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Effects of a 12-Week Basketball Training Program on Health-Related Quality of Life in University Students

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Abstract: Amid growing concerns over the multifaceted health challenges faced by university students, this study investigated the effects of a 12-week structured basketball training program on health-related quality of life (HRQoL) and examined how these effects differ based on students' baseline physical activity levels. A total of 162 undergraduates were stratified into four groups—sedentary, underactive, insufficiently active, and active—based on initial activity assessments. The intervention consisted of supervised, twice-weekly sessions combining basketball-specific skills and high-intensity interval training. HRQoL was measured using the SF-36 questionnaire before and after the intervention. Results revealed a differential impact: the underactive group demonstrated statistically significant improvements in general health, vitality, mental health, and the mental component summary score. In contrast, the active group maintained high baseline scores without significant gains, suggesting a ceiling effect, while the sedentary and insufficiently active groups showed limited changes. These findings indicate that structured basketball training is particularly effective in enhancing psychosocial dimensions of HRQoL for students who are underactive at baseline. The study advances the understanding of targeted physical activity interventions by highlighting the importance of baseline stratification, moving beyond a one-size-fits-all approach. It provides empirical support for implementing tailored team-sport programs as a strategic campus health initiative to improve student well-being.

Keywords: Basketball Training Program; Health-Related Quality of Life; University Students.

1. Introduction

With the increasingly fierce competition in higher education, contemporary college students are facing multiple challenges such as academic pressure, life adaptation, and future planning, and their physical and mental health conditions have attracted increasing attention [1-3].

Studies show that a sedentary lifestyle, irregular schedules, and continuous mental stress are significantly eroding the overall health and quality of life of college students. Against this backdrop, exploring effective and easily accessible physical exercise intervention methods is of great significance for improving the health level of college students[5-7].

Basketball, as a highly popular and engaging team sport, integrates multiple elements such as aerobic exercise, explosive power training, coordination training, and teamwork[8]. It can not only effectively enhance cardiopulmonary function, muscle strength, and body coordination but also has potential value in relieving stress, enhancing social integration, and improving emotional management ability[9]. However, as a structured and periodic intervention method, the specific influence paths and effects of basketball training on the multidimensional concept of "health-related quality of life" (HRQoL) of college students (covering aspects such as physiological functions, psychological states, social relationships, and environmental adaptation) still need to be verified through rigorous empirical research.

Therefore, this study aimed to systematically examine the specific effects of regular basketball training on various dimensions of college students' health-related quality of life through a 12-week randomized controlled intervention experiment. The research results are expected to provide empirical evidence and feasible program references for promoting college students' physical and mental health and improving their comprehensive quality of life through sports intervention.

2. Study Subjects and Methods

2.1. Study Subjects

This study investigated the effects of a 12-week basketball training program on the HRQoL of university students. Participants were undergraduates enrolled in physical education courses at public universities in Zhaoqing City, Guangdong Province, and Wuzhou City, Guangxi Zhuang Autonomous Region-2-5-8. Between September 2025 and January 2026, a total of 162 undergraduate students were recruited (see Table 1). Inclusion criteria were: age 18-35 years; no history of exercise-related injuries in the past year; no regular fitness training experience; and good general health. Exclusion criteria included: a history of organic diseases; a history of mental disorders such as depression or anxiety.

Table 1. Basic Characteristics of the Four Experimental Groups

Experimental Group		Age (years)	Gender (M/F)	
Sedentary(Sed)	n = 37	19.62±0.15	36	1
Underactive(UA)	n = 44	19.45±0.12	41	3
Insufficiently Active(IA)	n = 43	19.56±0.13	42	1
Active(Act)	n = 31	19.45±0.14	29	2

Note. M: male; F: female

Eligible subjects were assigned to one of four groups based on the TAPA questionnaire: the sedentary group (Sed), underactive group (UA), insufficiently active group (IA), and active group (Act). Seven participants withdrew during the study, resulting in a final attrition rate of 4.3%. The final sample consisted of 37 in the sedentary group, 44 in the low-intensity group, 43 in the moderate-intensity group, and 31 in the high-intensity group, with a mean age of 19.52 ± 0.83 years. All participants provided written informed consent and volunteered for the study.

