known as sensitivity. The capacity of the model to identify all information within a relevant class. Divide the total number of positive results by the total number of false negatives to determine the recall using Equation (14).

$$Recall = \frac{TP}{TP + FN} \tag{14}$$

- To identify class-imbalanced datasets, the F1-score is superior to accuracy. The F1-score occurs in the actual values of precision and recall when they are similar in value. It appears to be the lower of the two metrics when recall and precision using Equation (15) are widely distant.

$$F1 - Score = 2 \times \frac{Precision \times Recall}{Precision + Recall} \tag{15}$$

4.3. Outcome of proposed method BSHO-EVGGN

The proposed method BSHO-EVGGN includes a confusion matrix of 11 different sports and the performance metrics are employed for the comparison such as recall, accuracy, precision, and F1-score for the better involvement of students at extracurricular activities.

Figure 2 displays the confusion matrix for 11 sports features. For each activity, true positives (TP), false positives (FP), true negatives (TN), and false negatives (FN) predictions are examined as a confusion matrix, which displays the effectiveness of the BSHO-EVGGN. This confusion matrix helps in understanding the model's precision in accurately categorizing each student and the instances in which they have incorrectly labeled the emphasized regions. By dissecting this matrix, one can learn more about the model's advantages and disadvantages, which can help design a classification strategy for a more accurate assessment of student performance.

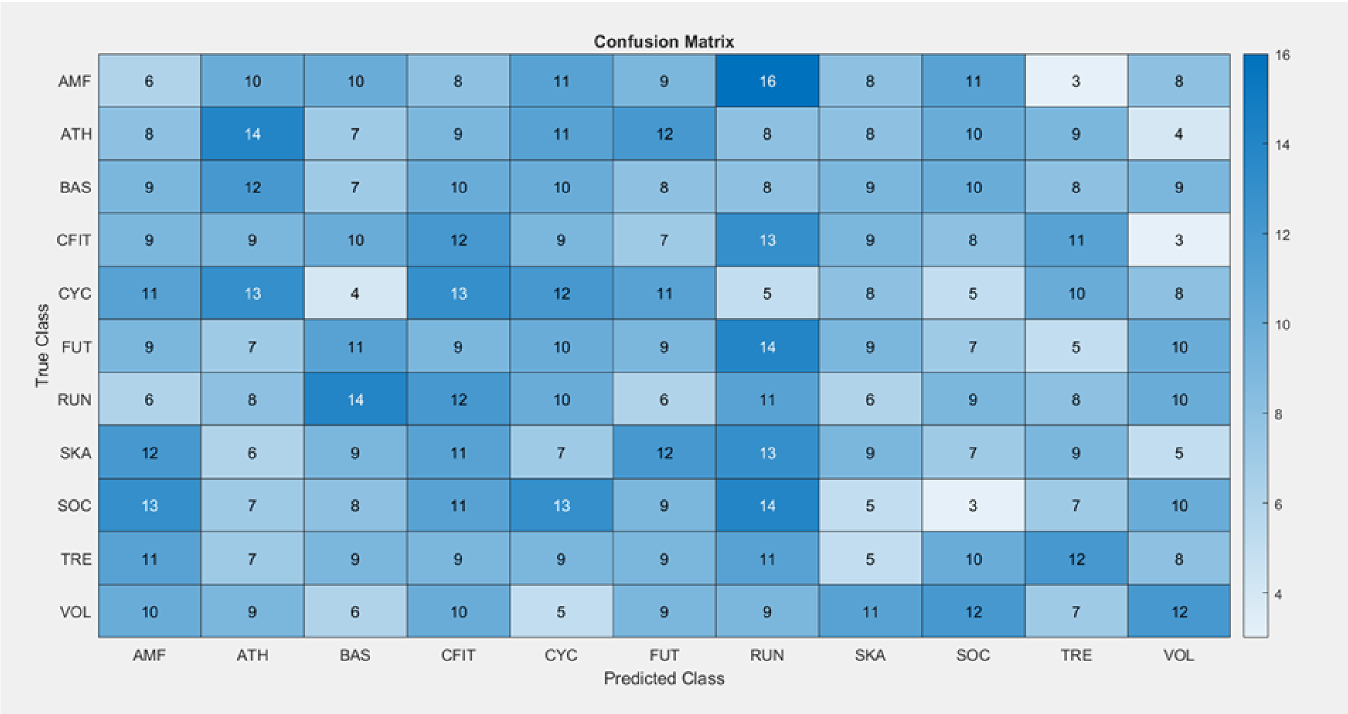

Figure 2. Confusion matrix of sports attributes.

