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Effects of Exercise on Biological Age Indices in High School Female Students

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Abstract:

Background: The study aimed to explore the influence of weekly physical activity on biological age (BA) among female adolescents aged 14 to 15. Objectives: The primary goal was to investigate whether weekly physical activity had an impact on female adolescents' biological age parameters. Method: The study included 129 female adolescents aged 14 to 15, categorized into two groups: the experimental group (EG, n = 66) and the control group (CG, n = 63). The participants' BA parameters were assessed. A statistical analysis was conducted to compare the BA parameters between the EG and CG. Result: The findings revealed a significant decrease in BA parameters among the female adolescents in the EG compared to those in the CG. This decrease was observed if, by the end of the study, the BA parameters of the CG did not significantly differ from the average data ($p > 0.05$). Statistical analysis ($p < 0.001$) supported this, indicating that biological age markers were influenced by the level of weekly physical activity. Conclusion:The study concludes that weekly physical activity has a significant impact on biological age markers among female adolescents aged 14 to 15. These findings emphasize the importance of regular physical activity in promoting healthy aging processes during adolescence.

Keywords: *Weekly physical activities; Biological age; Female adolescents Adolescence; Health promotions; Physical activity effects; Aging process; Physical fitness*

1. Introduction

Since the research conducted by Comfort. A in 1969, various studies have aimed to objectively measure biological age using identifiable biomarkers. Biological age is considered a more accurate indicator of an individual's aging process compared to chronological age, as it reflects the individual's health status, which is closely associated with aging, whereas chronological age merely represents the passage of time without considering health status. While several criteria have been proposed for biomarkers of aging, there are currently no standardized or widely accepted sets of biomarkers for estimating biological age (Arking R., 1991; Simm A. et al., 2008). These criteria include age-related changes, measurability without causing harm, relevance to health, reflection of biological processes, and reproducibility (Jinho Yoo et al., 2017). Apanasenko et al. (2014) developed a practical method for assessing individuals' health status, aimed at certifying nurses and other healthcare professionals working in the physical education and sports industries. According to research findings, less than 1% of the population currently maintains a "safe" health status, compared to approximately 8% twenty-five years ago. Studies by Apanasenko et al. (2014) and Thuc DC (2018a) have linked the aging of Vietnamese students to a number of things, such as biological decline, rising rates of chronic noncommunicable diseases, and a loss of the ability to reproduce. A suitable biological age (PBA), representing the population norm for age-related degradation, needs to be compared with an individual's biological age to assess the extent of aging relative to chronological age. The biological age index (BA/PBA) allows for determining how an individual's biological age deviates from the average biological age of their peers (Thuc DC, 2018b). The concept of "biological age" was introduced by gerontologists after recognizing that aging processes differ among bodily systems, with each organ having its own unique aging timetable (Pavel S. et al., 2018). Organs like the heart, lungs, and brain typically deteriorate faster, while digestive organs exhibit later signs of wear. Consequently, individuals with conditions like diabetes, high blood pressure, and obesity tend to be physiologically older than their counterparts (Pavel S. et al., 2018). The biological age should ideally correspond to the chronological age (Akhaladze, M., 2015), with a discrepancy of nine or ten years between the biological age and passport age considered alarming.

2. Materials and Methods

We examined 129 female adolescents aged 14 to 15, assigning them to experimental (EG, n = 66) and control (CG, n = 63) groups to investigate the effects of weekly physical activity on BA parameters. The study spanned an entire academic year, during which we evaluated the impact of physical activity on the EG females' biological age parameters. Statistical analysis using the Student's t-test determined the difference in biological age between the experimental and control groups compared to high school average data. We also analyzed changes in the study groups' findings over time.

3. **Results**

Throughout their high school years, students face numerous challenges, with a primary focus on reducing illnesses, enhancing health, and improving physical fitness. Improving students' cognitive performance follows closely behind. Hence, it is crucial to establish and maintain an educational environment that fosters objectives, values, and healthy lifestyle principles while also controlling variables affecting students' health (Stanislav P. et al., 2018). Student values influence their level of engagement and purposefulness in life. A value system encourages students to adopt healthier behaviors and adhere to a healthy lifestyle (Stanislav P. et al., 2018). The students' hierarchy of essential values is influenced by factors such as their physical fitness, living conditions, material well-being, and health status. The viability of the body is primarily determined by overall biological and non-nosological features rather than markers of morbidity, with biological age providing a comprehensive assessment (Bulych, E. H., et al., 2003). Biological age, which encompasses the morphological and functional maturity of tissues, organs, and the body, is influenced by environmental factors and genetic characteristics (Thuc D.C., 2018a). Even though it has some flaws, biological age is still a good way to tell if a person is still alive. This is because current methods don't fully understand molecular and genetic aging processes, and differences in conditions and lifestyles weaken the link between aging markers and viability. Our experimental program aimed to provide theoretical knowledge and foster a passion for health improvement among students, resulting in increased physical fitness levels and engagement in active recreation activities, which form the basis of health-promoting strategies (Table 1).

