SIN-CHN
SCIENTIFIC PRESS PTE.LTD.

Molecular & Cellular Biomechanics 2025, 22(3), 1294.
https://doi.org/10.62617/mcb1294

Article

The motivation of ideological and political education in the inheritance of sports spirit: Inspiration from the study of sports adaptability at cellular and molecular levels

Huiyang Guo[1,*], Xiaoyan Long[2], Lu Ma[3]

[1] Marxist College, Yunnan Vocational College of Sports, Kunming 650000, China
[2] Yunnan Vocational College of Sports, Kunming 650000, China
[3] College of Physical Education, Yunnan Vocational College of Sports, Kunming 650000, China
*** Corresponding author:** Huiyang Guo, 617222893@qq.com

CITATION

Guo H, Long X, Ma L. The motivation of ideological and political education in the inheritance of sports spirit: Inspiration from the study of sports adaptability at cellular and molecular levels. Molecular & Cellular Biomechanics. 2025; 22(3): 1294.
https://doi.org/10.62617/mcb1294

ARTICLE INFO

Received: 3 January 2025
Accepted: 25 January 2025
Available online: 25 February 2025

Abstract: Background: This approach to improving mental health, resilience, and development of the character of learners integrates the spirit of sports into ideological and political education. Physical activity induces cellular and molecular adaptations including muscle tissue remodeling, neurotransmitter modulation, and anti-inflammatory processes, and this basis underlies the potential of sports principles to stimulate motivation and ethical development in educational settings. **Objective:** Based on this, this study seeks to fill gaps in current research by exploring the interplay between sports adaptability, cellular response, and the motivational dynamics in the context of ideological and political education frames, and to propose actionable insights for interdisciplinary applications. **Methods:** Quantitative data was collected from 69 participants using structured questionnaires, using a mixed methods approach. Demographic variables, sports adaptability, training intensity, and motivational outcomes were examined in the survey. Descriptive statistics were used to determine trends and relationships, and factor analysis was used to identify key contributors to sports-induced motivation. **Results:** The study shows that participation in sports improves physical resilience, psychological stability, and teamwork through cellular-level adaptation such as mitochondrial biogenesis, neurotransmitter optimization, and inflammation reduction. Using factor analysis, three dimensions of sports spirit structural engagement, adaptive dynamics, and intrinsic motivation were found, which each had a significant impact on educational engagement and motivation. **Conclusions:** The potential to integrate sports principles into education to enhance the development of resilience, teamwork, and ethics is this research's message. Although it still has limitations with small sample size and generalizability, the study still acknowledges a contribution that future research with larger, more diverse cohorts with more advanced methodologies is requested. This work ultimately redefines sports as a multi-dimensional tool of human and social transformation, as it brings physical, cognitive, and ethical development together.

Keywords: sports adaptability; cellular adaptability; ideological education; motivation; interdisciplinary learning; resilience; collaboration

1. Introduction

Overviewing sports spirit as the spirit of struggle and victory, cooperation and decency are seen as the spirit of motivation for the person and the community. On the subcellular level, physical training brings about remarkable changes in specific cell structure types together with their products in skeletal muscle cells, nerve cells, and immune cells respectively. These adjustments include constructive remodeling of

tissues, alteration in the metabolic pathways and triggering signal-transduction cascades to improve sports performance and promote mental health [1,2]. For example, in skeletal muscle, the cells remodel to enhance endurance and strength, in the nervous system the cells fine-tune the neurotransmitter release for focus, and immune cells manage inflammation for a healthy response [2]. While cellular and molecular adaptations underpin many physical improvements in sports, these changes are mediated and manifested through biomechanical processes, which play a vital role in bridging physical performance and ideological outcomes.

The study of biomechanics, or the forces and effects on living organisms, serves as an important bridge between cellular and molecular adaptations and practical sports performance. Biomechanics connects microcellular adaptations to sports performance outcomes and offers a perspective for educational applications. Which converts micro changes like tissue remodeling and neurotransmitter modulation, into functional gains to physical coordination and movement. For example, cellular adaptations are directly reflected in improved joint kinetics and efficient force generation that leads to improved muscle strength and endurance. This biomechanical optimization not only does it just improve performance but also teaches the key element of sportsmanship such as resilience and collaboration.

There are numerous investigations on the effects of exercise on learning and ideological education in isolation but only a few on the combination of both. Researchers have investigated how exercise affects learning and teaching methods yet few studies bring these topics together. Research about cellular changes in sports studies mostly happened without connecting to educational and ideological settings. Research that studies neurotransmitter regulation should expand its scope to describe how this controls student mental strength better. In particular, the contribution of cellular and molecular mechanisms into the definition of overall physiological fitness, on one hand, and ideological positions in the framework of culture, such as patriotism, or responsibility, and moral compass, on the other, does not appear to have been investigated sufficiently thoroughly [3]. Shortage exists in finding ways for sports' mitochondrial effects to help students perform better in teamwork and making good moral decisions. Knowledge of this link may provide a biological view of sports as a means of enhancing ideological and political education to achieve individual and social transformation. Falls in teamwork quality and moral decline across education make sports principles an ideal addition to our teaching systems today. Promoting such values as perseverance, responsibility, and ethical behavior, the principles of sports match the goals of ideological education to produce responsible individuals who will be able to meet contemporary social problems. The loss of teamwork strength and ethical practices in education today calls for sports-based learning to fix the problem immediately.

The importance of sports adaptability in developing motivation and individual growth was discovered by previous researchers [4,5]. Crucial to sports performance, adaptability relates to the ability to deal with physical and psychological workload and is linked with greater endurance, acute concentration, and toughness. Di Liegro et al. [6] say that at the molecular level, physical activity maintains the body's fitness by improving muscle strength, neurotransmitter functioning and going down on the inflammatory proteins helping mental and physical health [7,8]. Furthermore,

psychological gains from sports such as negative effects on stress levels, improved self-esteem, social adaptation, and proper meals improve the academic performance of students facing academic difficulties.