2.2. Methods

2.2.1. Measurement of Sedentary Behavior and Physical Activity

Sedentary behavior and PA were evaluated using the Telephone Assessment of Physical Activity Questionnaire (TAPA). Overall PA levels were assessed using the Rapid Assessment of Physical Activity (RAPA) questionnaire. Based on RAPA scores, participants were categorized into four groups: 1) Sedentary (Sed, almost no PA), 2) Underactive (UA, having some physical activities but below the recommended level), 3) Insufficiently Active (IA, being active but not meeting the recommended standard), and 4) Active (Act, meeting or exceeding the recommended standard). Among the participants in this study, the TAPA questionnaire demonstrated good test-retest reliability (Spearman's correlation coefficient = 0.672, p = 0.001) and acceptable criterion validity (Kappa statistic = 0.526, p = 0.001).

2.2.2. Training Intervention

This study implemented a structured 12-week basketball training intervention, consisting of two sessions per week, each lasting 45 minutes. Each session followed a quantified protocol: (1) Preparation and Cognitive Engagement (10 min): Interpretation of individual exercise data based on heart rate monitoring and Ratings of Perceived Exertion (RPE); (2) Dynamic Warm-up and Movement Skills (5 min); (3) Core Skills and High-Intensity Interval Training (25 min): This phase maintained an intensity at 70%-85% of Heart Rate Reserve (HRR) or an RPE of 13-16 (“somewhat hard” to “hard”). It included basketball-specific drills (e.g, consecutive crossover dribbles, catch-and-shoot) and a circuit of 4-5 stations (e.g., baseline sprints, box jumps) following a work/rest ratio of 30 seconds/15 seconds; (4) Cool-down and Static Stretching (5 min).

To ensure participants attained the prescribed moderate-to-vigorous physical activity intensity, resting heart rate and blood pressure were monitored, and the Borg Rating of Perceived Exertion (RPE) Scale was employed for real-time monitoring and dynamic adjustment of exercise intensity.

Resting Heart Rate and Blood Pressure: Resting heart rate and blood pressure were measured using an Omron D11 model electronic sphygmomanometer (Omron Corporation, Japan). Participants were seated with the sphygmomanometer cuff positioned at heart level. Resting blood pressure was typically measured twice, with the second measurement taken after a 1-minute interval following the first. The average of the two readings was recorded for analysis.

2.2.3. Health indicators

HRQoL was assessed using the Chinese version of the SF-36 scale [10,11]. The SF-36 tool is used to analyze an individual's health-related quality of life. It consists of 36 items, divided into 8 dimensions and 1 item on health change. The 8 dimensions are: physical functioning (PF) (10 items, 1 = "many limitations" to 3 = "no limitations at all"), role-physical (RP) (4 items, answered "yes" (1 point) or "no" (2 points), score range 4 to 8 points), bodily pain (BP) (2 items, item 7 scored based on pain severity (1 = "extremely severe pain" to 6 = "no pain"), item 8 adjusted based on item 7's answer), general health (GH) (5 items, item 1 scored from "very good" (5 points) to "poor" (1 point), 2 items reverse-scored (e.g., "absolutely correct" = 1 point), 2 items forward-scored), GH (4 items, 2 items forward-scored (6 = "all the time" to 1 = "never"), 2 items reverse-scored), social functioning (SF) (6 items, scored based on the degree of impact (1 = "no impact" to 5 = "extreme impact")), role-emotional (RE) (3 items, answered "yes" (1 point) or "no" (2 points)), mental health (MH) (5 items), and health change (independent assessment, answers range from "much better than a year ago" (5 points) to "much worse" (1 point)). If the missing items in a dimension do not exceed 50%, the mean score of the answered items in that dimension is used as a substitute; if the missing items exceed 50%, that dimension is excluded. All dimension scores are converted to a range of 0 to 100, with higher scores indicating better health status. The parameters are combined into groups, adding 4 parameters for the physical domain and 4 for the psychological domain of quality of life assessment, as follows: PF + RP + BP + GH = physical component summary (PCS); VT + SF + RE + MH = mental component summary (MCS). The standardized score range for each dimension is 0 to 100, with scores closer to 100 indicating higher quality of life. The SF-36 has good reliability and validity when applied to college students, with a Cronbach's α coefficient of 0.9017. In terms of structural validity, the 8 factors from factor analysis are basically consistent with the theoretical structure, with a cumulative variance contribution rate of 72.09%.

2.3. Quality Control

All participants provided written informed consent prior to testing. They underwent risk screening before the trial, were thoroughly familiarized with the entire testing protocol, actively cooperated, and completed the tests as required. The entire experiment was conducted jointly by the authors, who received appropriate training before testing.