Accuracy and precision data for various play styles are shown in the following **Table 2** for each student. All athletes' accuracy is 0.85, with precision at 0.80, suggesting that the classification system is reliable. Basketball has the best player identification, with an accuracy of 0.90 and 0.85 precision respectively. In progression, the accuracy and precision values for CrossFit and cycling are 0.88 as well as 0.87, respectively, 0.82 and 0.81 for cycling. Soccer has an accuracy of between 0.72 and a precision value of 84. With 0.81 accuracy and 0.76 precision, volleyball exhibits the lowest performance criteria, highlighting areas that still require improvement.

The comparison between accuracy and precision based on various sports attributes is shown in **Figure 3** by the BSHO-EVGGN models' performance. Accuracy determines the overall accuracy of the forecasts and precision assesses the workability of the classification by evaluating the ratio of the precise recognition of those positive results within all the positive outcomes provided. The figure also reveals that basketball receives the highest accuracy value and precision which can be seen as having high model performance. The rest of the sports such as running and CrossFit sport also show competitive performance. Including these two metrics, the figure shows the significance of the equal consideration of both model completion and student involvement for sports analytics for better performance in categorization approaches.

Table 2. Accuracy and precision values for students' sports attributes.

Sports attributes	Proposed Method [BSHO-EVGGN]	
	Accuracy	**Precision**
AMF	0.86	0.82
ATH	0.85	0.80
BAS	0.90	0.85
CIFT	0.88	0.82
CYC	0.87	0.81
FUT	0.84	0.72
RUN	0.89	0.84
SKA	0.83	0.79
SOC	0.86	0.83
TRE	0.82	0.77
VOL	0.81	0.76

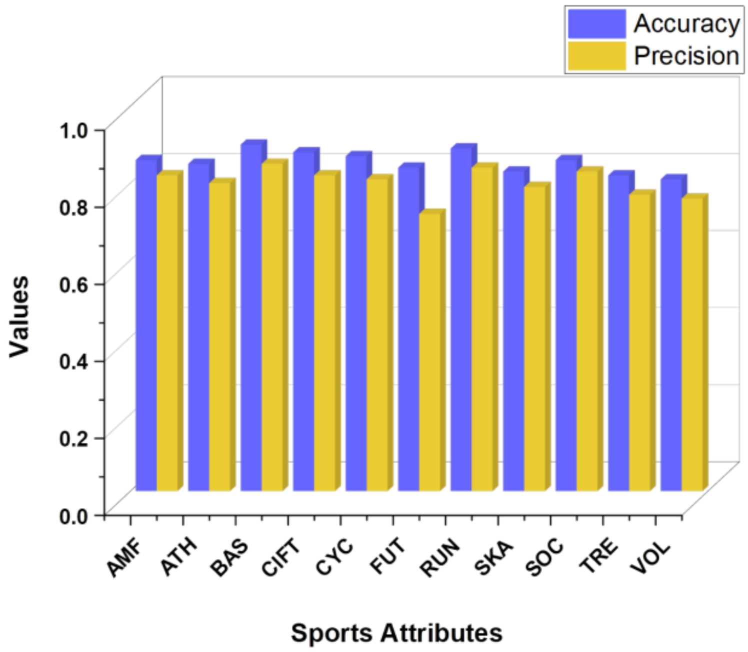

Figure 3. Comparison of accuracy and precision metrics.

The recall, as well as F1-score values for various sports features across students, is displayed in **Table 3**, which additionally shows how the classification model recognized the performance of students. Basketball has the highest recall of 0.88%, demonstrating the real existence of individuals in this sport. Recall gauges the model's capacity to collect genuine scores. Basketball leads the way at 0.87 in the F1 score, which balances the score and recall. Whereas soccer and volleyball show lower results (0.84, 0.83) and (0.76, 0.74), additional sports like running and CrossFit display comparable measures of recall and f1-score values (0.86, 0.85) and (0.85, 0.86), suggesting potential for development in the equal distribution of students in those attributes. These results show how well the models exhibit sports attributes.