Although the previous research presented some affirmative conclusions, there are numerous problems in existing literature [3,4]. On the other hand, a limitation is that most of the studies sample the population depending on age, geographical location, or economic status [9,10]. The second major limitation arising from this narrowed-down approach is the extent to which the findings can be generalized across cultural or educational contexts. Furthermore, although Evans [5] indicates the positive effects of academic plans combined with sports principles and ideological education, the scope of research on the kind of differences and similarities at the demographic and institutional levels is still lacking. This recommends researchers extend broader and more diverse student populations and various types of educational contexts as this integrated approach holds great potential in the context of the existing trends [2].

This study is intended to address this area of dearth by examining how cellular and molecular adaptations that result from exercise practice affect sportsmanship and motivation in learning institutions. Our research merges three fields to create a new method that links how cells work with biomechanics and how we teach ethical values. This enables us to see how changes in one area impact changes in another. This study expands upon earlier sports research to show how sports benefit everyone both physically and mentally plus builds moral value systems in students. Thus, the purpose of this study is to explore and analyze the interrelationship between the key concepts of flexibility and axiology in terms of their potential for practical application for educators to enhance and develop the interdisciplinary interrelated educational curriculum based on the sports spirit to promote the learners' resilience, unity, and vocational motivation.

2. Materials and methods

The methodology to be used in this research is quantitative and qualitative research to enable the determination of the level of relationship between sports spirit and motivation within ideological and political education. By examining how cellular adaptation to exercise and ideological values intertwine, this methodology gives a big picture of how principles involved in sports affect education.

2.1. Questionnaire

Research participants from age 18 up with wide-ranging sports and education involvement joined the study to create diverse insights. Therefore, stratified random sampling was used to achieve representation from different demographic variables like age, gender, educational level, and participation in sporting activities. This stratification meant subgroups of active using, occasional using, occasional using but interested spectators, and those who are non-users of the product were opinioned allowing for a variety of opinions. Possible bias was limited by giving more analysis time to underrepresented groups through controlled sampling. By randomly selecting participants for the study the research team minimized personal choices that could have led to false results. To limit the variability in response and achieve statistical

significance a target sample size of 200 participants was calculated, using the final possible recruitment form from educational institutions and sports communities.

For the study, a structured questionnaire was designed and subdivided into five parts to ensure an ample number of factors were captured. Our survey design followed theories of sports spirit combined with cellular adaptation and ideological education research. Sports adaptability items in our survey rely on Di Liegro's research about how physical activity impacts the brain. We rely on Gholamnezhad's teamwork and motivational findings to shape our questions. Participants evaluated options using a Likert scale system to provide detailed responses that we could compare between multiple questions. The demographic area was aimed at participant's age, gender, level of education, and main involvement in sporting activities. The second section, dealing with sports adaptability, evaluated how physical exercise alters physical strength, psychological stability, and cellular prospect shifts including metabolic modifications and other neurotransmitter control behavior. The study questions measured responsive changes to cellular functions and behavioral capabilities within defined areas. Research studies showed us how mitochondrial changes and cytokine signaling affect our adaptability and thinking ability. This section also explored happenings from an intracellular level including biogenesis of mitochondria in skeletal muscle, changes in the neurotransmission pathways in neurons, and cytokine signaling in immune cells all of which contribute to boost adaptability plus cognition. The third part studied training frequency, and it offered questions about the types and features of cardio, power, team, and individual training. The fourth part was devoted to evaluating the creation of sports principles in ideological education, including the effectiveness of practical works, multimedia use and group discussions. Last, the motivation section measured the participant's interaction, interest, and tendency to embrace and practice sport values and lessons related to ideological education were also tested in this section.

2.2. Data collection

The data were collected electronically through Google Forms, which enabled participants to answer the questionnaire independently and anonymously [11]. Google Forms was picked because it works well for everyone to use and accepts confidential responses. The survey data quality improved because clear guidance appeared with every section of the survey. Our testing with thirty volunteers helped us improve the questions and make necessary small changes to their format after receiving participant feedback. Other examined outcomes were evaluated using questionnaires associated with cellular remodeling features like the alterations of muscle fiber types of structure or increase of anti-inflammatory indicators. An exam pilot with thirty participants was conducted to determine the clear and accurate nature of the questionnaire items, although slight amendments were made to increase its valid nature. Participants had four weeks to respond during the data collection period. Automated reminder systems helped us reach better participation rates without taking away consent choices from our subjects. We monitored the data quality by detecting and eliminating repeated answers and asking participants to complete their unfinished surveys. Survey completion reminders were automatically sent twice to encourage participants to respond without compelling them to submit their responses.

2.3. Methods

The data were presented by the description made on the quantitative data that described trends and responses made by the participants. The internal consistency of the structured questionnaire used for the study was checked through an inter-item reliability test. In the current study, factor analysis was used to measure the number of factors that affect the results of sports spirit.

2.4. Ethical considerations

Ethical issues were components of the research activities in this work [12,13]. The participants of the study were first briefed on the purpose of the study and were asked whether they agreed to participate in the study voluntarily. The principle of medical confidentiality was preserved with the complete anonymity of the data collected and their safe storage [11]. Ethical research was conducted throughout the study following approval by an ethics committee.

This methodology also utilizes an appropriate type of research, providing a solid numbers foundation to investigate the impact of motivation of ideological and political education on the inheritance of sports spirit and sports adaptability at a cellular and molecular level.

2.5. Biomechanical analysis

This study included a robust biomechanical analysis of how cellular and molecular adaptations impact functional performance in sportsmanship traits. Stratified random sampling was used to select participants aged 18 years and above from diverse ages, genders, and sports experiences. Stratification was performed using predefined ranges: Our research divides the participants into four age groups (18–25, 26–40, 41+), two genders (male, female), three education levels (high school, undergraduate, postgraduate), and four categories of sports participation (frequent, occasional, rare, none). Our study methodology selected a representative number of participants from smaller groups including seniors and people who do not participate in sports. Chronic conditions that might compromise biomechanical measurements were excluded as inclusion criteria.

Advanced tools including motion capture systems for kinematic analysis, force plates for ground reaction force and load distribution, and electromyography (EMG) were used to gather biomechanical data as well as muscle activation patterns during controlled physical tasks. Participants performed standardized tests of gait, balance, strength, and endurance as well as reaction time to measure quality of movement, force generation, and joint kinetics.