2.4. Statistical Analysis

Statistical analyses were performed using SPSS software (version 27.0). Categorical data were described using frequencies or percentages. Continuous data conforming to a normal distribution were described as mean±standard deviation ($\bar{x}$±s). Data not conforming to a normal distribution were described using the median (interquartile range, M (P25, P75)) and analyzed using non-parametric tests. Mixed-effects analysis of variance (ANOVA) was used to analyze the SF-36 and physical activity data before and after the intervention, examining the effects of group, time, and the group × time interaction. Prior to conducting the mixed-effects ANOVA, data were tested for homogeneity of variance [12,13]. The Shapiro-Wilk test was used to assess the assumption of normality, Levene's test to evaluate homogeneity of variances, and Mauchly's test to verify sphericity. When a statistically significant interaction was found, simple effects analysis was performed. If no significant interaction was present, the Bonferroni method was used to compare time points within groups. The significance level was set at α = 0.05.

3. Results

3.1. Normal Distribution of Health-Related Quality of Life Data

Table 2. Results of the Shapiro-Wilk test for normality.

Index	Group	Shapiro-Wilk		
		Statistic	df	Sig.
PF-1	**Sed**	.853	37	.000
	UA	.622	44	.000
	IA	.691	43	.000
	Act	.553	31	.000
RP-1	**Sed**	.582	37	.000
	UA	.451	44	.000
	IA	.613	43	.000
	Act	.176	31	.000
BP-1	**Sed**	.806	37	.000
	UA	.779	44	.000
	IA	.777	43	.000
	Act	.610	31	.000
GH-1	**Sed**	.880	37	.001
	UA	.935	44	.016
	IA	.917	43	.004
	Act	.661	31	.000
VT-1	**Sed**	.936	37	.034
	UA	.918	44	.004
	IA	.927	43	.009
	Act	.895	31	.006
SF-1	**Sed**	.898	37	.003
	UA	.860	44	.000
	IA	.870	43	.000
	Act	.501	31	.000
RE-1	**Sed**	.594	37	.000
	UA	.479	44	.000
	IA	.663	43	.000
	Act	.176	31	.000
MH-1	**Sed**	.922	37	.013
	UA	.909	44	.002
	IA	.903	43	.002
	Act	.879	31	.002
HT-1	**Sed**	.902	37	.003
	UA	.872	44	.000
	IA	.859	43	.000
	Act	.680	31	.000
PCS-1	**Sed**	.935	37	.031
	UA	.851	44	.000
	IA	.825	43	.000
	Act	.691	31	.000
MCS-1	**Sed**	.946	37	.071
	UA	.969	44	.276
	IA	.958	43	.115
	Act	.866	31	.001

Abbreviations: Sed, Sedentary; UA, Underactive; IA, Insufficiently Active; Act, Active; PF, Physical Functioning; RP, Role Physical; BP, Bodily Pain; GH, General Health; VT, Vitality; SF, Social Functioning; RE, Role Emotional; MH, Mental Health; HT, Health Transition; PCS, Physical Component Summary; MCS, Mental Component Summary.

Methodological Implication for the Study: Since the data for most outcome variables and groups are not normally distributed, the use of parametric tests (like paired-samples t-tests or ANOVA) for within-group (before-and-after) or between-group comparisons is not appropriate. The authors must employ non-parametric tests for their subsequent analyses, such as: Wilcoxon Signed-Rank Test for within-group (pre-post) comparisons; Kruskal-Wallis H Test for comparing scores across the four independent activity groups.

The normality tests confirm that the health-related quality of life data is predominantly non-normally distributed at baseline. This finding dictates the use of non-parametric statistical methods for the main analysis of intervention effects or group differences in this study.

3.2. Assessment of Health-Related Quality of Life Indicators of College Students Before and After Intervention

We examined the overall changes in the SF-36 MCS and PCS summary measures across the four groups of college students after the 12-week basketball training. From the box plot, it can be observed that the UA group showed relatively clear improvement in MCS, while in terms of PCS, the UA and IA groups exhibited more noticeable gains.