Table 3. Recall and score of sports attributes among the students.

Sports Attributes	Proposed Method [BSHO-EVGGN]	
	Recall	**F1-Score**
AMF	0.84	0.85
ATH	0.82	0.81
BAS	0.88	0.87
CIFT	0.85	0.86
CYC	0.83	0.84
FUT	0.75	0.78
RUN	0.86	0.85
SKA	0.80	0.79
SOC	0.84	0.83
TRE	0.78	0.77
VOL	0.76	0.74

The comparison of F1 scores and recall values for different sports attributes in the process of evaluating the performance of student involvement is represented in the form of **Figure 4**. The F1-score is adopted from the F1 measure that calculates the harmonic median of recall and precision which enables an accurate evaluation of the framework, while recall determines the model's performance in terms of true identification. The figure shows that basketball displays the highest values of both measures and the ideal classification has been achieved. There are also such sports as running and CrossFit where the scores indicate an obvious comparison. This comparison argues that both these metrics are useful in the assessment of the efficiency of BSHO-EVGGN in the sports region.

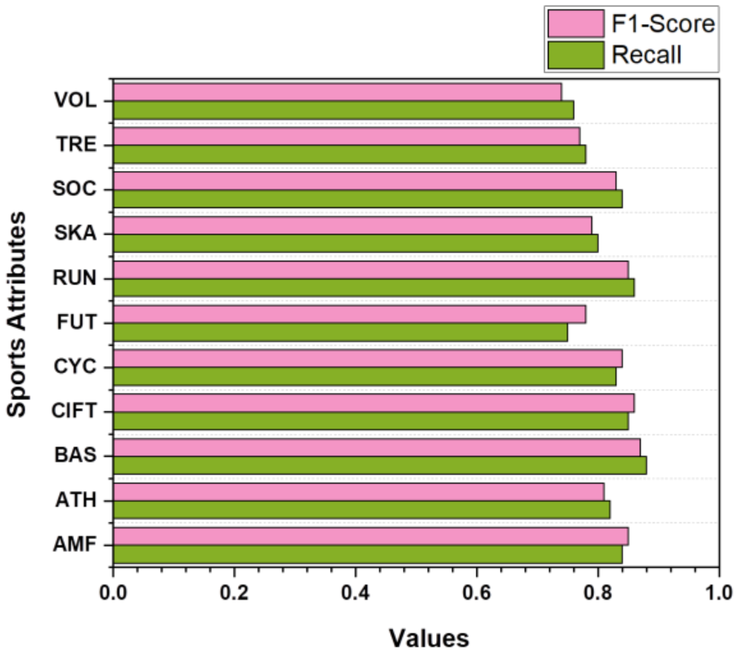

Figure 4. Comparison of f1-score and recall metrics.

4.4. Discussion

The BSHO-EVGGN technique emphasizes the significant influence of integrating biomechanics and information technology in enhancing student participation in sports through the unique examination of more physical exercise activities for college students. The model is effective in categorizing students into different sports activities, with basketball distinguishing the performance matrices that include accuracy, precision, recall, and F1-score. The beneficial basketball result indicates that performance and involvement can be maximized by focusing on the interventions. Further educational programs can be informed by the thorough analysis presented by the confusion matrix and academic measures, providing that it generates a classroom that is more inclusive and engaging for all the students. This proposed method improves college student's physical fitness and develops their overall well-being. It demonstrates the potential for improving knowledge of physical activity initiatives and their influence on student involvement and the benefits of the proposed method BSHO-EVGGN for the best outcome to ensure the accurate outcomes.

5. Conclusion

In the modern age of information education, traditional college courses in sports need innovative approaches to instruction to maintain with modern technology. By employing modern biomechanics and information technology, the study investigated innovative physical fitness plans that college learners can participate in outside of the classroom. The utilization of wearable sensors for real-time motion monitoring, deep learning techniques for pattern recognition, and AR for immersive training experiences, the research evaluated the effects of those integrations on student engagement and physical health. Data from 130 participants, comprising cardiorespiratory signals heart rates, and motion imagery, were analyzed using the BSHO-EVGGN to increase the accuracy of determining movement intentions. There are 11 sports features were employed for the result performance AMF, ATH, BAS, CIFT, CYC, FUT, RUN, SKA, SOC, TRE, and VOL with various parameters like accuracy, recall, F1-score, and precision. The results demonstrated that these technological developments provided real-time physiological measurement monitoring and significantly improved the motivation for learners and exercise performance. Based on the evaluation, students' learning performance and engagement were significantly improved by the proposed BSHO-EVGGN technique which received significant support from students. The innovative application of physical teaching methods in college physical education provided improved efficacy and efficiency in the instruction of physical activity.