Table 1. A structured weekly regimen of physical activity and sports is designed for adolescent female students

S.No	*Activity Type Frequency*	*Duration*	*Weekly Duration* minutes
1	Active Breaks During School Hours (Micro-activity or short physical pauses)	15–20 minutes x 5 days	90
2	Physical Education and Sports Classes	1.5-2 hours per week	120
3	Walking to School	20-30 minutes x 5 days	150
4	Active Breaks While Studying	25-30 minutes x 6 days	180
5	Morning Physical Exercises	20-30 minutes x 6 days	180
6	School Sports Event Participation	2–3 times x 1 hour	180
7	Individual Physical Exercise or Sports Training Sessions	3 times-1.5–2 hours per week	360

Table 2 illustrates that the biweekly physical education classes, lasting only two hours per week, did not yield any positive outcomes for the CG females. The BA parameters for CG females remained nearly unchanged compared to the high school average values (high school average values: 35.79 ± 0.41 vs. 36.06 ± 0.48 years in CG females, $p > 0.05$). There are instances where a structured physical education regimen adversely affects the well-being of adolescent students. Engaging in physical activity only once a week may lead to temporary discomforts (e.g., headaches, insomnia, decreased appetite, muscle soreness, and reluctance to participate in physical education classes).

Table 2. *Relationship between the duration of weekly physical activity throughout the academic year (n = 129) and the biological age markers of females.*

Statistical metrics	Mean values at the higher education	Control group	Experimentation is underway to assess the weekly levels of physical activity within the group

	institution		120 minutes	240 minutes	360 minutes
M	35.79	36.06	36.89	37.07	35.01
±SD	0.41	0.48	0.41	0.47	0.28
t		1.12	1.32	1.26	5.01
P		>0.05	>0.05	>0.05	<0.001

Following two hours of individual training and one physical education session per week, females in the first experimental group (EG1) exhibited a slight trend towards increasing their biological age (BA) parameters at the trial's conclusion (from 36.89 ± 0.41 to 37.07 ± 0.47 years; $p > 0.05$). Similar findings were observed for females in the second experimental group (EG2), who underwent one physical education session and four hours of individual training per week. At the trial's conclusion, BA parameters remained nearly unchanged, increasing from 36.68 ± 0.51 to 37.02 ± 0.45 years ($p > 0.05$). Remarkably, females in the third experimental group (EG3) exhibited the most favorable outcomes. Following the implementation of one physical education class and an additional six or more hours of individual training per week, a significant decrease in BA parameters was observed. As a result, females' BA parameters in EG3 were significantly lower—35.01 ± 0.28 compared to 36.68 ± 0.51 —than the average values at the high school. Statistical analysis ($p<0.001$) supported these findings. The chosen approach to health education courses proved highly effective, and it may even set a standard for assessing a student's weekly mobility status at higher education institutions. The data on biological ages underscores the effectiveness of the experiment.

Furthermore, females in EG3 experienced improvements in overall health, enhanced lung capacity, intensified redox processes in the body, normalization of gastrointestinal and excretory functions, and improved synchronization between muscular activity and vegetative and trophic functions, among others. These findings are consistent with research conducted by other Vietnamese scientists (Thuc, D.C., 2018b).

4. Discussion and Conclusion.

The combination of two-hour weekly physical education lessons and at least six hours of independent training demonstrated the most significant impact. This regimen represents the minimum requirement for females to maintain physical fitness and slow down the aging process. The inadequate impact of physical activity on the biological age parameters of high school females aged 14 to 15 can be attributed to several factors:

Insufficient physical education class hours result in females receiving only 20 to 30 percent of the necessary motor activity in general education settings.

Ineffectiveness of physical education programs.

Non-adherence to the teacher's methodological advice regarding the structure and conduct of individual courses.

Reluctance of students to consult with physical education department instructors regarding individual training activities.

Lack of compliance with the schedule for independent training activities.

Unformed drive for bodily self-improvement.

The proposed model for weekly motor activity among first-year female students contributes to maintaining normal viability, improving health, fostering motivation for physical self-improvement, enhancing academic success, and increasing weekly motor activity from 14 to 15 hours to 17–20 hours for females aged 14 to 15. After verifying the experimental program's influence, it was evident that it had a more significant beneficial impact than the existing physical education program at Vietnam's higher education institutions. [There exists a correlation between biological age and the amount of weekly physical activity engaged in.

The study investigated the impact of different exercise regimens on biological age indices in high school female students. Three experimental groups were formed, each with varying combinations of physical education sessions and individual training hours per week.

The results revealed interesting trends. The first two experimental groups, despite engaging in physical activity, showed either minimal change or a slight increase in biological age parameters. However, the third experimental group,

which underwent a more rigorous exercise regimen, demonstrated significant improvements. Notably, their biological age parameters decreased significantly compared to the average values at the high school.

These findings suggest that a combination of regular physical education classes and additional hours of individual training can effectively reduce biological age in high school female students. The statistical analysis supported these conclusions, indicating the significance of the observed differences.

Furthermore, the study highlighted various health benefits associated with the exercise interventions, including improvements in overall health, lung capacity, redox processes, and gastrointestinal and excretory functions. These positive outcomes align with previous research conducted by Vietnamese scientists, emphasizing the validity of the study's findings.

In conclusion, the study underscores the importance of regular physical activity in high school students' health and well-being. It provides valuable insights into the effectiveness of different exercise regimens in reducing biological age and improving overall health outcomes. These findings may have implications for designing health education programs and assessing students' mobility status in educational institutions.

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