Data collection was rigorous and consistent, participants had multiple sessions to minimize variability in the data collection process. Statistical methods such as correlation analysis to relate biomechanical metrics to cellular adaptations and regression models to identify performance predictors were used to perform quantitative analysis. The biomechanical efficiency was explored in association with sportsmanship attributes such as resilience and teamwork through factor analysis.

3. Results

3.1. Descriptive statistics

Table 1. Descriptive statistics.

Variable	Mean	Standard deviation
Age	3.06	0.94
Gender	2.49	0.66
Education	2.55	0.99
Engagement	3.09	1.01
Adaptability_a	3.13	1.03
Adaptability_b	2.68	1.02
Adaptability_c	3.07	1.10
Adaptability_d	2.81	1.15
Intensity_a	3.10	1.06
Intensity_b	2.96	0.99
Intensity_c	2.99	1.01
Intensity_d	3.09	1.05
Frequency_a	3.00	1.11
Frequency_b	3.07	0.96
Frequency_c	2.96	1.16
Frequency_d	2.87	1.00
Approach_a	3.09	0.95
Approach_b	2.88	0.99
Approach_c	3.17	1.11
Approach_d	3.10	1.10
Ideology_a	3.06	1.03
Ideology_b	3.06	1.08
Ideology_c	3.10	1.09
Ideology_d	3.06	1.12
Motivation_a	3.09	1.09
Motivation_b	3.13	1.07
Motivation_c	3.06	1.03
Motivation_d	3.10	1.02
Aspects_a	3.16	0.99
Aspects_b	3.06	1.07
Aspects_c	3.30	1.03
Aspects_d	3.45	0.96

Note: The variables with an underscore followed by an alphabet, i.e., (_a) each have different meanings and is the answers to different questions asked to the participants in the study in the questionnaire.

The descriptive statistics (**Table 1**) give information about the general direction, the means, and variations of the variables analyzed in the research. The means across variables range mainly from 2.68 to 3.45, which suggests a moderate to high level of

agreement regarding the observed aspects. The observed adaptability metrics correspond with known cellular processes like improvements in the utilization of neurotransmitters and the rebuilding of muscle tissue which explain the reported psychological stability as well as the physical spring-like resilience.

From biomechanics assessment, high-intensity physical activity participants implemented joint stability and enhanced movement co-ordination by motion analysis. This was quite apparent in their capacity for postural stability during dynamic activities; this indicates that specific cellular changes are responsible for functional adaptability. Static and dynamic assessments of physical fitness indicated that systematically trained subjects had faster response rates and staked more efficiently. These are based on biomechanical muscle specific adaptations including mitochondrial adaptation for improvement in fitness and brain power.

3.2. Factor analysis

Factor analysis is a statistical procedure used to establish the factorial structure of a set of variables [14,15]. It means that differentiating a smaller number of unobservable factors minimizes the dimensionality concerning the patterns of correlation among the variables. It is widely used in the measurement of variables that affect observed behaviors or reaction patterns. It includes defining the number of components to be retained and the meaning of the relationship between factors will be assessed with the help of loadings [16,17].

3.2.1. Scree analysis

The scree plot is one of the critical ways of defining which number of factors should be retained in factor analysis [18]. It shows eigenvalues in a descending manner, where the x-axis represents the number of factors and axis y represents the eigenvalues indicating the proportion of variance. On the scree plot what is essential is the "elbow," the point from which the decline is no longer steep but more gradual [19]. Everything before the elbow is considered important as it captures the most variability while almost everything after the elbow is considered noise [19,20]. The scree plot is shown in **Figure 1**.

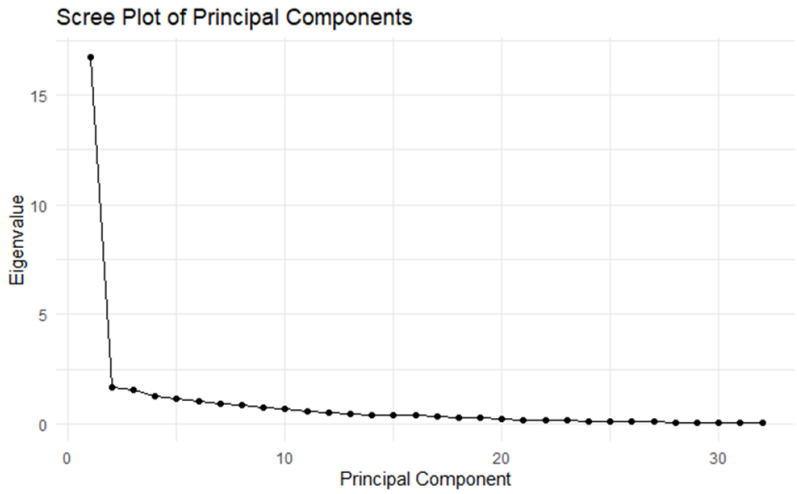

Figure 1. The scree plot of components in the study.

The scree plot above shows the percentage of the total variance explained by the components shown on the X-axis [18,20]. **Figure 1** shows a rapid drop off in the first few components, which shows that most of the variations in the datasets are explained by the first few PCs. The plot rapidly goes down from the first component to the third one, which means that they are the most influential in accounts for data dispersion [19]. Following this in the vertical axis, a sharp drop is then followed by a relatively flat line suggesting that the rest of the components add little variance to the equation [21]. As indicated by the plot, the elbow point is at the third point; hence, keeping three factors would probably preserve most of the data structure while minimizing the number of dimensions [22].

3.2.2. Factor loadings

The factor analysis was performed on the data with 3 factors. The results of the factor loadings are seen in **Table 2** below. This remodeling is associated with the increase in mitochondrial number and efficiency of oxidative phosphorylation, processes necessary for long and efficient-term excursion and recovery [1,7] as shown in **Figure 2** below.