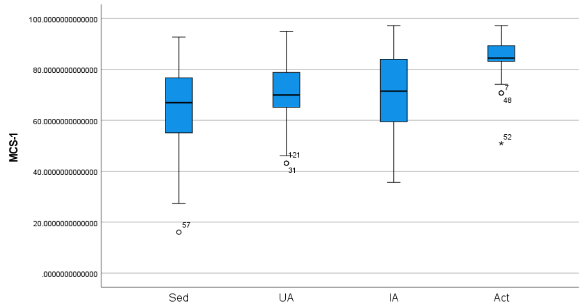

Figure 1. First-Week Box-and-Line Chart Results for MCS

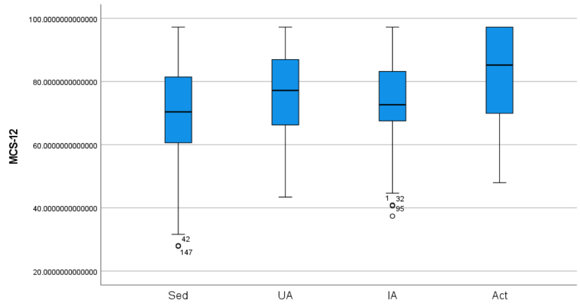

Figure 2. 12-Week Box-and-Line Chart Results for MCS

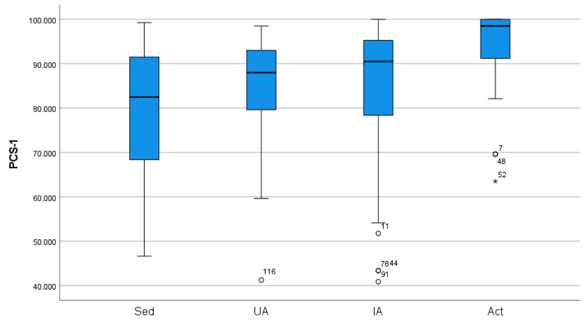

Figure 3. First-Week Box-and-Line Chart Results for PCS

Predominance of Non-Significant Changes: For the majority of outcome measures across all groups, the p-values are greater than 0.05. This indicates that for most domains, there was no statistically significant change from the beginning to the end of the 12-week intervention period.

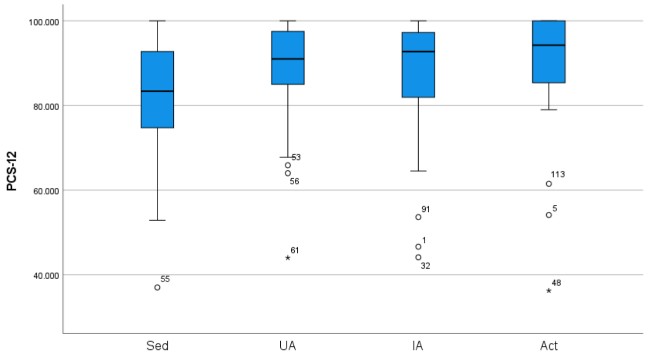

Figure 4. 12-Week Box-and-Line Chart Results for PCS

Significant Improvements (Where p < 0.05): A few specific domains showed statistically significant improvements within certain groups: GH:

Table 3. Results of Assessment of Health-Related Quality of Life Indicators of College Students Before and After Intervention

