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The Influence of Exercise Habits on Body Composition and Physical Fitness Among Female College Freshmen: A Cross-Sectional Study

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***Abstract*—** *Transition to university life is critical for long-term health, yet rising inactivity and sedentary behaviors among female college students impair fitness and increase health risks. This study examined how exercise habits affect body composition and fitness in female freshmen to inform campus health strategies. Methods: 222 female freshmen from 2022–2023 cohorts completed a physical activity questionnaire and were divided into exercise and non-exercise groups. Objective measures included body composition (BMI, body fat percentage, visceral fat index, waist-to-hip ratio, muscle mass) and fitness (vital capacity, 50-m sprint, 800-m run, sit-ups, standing long jump, sit-and-reach, grip strength, ruler drop, single-leg stance). Data were analyzed using General Linear Model. Results: The exercise group showed significantly better muscle mass, 50-m sprint, 800-m run, sit-ups, and grip strength ($p < .05$). Interaction effects between cohort and exercise habits were significant for body fat percentage, visceral fat index, and standing long jump ($p < .05$). No differences in BMI, vital capacity, or sit-and-reach ($p > .05$). Conclusion: Regular exercise improves body composition (increased muscle, reduced fat) and enhances speed, strength, and cardiorespiratory endurance in female freshmen. Since BMI alone cannot detect "hidden obesity," universities should use comprehensive body composition assessments and combine environmental and digital interventions to promote sustainable exercise.*

***Keywords*— Body fat percentage, Emerging adulthood, Exercise habits, Female college students, Physical fitness, Sedentary behavior.**

I. INTRODUCTION

The transition from adolescence to "emerging adulthood" during the university years represents a critical developmental junction. During this phase, individuals experience a significant shift in personal autonomy, academic demands, and environmental exposures, which often precipitates the adoption of sedentary lifestyles [1,2]. Global epidemiological surveillance highlights that a staggering proportion of young adults—upward of 81%—fail to meet the World Health Organization's (WHO) recommendation of at least 150 minutes of moderate-to-vigorous physical activity (MVPA) per week[3,4]. This phenomenon is particularly concerning among female college students,

who typically report lower physical activity levels, higher perceived barriers to exercise, and a greater propensity for physical inactivity compared to their male counterparts[5,6].

Prolonged sedentary behavior and physical inactivity are directly associated with an increased risk of deteriorating body composition, including skeletal muscle loss and visceral fat accumulation, which subsequently elevate the risk of metabolic syndrome in early adulthood[7]. Traditional screening methods, such as the Body Mass Index (BMI), often fail to identify "hidden obesity"—a condition characterized by a normal body weight but an excessively high body fat percentage (BFR)[8]. Therefore, utilizing comprehensive anthropometric indicators like BFR and waist-to-hip ratio (WHR) is crucial for accurately assessing metabolic risks among young females[9].

Beyond physiological detriments, the psychological toll of inactivity in higher education is profound. Recent evidence demonstrates a steady rise in the incidence of mental health issues, including anxiety, depression, and academic stress among college students[10,11]. Engaging in regular physical activity has been shown to serve as a vital protective buffer, fostering positive mental health, improving sleep quality, and alleviating depressive symptoms through neurobiological and psychosocial mechanisms[12,13]. Furthermore, higher physical fitness is intrinsically linked to greater exercise enjoyment, which is a primary determinant of sustainable physical activity participation[14].

Despite existing literature confirming the efficacy of physical activity interventions on overall well-being[15,16], there is a distinct gap in empirical studies that directly compare a comprehensive set of objective fitness and body composition parameters between active and inactive female college freshmen across different enrollment cohorts. Thus, the present cross-sectional study aims to evaluate the differences in body composition and physical fitness between female freshmen with and without regular exercise habits, providing robust evidence to inform university health promotion strategies, campus built-environment designs[17,18], and future eHealth interventions[19].

II. METHODS

2.1 Participants

The study recruited female college freshmen from the 2022 and 2023 cohorts. A "College Student Exercise Habit Questionnaire" was administered to evaluate their physical activity levels. The criteria for possessing a "regular exercise habit" were defined based on WHO guidelines: engaging in MVPA three or more times per week, with each session lasting at least 30 minutes[4]. Participants meeting these criteria were assigned to the "Exercise Group," while those who did not were assigned to the "Non-exercise Group."

Following the exclusion of invalid responses and participants with physical contraindications to exercise, 222 female students were included in the final analysis. The sample consisted of the 2022 cohort (86 non-exercisers, 33 exercisers) and the 2023 cohort (71 non-exercisers, 32 exercisers). All participants provided informed consent prior to the commencement of the physical assessments. The demographic characteristics are presented in Table 1.