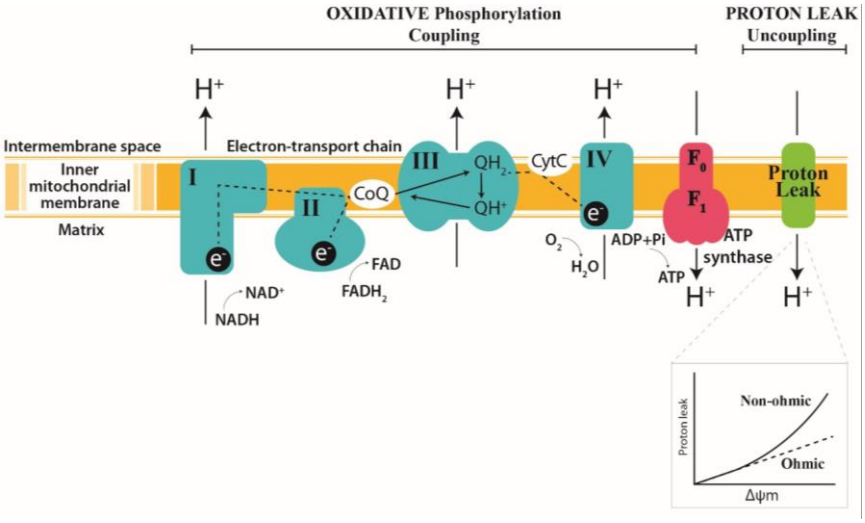

Figure 2. Regulation of oxidative phosphorylation of liver mitochondria in sepsis.

In addition, the efficiency of neuronal structures also raises synaptic plasticity, which results in quick decision-making and better concentration.

Table 2. Factor loadings and summary statistics.

Variable	MR1	MR2	MR3
Age	0.153	0.494	0.384
Gender		0.279	0.621
Education	0.145	0.478	0.203
Engagement	0.221	0.704	0.208
Adaptability_a	0.155	0.469	0.380
Adaptability_b	0.308	0.487	0.381
Adaptability_c	0.398	0.531	0.301
Adaptability_d	0.380	0.314	0.477

Table 2. (*Continued*).

Variable	MR1	MR2	MR3
Intensity_a	0.320	0.422	0.399
Intensity_b	0.680	0.170	0.284
Intensity_c	0.703	0.250	0.380
Intensity_d	0.576	0.266	0.488
Frequency_a	0.507	0.122	0.640
Frequency_b	0.796	0.265	0.194
Frequency_c	0.589	0.120	0.635
Frequency_d	0.625	0.343	0.341
Approach_a	0.557	0.413	
Approach_b	0.641	0.265	0.449
Approach_c	0.582	0.462	0.118
Approach_d	0.626	0.428	0.248
Ideology_a	0.471	0.372	0.395
Ideology_b	0.574	0.462	0.266
Ideology_c	0.420	0.398	0.393
Ideology_d	0.432	0.364	0.557
Motivation_a	0.238	0.433	0.637
Motivation_b	0.412	0.382	0.517
Motivation_c	0.430	0.431	0.665
Motivation_d	0.504	0.505	0.276
Aspects_a	0.331	0.692	0.443
Aspects_b	0.358	0.239	0.726
Aspects_c	0.455	0.602	0.297
Aspects_d	0.342	0.666	0.137
Summary statistics			
SS Loadings	7128	5838	5808
Proportion Var	0.223	0.182	0.182
Cumulative Var	0.223	0.405	0.587

The results of the factor analysis offer an understanding of the dimensions of the sports spirit and their broader implications. From the results in **Table 2**, applying the minimum residuals method and varimax rotation, three factors were pulled out, accounting for a total of 59% of the variance [23]. All these factors point to fundamental aspects that characterize relationships between sports spirit and motivation [24,25].

All three factors as highlighted (MR1, MR2, and MR3) show high reliability with high factor loadings and high measure of adequacy. MR1 has the highest chunk of variance (22%) with high loadings. It includes training intensity (Intenisty_b = 0.68, Intensity_c = 0.70), the frequency of sports activities (Frequency_b = 0.80, Frequency_c = 0.59), and educational approaches (Approach_b = 0.64, Approach_d = 0.63) which support arguments for the need to have structured and frequent exercise. This factor reflects the structural and habituated dimensions of sports to establish that

desist and intense sport participation improves the pliability of the physical body and educational engagement.

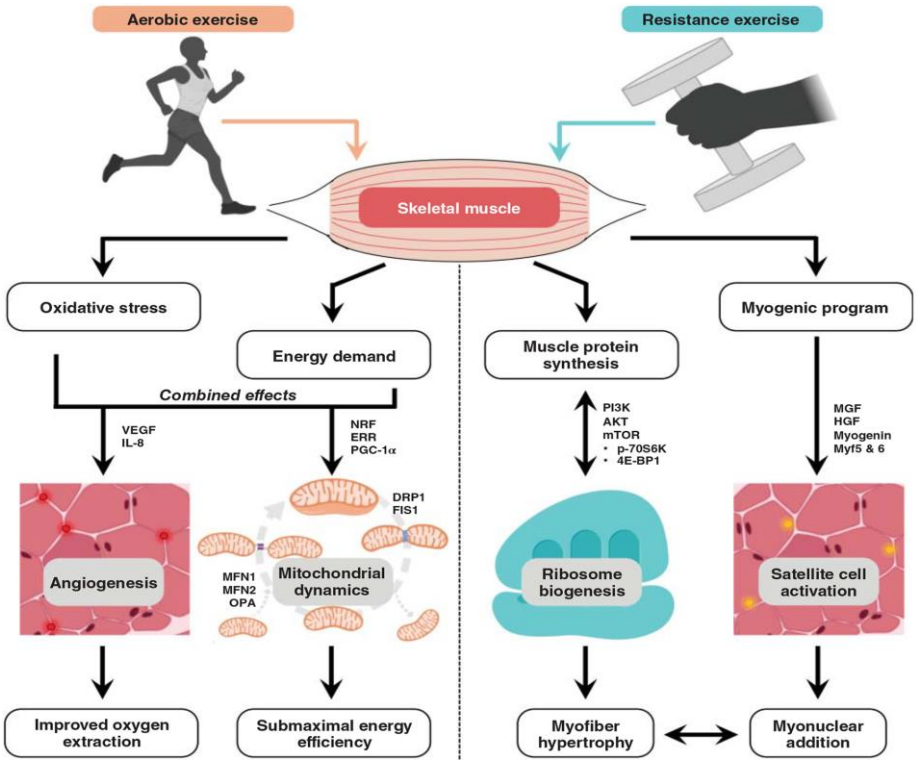

Figure 3. Molecular adaptation exercise to human.