5.1. Limitations

This research has some problems that limit its applicability, a limited number of participants, and possible self-selection bias. Also, the demand for specific technological tools can limit extensibility. However, the biomechanics-technology interface also lacks research and study generalizability about an inclusive variety of sports settings.

5.2. Future scope

It is recognized that sequential studies should have a larger and more heterogeneous sample to raise external validity. It was found that expanding the range of sports and incorporating new approaches, including new machine learning techniques and VR, are also promising to develop new and more efficient athlete classification models. Long-term effects on physical health status and program participation will also be explored to yield important ideas about improving physical education programs.

Acknowledgments: Chongqing Municipal Commission of Education Science and Technology Research Project Youth Project: under the background of Big Data Chongqing higher vocational college students after-school physical exercise governance model research (No.: KJQN20240).

Ethical approval: Not applicable.

Informed consent: Not applicable.

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

References

1. López-Moranchel, I., Franco, E., Urosa, B., Maurelos-Castell, P., Martín-Íñigo, E. and Montes, V., 2021. University students' experiences of the use of learning as a training resource for the acquisition of biomechanical knowledge. Education sciences, 11(9), p.479.https://doi.org/10.3390/educsci11090479
2. Donaldson, B.J., Bezodis, N.E. and Bayne, H., 2022. Inter-and intra-limb coordination during initial sprint acceleration. Biology Open, 11(10), p.bio059501.https://doi.org/10.1242/bio.059501
3. van der Woude, L.H., Houdijk, H.J., Janssen, T.W., Seves, B., Schelhaas, R., Plaggenmarsch, C., Mouton, N.L., Dekker, R., van Keeken, H., de Groot, S. and Vegter, R.J., 2021. Rehabilitation: mobility, exercise & sports; a critical position stand on current and future research perspectives. Disability and Rehabilitation, 43(24), pp.3476-3491.https://doi.org/10.1080/09638288.2020.1806365
4. Soltani, P. and Morice, A.H., 2020. Augmented reality tools for sports education and training. Computers & Education, 155, p.103923.https://doi.org/10.1016/j.compedu.2020.103923
5. Malikov, N., Tyshchenko, V., Bogdanovska, N., Savchenko, V., Moskalenko, N., Ivanenko, S., Vaniuk, D., Orlov, A. and Popov, S., 2021. Functional fitness assessment of elite athletes. Journal of Physical Education and Sport, 21(1), pp.374-380.
6. Huang, G. and Ren, Y., 2020. Linking technological functions of fitness mobile apps with continuance usage among Chinese users: The moderating role of exercise self-efficacy. Computers in Human Behavior, 103, pp.151-160.https://doi.org/10.1016/j.chb.2019.09.013
7. DiPietro, L., Al-Ansari, S.S., Biddle, S.J., Borodulin, K., Bull, F.C., Buman, M.P., Cardon, G., Carty, C., Chaput, J.P., Chastin, S. and Chou, R., 2020. Advancing the global Physical Activity agenda: recommendations for future research by the 2020 WHO Physical Activity and sedentary behavior guidelines development group. International Journal of Behavioral Nutrition and Physical Activity, 17, pp.1-11.https://doi.org/10.1186/s12966-020-01042-2
8. Supriani, Y., Meliani, F., Supriyadi, A., Supiana, S. and Zaqiah, Q.Y., 2022. The Process of Curriculum Innovation: Dimensions, Models, Stages, and Affecting Factors. Nazhruna: Jurnal Pendidikan Islam, 5(2), pp.485-500.https://doi.org/10.31538/nzh.v5i2.2235
9. Holdsworth, S. and Sandri, O., 2021. Investigating undergraduate student learning experiences using the good practice learning and teaching for sustainability education (GPLTSE) framework. Journal of Cleaner Production, 311, p.127532.https://doi.org/10.1016/j.jclepro.2021.127532
10. Corbin, C.B., 2021. Conceptual physical education: A course for the future. Journal of Sport and Health Science, 10(3), pp.308-322.https://doi.org/10.1016/j.jshs.2020.10.004