Table 1. Demographic characteristics of the female freshmen participants (N=222)

Cohort	Group	Sample Size (n)	Height (cm, Mean ± SD)	Weight (kg, Mean ± SD)
2022	Non-exercise	86	160.45 ± 5.59	51.65 ± 8.28
	Exercise	33	164.19 ± 5.83	54.13 ± 7.68
2023	Non-exercise	71	160.01 ± 5.78	52.15 ± 8.86
	Exercise	32	162.77 ± 5.38	51.07 ± 6.98

2.2 Measures and Instruments

The assessment protocol adhered to standardized national fitness testing guidelines to ensure high reliability and validity:

a. Body Composition: An InBody H20N bioelectrical impedance analyzer was utilized to measure BFR (%), skeletal muscle mass (kg), and visceral fat index. Waist and hip circumferences were measured using a non-elastic tape to calculate the WHR.

b. Physical Fitness: Cardiorespiratory endurance, muscular strength, and flexibility were evaluated via height/weight (for BMI calculation), vital capacity (ml),

50-m sprint (s), standing long jump (cm), sit-and-reach (cm), 800-m run (s), and 1-minute sit-ups (reps).

c. Neuromuscular and Functional Attributes: An electronic dynamometer assessed the maximal grip strength of both dominant and non-dominant hands (kg). Reaction time was evaluated via a ruler drop test (cm), and proprioceptive balance was assessed using a closed-eye single-leg stance test (s).

2.3 Data Analysis

All statistical analyses were performed using SPSS 25.0 software. A General Linear Model (GLM) was employed for multivariate analysis to examine the main and interaction effects of "enrollment cohort" (2022 vs. 2023) and "exercise habits" (Exercise vs. Non-exercise) on the dependent variables (body composition and physical fitness metrics). The significance level was established at $\alpha = .05$. Significant interaction effects were followed by post-hoc comparisons.

III. RESULTS

3.1 Body Composition Results

The GLM analysis (Table 2) revealed that exercise habits exerted a significant main effect on muscle mass. The exercise group demonstrated significantly greater skeletal muscle mass compared to the non-exercise group ($F = 10.159$, $p < .05$). Regarding interaction effects, a significant interaction between "enrollment cohort" and "exercise habits" was identified for BFR ($F = 5.720$, $p < .05$) and visceral fat index ($F = 4.098$, $p < .05$).

Analysis of cohort main effects indicated that the 2022 cohort maintained a significantly healthier WHR compared to the 2023 cohort ($F = 10.508$, $p < .05$). Notably, BMI showed no statistically significant differences across any group or cohort ($p > .05$).

Table 2. Body composition results among female freshmen (Mean ± SD)

Body Composition Indicator	2022 Non-exercise (A)	2022 Exercise (B)	2023 Non-exercise (C)	2023 Exercise (D)
BMI (kg/m²)	20.06 ± 3.03	20.08 ± 2.73	20.34 ± 3.06	19.24 ± 2.04
Body Fat Rate (%) *	28.16 ± 5.98	24.33 ± 4.57	29.07 ± 5.16	21.60 ± 2.71
Muscle Mass (kg) [b]	19.88 ± 2.73	22.12 ± 3.06	20.34 ± 6.49	23.20 ± 8.88
Visceral Fat Index *	5.85 ± 3.16	5.18 ± 2.08	6.05 ± 2.67	3.81 ± 0.99
Waist-to-Hip Ratio [a]	0.74 ± 0.07	0.74 ± 0.04	0.76 ± 0.04	0.76 ± 0.05

*Notes. [a] Significant difference between cohorts ($p < .05$); [b] Significant difference between exercise habits ($p < .05$); * Significant interaction effect ($p < .05$).*

3.2 Physical Fitness Results

As shown in Table 3, the exercise group exhibited robust and significant advantages in multiple fitness domains, including the 50-m sprint ($F = 38.148$, $p < .05$), 800-m run ($F = 38.268$, $p < .05$), sit-ups ($F = 12.820$, $p < .05$), dominant hand grip strength ($F = 24.671$, $p < .05$), and non-dominant hand grip strength ($F = 14.293$, $p < .05$).

A significant interaction effect was noted in the standing long jump ($F = 8.385$, $p < .05$). Additional cohort differences emerged, with the 2023 cohort outperforming the 2022 cohort in the 50-m sprint and single-leg stance, whereas the 2022 cohort demonstrated superior reaction times in the ruler drop test. No significant differences were observed for vital capacity or sit-and-reach flexibility across subgroups ($p > .05$).