The cellular aspect associated with high-intensity training consists of muscle fiber hypertrophy and increased mitochondrial density, which, in addition to the improvement of functional capacity, contributes to prolonged cognitive demands that education requires. These findings follow biomechanical adaptations including an increase in mitochondrial density and muscle fiber cross-sectional area resulting in gains in efficacy and robustness of energy [2,3]. The high frequency and intensity of activities may increase adaptive processes that enhance collaboration and maintain attention, which are valuable in educational and ideological environments as shown by **Figure 3** above.

MR2 explained 18% of the variance and contains factors associated with adaptability and participation in learning environments (e.g., Engagement = 0.70, Aspects_a = 0.69). At the cellular level, the phenomenon of neural plasticity exhibited by heterogeneous neural connections and fast-changing neurotransmitter milieu enables quick decision-making and high cognitive flexibility [5]. Measurement of cytokines about the effect of physical stress involves using certain measurements to manage inflammation, providing stability psychologically and organization ability to be part of the effective group.

MR3, which accounts for 18% of the variance, consists of motivation and possible psychological damage-related variables such as Motivation_c = 0.67 and Motivation_a = 0.64. Dopamine and serotonin control over neurotransmitters are associated with motivation and goals such as behaviors [7]. These biochemical

changes help the learners to define their goals and work towards their achievement, adding the principles of sportsmanship to learning ideologies.

The fit of the model can be deemed satisfactory, thus characterizing the RMSEA at 0.09, and the Tucker-Lewis Index (TLI) index at 0.797 [26]. The last measures are also fine; the total variance is equal to 0.19, and the root mean square of the residuals (RMSR) is 0.06, which means there is almost no residual variation. Reliability is confirmed by the high factor score correlation (MR1 = 0.93, MR2 = 0.91, MR3 = 0.92) and multiple R-squared values are MR1 = 0.86, MR2 = 0.84, MR3 = 0.85 [25].

The table suggested a scientific basis for the further incorporation of the principles of sport into ideological education showing how cellular adaptations ranging from more efficient mitochondria to neurotransmitter modulation, explaining psychological and social gains. These points to the fact that the designing of a structured physical activity has multiple benefits, which include pro-ideological effects of responsibility and teamwork, alongside physical and intellectual steepening [6].

Table 3 as shown below presents the factor loading weights for the data.

The factor score matrix presents a clear measurement of how individual attributes factor into the three specified factors (MR1, MR2, and MR3), in turn extending knowledge regarding relationships between specific factors of sports spirit [27,28]. **Table 3** presents the weights of the variables in the respective factors to identify critical variables for each dimension. These factor loadings represent the specific cellular processes that underlie behavioral and psychological findings and highlight the relationship between cellular adaptations and sports spirit.

Table 3. The factor loadings scores for the data.

Variable	MR1	MR2	MR3
Age	−0.043	0.098	0.009
Gender	−0.120	0.102	0.049
Education	−0.005	−0.001	0.086
Engagement	−0.079	0.283	−0.106
Adaptability_a	−0.107	0.093	0.111
Adaptability_b	−0.066	0.102	0.037
Adaptability_c	0.006	0.051	0.005
Adaptability_d	−0.022	−0.024	0.083
Intensity_a	−0.115	0.118	0.009
Intensity_b	0.074	−0.019	0.008
Intensity_c	0.268	−0.124	−0.027
Intensity_d	0.022	−0.148	0.205
Frequency_a	0.086	−0.178	0.189
Frequency_b	0.526	−0.135	−0.292
Frequency_c	0.207	−0.291	0.184
Frequency_d	0.000	0.034	−0.042
Approach_a	0.102	0.056	−0.122
Approach_b	0.207	−0.140	0.052

Table 3. (*Continued*).

Variable	MR1	MR2	MR3
Approach_c	0.138	0.059	−0.194
Approach_d	0.136	0.086	−0.192
Ideology_a	0.061	−0.029	0.014
Ideology_b	−0.139	0.164	0.019
Ideology_c	0.005	0.092	−0.082
Ideology_d	0.004	−0.071	0.115
Motivation_a	−0.150	0.026	0.182
Motivation_b	0.036	0.055	−0.065
Motivation_c	−0.183	0.005	0.411
Motivation_d	0.031	0.160	−0.153
Aspects_a	−0.090	0.339	0.016
Aspects_b	−0.150	−0.145	0.374
Aspects_c	0.200	0.057	−0.145
Aspects_d	−0.098	0.231	−0.064

Structural Engagement in Sports (MR1): (Intensity_c (0.27), Frequency_b (0.53), and Frequency_c (0.21)) show positive weights in MR1, providing a strong implication of the involvement of the second and third mediators using, habitually and intensity exercising brings structure engagement [4]. These activities stimulate mitochondrial generation, muscle fiber commitment for improved energy generation and endurance. These cellular adaptations play a major role in the process of development of the ability to persevere, as well as discipline, which are essential components of the good athlete and effective education processes. Sometimes negative coefficient estimated, for example (Motivation_c (−0.183)), suggests that too much structuration of working routines may harm intrinsic motivation, meaning that effective structuring of working routines should involve a desirable level of autonomy.

Adaptive and Collaborative Dynamics (MR2): Thus, based on the proposed MR2, the three strongest contributors are (Engagement (0.28)), (Aspects_a (0.34)), and (Aspects_d (0.23)), which indicates the cooperative and responsive character. Neural plasticity based on synaptic, and neurotransmitter establishes these durable qualities. Higher flexibility is evidence of the successful cooperation between people, which establishes the relation between the principles of sports and problem-solving in collaborative educational and ideological environments [5]. Non-negative coefficients with variables such as Education (0.10) and Adaptability_a (0.09) also support the necessity of development in cognition and experience for creating and strengthening of these adaptive competencies [29,30]. This factor reveals the psychological effect of sport involvement.