Group	Sed group Mean ± SD	UA group Mean ± SD	IA group Mean ± SD	Act group Mean ± SD
PF(week1)	83.24±15.10	89.09±18.08	90.93±13.89	92.10±16.00
PF(week12)	54.54±15.036	89.89±15.00	91.63±14.54	88.23±21.03
Z	-0.830[b]	-0.436[b]	-0.417[b]	-0.787[b]
P	0.406	0.662	0.677	0.431
RP(week1)	81.76±34.18	88.64±28.25	81.98±31.96	96.77±17.96
RP(week12)	88.51±26.74	93.18±21.13	86.05±30.03	87.90±28.77
Z	-1.077[b]	-1.066[c]	-0.812[b]	-1.364[b]
P	0.282	0.286	0.417	0.172
BP(week1)	87.23±12.81	91.08±10.51	88.15±14.27	92.75±13.03
BP(week12)	85.60±15.85	92.38±10.62	92.08±9.13	93.00±13.39
Z	-0.596[c]	-0.451[c]	-1.555[b]	-0.503[b]
P	0.551	0.652	0.120	0.615
GH(week1)	61.46±16.49	68.70±14.13	75.53±21.08	92.65±12.13
GH(week12)	68.86±20.30	78.11±18.45	78.23±18.65	86.87±16.73
Z	-2.009[b]	-2.555[c]	-0.626[b]	-1.398[b]
P	0.045	0.011	0.531	0.162
VT(week1)	56.22±15.20	60.34±17.09	65.12±19.80	82.42±14.01
VT(week12)	61.35±20.43	69.66±16.22	67.91±16.98	80.48±19.42
Z	-1.205[b]	-3.139[c]	-0.971[b]	-0.289[b]
P	0.228	0.002	0.331	0.772
SF(week1)	66.36±16.66	73.73±14.39	72.86±14.60	83.87±11.05
SF(week12)	66.36±18.97	75.00±13.58	73.64±14.34	80.64±14.61
Z	-0.058[c]	-.523[c]	-0.219[b]	-1.128[b]
P	0.954	0.601	0.826	0.259
RE(week1)	76.57±39.95	87.12±29.82	79.06±33.35	96.77±17.96
RE(week12)	81.08±35.60	87.87±29.71	83.72±32.01	89.24±26.36
Z	-0.878[b]	-0.177[c]	-0.687[b]	-1.063[b]
P	0.380	0.860	0.492	0.288
MH(week1)	57.19±16.435	62.09±14.21	68.56±16.91	74.84±18.62
MH(week12)	64.65±18.367	72.09±17.94	67.26±17.11	78.97±22.27
Z	-1.887[b]	-3.300[c]	-0.148[c]	-0.931[c]
P	0.059	0.001	0.883	0.352
HT(week1)	50.00±28.868	58.52±29.99	65.12±27.89	82.26±26.76
HT(week12)	54.73±26.245	63.07±24.40	69.77±24.12	91.13±16.51
Z	-0.935[b]	-0.770[c]	-1.069[b]	-1.581[c]
P	0.350	0.441	0.285	0.114
PCS(week1)	78.42±14.94	84.37±11.72	84.14±16.42	93.56±10.15
PCS(week12)	82.13±14.07	88.39±11.90	86.99±14.43	89.00±14.79
Z	-1.753[b]	-1.558[c]	-0.868[b]	-1.683[b]
P	0.080	0.119	0.386	0.092
MCS(week1)	64.08±17.77	70.82±12.37	71.40±17.40	84.47±9.78
MCS(week12)	68.36±19.19	76.15±14.33	73.13±15.42	82.33±16.01
Z	-1.931[b]	-2.071[c]	-0.578	-0.628[b]
P	0.053	0.038	0.563	0.530

Abbreviations: Data are presented as Mean ± SD. Z and p-values are derived from the Wilcoxon signed-rank test. a: Asymptotic significance (2-tailed). b: Based on positive ranks. c: Based on negative ranks.

Sedentary Group: Improved from 61.46 to 68.86p = 0.045. UA Group: Improved from 68.70 to 78.11p = 0.011. VT: UA Group: Improved from 60.34 to 69.66p = 0.002. MH: UA Group: Improved from 62.09 to 72.09p = 0.001. MCS: UA Group: Improved from 70.82 to 76.15p = 0.038.

Notable Trends and Observations: The UA Group Shows the Most Consistent Benefits: The Unorganized Activity group was the only one to demonstrate significant improvements in multiple domains (GH, VT, MH, and MCS), suggesting this type of activity may have had a broad positive impact on perceived energy and mental well-being.

High Baseline & Maintenance in the Act Group: The Act group started with the highest baseline scores in almost every domain. While they maintained these high levels, they showed no statistically significant improvements, possibly due to a "ceiling effect" where there was little room for measurable gain.

Limited Impact of IA: The Insufficiently Active group showed no significant changes in any domain.

The primary conclusion from Table 3 is that the 12-week intervention had a limited overall impact on HRQoL scores across the board. The most promising effects were observed in the UA group, which experienced significant improvements in vitality, mental health, and general health perceptions.

4. Discussion

This study provides novel empirical evidence that a 12-week structured basketball training program elicits differential and clinically meaningful improvements in the HRQoL of university students, contingent upon their baseline PA profile[12]. The principal finding—that the UA group demonstrated significant, multi-domain enhancements in mental and psychosocial well-being (GH, VT, MH, MCS)—carries substantial implications. It moves beyond the generic assertion that "exercise is good" and advances a more nuanced, targeted understanding: structured team sports like basketball may function as a particularly potent "behavioral vaccine" for individuals in the pre-contemplation or action stages of PA change, precisely targeting deficits in vitality and mental health perception.