Table 3. Physical fitness results among female freshmen (Mean ± SD)

Physical Fitness Indicator	2022 Non-exercise (A)	2022 Exercise (B)	2023 Non-exercise (C)	2023 Exercise (D)
Vital Capacity (ml)	2842.21 ± 464.30	2945.27 ± 422.80	2851.30 ± 459.32	2934.00 ± 401.73
50-m Sprint (s) [ab]	8.81 ± 0.78	8.20 ± 0.71	8.50 ± 0.80	7.67 ± 0.85

Standing Long Jump (cm) *	168.36 ± 19.65	184.39 ± 23.07	160.07 ± 15.42	193.13 ± 25.23
Sit-and-Reach (cm)	17.70 ± 7.25	19.45 ± 6.00	19.07 ± 6.60	19.60 ± 6.16
800-m Run (s) [b]	243.81 ± 35.10	220.82 ± 25.12	243.04 ± 21.75	214.38 ± 22.96
Sit-ups (reps) [b]	37.16 ± 7.93	40.73 ± 10.77	36.30 ± 8.65	41.81 ± 7.47
Ruler Drop (Dominant) (cm) [a]	18.83 ± 6.99	17.53 ± 6.45	20.02 ± 3.90	21.47 ± 3.96
Ruler Drop (Non-Dominant) (cm) [a]	16.49 ± 5.97	16.64 ± 6.41	20.16 ± 4.57	21.46 ± 4.35
Grip Strength (Dom.) (kg) [b]	23.87 ± 5.07	28.34 ± 6.18	25.25 ± 3.85	28.30 ± 6.41
Grip Strength (Non-Dom.) (kg) [b]	22.84 ± 5.01	25.54 ± 5.20	23.16 ± 3.71	25.70 ± 5.14
Single-Leg Stance (Dom.) (s) [a]	40.14 ± 36.68	53.39 ± 37.12	75.77 ± 48.57	66.44 ± 39.50
Single-Leg Stance (Non-Dom.) (s) [a]	47.77 ± 52.66	51.21 ± 31.84	71.63 ± 43.76	61.97 ± 40.96

*Notes. [a] Significant difference between cohorts ($p < .05$); [b] Significant difference between exercise habits ($p < .05$); * Significant interaction effect ($p < .05$).*

IV. DISCUSSION

The current study demonstrates that female college freshmen who maintain regular exercise habits possess significantly better muscle mass, sprint speed, cardiorespiratory endurance, and localized muscular strength (sit-ups and grip strength). These physiological adaptations align with extensive literature emphasizing the musculoskeletal and metabolic benefits of maintaining consistent MVPA during emerging adulthood[20,21].

Hidden Obesity and Body Composition Limitations: A critical finding of this study is the lack of significant differences in BMI between the exercise and non-exercise groups, despite substantial differences in BFR and visceral fat indices. This supports the paradigm that BMI is an inadequate proxy for adiposity in young female populations, as it fails to distinguish between lean muscle mass and fat tissue[8]. Within the study sample, over 60% of participants presented with a BFR exceeding the healthy threshold, underscoring a high prevalence of "hidden obesity." Regular physical activity functions as a primary mitigator of visceral fat accumulation and metabolic syndrome, making the promotion of exercise imperative for cardiometabolic health[7].

Physical Fitness, Enjoyment, and Mental Health: The superior performance of the exercise group in the 800-m run and sit-ups indicates enhanced cardiorespiratory and core strength. In higher education contexts, such physiological resilience is not merely a physical asset but a critical mediator for psychological well-being. Substantial cardiorespiratory fitness buffers against the onset of depression and anxiety, which are heavily correlated with academic pressures and sedentary behaviors[2,12]. Furthermore, elevated physical fitness acts as a prerequisite for experiencing "exercise enjoyment," fostering positive self-efficacy and driving sustainable physical activity participation over the lifespan[14].

Environmental Barriers and Future Interventions: The absence of significant differences in vital capacity and flexibility across the groups suggests that daily activities among female students might lack specialized aerobic or stretching protocols. Female students universally encounter barriers such as heavy academic workloads, lack of motivation, and suboptimal environmental support[5,22]. Addressing physical inactivity necessitates systemic environmental transformations. Enhancing campus "walkability" through optimized built-environment designs—such as better land-use diversity and improved pedestrian infrastructure—can passively increase students' daily non-exercise physical activity[17,18]. Concurrently, implementing digital health technologies, such as gamified eHealth apps and wearable devices, can significantly boost intrinsic motivation and adherence among the digital-native student population[19,23].

V. CONCLUSION

This study provides compelling empirical evidence that regular physical exercise significantly improves body composition—by mitigating hidden fat accumulation and preserving muscle mass—and enhances holistic

physical fitness in female college freshmen. Given the limitations of BMI in identifying "hidden obesity," universities must adopt comprehensive anthropometric evaluations in routine health screenings. To combat the public health threat of student inactivity, higher education institutions should proactively design walkable campus environments, promote digital and gamified physical activity interventions, and encourage at least 150 minutes of weekly MVPA. These multidimensional approaches will ultimately foster the physical, psychological, and academic well-being of young adults.

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