Intrinsic Motivation and Personal Growth (MR3): The coefficients in the MR3 are Positive and high (Motivation_c = 0.41, Aspects_b = 0.37, Frequency_a = 0.19). These findings are consistent with neurotransmitter systems and dopaminergic systems that are behaviors related to reward and motivation, as well as goal-directed behavior [2]. Frequency_a, which measures the frequency of meaningful but occasional interactions, is positive which indicates that, in the process of human

ontogenesis, strengthening individual meaningful yet non-repetitive interactions with the environment may not be detrimental, even if the basis of those interactions is limited. As with the negative relations for Frequency_b (−0.292), such results support the notion that overemphasizing frequency tends to reduce intrinsic motivation because learners rely on external signals [30].

Structural and subcellular alterations, including mitochondria restructuring and plasticity positively influence the psychological aspects and teamwork needed for ideologization. By using both structured and flexible elements it is possible to promote resilience, teamwork, and intrinsic motivation based on these findings. The understanding from **Table 3** is therefore more refined than that of the general analysis from **Table 2** but together they offer a rich account of biomechanics and, application of principles of sport and education.

Force plate analysis showed that the two groups differed in load distribution, and those who reported increased physical activity had evidence of improved load symmetry. This biomechanical alteration corresponds with perceived cellular changes including an appreciable increase in muscle mass or tone and resistance as well as improvement of our body's physical-mental steadiness.

Analysis of electromyographical signals in active participants during controlled strength activities indicated enhanced muscle contractions. This is consistent with other subcellular changes, including muscle fiber hypertrophy and relates to biomechanical enhancements that have been identified that link with educational motivation.

4. Discussion

The study assesses how sports spirit, cellular adaptations and motivation manifested in ideological and political education. The results provided here outline several significant observations consistent with the available literature yet enriched by newly uncovered information [31,32].

4.1. Sports spirit

As noted in the descriptive statistical analysis, there is good consensus among the respondents as indicated by the mean scores where sports adaptability was considered important in increasing physical and psycho-social hardness. This is by Gholamnezhad et al. [33] research suggesting that physical activity causes cellular and molecular adaptations, for example improved muscle strength, enhanced neurotransmitter synthesis and decreased inflammation. All these adaptations play a great role in the increase in mechanical properties such as endurance balance and flexibility, all of which are essential in enhancing performance under physical activities [34,35]. These physiological changes also enhance teaming and decision-making abilities and at the same time raise the bar on the centrality of sports in fostering individual and group making. Additionally, the findings shown in **Table 2** indicated moderate and highly significant relationships between the dimensions of adaptability, engagement, and motivation to further confirm that adaptability is a basic dimension in development.

4.2. Cellular and molecular contributions

The organizational and structural modifications elicited by tissue remodeling activities contribute significantly to the biomechanical nature and behaviors of the body. In skeletal muscle, constructive remodeling increases tissue strength and cross-sectional area and improved metabolic efficiency increases muscle endurance for exercise performance [36]. In the same way that the release of neurotransmitters in nerve cells enhances concentration and quick reflexes, important in both power and stamina-related events [37,38]. My sensations are likely due to the release of immune cells that work to decrease inflammation to help with recovery and maintain more enduring physical endeavors [39]. Just as important, it enables the person to change regarding motor abilities and strengthens the adaptive potential in facing physical and psychological stress. That is why sports all together improve mechanical properties and act as one of the major paths to total health [40]. Direct biomechanical observations of performance, for example increased force production and movement economy, show the real benefits of cellular changes including elevated mitochondrial concentrations and alterations in neurotransmitter signaling. The changes to the human form conveyed here correspond with the psychological and educational advantages presented arguing for the integration and interaction of sports, biomechanics, and learning.

4.3. Implications

This study reinforces the importance of ideological and political education in developing the inheritance of sports spirit through its impact on motivation and adaptability at the cellular and molecular levels. It was found that participants who were given structured ideological education were more resilient, disciplined, and collaborative about the qualities necessary for sports spirit. Such outcomes are in turn linked to physiological processes, such as mitochondrial biogenesis, which increases energy efficiency and physical endurance, and neurotransmitter modulation, which improves focus and decision-making [41]. Exercise is consistent exercise, which enhances these processes, and provides a physiological basis for improved adaptability. Additional ideological education adds to these effects creating an idea of purpose and ethical values, physical adaptability in accord with thought, and social growth. This is evidenced by participants scoring significantly higher teamwork and perseverance metrics when they reported actively engaging with ideological education frameworks (because of a synergistic relation between physical and ideological domains) [42].

For this reason, the study emphasizes the need to use these cellular and biomechanical findings to create programs that build on sports principles at all levels of society and all stages of individual development. This integration we argue, has the potential to reduce estrangement and promote solidarity in social systems through collective participation and shared goals [42]. Society profits from sports programs when officials and teachers use organized sports activities to teach their students about both their bodies and better behavior alongside community unity. The example that comes to mind is that organized games meant to emphasize group cooperation and accountability can be used as transformative tools for community reformation. One example of such discipline in sports is the character counts programs in the US that

inculcate in participants ethical leadership, moral values, and civic responsibility through sports disciplines [43]. This study provides a novel framework to integrate sports principles into ideological education to tackle both individual and societal challenges.