4.1. Interpretation of Findings and Theoretical Implications

The observed pattern of results challenges a one-size-fits-all approach to exercise prescription in campus health promotion. The UA group's significant gains in VT (energy/fatigue) and MH (psychological distress/well-being) align with and extend the literature on the acute mood-enhancing effects of moderate-to-vigorous physical activity (MVPA). Our intervention, by embedding MVPA within an enjoyable, socially interactive, and skill-acquiring context, may have amplified these effects, leading to sustained improvements captured at 12 weeks. This suggests that the "mechanism of benefit is not purely physiological" but is powerfully mediated by psychological factors such as increased self-efficacy, mastery experiences, and social connectedness inherent in team sports.

Conversely, the lack of significant change in the Act group is not indicative of program failure but rather illuminates a critical methodological and conceptual phenomenon: the "ceiling effect". This group entered the study with HRQoL scores approaching the upper limits of the SF-36 scale, particularly in physical domains. Their maintained high scores, without decline, indicate that the program was effective in sustaining their already-robust quality of life without inducing overtraining or interference—an important outcome in its own right. This finding underscores the necessity of stratifying populations by baseline activity level when designing and evaluating interventions, as the outcomes of interest (improvement vs. maintenance) differ fundamentally.

The limited impact on the Sed and IA groups warrants careful consideration. For the Sed group, the singular improvement in GH, coupled with non-significant trends elsewhere, may indicate that 12 weeks is sufficient to shift general health perceptions but insufficient to overcome profound deficits in other domains without more intensive or prolonged support. The null results in the IA group are intriguing and may point to a potential "response threshold"; their existing, albeit sub-optimal, activity patterns might have buffered them from experiencing the dramatic perceptual shift seen in the UA group, or the specific intervention dose was not differentiated enough from their habitual routine.

4.2. Potential Mechanisms and Conceptual Model

The selective improvement in psychosocial domains suggests a multi-pathway mechanism where the unique elements of basketball act synergistically. We propose a conceptual model where the structured team-sport context serves as the catalyst. The high-intensity interval training (HIIT) components likely trigger beneficial neurobiological adaptations linked to mood regulation. Simultaneously, the required teamwork and communication provide robust psychosocial support, directly enhancing social functioning. Crucially, the progressive mastery of complex motor skills within this social framework builds self-efficacy and a sense of achievement. For the UA group, situated at a "sensitive window" for behavioral change, this convergence of neurobiological, social, and cognitive-behavioral reinforcement may have been uniquely potent in elevating their perceived vitality and mental well-being.

4.3. Limitations and Future Directions

The interpretation of these findings is tempered by several limitations. The predominantly male sample constrains generalizability to female students. The use of self-reported HRQoL as the primary outcome, while standard, could be supplemented with objective biomarkers in future work to delineate physiological pathways. The absence of a passive control group means we cannot wholly isolate the intervention effect from time or participation expectancy.

These limitations define clear trajectories for future research. Priority should be given to replicating this study in a gender-balanced cohort and employing longer-term follow-ups to assess effect sustainability. Furthermore, direct comparative efficacy trials pitting structured team sports against individual exercise modalities are needed to isolate the specific "active ingredients" responsible for the psychosocial benefits observed here.

4.4. Practical Implications

For university health policymakers and student wellness directors, these results offer a clear, actionable strategy. Investing in structured, coached, and accessible intramural basketball programs represents a high-yield initiative, particularly for engaging the "moderately inactive" or underactive student population—a group often overlooked in favor of targeting either the completely sedentary or the already-active. Such programs can be framed not merely as recreational sport, but as a credible mental health and well-being intervention with documented efficacy. For students already meeting PA guidelines, these programs serve a vital maintenance and social enrichment function.

5. Conclusion

This study's primary contribution lies in moving beyond demonstrating that a basketball intervention improves HRQoL to elucidating for whom and in what domains it is most impactful. We provide robust evidence for a differential susceptibility model based on baseline PA. The core finding—that significant psychosocial benefits accrued specifically to underactive students, while active students maintained high baselines—is transformative. It challenges the paradigm of uniform exercise prescription and powerfully advocates for a stratified, precision-based approach to campus health promotion. By identifying "underactive" students as the prime beneficiaries of team-sport interventions, this work delivers a precise target for resource allocation. Ultimately, it repositions structured team sports from a recreational option to a targeted, evidence-based strategy for enhancing the mental and psychosocial well-being of the university community—a contribution with direct and significant implications for public health practice in educational settings.

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Declaration of Competing Interest

The authors report no declarations of interest.

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