11. Liu, J., Wang, L. and Zhou, H., 2021. The application of human-computer interaction technology fused with artificial intelligence in sports moving target detection education for college athletes. Frontiers in Psychology, 12, p.677590.https://doi.org/10.3389/fpsyg.2021.677590
12. Wild, J.J., Bezodis, I.N., North, J.S. and Bezodis, N.E., 2022. Characterizing initial sprint acceleration strategies using a whole-body kinematics approach. Journal of Sports Sciences, 40(2), pp.203-214.https://doi.org/10.1080/02640414.2021.1985759
13. Knudson, D. and Wallace, B., 2021. Student perceptions of low-tech active learning and mastery of introductory biomechanics concepts. Sports Biomechanics.
14. Matabuena, M., Riazati, S., Caplan, N. and Hayes, P., 2021. Are multilevel functional models the next step in sports biomechanics and wearable technology? A case study of Knee Biomechanics patterns in typical training sessions of recreational runners. Arrive preprint arXiv: 2103.15704.
15. Alt, T., Roos, T., Nolte, K., Modenbach, D., Knicker, A.J. and Jaitner, T., 2023. Modulating the Nordic Hamstring Exercise From" Zero to Hero": A Stepwise Progression Explored in a High-Performance Athlete. Journal of Athletic Training (Allen Press), 58(4).https://doi.org/10.4085/1062-6050-0010.22
16. Lee, K., 2021. The relationship of trunk muscle activation and core stability: a biomechanical analysis of pilates-based stabilization exercise. International journal of environmental research and public health, 18(23), p.12804.https://doi.org/10.3390/ijerph182312804
17. Kim, J. and Park, S.K., 2022. Differences in physical characteristics of the lower extremity and running biomechanics between different age groups. International Journal of Environmental Research and Public Health, 19(7), p.4320.https://doi.org/10.3390/ijerph19074320
18. Brazil, A., Exell, T., Wilson, C. and Irwin, G., 2020. A biomechanical approach to evaluate overload and specificity characteristics within physical preparation exercises. Journal of Sports Sciences, 38(10), pp.1140-1149.https://doi.org/10.1080/02640414.2020.1743065
19. Jafarnezhadgero, A.A., Fatollahi, A. and Granacher, U., 2022. Eight weeks of exercising on sand has positive effects on biomechanics of walking and muscle activities in individuals with pronated feet: A randomized double-blinded controlled trial. Sports, 10(5), p.70.https://doi.org/10.3390/sports10050070
20. Di Domenico, F., 2020. From biomechanics to learning: Continuum for the theory of physical and sports education.https://doi.org/10.14198/jhse.2020.15.Proc2.18
21. Wang, K., Li, Y., Zhang, T. and Luo, J., 2022. The relationship among college students' physical exercise, self-efficacy, emotional intelligence, and subjective well-being. International journal of environmental research and public health, 19(18), p.11596.https://doi.org/10.3390/ijerph191811596
22. Li, J., Wang, L., Pan, L., Hu, Z., Yin, R. and Liu, J.F., 2024. Exercise motivation, physical exercise, and mental health among college students: examining the predictive power of five different types of exercise motivation. Frontiers in Psychology, 15, p.1356999.https://doi.org/10.3389/fpsyg.2024.1356999
23. Zhang, Z., 2024. Quantum sensors in sports biomechanics in revolutionizing injury prevention. Optical and Quantum Electronics, 56(3), p.311.https://doi.org/10.1007/s11082-023-06017-8
24. Zhao, F., 2024. The Application of Sports Biomechanics in Sports Injury Prevention and Rehabilitation. Frontiers in Sport Research, 6(3).https://doi.org/10.25236/FSR.2024.060320
25. Plakias, S., Tsatalas, T., Mina, M.A., Kokkotis, C., Kellis, E. and Giakas, G., 2024. A bibliometric analysis of soccer biomechanics. Applied Sciences, 14(15), p.6430.https://doi.org/10.3390/app14156430
26. Kapadnis, S. Collective Sports [Sensor] DB of Practice Sessions. Available online: https://www.kaggle.com/datasets/sujaykapadnis/comprehensive-sports-database (accessed on 26 June 2024).