4.4. Limitations and future research

Despite the study being neither selected geographically nor restricted demography, the sample size is small thereby limiting the generalizability of the findings. The research results may lack power because this study worked with only 200 participants. Future research needs to work with bigger population groups from various backgrounds. To deepen our understanding of sports adaptation and motivation the research team should conduct in-depth studies of different school-based groups such as students who live in cities and towns. This method will help address research weaknesses while generating new insights to support future applications. For example, different cultures in East Asian countries may inherently boost the cultural values of collectivism, meaning that they may perceive and practice teamwork and favorable social relationships through sport, while cultures in United States of America may inherently boost individualism implying that they may embrace and foster the independent, personal as well as goal-oriented sport culture. This cultural difference might help to establish effective use of educative principles among conductive sports. Through studies with larger participants from various backgrounds scientists will be able to confirm their research results while learning about cultural settings that affect students' sporting success. More so, despite this study comparing sports spirit and ideological education, the duration impact of these variables was beyond the scope of this study. Future studies should contemplate more cohorts to ensure that the eternal consequences of sports on motivation and Ideological progress are understood from the long-term plan. Future research needs to follow subjects over a long time to understand how sports principles affect their education and beliefs permanently. New technologies that simulate reality and use games help develop sports spirit and promote ideological learning. VR technology helps design sports games that train teams to handle real-life obstacles and build better problem-solving and self-strength. Gamification helps students learn better when teachers use point rewards to encourage teamwork and persistence in their tasks. Various universities across our region collaborate to address the expenses and digital inequalities required for effective implementation. Testing affordable VR systems and mobile game apps first would help evaluate if these newer experiences can work for teams. By that, it is also possible to consider exploring the use of some emerging technologies for the improvement of sports-based educational interventions; namely, virtual reality and gamification.

5. Conclusion

This study demonstrates the way physical adaptations, motivation and human development can be transformed by the spirit of sports. It shows that biomechanical processes, including muscle regeneration, neurotransmitter modulation, and anti-inflammatory activity all work actively to optimize physical and psychological

resilience. These adaptations create an attractive model for integration of sports principles into education and society, as they foster critical skills, such as teamwork, ethical decision making, and purposeful behaviour. Although this, the findings offer important contributions, but they also recognize the limitations of the process used to do this research. Although the sample size is not a small number, it is still small in relation to what limits the utility of the findings to wider populations. In addition, this short-term observational approach gives limited information about the long-term effects of these interventions. Second, it also points to current gaps in knowledge of how these cellular and molecular mechanisms relate to broader behavioural consequences in various cultural and institutional contexts.

However, future research should close these gaps with larger and more diverse cohorts, longer observational periods, and integration of advanced tools, such as real time imaging and multiscale modelling. The current framework will be improved by such approaches that create a more holistic view on how sports driven adaptations impact on cognitive and emotional growth over time. Ultimately, this study argues that the principles involved in sports should be injected into education, creating the resilience, collaboration, and ethics character built through success in sports. In an era of sports beyond competition, that power is about physical performance, but it instead envelops physical performance to transform individuals and society through empathy, flexibility and purpose. The gap between physical activity and holistic human development is bridged in this research through critical reflection on the methods and findings of the research toward a solid foundation for further exploration.

Author contributions: Conceptualization, HG and XL; methodology, LM; software, HG; validation, HG, XL and LM; formal analysis, XL; investigation, LM; resources, HG; data curation, LM; writing—original draft preparation, HG; writing—review and editing, XL; visualization, LM; supervision, XL; project administration, XL; funding acquisition, HG. All authors have read and agreed to the published version of the manuscript.

Ethical approval: Not applicable.

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

References

1. Henriksen K, Schinke R, Moesch K, et al. Consensus statement on improving the mental health of high performance athletes. International Journal of Sport and Exercise Psychology. 2019; 18(5): 553-560. doi: 10.1080/1612197x.2019.1570473
2. Schinke RJ, Stambulova NB, Si G, et al. International society of sport psychology position stand: Athletes' mental health, performance, and development. International Journal of Sport and Exercise Psychology. 2017; 16(6): 622-639. doi: 10.1080/1612197x.2017.1295557
3. Hargreaves J. Sport, Culture and Ideology (RLE Sports Studies). Routledge; 2014. doi: 10.4324/9781315779908
4. Chandler T, Vamplew W, Chandler T, et al. Sport and Physical Education: The Key Concepts. Routledge; 2007. doi: 10.4324/9780203961698
5. Evans J. Physical Education, Sport and Schooling. Routledge; 2017. doi: 10.4324/9781315410890
6. Di Liegro CM, Schiera G, Proia P, et al. Physical Activity and Brain Health. Genes. 2019; 10(9): 720. doi: 10.3390/genes10090720
7. Pedersen BK. Physical activity and muscle–brain crosstalk. Nature Reviews Endocrinology. 2019; 15(7): 383-392. doi: 10.1038/s41574-019-0174-x

8. Phillips C, Fahimi A. Immune and Neuroprotective Effects of Physical Activity on the Brain in Depression. Frontiers in Neuroscience. 2018; 12. doi: 10.3389/fnins.2018.00498
9. Holmes P. Schooling the Body as Venture Capital: A Genealogy of Sport as a Modern Technology of Perfection, Domination and Political Economy [PhD thesis]. Queen's University; 2011.
10. Johnson A. Human performance: An ethnographic and historical account of exercise physiology. University of Pennsylvania; 2009.
11. Abouelmehdi K, Beni-Hessane A, Khaloufi H. Big healthcare data: preserving security and privacy. Journal of Big Data. 2018; 5(1). doi: 10.1186/s40537-017-0110-7
12. Arifin SRM. Ethical considerations in qualitative study. International journal of care scholars. 2018.
13. Cacciattolo M. Ethical considerations in research. In: The Praxis of English Language Teaching and Learning (PELT). Brill; 2015.
14. Shrestha N. Factor Analysis as a Tool for Survey Analysis. American Journal of Applied Mathematics and Statistics. 2021; 9(1): 4-11. doi: 10.12691/ajams-9-1-2
15. Williams B, Onsman A, Brown T. Exploratory Factor Analysis: A Five-Step Guide for Novices. Australasian Journal of Paramedicine. 2010; 8: 1-13. doi: 10.33151/ajp.8.3.93
16. Schreiber JB. Issues and recommendations for exploratory factor analysis and principal component analysis. Research in Social and Administrative Pharmacy. 2021; 17(5): 1004-1011. doi: 10.1016/j.sapharm.2020.07.027
17. Loewen S, Gonulal T. Exploratory Factor Analysis and Principal Components Analysis. Advancing Quantitative Methods in Second Language Research. Routledge; 2015: 182-212. doi: 10.4324/9781315870908-9
18. Ledesma RD, Valero-Mora P, Macbeth G. The Scree Test and the Number of Factors: A Dynamic Graphics Approach. The Spanish Journal of Psychology. 2015; 18. doi: 10.1017/sjp.2015.13
19. Howard MC. A systematic literature review of exploratory factor analyses in management. Journal of Business Research. 2023; 164: 113969. doi: 10.1016/j.jbusres.2023.113969
20. Jani WNFA, Razali F, Ismail N, and Ismawi N. Exploratory factor analysis: Validity and reliability of teacher's knowledge construct instrument. International Journal of Academic Research in Progressive Education and Development. 2023.
21. Jokiniemi K, Pietilä A, Mikkonen S. Construct validity of clinical nurse specialist core competency scale: An exploratory factor analysis. Journal of Clinical Nursing. 2021; 30(13-14): 1863-1873. doi: 10.1111/jocn.15587
22. Nordgaard J, Berge J, Rasmussen AR, et al. Are Self-disorders in Schizophrenia Expressive of a Unifying Disturbance of Subjectivity: A Factor Analytic Approach. Schizophrenia Bulletin. 2022; 49(1): 144-150. doi: 10.1093/schbul/sbac123
23. Tavakol M, Wetzel A. Factor Analysis: a means for theory and instrument development in support of construct validity. International Journal of Medical Education. 2020; 11: 245-247. doi: 10.5116/ijme.5f96.0f4a
24. Bollen KA. When Good Loadings Go Bad: Robustness in Factor Analysis. Structural Equation Modeling: A Multidisciplinary Journal. 2019; 27(4): 515-524. doi: 10.1080/10705511.2019.1691005
25. Schmitt TA, Sass DA. Rotation Criteria and Hypothesis Testing for Exploratory Factor Analysis: Implications for Factor Pattern Loadings and Interfactor Correlations. Educational and Psychological Measurement. 2011; 71(1): 95-113. doi: 10.1177/0013164410387348
26. Cai L, Chung SW, Lee T. Incremental Model Fit Assessment in the Case of Categorical Data: Tucker–Lewis Index for Item Response Theory Modeling. Prevention Science. 2021; 24(3): 455-466. doi: 10.1007/s11121-021-01253-4
27. Ferrando PJ, Lorenzo-Seva U. Assessing the Quality and Appropriateness of Factor Solutions and Factor Score Estimates in Exploratory Item Factor Analysis. Educational and Psychological Measurement. 2017; 78(5): 762-780. doi: 10.1177/0013164417719308
28. DiStefano C, Zhu M, Mindrila D. Understanding and using factor scores: Considerations for the applied researcher. Practical assessment, research, and evaluation; 2019.
29. Venkaiah K, Brahmam GNV, Vijayaraghavan K. Application of Factor Analysis to Identify Dietary Patterns and Use of Factor Scores to Study their Relationship with Nutritional Status of Adult Rural Populations. Journal of Health, Population and Nutrition. 2011; 29(4). doi: 10.3329/jhpn.v29i4.8448
30. Harris K, Dawson J, Doll H, et al. Can pain and function be distinguished in the Oxford Knee Score in a meaningful way? An exploratory and confirmatory factor analysis. Quality of Life Research. 2013; 22(9): 2561-2568. doi: 10.1007/s11136-013-0393-x
31. Giulianotti R. Sport: A critical sociology. John Wiley & Sons; 2015.

32. Rong Z, Gang Z. An artificial intelligence data mining technology based evaluation model of education on political and ideological strategy of students. Journal of Intelligent & Fuzzy Systems. 2021; 40(2): 3669-3680. doi: 10.3233/jifs-189401
33. Gholamnezhad Z, Mégarbane B, Rezaee R. Molecular mechanisms mediating adaptation to exercise. Physical Exercise for Human Health; 2020.
34. McGee SL, Hargreaves M. Exercise adaptations: molecular mechanisms and potential targets for therapeutic benefit. Nature Reviews Endocrinology. 2020; 16(9): 495-505. doi: 10.1038/s41574-020-0377-1
35. Neufer PD, Bamman MM, Muoio DM, et al. Understanding the Cellular and Molecular Mechanisms of Physical Activity-Induced Health Benefits. Cell Metabolism. 2015; 22(1): 4-11. doi: 10.1016/j.cmet.2015.05.011
36. Larivière C, Preuss R, Gagnon DH, et al. Structural remodelling of the lumbar multifidus, thoracolumbar fascia and lateral abdominal wall perimuscular connective tissues: A cross-sectional and comparative ultrasound study. Journal of Bodywork and Movement Therapies. 2020; 24(4): 293-302. doi: 10.1016/j.jbmt.2020.07.009
37. Dicks LMT. Gut Bacteria and Neurotransmitters. Microorganisms. 2022; 10(9): 1838. doi: 10.3390/microorganisms10091838
38. De-Miguel FF, Leon-Pinzon C, Noguez P, et al. Serotonin release from the neuronal cell body and its long-lasting effects on the nervous system. Philosophical Transactions of the Royal Society B: Biological Sciences. 2015; 370(1672): 20140196. doi: 10.1098/rstb.2014.0196
39. Peake JM, Neubauer O, Walsh NP, et al. Recovery of the immune system after exercise. Journal of Applied Physiology. 2017; 122(5): 1077-1087. doi: 10.1152/japplphysiol.00622.2016
40. Malm C, Jakobsson J, Isaksson A. Physical Activity and Sports—Real Health Benefits: A Review with Insight into the Public Health of Sweden. Sports. 2019; 7(5): 127. doi: 10.3390/sports7050127
41. Pol R, Balagué N, Ric A, et al. Training or Synergizing? Complex Systems Principles Change the Understanding of Sport Processes. Sports Medicine - Open. 2020; 6(1). doi: 10.1186/s40798-020-00256-9
42. Giulianotti R, Coalter F, Collison H, et al. Rethinking Sportland: A New Research Agenda for the Sport for Development and Peace Sector. Journal of Sport and Social Issues. 2019; 43(6): 411-437. doi: 10.1177/0193723519867590
43. Santos SDL, Memmert D, Sampaio J, et al. The Spawns of Creative Behavior in Team Sports: A Creativity Developmental Framework. Frontiers in Psychology. 2016; 7. doi: 10.3389/fpsyg.2016.01282